Appendix B: Forecasting and Traffic Operations Analysis Framework Document
Forecasting and Traffic Operations Analysis Framework Document

This document defines the methodology and assumptions that will be used in the traffic forecasting and traffic operational analysis efforts for the Rosslyn Street Reconfiguration Implementation Study. The project focuses on the Fort Myer Drive and N Lynn Street corridors, with project limits in Rosslyn extending from N Pierce Street (west) to N Arlington Ridge Road (east) and between Arlington Boulevard (U.S. 50) (south) to Francis Scott Key Bridge (north). For the purposes of traffic forecasting and analysis, the study area boundary is extended to the area shown in Figure 1 to assess traffic patterns and impacts resulting from potential street reconfigurations of the Fort Myer Drive and N Lynn Street corridors. At a high level, the forecasting and traffic operations analysis effort consists of the following tasks:

- Framework document consensus
- Field data collection and data processing
- Travel demand forecasting (Existing 2017, Baseline 2030, and Build 2030; AM and PM peak periods)
  - Subarea model development
  - Model validation
  - Volume post-processing
  - Volume reporting
- Synchro traffic analysis (Existing 2017, Baseline 2030, and Build 2030; AM and PM peak hours)
  - Model update
  - Analysis and reporting
- VISSIM microsimulation analysis (Existing 2017, Baseline 2030, and Build 2030; AM and PM peak periods)
  - Model development
  - Model calibration
  - Analysis and reporting

FRAMEWORK DOCUMENT CONSENSUS

This framework document defines modeling proposed methodology and assumptions required to develop traffic volumes, growth rates and future forecast volumes, and origin-destination (O-D) trip tables; develop and validate a VISUM subarea model; refine the Arlington County Synchro model for analysis; develop and calibrate a VISSIM model for analysis; and report analysis results. The document shall be reviewed and agreed upon with Arlington County and other stakeholders deemed appropriate by the County, including the Virginia Department of Transportation (VDOT), before the start of the traffic forecasting and analysis effort.

FIELD DATA COLLECTION AND DATA PROCESSING

Available data and data gaps will be summarized in a separate document and included in the existing conditions report. A summary of traffic count data regarding count locations and time will be provided and agreed upon prior to the start of forecasting and analysis. The data to be used for traffic forecasting and analysis include the following:

- Traffic volumes (intersections, freeway/arterial mainlines, ramps)
Origin-Destination (O-D) data
Travel time data
Observed queue data
Multimodal data (pedestrian/bicycle/transit operations)
Development data

The summary of data collection and data processing results will be provided in the existing conditions report.

TRAVEL DEMAND FORECASTING

The overall travel demand forecasting process is summarized in Figure 2. The process uses the most currently adopted version of the Metropolitan Washington Council of Governments (MWCOG) travel demand model (Version 2.3.70) and extracts a subarea model in VISUM (Version 16). At a high level, the MWCOG model is the source of traffic analysis zone (TAZ) land use inputs, growth rates, and a seeding O-D trip table that will be refined in VISUM. The MWCOG model is calibrated to reflect travel conditions at a regional level, but it may not accurately reflect traffic patterns within the study area due to coarse TAZs and model network structures; therefore VISUM is used as a supplemental tool to assign traffic and develop forecasts with greater detail of the TAZs and street network. VISUM is used for subarea model
development and validation, evaluating traffic diversion, and forecasting future volumes. The subarea model will be used for existing (2017) and future year (2030) Baseline and Build scenarios.

A subarea model from the MWCOG model will be extracted that encompasses the major roadway network surrounding the study area (see Figure 1). The subarea model will be imported into VISUM, at which point the network, TAZ structure, and peak period trip tables will be refined. The TAZs and associated trips will be split to provide a greater level of detail and more accurate trip loading and assignment to the network. Data such as population, employment, and parking supply will be used as the basis for proportioning trips into subdivided TAZs. The TAZ inputs will also be modified as needed to reflect the County adopted Realize Rosslyn plan and recently approved development projects for the future year scenarios based on input and guidance from the County. Additional detail, such as major parking access, will be added to the roadway network, particularly in the Synchro and VISSIM analysis areas, for more accurate trip loading and traffic assignment.

Existing weekday AM and PM peak period traffic counts will be balanced throughout the network and input to the VISUM model. A network peak hour will be established based on the highest traffic volumes or worst traffic conditions on Fort Myer Drive and N Lynn Street, and peak hour volumes will be balanced for the VISSIM model area only. This will be needed to reasonably represent the peak hour O-D patterns and vehicle routes in the VISSIM model. Adjustment factors will be applied to the balanced peak period traffic counts to obtain AM and PM peak hour traffic volumes for the rest of the study roadway network and study intersections. Weekday daily volumes will be developed based on the balanced peak period volumes.

The 2017 peak period trip tables will undergo a demand matrix correction process called TFlowFuzzy to adjust the trip tables such that the resulting traffic assignment closely matches the peak period traffic counts while the overall travel patterns from the seeding trip table are maintained. The VISUM model will be validated within 10% of observed field counts on the major arterials and within 20% on collectors for the critical roadway segments in the subarea. Critical roadway segments will be defined after a review of the count data. The corrected peak period trip tables will be the basis of the VISUM model validation, used in evaluation of traffic diversion for future alternative concepts, and used as the baseline for determining future year growth rates.

The TFlowFuzzy process will also be completed on peak hour trip tables scaled down from the peak period seeding trip tables. This process will adjust the trip tables in a way such that the resulting traffic assignment on the validated VISUM network closely matches the peak hour traffic counts at the VISSIM model area intersections. The corrected peak hour trip tables will be the basis of the vehicle routing used in the VISSIM analysis.

The 2030 peak period trips tables will be determined by applying O-D growth rates obtained from the MWCOG model to the 2017 corrected peak period trips tables. The growth rates will be refined as needed using supplemental data on development from the County. After applying the growth rates to the 2017 trip tables, the 2030 trip tables will be assigned to the VISUM network. Trip generation data and method will be used to assist with the growth and assignment of internal trips (trips originated from
or destined to the study area TAZs). The traffic assignment results will be post-processed in VISUM according to the industry-standard National Cooperative Highway Research Program (NCHRP) Report 765 methodology to obtain the final 2030 traffic forecasts. The output of this process is peak period and peak hour link and turn volumes. Adjustment factors will be applied to the peak period volumes to obtain average weekday daily volumes.

In addition to growing vehicular trips, the travel demand forecasting effort will estimate growth in transit trips and non-motorized trips. Combining with vehicular trips, inflow and outflow person trips will be estimated and reported for the Rosslyn study area for existing (2017), 2030 baseline, and 2030 build scenarios.
Figure 2: Travel Demand Forecasting and Multi-Tiered Modeling Process
VISSIM MICROSIMULATION ANALYSIS

VISSIM (Version 9.0, Build 10) will be used for evaluating traffic operations and queuing impacts at the study intersections and ramps within the VISSIM network limits. These locations are highlighted in purple in the map shown in Figure 1. Kimley-Horn will adhere to the guidance provided in the VDOT Traffic Operations and Safety Analysis Manual (TOSAM).

VISSIM will be used to model AM and PM peak period vehicle, transit, pedestrian, and bicycle operations. Passenger vehicle and heavy vehicle classes will be modeled, and heavy vehicle percentage will be based on existing count data. WMATA Metrobus and Arlington Transit buses and stops within the VISSIM study area will be modeled using existing timetables. Pedestrian and bicycle activity will be modeled based on existing available pedestrian and bicycle counts. Due to seasonal variability of pedestrian and bicycle activities in Rosslyn, intersection bicycle and pedestrian counts collected from different months of year will be adjusted based on seasonal factors derived from bicycle and pedestrian count station data provided by the County.

VISSIM Study Area
The VISSIM microsimulation area consists of the N Lynn Street and N Fort Myer Drive corridors, plus one adjacent intersection on each side of the corridor. VISSIM intersections are shown in Figure 1 as intersections 1 through 26. Freeway mainline segments (I-66, Arlington Boulevard, and Route 110) and ramps that provide access to N Lynn Street and N Fort Myer Drive are also included.

Intersections
1. N Fort Myer Drive & George Washington Memorial Parkway (GW Parkway) on-ramp
2. N Fort Myer Drive & westbound Lee Highway
3. N Fort Myer Drive & eastbound Lee Highway
4. N Fort Myer Drive & N Nash Street/19th Street N
5. N Fort Myer Drive & Wilson Boulevard
6. N Nash Street & 17th Street N
7. N Fort Myer Drive & Fairfax Drive
8. N Meade Street & Arlington Boulevard
9. N Moore Street & eastbound Lee Highway
10. N Moore Street & 19th Street N
11. N Moore Street & Wilson Boulevard
12. N Lynn Street & westbound Lee Highway
13. N Lynn Street & eastbound Lee Highway
14. N Lynn St & 19th Street N
15. N Lynn Street & Wilson Boulevard
16. N Lynn Street & 17th Street N
17. N Lynn Street & Fairfax Drive
18. N Nash Street & westbound Lee Highway
19. N Nash Street & eastbound Lee Highway
20. N Nash Street & Key Boulevard
21. N Nash Street & Wilson Boulevard
22. N Nash Street & eastbound Arlington Boulevard
23. N Meade Street & Arlington Boulevard
24. N Kent Street & 19th Street N
25. N Kent Street & Wilson Boulevard
27. N Oak Street & Wilson Boulevard

Ramps

- Southbound GW Parkway off-ramp to N Lynn Street
- Northbound GW Parkway on-ramp from N Lynn Street
- Westbound I-66 off-ramp to N Lynn Street/Lee Highway
- Eastbound I-66 on-ramp from N Lynn Street/Lee Highway
- Eastbound I-66 off-ramp to Route 110
- Westbound I-66 on-ramp from Route 110
- Westbound I-66 off-ramp to Arlington Boulevard
- Eastbound I-66 on-ramp from Arlington Boulevard
- Southbound GW Parkway off-ramp to Arlington Boulevard
- Southbound GW Parkway on-ramp from Arlington Boulevard
- Northbound GW Parkway off-ramp to Arlington Boulevard
- Westbound Arlington Boulevard off-ramp to N Meade Street
- Westbound Arlington Boulevard on-ramp from N Meade Street
- Eastbound Arlington Boulevard off-ramp to southbound N Meade Street
- Eastbound Arlington Boulevard off-ramp to northbound N Meade Street
- Eastbound Arlington Boulevard on-ramp from N Meade Street

VISSIM Analysis Scenarios

The VISSIM analysis will consist of AM and PM peak period analyses for:

- Existing (2017)
- Future baseline (2030)
- Two alternative future year concepts (2030)
- One preferred alternative\(^1\) future year concept (2030)

A network peak period and network peak hour was determined for AM and PM separately using all the traffic count data for intersections and ramps. A four-hour simulation period is proposed, with a one-hour seeding period, two peak period hours (which span the network peak hour), and one shoulder hour. Table 1 shows the AM and PM simulation periods.

\(^1\) the preferred alternative may include forms of elements in the two alternative concepts. Therefore, it is considered a standalone alternative from traffic analysis standpoint.
Table 1. Simulation Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Seeding Period</th>
<th>Peak Period</th>
<th>Shoulder Hour</th>
<th>Network Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>6:30 to 7:30 AM</td>
<td>7:30 to 9:30 AM</td>
<td>9:30 to 10:30 AM</td>
<td>8:00 to 9:00 AM</td>
</tr>
<tr>
<td>PM</td>
<td>3:30 to 4:30 PM</td>
<td>4:30 to 6:30 PM</td>
<td>6:30 to 7:30 PM</td>
<td>5:00 to 6:00 PM</td>
</tr>
</tbody>
</table>

**VISSIM Model Development**

VISSIM network geometry will be developed using current aerial imagery of the study area and confirmed through field observations. Model development will include the following elements:

- Subarea extraction of the VISSIM study area from the VISUM model
- Vehicle inputs coded in 15-minute intervals based on count data to reflect variations in traffic counts across the peak period.
- Vehicle routes through the network as continuous O-D's, based on the VISUM traffic assignment validated against balanced peak hour traffic counts
- Ring-barrier controllers (RBCs) for signal controllers
- Heavy vehicle percentage based on existing count data
- Pedestrian activities at the model intersections
- Transit operations (bus routes, stops, and dwell time) along the Fort Myer Drive and N Lynn Street corridors
- Major parking access points at mid-block locations

Existing signal timings provided by Arlington County will be used for the existing conditions models. Splits and offsets will be optimized to future traffic volumes for the other scenarios.

**VISSIM Model Calibration**

The VISSIM models will be calibrated to existing traffic conditions using guidance and direction provided in the TOSAM Version 1. Traffic volumes, travel time, and queue lengths will be used as calibration measures for arterials and intersections. Traffic volumes, speeds, and travel times will be used as calibration measures for freeway and ramp segments. Table 2 provides an overview of calibration measures and targets. The critical locations for queue calibration were identified in Table 3 below.
Table 2. Calibration Items and Targets.

<table>
<thead>
<tr>
<th>Simulated Measure</th>
<th>Calibration Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simulated Traffic Volume</strong> (vehicles per hour)</td>
<td>Within ± 20% for &lt;100 vph</td>
</tr>
<tr>
<td>- At intersections, difference targets must be met for at least 85% of approaches</td>
<td>Within ± 15% for ≥100 vph to &lt;300 vph</td>
</tr>
<tr>
<td>- For freeways, difference targets must be met for at least 85% of freeway mainline segments and ramps</td>
<td>Within ± 10% for ≥300 vph to &lt;1,000 vph</td>
</tr>
<tr>
<td>- Within ± 5% for ≥1,000 vph</td>
<td></td>
</tr>
<tr>
<td><strong>Simulated Travel Time</strong> (seconds)</td>
<td>Within ± 1 minute for routes with observed travel times that are less than 7 minutes</td>
</tr>
<tr>
<td>Difference targets must be met for a minimum of 85% of travel time routes. Four arterial routes and three freeway routes will be used for calibration. Google data will be used to supplement field travel time data.</td>
<td>Within ± 15% for routes with observed travel times that are greater than 7 minutes</td>
</tr>
<tr>
<td><strong>Maximum Simulated Queue Length</strong> (feet)</td>
<td>Modeled queues qualitatively reflect the impacts of observed queues in the following areas:</td>
</tr>
</tbody>
</table>
| Calibration target must be met for a minimum of 85% of the critical locations to be agreed upon by the County and VDOT consisting of ramps and intersection approaches. Queue impact will be used to justify calibration in addition to quantitative comparison of queue length. | - Spillback to adjacent intersections  
- Spillback from ramp intersection to freeway mainline and vice versa  
- Spillback from turn lanes |
| **Visual Review of Bottleneck Locations**                | Speed heat map will be plotted for freeway segments to qualitatively review the patterns and duration of congestions |
| Simulated average speed (miles per hour) will be compared with INRIX data for the freeway segments (I-66, Route 110, and Arlington Boulevard) |                                                                                       |
Table 3. Critical Locations for Queue Calibration

<table>
<thead>
<tr>
<th>Intersection /ramp</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N. Lynn Street northbound left-turn at Fort Myer Drive/northbound George Washington Memorial Parkway on-ramp</td>
</tr>
<tr>
<td>4</td>
<td>Fort Myer Drive southbound at 19th Street N</td>
</tr>
<tr>
<td>5</td>
<td>Wilson Boulevard eastbound/westbound at Fort Myer Drive</td>
</tr>
<tr>
<td>11</td>
<td>N. Moore Street southbound at Wilson Boulevard (unsignalized)</td>
</tr>
<tr>
<td>12</td>
<td>Lee Highway westbound (I-66 westbound off-ramp) at N. Lynn Street</td>
</tr>
<tr>
<td>13</td>
<td>Lee Highway eastbound at N. Lynn Street</td>
</tr>
<tr>
<td>14</td>
<td>19th Street N eastbound at N. Lynn Street</td>
</tr>
<tr>
<td>15</td>
<td>N. Lynn Street northbound at Wilson Boulevard</td>
</tr>
<tr>
<td>15</td>
<td>Wilson Boulevard eastbound at N. Lynn Street</td>
</tr>
<tr>
<td>17</td>
<td>N Lynn Street northbound at Fairfax Drive</td>
</tr>
<tr>
<td>20</td>
<td>Key Boulevard eastbound at N Nash Street</td>
</tr>
<tr>
<td>27</td>
<td>Wilson Boulevard westbound at N. Oak Street</td>
</tr>
<tr>
<td>37</td>
<td>Clarendon Boulevard eastbound at N. Oak Street</td>
</tr>
<tr>
<td>-</td>
<td>N. Lynn Street northbound at Key Bridge</td>
</tr>
<tr>
<td>Ramp</td>
<td>George Washington Memorial Parkway southbound off-ramp to N. Lynn Street northbound (Key Bridge)</td>
</tr>
<tr>
<td>Ramp</td>
<td>Arlington Boulevard eastbound on-ramp from N. Meade Street (N Lynn Street)</td>
</tr>
<tr>
<td>Ramp</td>
<td>Arlington Boulevard eastbound off-ramp at N. Meade Street (N Lynn Street)</td>
</tr>
</tbody>
</table>

VISSIM model calibration will be achieved by adjusting specific parameters to achieve target traffic volumes, speed, travel time, and queue lengths. The primary parameters that will be adjusted include:

- Driver behavior
- Lane-change distance
- Speed reductions at network termini to simulate any external congestion

External congestion that impacts operations within the VISSIM study area exists on Francis Scott Key Bridge and I-66. Time-dependent speed reductions at the edge of the VISSIM network will be used to replicate the extent and duration of reduced speeds in these locations.

VISSIM Measures of Effectiveness
The measures of effectiveness of simulated throughput, intersection and approach delays, maximum queue lengths, freeway segment average speeds and densities, and travel times will be reported. For
non-motorized traffic, output data in the forms of delay will be reported by VISSIM for up to thirteen intersections identified as below where significant pedestrian and bicycle activities are observed or anticipated. For transit operations, bus travel time and delay along the Fort Myer Drive and N Lynn Street corridors will be reported.

- #2 - Fort Myer Drive and westbound Lee Highway
- #12 - N Lynn Street and westbound Lee Highway
- #3 - N Fort Myer Drive and eastbound Lee Highway
- #13 - N Lynn Street and eastbound Lee Highway
- #4 - Fort Myer Drive and 19th Street N
- #14 - N Lynn Street and 19th Street N
- #27- N Oak Street and Wilson Boulevard
- #36 - N Oak Street and Clarendon Boulevard
- #21 - N Nash Street and Wilson Boulevard
- #5 - Fort Myer Drive and Wilson Boulevard
- #15 - N Lynn Street and Wilson Boulevard
- #10 - N Moore Street and 19th Street N
- Mid-block crossings over N Lynn Street

The VDOT Sample Size Determination Tool will be used to determine the appropriate number of microsimulation runs needed for the AM and PM VISSIM models. This tool uses a statistical process to ensure that an appropriate number from runs are performed at a 95th percentile confidence level. Volume and travel time MOEs will be used to determine number of runs:

- Travel time on the arterial routes used for calibration
- Volume on northbound N Lynn Street and southbound N Fort Myer Drive at 19th Street N
- Volume of eastbound and westbound I-66 between Lee Highway and Route 110 ramps

**SYNCHRO TRAFFIC ANALYSIS**

Synchro 9 will be used for evaluating traffic operations and queueing impacts at a subset of the study intersections. These locations are highlighted in yellow in the map shown in Figure 1. In addition, Synchro will be used to assess, optimize and develop signal timings for the VISSIM analysis intersections (#1 to 27). Kimley-Horn will review and update model volumes, lane geometry and signal timing, if necessary, for the existing Arlington County Synchro traffic model. The following 12 intersections will be analyzed and reported for MOEs using Synchro and are listed as intersections 27 through 40 on Figure 1:

27. Wilson Boulevard & N Oak Street
28. Wilson Boulevard & N Pierce Street
29. Wilson Boulevard & N Quinn Street
30. Wilson Boulevard & N Rhodes Street
31. Clarendon Boulevard & N Rhodes Street
32. Clarendon Boulevard & N Quinn Street
33. Clarendon Boulevard & N Queen Street
34. Clarendon Boulevard & N Pierce Street
35. Clarendon Boulevard & N Ode Street
36. Clarendon Boulevard/Wilson Boulevard & N Oak Street
37. 17th Street N & N Oak Street
38. 16th Street N & N Rhodes Street
39. 14th Street N & N Rhodes Street
40. Arlington Boulevard & N Rhodes Street/N Queen Street

**Synchro Analysis Scenarios**
The Synchro analysis will consist of AM and PM peak hour analyses for:

- Existing (2017)
- Future baseline (2030)
- Two alternative future year concepts (2030)
- One preferred alternative future year concept (2030)

**Synchro Measures of Effectiveness**
The measures of effectiveness of delay, level of service, and 95th percentile queue length will be reported. Synchro will also be used as a tool to optimize signal timings for the future scenario analyses.