TRAFFIC ANALYSIS METHODOLOGY

Durham-Orange Light Rail Transit Project

November 2013

The NEPA Preferred Alternative for the D-O LRT Project would generally follow NC 54, I-40, US 15-501, and the North Carolina Railroad (NCRR) Corridor in downtown Durham and east Durham. The alignment would begin at UNC Hospitals, parallel Fordham Boulevard, proceed east on NC 54, travel north on I-40, parallel US 15-501 before it turns east toward the Duke University campus along Erwin Road, and then follow the NCRR Corridor parallel to NC 147 through downtown Durham, before reaching its eastern terminus near Alston Avenue. The alignment would consist of at-grade alignment, fill and cut sections, and elevated structures. In two sections of the alignment, Little Creek and New Hope Creek, multiple Light Rail Alternatives are evaluated in the DEIS.

This technical report contains information for all alternatives analyzed in the DEIS. However, pursuant to MAP 21, the Moving Ahead for Progress in the 21^{st} Century Act (P.L. 112-141), a NEPA Preferred Alternative has been developed, which recommends C2A in the Little Creek section of the alignment, NHC 2 in the New Hope Creek section of the alignment, the Trent/Flowers Drive station, and the Farrington Road Rail Operations and Maintenance Facility.

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1. Introduction

The proposed Triangle Transit Durham-Orange Light Rail Transit Draft Environmental Impact Statement (D-O LRT Draft EIS) will address existing and future transportation conditions along the proposed corridor and quantify the transportation impacts of the No-Build and Build Alternatives as well as some transportation system management (TSM) improvements. For the purposes of this study the No-Build and TSM scenarios will be combined. The project will potentially have transportation and traffic impacts that will include impacts to streets and highways, bikeways, parking, railroad operations, and public transit.

Following is a description of the proposed methodology for evaluating the potential impacts to traffic and transportation services and facilities that could occur due to the implementation of the proposed D-O LRT. This proposal includes analysis methodologies used to describe existing and future travel patterns and the transportation environment, estimation of forecast year traffic volumes under the No-Build and Build Alternatives, and the analysis of impacts of the light rail operations at intersections and railroad/highway at-grade crossings.

Generally, data required for the traffic and transportation analyses will be developed by the study team, or will be provided by either Triangle Transit, the Town of Chapel Hill, City of Durham, Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO), or the North Carolina Department of Transportation (NCDOT). Data from other agencies, if needed, is noted in the task descriptions. Triangle Transit will provide information on existing and planned transit services and performance. Existing conditions traffic data from the previous Alternatives Analysis (AA) study will be utilized for the base year analysis and future year volumes will be developed based on travel demand analysis completed by other members of the project teams. The analysis will include both regional travel demand data as well as specific transit route ridership forecasts. The base year for the analysis will be 2011 and the design year will be 2040 in order to be consistent with the DCHC MPO's *2040 Metropolitan Transportation Plan*.

The project team will use the Triangle Regional Travel Demand Model V5 (TRTDM) for this project. The model is based on the traditional four-step travel demand process of trip generation, trip distribution, mode split, and traffic assignment. Documentation for the model development and calibration process is maintained by NCDOT and the Institute for Transportation Research and Engineering (ITRE).

2. Existing Conditions

Following is a description of the elements that will be used to define existing transportation conditions, and the procedures to be used in developing that definition.

Calibrated base models will be constructed and validated using VisSim. The calibration and validation process is described below. For this study 2011 will serve as the base year for analysis.

2.1 Identification Of Simulation Areas

Specific segments of the D-O LRT corridor where the proposed LRT interacts with the roadway network will be analyzed. Along much of the D-O LRT corridor the track is not at grade or is routed in areas that are not near the roadway network. As such, there is no interaction between the proposed D-O LRT and the current or planned roadway network. The segments that are proposed for analysis are as follows:

- Mason Farm Road – East Drive to US 15-501
- NC 54 – Hamilton Road to Downing Creek including Prestwick Road and Meadowmont Lane (Alternative C-1)
- Leigh Village – Includes crossings of proposed Leigh Village as well as Ephesus Church Road and Farrington Road intersection if needed
- Patterson Place – McFarland Drive from Mt. Moriah Road to Witherspoon Boulevard as well as any crossing of Garrett Road
- South Square – Including University Drive from Snow Creek Trail to Shannon Road, Shannon Road from University Drive to US 15-501, and Tower Road from US 15-501 northbound ramps to Pickett Road
- Cornwallis Road – At Grade crossing near US 15/501 (as needed)
- Erwin Road – Cameron Drive to Anderson Street/15th Street, Fulton Street and Trent Drive, and Elba Street as needed
- Pettigrew Street – Erwin Road/9th Street to Sumter Street and Chapel Hill Street to Alston Avenue and proximate intersections as needed
- Peabody Street – Gregson Street to Duke Street

Maps of the proposed simulation areas and intersections are shown in Figures 1 and 2. The selection of the studied areas and intersection was based on the results from the AA. Potential changes to alignment and sunsequently crossings may require revision and correction of the current selection.

2.2 Balanced Volume Data

For the traffic analysis portion of the D-O LRT Draft EIS we will employ the data collected as part of the AA phase of the project, including peak hour turning movements for all intersections identified. Traffic counts from 2008 or before will be increased based on the growth of background traffic to represent base year conditions. If significant changes in street configuration or roadway geometry have occurred since the count was taken then newer counts in these areas reflecting such changes will be collected and used for the traffic anysis.

Background growth will be based on data from the NCDOT traffic volume maps (http://www.ncdot.gov/travel/statemapping/trafficvolumemaps/). After developing the raw peak hour turning volumes for the base year, the volumes will be balanced across the networks. Sink and source nodes will be added where necessary to account for mid-block changes in traffic volumes due to major origins or destinations. Input data for the loading points will be developed based on the balanced volumes.

2.3 Model Development

For the development of the base model in VisSim, the following will be completed:

- Develop base data including acceleration, speed distributions, vehicle classes, vehicle distributions, and link behavior types
- Develop link geometric data
- Input traffic demand data based on outcome of previous step
- Input origin-destination routing
- Input traffic control data at intersections, including signal timings
- Input traffic operations and management data for links
- Input driver behavior data
- Set simulation run control
- Code network outputs

Data Needs:

Signal Plans from Chapel Hill, Durham, and NCDOT

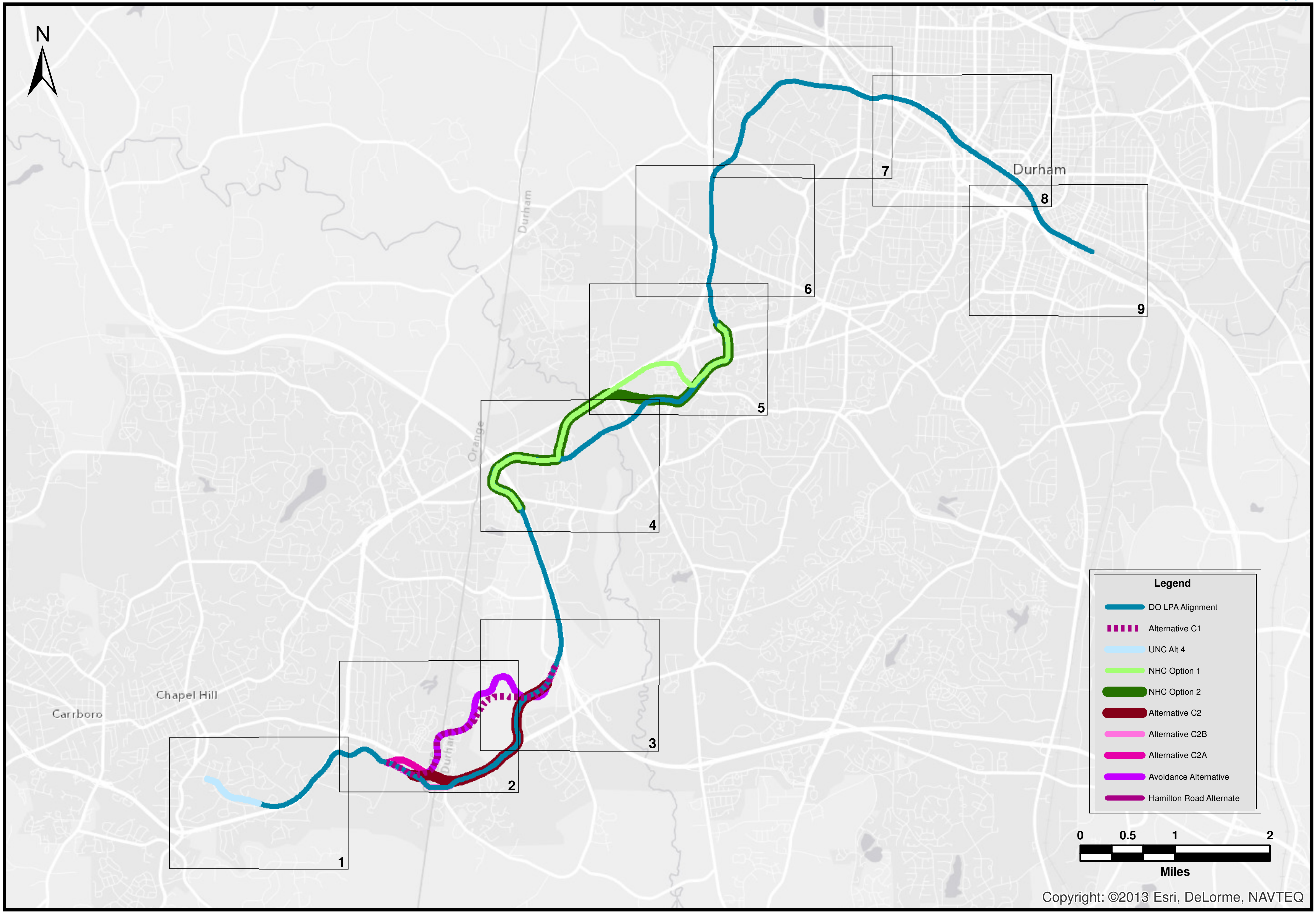
2.4 Pedestrian And Bicycle Volumes

Where necessary, pedestrian and bicycle data will be collected and utilized in the model stream. To guide this effort, *Effects of Pedestrians on Capacity of Signalized Inersections* by Milazzo et al published in Transportation Research Record 1646 was reviewed. This article serves as the basis for determining the impact of pedestrians on saturation flow rates at signalized intersections as described in chapter 31 of the *2010 Highway Capacity Manual* published by the Transportation Research Board. In that review it was found that pedestrian conflicts reduce saturation flow in a linear manner from 0 to 1000 conflicting pedestrians per hour of green time. The reduction in saturation flow at 1000 conflicting pedestrains per hour of green time is 50%. A threshold of 20% reduction in saturation flow rate will be utilized for this analysis based on the previously referenced items. This 20% reduction threshold corresponds to 400 conflicting pedestrians per hour of green time. If a conservative assumption is made that turning movements are provided green time equal to 25% of the cycle length, then we can interpolate that for a 20% reduction in turning movement saturation flow rate there must be at least 100 conflicting pedestrians for that particular movement in the peak hour. As such, we are proposing to include only pedestrian movements in the simulation where pedestrian volumes are greater than 100 conflicting pedestrians in the peak hour. To reach that threshold either the volume of conflicting pedestrians on a single crosswalk must be greater than 100 pedestrians in the peak hour or the combined volume of conflicting pedestrians of two adjacent crosswalks must be greater than 100 pedestrians in the peak hour.

A partial field review was conducted to determine locations where pedestrian and bicycle volumes were above the 100 pedestrians per hour threshold. Initial review of the proposed areas revealed that the intersection of Erwin Road and Fulton Street meets this threshold in the base year. Additional examination will be conducted later.

2.5 Calibration Of Model

Once the model is created and visually validated, model data will be extracted to ensure that the model is accurately representing base year conditions. The model will be pre-loaded for 15 minutes with volumes that are 75% of those anticipated for the peak hour. Model outputs will be compared to INRIX traffic data from the base year to ensure relatively similar travel times. The models will be considered calibrated when the travel speeds are within 5 mph of the data obtained from INRIX. That said, reasonable efforts will be made to reduce the difference between model travel time speeds and INRIX data to be within 2.5 mph. Given that INRIX data is aggregated over a period of time and that the model run is for one specific day it may not be possible to achieve the narrower band for the purposes of calibration. The model will be run for a sufficient number of iterations to ensure calibration based on Federal Highway Administration (FHWA) guidelines. The number of iterations necessary to achieve calibration for each corridor will be recorded and future year models will be run utilizing the same number of iterations. Models will be run using static trip assignment.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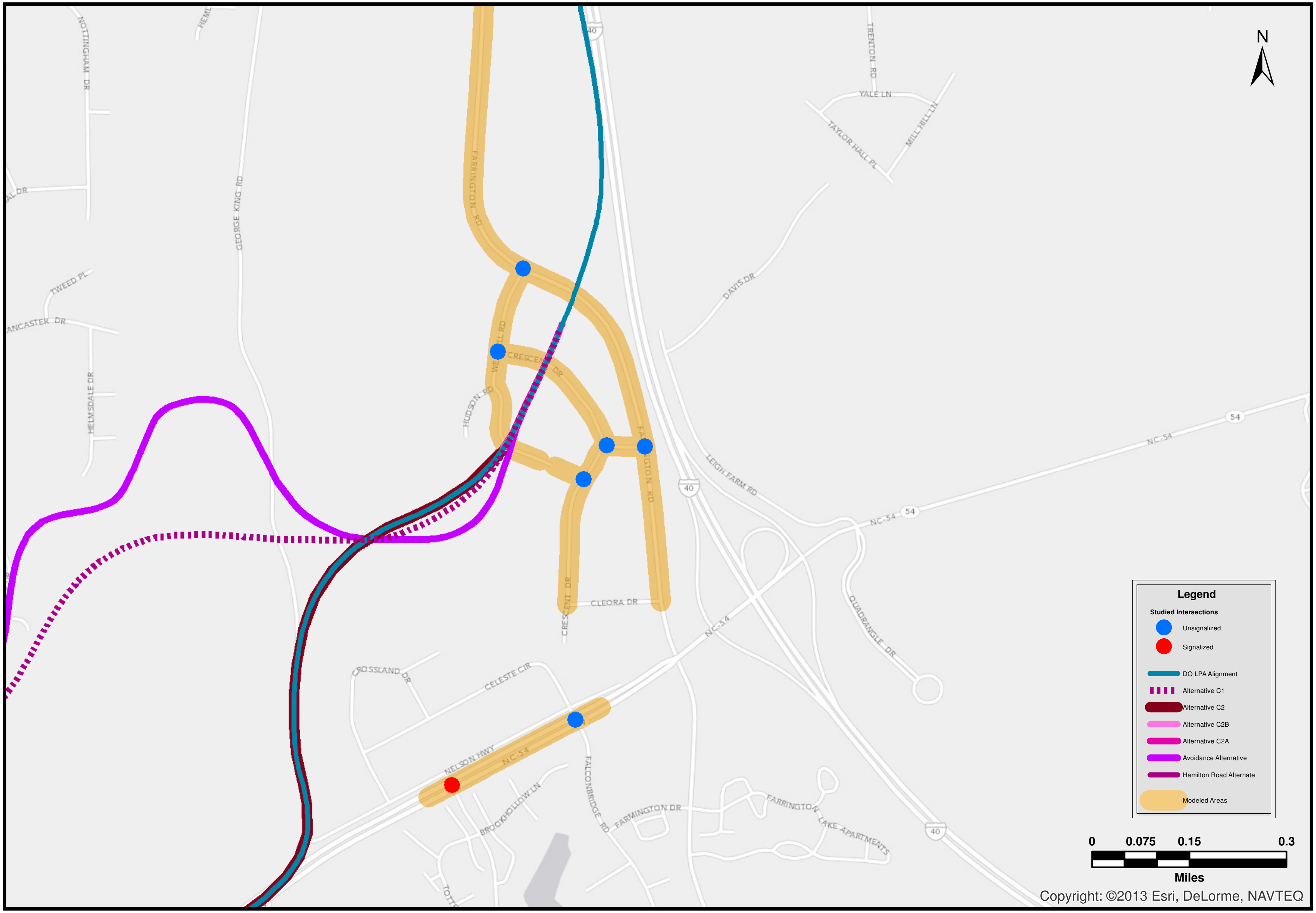

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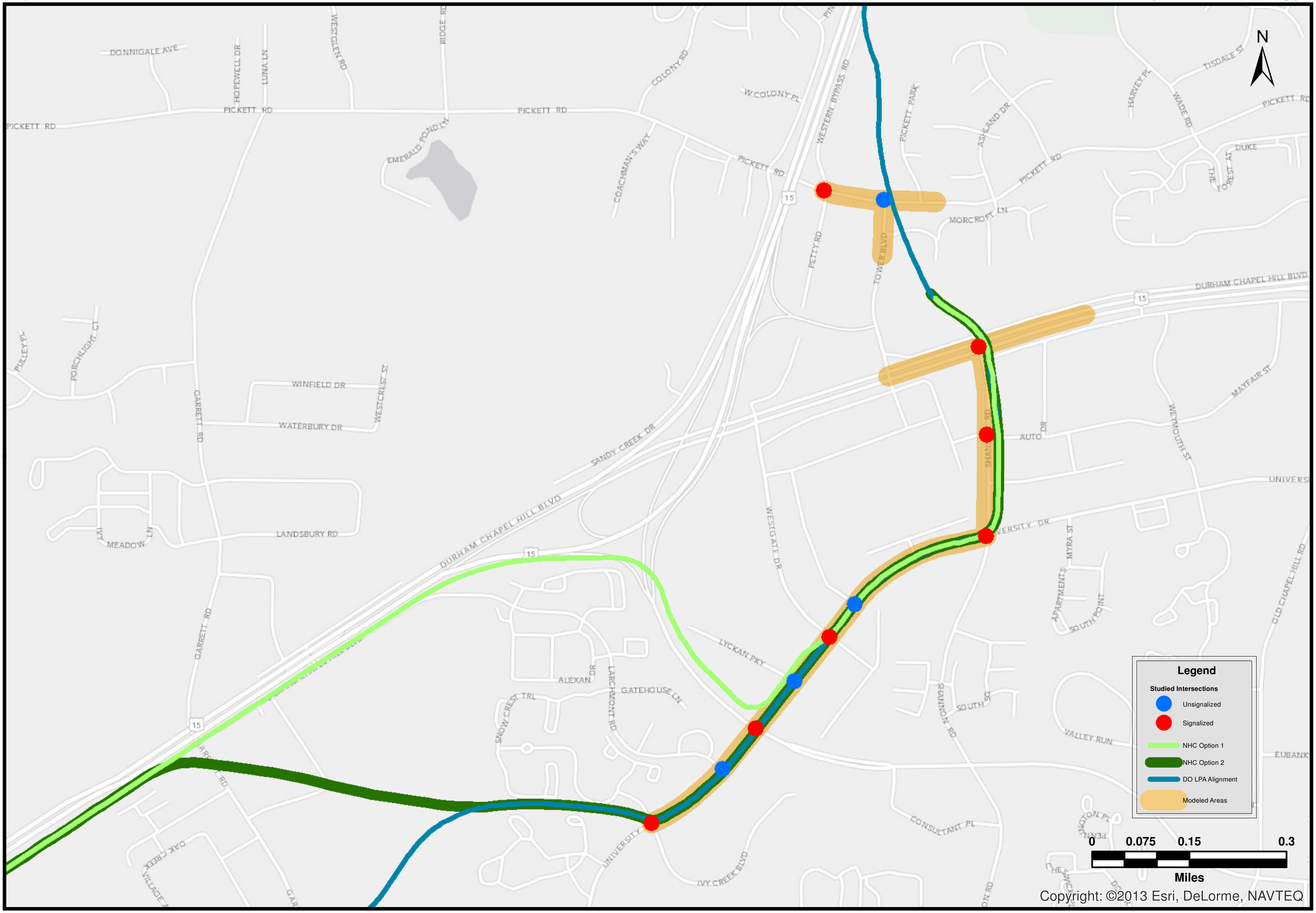
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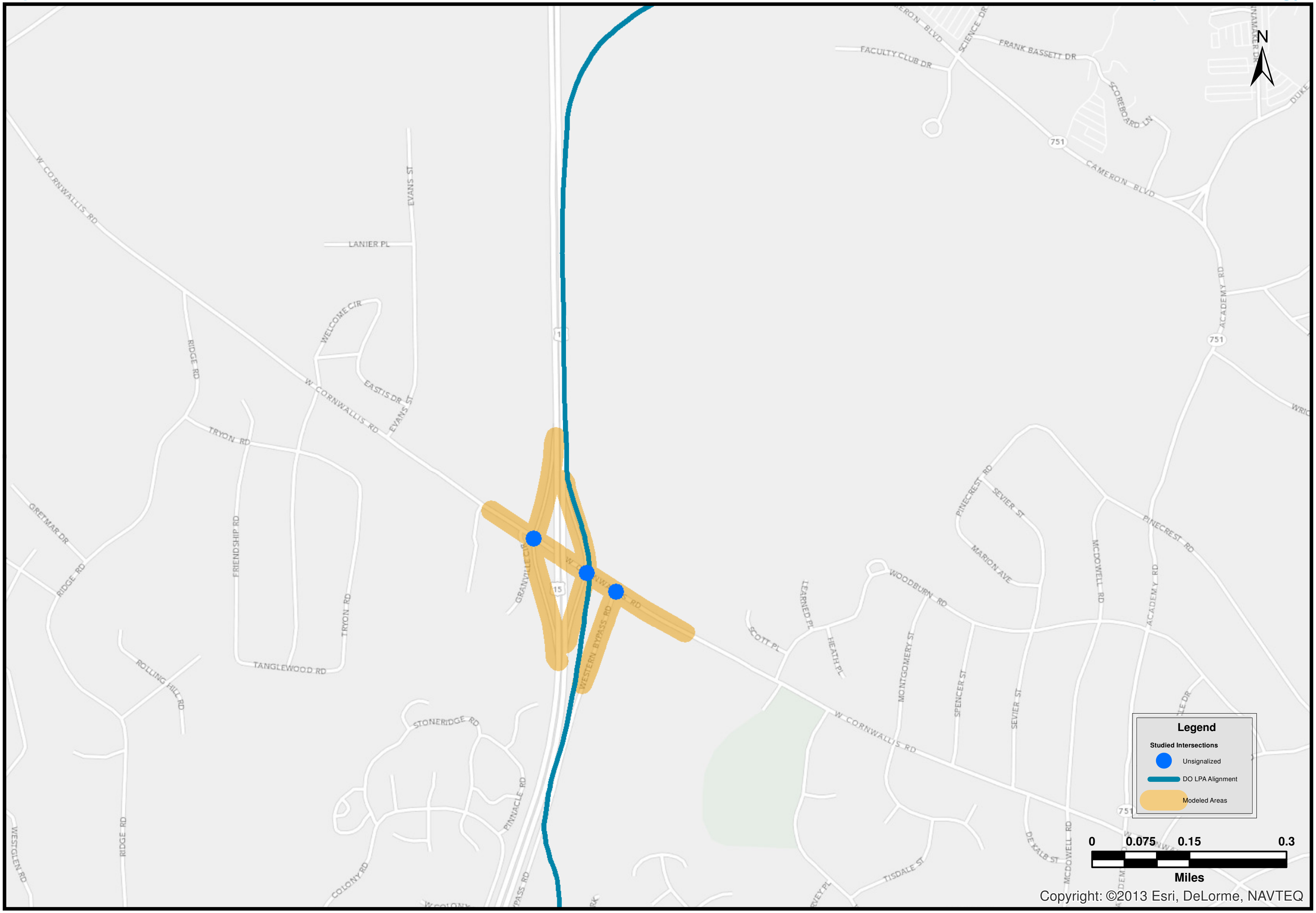
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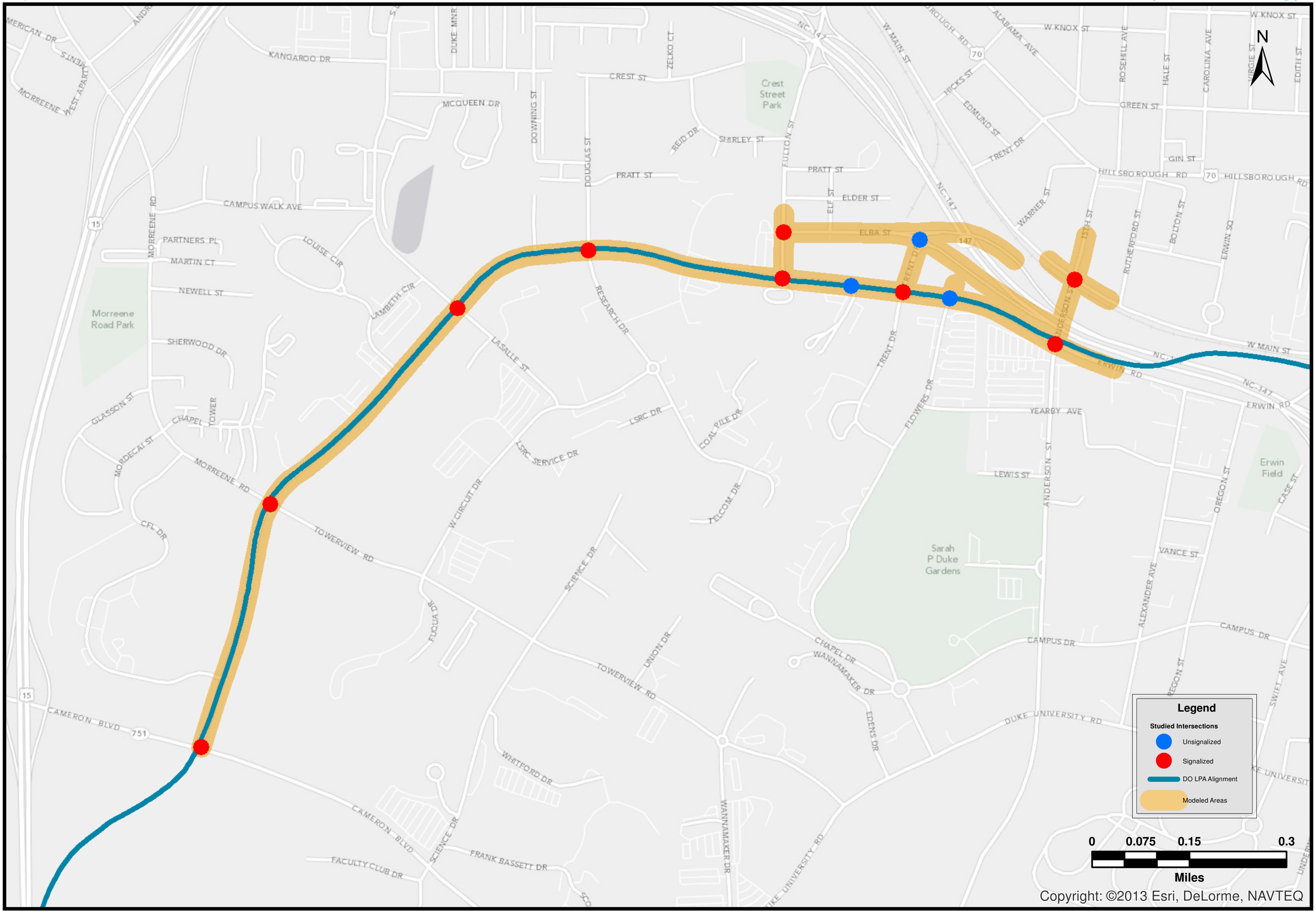
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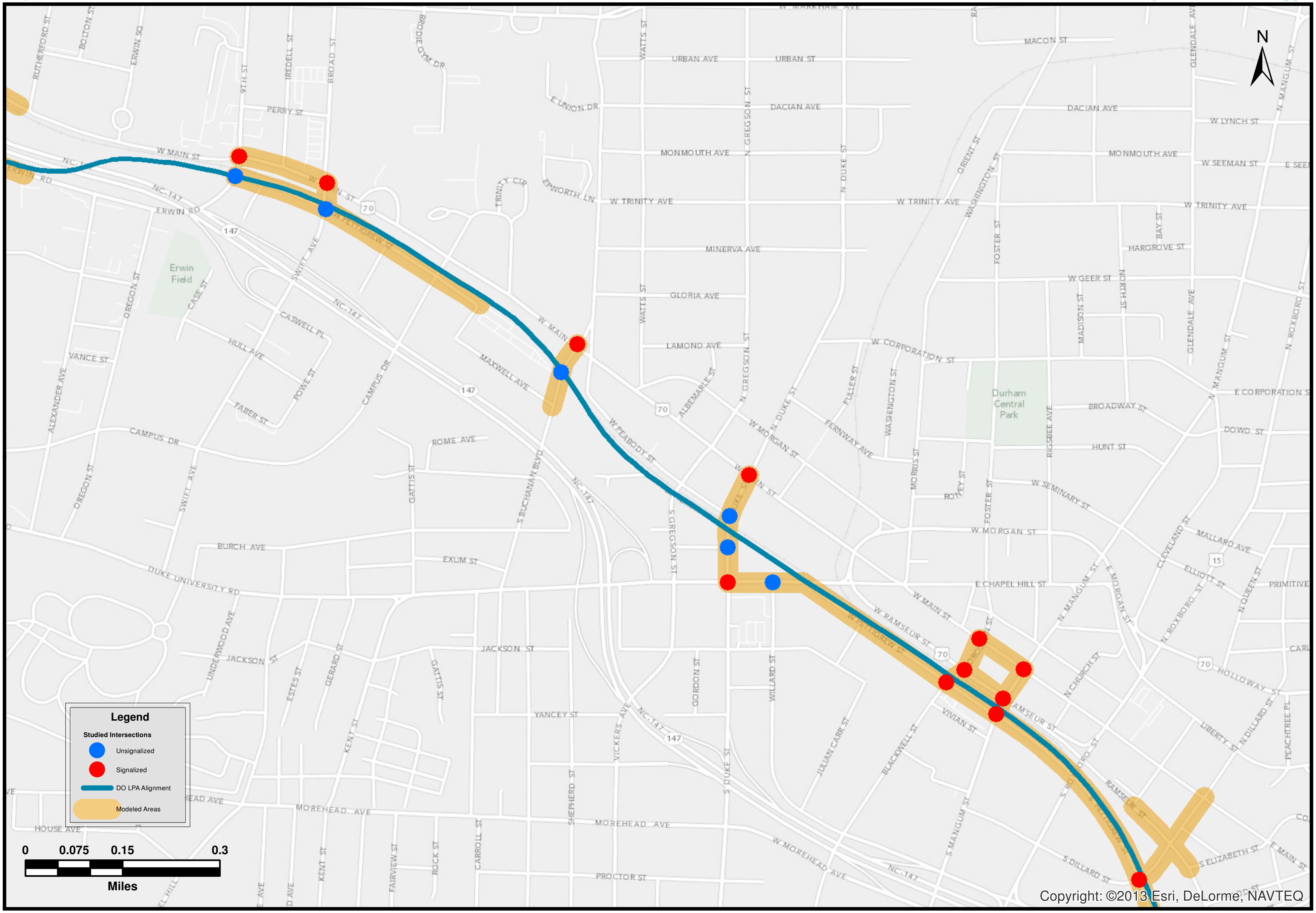
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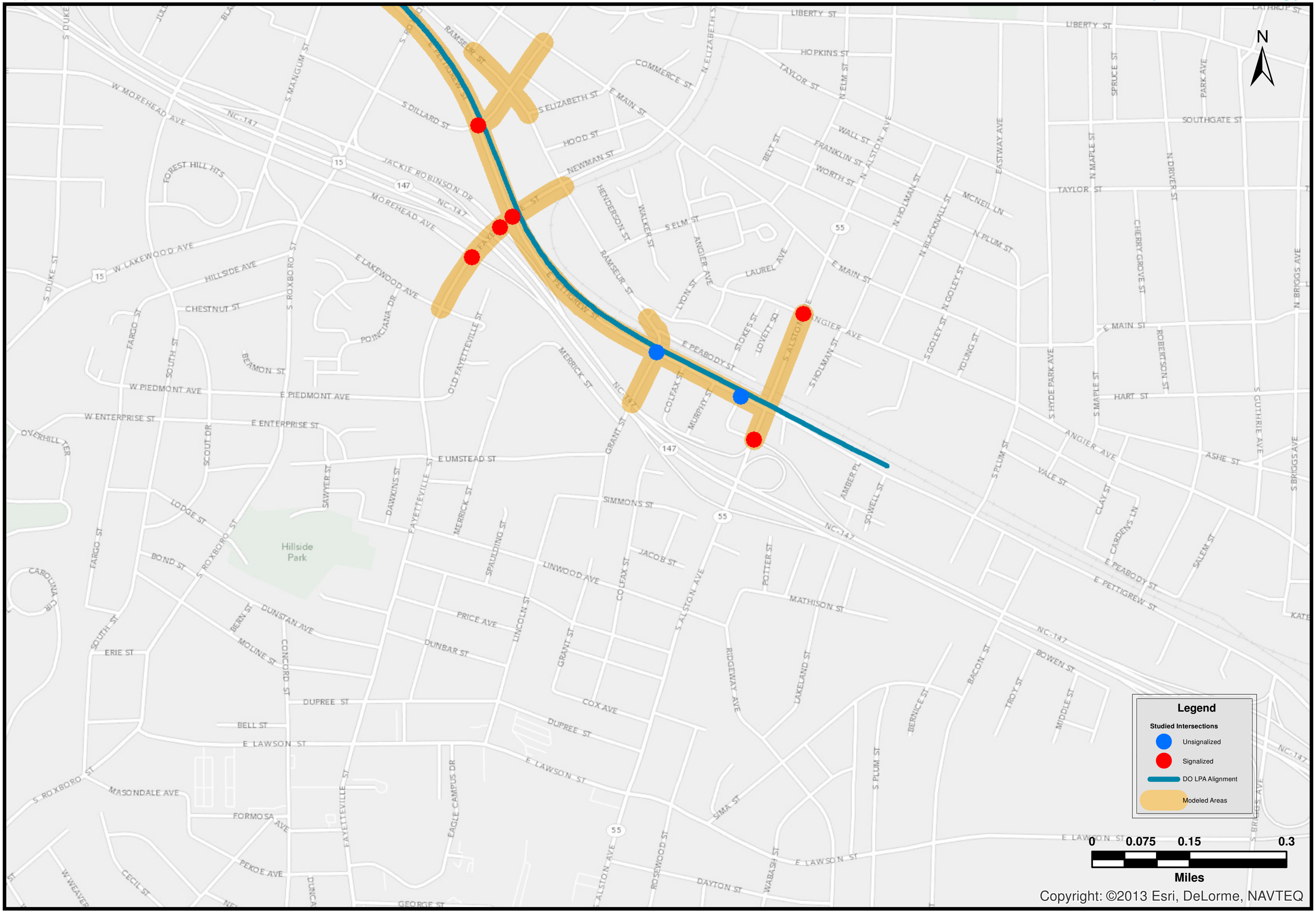
Erwin Field
Durham Central Park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3. Future Year No-Build/TSM Model

The No-Build and TSM alternatives are being combined as the traffic volumes are expected to be roughly similar. A future year No-Build/TSM model will be developed for each of the areas identified in section 2.1. These models will examine future conditions that could occur if the D-O LRT line were not constructed. As part of this analysis some projected deficiencies of the roadway network could be discovered. This analysis will not aim to categorize those deficiencies or to develop mitigation strategies. This analysis will be limited to determining likely future year conditions.

3.1 Develop Future Year No-Build/Tsm Volume Data

The balanced volumes developed for the base year analysis will be employed as the starting point for developing the future year No-Build/TSM volume data. Based on the balanced base-year peak-hour turning-movement, data link volumes will be generated for both the AM and PM peak hours. Data from the TRTDM will be used to obtain an appropriate growth factor for every link and this growth factor will be applied to base year link volumes to forecast future year No-Build/TSM peak-hour link volumes for the AM and PM peak hours. Data utilized for this will include daily volume growth, daily percentage growth, peak hour volume growth, and peak hour percentage growth. It will be critical to examine the peak hour data as well as the daily volume data as some peak spreading is likely to occur along the D-O LRT corridor given the developed nature of the corridor and the limited right-of-way available for additional roadway expansion. Engineering judgment will be employed to ensure that appropriate growth rates are extracted from the model.

Growth rates and projected link volumes will be reviewed in light of planned improvements in the area including projected development and changes to parking and transit operations. The model will be reviewed to determine which changes may have already been included within the socio-economic assumptions in the TRTDM. Forecasted link volumes will then be adjusted as necessary to reflect known changes that were not captured in the TRTDM.

Peak-hour turning volumes will be forecasted based on the peak-hour link volumes. Using the *TurnsW32* program (http://www.kittelson.com/toolbox/turnsw32) and the future year peak-hour link volumes and the base-year turning movements as input data, future year turning movements will be generated. These volumes will then be balanced in a manner similar to that used in the base year, although this process is likely to be less intensive.

Lastly, the sink and source nodes developed for the base year will be revisited. Based on existing development, planned development, and, to a lesser extent, sink and source nodes for the future year, a No-Build/TSM scenario will be developed.

3.2 Pedestrian And Bicycle Volumes

Local pedestrian and bicycle plans will be examined and proposed improvements that intersect the corridor will be noted. Qualitative estimates of the extent to which pedestrian and bicycle traffic will interact with the roadway network will be developed based on base year conditions and proposed developments. For this analysis cyclists will be assumed to cross at crosswalks and will not be included in the vehicular flow. At those locations where pedestrian and bicycle traffic is expected be above the 100 conflicting pedestrians per hour data will be developed and added to the model. The intersection Erwin Road and Fulton Street will include pedestrian or bicycle flow data in keeping with the base year calibration process. Additional intersections, particularly in downtown Durham or near either of the major college campuses, may also include pedestrian data in the future year No-Build/TSM analysis.

3.3 Future Year No-Build/Tsm Model Development

The base year model will be updated based on expected improvements to the roadway network. For this process the State Transportation Improvement Plan (STIP), the Metropolitan Transportation Improvement Plan (MTIP), various Capitol Improvement Plans (CIP), and bond packages will be reviewed to ensure that anticipated improvements are included in the future year model network. Unsignalized intersections will be given a cursory examination to determine if signalization is appropriate for future year conditions based on the volumes developed in the previous steps.

Signal timings will be updated using either Synchro or Vistro and the projected volumes and geometries. These new timings will be added to the model. Regardless of the development of pedestrian and bicycle data from the previous step all signals will be optimized to allow for safe pedestrian crossings.

Lastly routing information will be updated as needed to reflect changes in the roadway network based on proposed changes.

3.4 Model Simulation And Output Extraction

Upon developing the future year No-Build/TSM model, the model will run for the number of iterations necessary to achieve base year calibration. Models will be run using static trip assignments. The following data will be extracted and analyzed:

- Intersection Level of Service (LOS)
- Queuing
- Control delay
- Travel time
- Travel speeds
- Network delay (total and average per vehicle)

3.5 Comparison To Synchro

The Synchro analysis completed in the Alternative Analysis phase will be updated with new traffic volumes. The data from Synchro will be compared to the VisSim output. Differences will be noted and explained.

4. Future Year Build Models

A future year Build model will be developed for each of the areas identified in section 2.1. As noted in section 3.0 this analysis may reveal potential deficiencies in the future year roadway network. Only those areas negatively impacted above a certain threshold will be identified as part of this analysis. Areas anticipated to be deficient regardless of construction of the D-O LRT will not be identified nor will any potential mitigation strategy be developed.

4.1 Develop Future Year Build Volume Data

The balanced volumes developed for the future year No-Build/TSM analysis will be used as the starting point for developing the future year build volume data. Based on the balanced future-year No-Build/TSM turning-movement data, peak-hour link volumes will be generated for both the AM and PM peak hours. Data from the TRTDM will be used to obtain an appropriate diversion factor for every link for the AM and PM peak hours. Data utilized for this will include daily volume diversion, daily percentage diversion, peak hour volume diversion, and peak hour percentage diversion. It will be critical to examine the peak hour data as well as the daily data as some peak spreading is likely to occur along the D-O LRT corridor given the developed nature of the corridor and the limited right-of-way available for additional roadway expansion. Engineering judgment will be employed to ensure that appropriate growth rates are extracted from the model. A check will also be done between the Build and No-Build/TSM volume data to see if patterns suggested by the TRTDM are reflected in the volume data.

Growth rates and projected link volumes will be reviewed in light of planned improvements in the area including projected development and changes to parking and transit operations. The model will be reviewed to determine which changes may have already been included within the socio-economic assumptions in the TRTDM. Forecasted link volumes will then be adjusted as necessary to reflect known changes that were not captured in the TRTDM.

Peak-hour turning volumes will be forecast based on the peak-hour link volumes. Using the *TurnsW32* program (http://www.kittelson.com/toolbox/turnsw32) and the future year peak hour link volumes and the base year turning movements as input data future year turning movements will be generated. These volumes will then be balanced in a manner similar to that used in the base year, although this process is likely to be less intensive.

Lastly, the sink and source nodes developed for the base year will be revisited. Based on existing development, planned development, and, to a lesser extent, sink and source nodes for the future year, a Build scenario will be developed.

4.2 Pedestrian And Bicycle Volumes

In addition to data collected in section 3.2, station area data and ridership information will be examined to determine which areas may need to include pedestrian and bicycle flows in the analysis. The increase in pedestrian traffic due to the proposed D-O LRT will be above and beyond any increase due to future year land use. Qualitative estimates of pedestrian and bicycle flows will be developed based on base year conditions and proposed developments. In keeping with the future year No-Build/TSM analysis cyclists will be assumed to cross at crosswalks and will not be included in the vehicular flow. At those locations where pedestrians and bicycles are expected to be above the 100 conflicting pedestrians in the peak hour, data will be developed and added to the model.

4.3 Future Year Build Model Development

The future year Build model will be updated based on the proposed D-O LRT. Unsignalized intersections will be given a cursory examination to determine if signalization is appropriate for future year conditions based on the volumes developed in the previous steps.

Prior to signal optimization the project team will meet with local officials to discuss preferred interactions between the LRT and nearby signals. This will include discussions of both transit signal priority (TSP) and pre-emption. An interaction strategy for each individual signal will be identified.

Signal timings will be updated utilizing either Synchro or Vistro and the projected volumes and geometries and interaction strategy. These new timings will be added to the model. Regardless of the development of pedestrian and bicycle data from the previous step all signals will be optimized to allow for safe pedestrian crossings.

Lastly routing information will be updated as needed to reflect changes in the roadway network based on proposed changes.

4.4 Model Simulation And Output Extraction

Upon developing the future year Build model, the model will run for the number of iteration necessary to achieve base year calibration. Models will be run utilizing static trip assignment. The following data will be extracted and analyzed:

- Intersection LOS
- Queuing
- Control delay
- Travel time
- Travel speeds
- Network delay (total and average per vehicle)

4.5 Identify D-O LRT Impacts

Future year build output will be compared to future year no-build data. Those intersections that are expected to increase delay above a certain threshold will be identified. For the purposes of this study NCDOT's Policy on Street and Driveway, Chapter 5, Section J will be used to identify intersections on facilities owned by NCDOT and in the Town of Chapel Hill. The *Durham Comprehensive Plan Policy 8.1.2a, Traffic Level of Service (LOS) Standards* from the City of Durham will be applied to identify intersections on facilities owned by the City of Durham. Mitigation strategies to address the degradation in LOS and control delay will be developed for those identified intersections in the next phase of the project.

5. Friday Center Drive and Barbee Chapel Road Grade Separation Analysis

A grade separation analysis will be conducted to determine the benefit of grade separating the LRT crossings at Friday Center Drive and Barbee Chapel Road, both near NC 54. These locations were determined based on an analysis completed during the AA portion of the project and due to recent adjustments to the proposed D-O LRT alignment. The AA included a high level review of grade-separated and at-grade crossings and made definitive recommendations for the other crossings. The analysis for the Friday Center Drive and Barbee Chapel Road crossings could not be completed during the AA phase because of the more limited data available in this phase. This analysis will include altering the future year build network in the area to include a grade separated LRT crossing at Friday Center Drive. The model will then be re-run and new data will be extracted. The new model run data will be compared to the previous future year build data to determine the benefits of grade separating at this crossing. If necessary the analysis will review both alternative C1 and C2 to determine the benefits of grade separation.

6. Mitigation Plan

As noted above, a list of intersections expected to experience an increase in control above given thresholds will be developed. To reduce the impact of the D-O LRT, mitigation strategies will be identified for these locatoins. Such strategies could include additional turn lanes, improvements to alternative paths, alterations to travel patterns reducing delay, and improvements that do not add capacity such as improved wayfinding. These strategies will be tested utilizing VisSim to the extent possible. The modeled networks will be altered to include the roadway improvements or, in the case of strategies that alter travel patterns, the routing and volume data will be adjusted to reflect those new paths. The effectiveness of the strategies will be determined based on model results.

While the sections simulated are generally corridors, it is possible that some mitigation strategies may include the creation or improvement of alternative paths. Such an improvement may require the use of dynamic traffic assignment. A previously proposed mitigation strategy that would create an alternative path is the conversion of the Trent Drive and Elba Street intersection from the current configuration to a roundabout. Currently traffic on northbound Trent Drive cannot continue to westbound Elba Street. The conversion of this intersection to a roundabout would allow traffic on northbound Trent Drive to continue to westbound Elba Street. This conversion would provide an alternative path to the right-turning traffic from westbound Erwin Road to northbound Fulton Street, thus allowing this stream of traffic the opportunity to bypass the Erwin Road and Fulton Street intersection.

For this potential improvement, as well as similar improvements that create alternative paths, we are proposing to continue the use of static traffic assignment. Routing decisions will be updated such that traffic will be diverted to the new route and the model will be re-run and data on travel times extracted. The congested travel time of the new path will be compared to the existing path for the runs with the shifted traffic. If the travel time for the new path is still less than that for the existing path then no additional analysis will be required. In a case like this dynamic traffic assignment would shift all traffic to the new path as it is the shortest path. If the travel time for the new path is greater than the travel time for the existing path then dynamic traffic assignment will be used to provide the appropriate balance between traffic that will use the new path and traffic that will use the existing path. It is under this, and only this, condition that dynamic traffic assignment would be employed.