



Summary of Traffic Forecasts and Analyses Conducted for the Proposed Complete 540 Project

Complete 540 Triangle Expressway Southeast Extension
Wake and Johnston Counties, North Carolina
STIP Project Nos. R-2721, R-2828, and R-2829

North Carolina Department of Transportation
Federal Highway Administration

May 24, 2018

INTRODUCTION

This document describes the traffic forecasts and analyses conducted by the NCDOT for the “Complete 540” planning, environmental, and design study. Because it would include federal funding, this project would be a federal action and must comply with the National Environmental Policy Act (NEPA) and related regulations.

As with any large, new-location highway project, the Complete 540 NEPA process produced several technical analyses that required some form of traffic forecasting or other traffic data. Examples include the study’s purpose and need statement, air quality assessment, traffic noise analyses, indirect and cumulative effects assessments, capacity analysis, design, and others. In most cases, the Capital Area MPO’s adopted traffic travel demand model was used to generate traffic data.

No two NEPA studies for large highway projects are alike—each has a unique history and set of circumstances that dictate the extent of analyses and the emphasis that is placed on various technical studies and impact assessments. In the case of the Complete 540 project, the quantitative assessment of potential indirect and cumulative impacts was especially rigorous. These assessments relied on extensive analysis of future traffic conditions with and without the proposed project.

Transportation planning relies on traffic models to forecast future conditions. Likewise, the population, employment, and land use forecasts used as inputs to traffic models are themselves generated by their own predictive models. Because a model is a simplified representation of a more complex system, using model output to inform policy or design decisions requires accepting that there is an inherent tradeoff between simplicity and accuracy. This tradeoff can sometimes be masked, however, by the high level of precision generated by these models. In other words, it is easy to confuse precision with accuracy. Regardless of the precision with which data are reported, we must remember that model results are always approximations. Although advancements in the science of traffic modeling have produced more accurate forecasts, the preparation and use of such models still requires the judgement and skill of experienced transportation professionals.

CHRONOLOGY OF TRAFFIC ANALYSES

This section describes each of the traffic analyses conducted over the course of the Complete 540 planning and environmental study. This information is organized chronologically and by key elements in the NEPA process.

2008-2009 PURPOSE AND NEED

Traffic Analysis Objectives

The objectives at this beginning stage of the study were to produce the data necessary to: (1) document the need for the project, and (2) to compare present and future traffic volumes with and without the proposed project.

Method

Using the MPO's adopted travel demand model,⁽¹⁾ NCDOT generated traffic volumes for base year conditions (2008), interim year conditions (2011), and future year conditions (2035). For each of these conditions, two sets of traffic volumes were generated, one that included a representation of the Complete 540 route included in the overall roadway network (the "build" scenario); and one without the 540 route (the "no-build" scenario). This resulted in six sets of traffic data containing daily traffic volumes (averaged over a year's time) for each roadway segment in the modeled network.

NCDOT used this information to identify traffic capacity deficiencies today and in the future, with the deficiencies expressed in terms of volume-to-capacity ratios. A segment was considered to be nearing its capacity (becoming congested) if its v/c ratio was at or above 0.8 during daily peak travel times. (A roadway segment is considered to be *over-capacity* when its v/c ratio exceeds 1.0.) The v/c ratios were calculated by applying the daily traffic volumes generated by the model to each roadway segment's daily traffic capacity,⁽²⁾ as established in the adopted regional travel demand model.

Results/Discussion

Under NEPA, the purpose of a proposed federal action must be clearly stated, and the needs or problems triggering the action must be identified and measured. Alternative ways of meeting the stated purpose can then be studied and their benefits and impacts assessed. In this way, informed decisions can be made about whether the action should be carried out, and alternatives can be compared.

While the area's long range planning process identifies transportation needs at a regional level, individual projects subject to NEPA must reaffirm the needs at the project level, then document the purpose the individual project is intended to achieve. The traffic data sets generated in 2009 provided the more focused level of analysis required to quantify the transportation needs in the project's study

⁽¹⁾ The Capital Area MPO's Triangle Regional Model, Version 4.

⁽²⁾ Traffic capacity is defined as; "The maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions..." (Highway Capacity Manual. Transportation Research Board, 2016).

area. This information was used to establish the Complete 540 project's two formal purposes: improving mobility and reducing traffic congestion.

Traffic Documents Produced

- *Traffic Forecast Report* – December 2009
- *Build Traffic Capacity Analysis Report* – December 2009
- *No-Build Traffic Capacity Analysis Report* – December 2009

2010-2014 ⁽³⁾ **SCREENING OF ALTERNATIVE CONCEPTS**

Traffic Analysis Objective

The traffic analysis objective at this stage was to provide data required to measure the effectiveness of the alternative transportation concepts NCDOT examined for meeting the project's purposes.

Method

In its Technical Advisory T 6640.8A, the Federal Highway Administration recommends that several alternative concepts be analyzed when conducting an environmental study; NCDOT included each of those concepts in its initial screening of alternatives. Those that required traffic data included: (1) the already-planned roadway network⁽⁴⁾ *without* the proposed project (the "no-build" alternative); (2) planned roadway network *with* the proposed project (the "build" alternative); (3) various "hybrid" alternatives that combine the no-build network with various shorter segments of new highways; and, (4) various "upgrade existing" alternatives that combine the no-build network with additional upgrades to certain area roads.⁽⁵⁾

NCDOT established several measures to assess the effectiveness of these alternative concepts. These included: vehicle miles and hours traveled (VMT and VHT); congested VMT and VHT; miles of congested roadway; average speeds; and travel times between representative origins and destinations.⁽⁶⁾ The Triangle

⁽³⁾ During this time period, progress on the study slowed with passage of NC House Bill 225, in March 2011, which prohibited consideration of certain project alternatives. House Bill 10 repealed the law in March 2013, allowing required study activities to resume.

⁽⁴⁾ The already-planned network is defined as the network that would be in place if each project included in the MPO's 2040 Metropolitan Transportation Plan for the Triangle region were built.

⁽⁵⁾ Three other concepts (mass transit, travel demand management, and transportation systems management) were also considered, but traffic capacity data were not needed to measure their effectiveness.

⁽⁶⁾ These measures were calculated using daily and PM peak traffic volumes. Details are contained in the Study's "Alternatives Development and Analysis Report," May 2014.

Regional Model (Version 4) was used to generate the data required to apply these measures.

Results/Discussion

For each measure of effectiveness, the percent change in the metric for each build concept was compared to the same metric for the no-build concept. The results were then used to establish a quartile ranking, with each build concept assigned a ranking from 1 (lowest quartile, representing the least percent change in the metric) to 4 (highest quartile, representing the largest percent change in the metric).

Working with regulatory agencies and local governments, NCDOT concluded that concepts scoring above the median value (quartiles 3 and 4) for each measure of effectiveness would be said to provide enough benefit to warrant further analysis; those scoring below the median value (quartiles 1 and 2) would not provide enough benefit and would be dropped from further consideration. Using this system, NCDOT selected two of the alternative concepts for further study: the new highway alternative, and one hybrid concept.

Traffic Documents Produced

- *First Tier Screening Traffic Memo – (included as an appendix to the study's 2014 Alternatives Development and Analysis Report)*

2014-2015 ANALYSIS OF NEW HIGHWAY ALTERNATIVES

Traffic Analysis Objective

The screening of alternative concepts resulted in the dropping of all except the New Highway and one Hybrid concept. NCDOT then developed several individual alternatives for these concepts, and screened them against environmental impact factors. The result was the dropping of the Hybrid alternative and the selection of seventeen new location highway alternatives for more detailed study.

Having conducted additional analyses, and by collaborating with agencies, local governments, and the public, NCDOT narrowed the range of alternatives to seventeen new highway options. The traffic analysis objective at this stage was to provide future traffic volume data for use in developing functional designs, air quality analyses, noise analyses, and pavement design for the seventeen Detailed Study Alternatives.

Method

The traffic analysis objective was primarily met by making comparisons between existing traffic volume data and future year traffic estimates from the Triangle

Regional Model. To obtain the data required to make these comparisons, a detailed traffic forecast was prepared. (This was conducted in 2014, using Version 4 of the regional model).

Data sets were generated for base year (2010), interim year (2012), and future year (2035) conditions. While a typical traffic forecast would include only the base and future years, an interim year scenario was added to account for changes in traffic patterns resulting from the opening of the Triangle Expressway (located just west of the Complete 540 study area), in December of 2011.

No-build traffic forecasts were produced for the base, interim, and future years, as well. The future year no-build forecast was included because it is a step in preparing a future year capacity analysis, which is then used in developing the alternatives' functional designs.

Build traffic forecasts were generated only for the interim and future years. Base year forecasts were not prepared because the resulting data would not have been useful, given the presence of the new Triangle Expressway.

Results/Discussion

Build traffic forecasts were developed that represented each of the seventeen highway alternatives. This information was used to conduct a traffic capacity analysis to ensure that the functional designs would provide acceptable levels of service in future conditions.

Traffic Documents Produced

- *Traffic Forecast Technical Memorandum – April 2014*
- *Traffic Analysis Technical Memorandum – February 2015*

2016-2017

PREFERRED ALTERNATIVE, INDIRECT AND CUMULATIVE EFFECTS ANALYSIS, AND TIER 1 SCREENING REASSESSMENT

After comparing the alternatives' impacts and benefits, and after extensive public and agency involvement, NCDOT selected a preferred alternative for the project, in early 2016. At this stage of the study, traffic analyses were required for three specific purposes: (1) to prepare a traffic capacity analysis for the preferred alternative's preliminary design; (2) as input to the indirect and cumulative effects assessment required for the preferred alternative; and (3) to reassess the results of the 2011 screening of alternative concepts to ensure that newly developed socioeconomic data and the updated Triangle Regional Model would not alter the original conclusions. Each of these topics is discussed in its own section, below.

PREFERRED ALTERNATIVE DESIGN DETAILS

Traffic Analysis Objectives

The traffic analysis objective was to prepare a build forecast for the preferred alternative using the new travel demand model and to perform a capacity analysis for use in developing the preferred alternative's preliminary design plans.

Methods

In keeping with the "continuing, cooperative, and comprehensive" planning process required of all MPOs, the Capital Area MPO regularly updates its regional travel demand model and the data inputs used in the model. In 2016, CAMPO updated its model from version 4 to version 5 and extended the model's horizon year from 2035 to 2040. NCDOT used this new model to prepare traffic volume forecasts for the preferred alternative, with build forecasts developed for both the base year (2016) and new future year (2040). A future year no-build forecast was not prepared using model version 5 (see Indirect and Cumulative Effects Assessment, below, for details).

Results/Discussion

The build forecasts generated with the new model were used to conduct a traffic capacity analysis (completed in 2017). The results of this analysis were used to ensure that the preliminary roadway designs being prepared for the preferred alternative would accommodate future traffic volumes at acceptable levels of service (as established for the region as a whole by CAMPO and NCDOT).

Traffic Documents Produced

- *Project Level Traffic Forecast – October 2016*
- *Preferred Alternative Traffic Analysis Technical Memorandum – July 2017*

INDIRECT AND CUMULATIVE EFFECTS ASSESSMENT

Traffic Analysis Objectives

The traffic analysis objective was to prepare a new set of future year traffic data using the updated Triangle Regional model and the new, project-specific socio-economic data⁽⁷⁾ that was developed to reflect conditions without the influence of the Complete 540 project. The results could then be used to (1) assess and disclose traffic effects relative to the indirect and cumulative effects analyses, and (2) reassess the results of the earlier (2009) findings to see if any of the project's purpose and need conclusions would need to be revised.⁽⁸⁾

⁽⁷⁾ Developed for use in the project's Indirect and Cumulative Effects analyses.

⁽⁸⁾ The previous analysis (2009), indicated there would be several locations in the area roadway network with unacceptable levels of service under the future no-build scenario, which indicated a need for improvements in network traffic capacity.

Methods

As part of the methodology for assessing indirect and cumulative effects, NCDOT developed a set of socioeconomic data for future year no-build conditions that specifically excluded the effect the Complete 540 project might have on population and employment.⁽⁹⁾ NCDOT then used this data for the future year (2040) *no-build* model run, ensuring that the possible effects of the Complete 540 project would not influence the outcome. For the base year (2016) and future year (2040) *build* forecasts, NCDOT used the regional socioeconomic data developed by the MPO and Triangle J as part of their regional long range planning process.

Once the build and no-build model runs were complete, future conditions with and without the project could be compared. This comparison was carried out at three levels, or “tiers” of analysis:

(1) *Network Level* — The Tier One approach examined traffic conditions within a large “future land use study area” (FLUSA).⁽¹⁰⁾ CAMPO’s regional travel demand model was used to analyze 2040 build and no-build network conditions using ten measures of effectiveness.

(2) *Corridor Level* — The Tier Two approach examined traffic conditions at the corridor level for specific roads within the FLUSA. Compound annual growth rates were calculated for the vehicle hours traveled and vehicle miles traveled measures of effectiveness, to evaluate and disclose the potential indirect effect of Complete 540 on existing corridors within the FLUSA.

(3) *Intersection/Link Level* — The Tier Three approach examined various specific locations (intersections or roadway links) where the 2017 traffic capacity analysis showed deficient levels of service in future years.

At each level, the same measures of effectiveness used previously in the study were applied to assess future build and no build conditions.

Results/Discussion

At the Tier 1 (FLUSA) level of analysis, traffic conditions were found to be consistent with the conditions documented in the study’s earlier traffic reports. While the new 2040 no-build scenario showed a slight reduction in congested vehicle miles of travel compared to the original no-build scenario, the analysis reaffirmed that substantial traffic congestion is likely in the FLUSA without the Complete 540 project. Overall, the future year (2040) build scenario indicated higher

⁹ The method used to generate this data set was identical to the method used by the Capital Area MPO and the Triangle J Council of Governments in their “Imagine 2040” plan. Under this method, the effects of various competing development scenarios and major transportation project are measured and evaluated using a software package called “CommunityViz” (see <http://www.tjco.org/future-growth-scenarios-imagine-2040-connect-222045.aspx>).

⁽¹⁰⁾ Distinct from the project’s main study area boundaries, the FLUSA is a geographic area developed during a study’s indirect and cumulative effects analysis. It approximates the area that could experience indirect effects (later in time or farther in distance) caused by the project’s “footprint.” Often indirect effects include land use changes (and, as a subsequent result, changes in traffic volume or patterns).

levels of mobility within the FLUSA than the future no-build scenario by accommodating the anticipated growth of vehicles and improving speed of travel.

At the Tier 2 (corridor) level, the analysis indicated that the differences in the compound annual growth rates for the majority of corridors in the FLUSA are less than one percent when comparing the 2015 and 2040 no-build and build scenarios. The analysis also showed that traffic would tend to shift, with volumes increasing on roads that connect to Complete 540 and decreasing on roads that parallel Complete 540. (This finding was not unexpected—traffic will naturally gravitate toward interchange areas.)

Although traffic volumes would increase near interchanges, the analysis showed that those increases would not typically cause a reduction of average operating speeds and would, in fact, improve (increase) average speeds on most of the major corridors in the FLUSA (comparing future year (2040) build and no-build scenarios for daily and PM traffic conditions.)

At the Tier 3 (intersection/link) level of analysis, a small number of freeway and intersection locations were found to have poor levels of service under the future build scenario. Because of this, the base year and future year build and no-build volume-to-capacity ratios were examined to see if the Complete 540 project was causing or contributing to those deficiencies. The results showed that each of these areas had v/c ratios at the same general level under both the future no-build and build scenarios. NCDOT concluded that these operational deficiencies are the result of growth that is expected to occur in the area with or without Complete 540 project.

In general, a project's indirect effects on traffic are typically attributable to either changes in land uses or changes in travel patterns. In the case of Complete 540, the project's expected traffic effects are nearly all attributable to changes in travel patterns and not because of growth induced by the project. This is the case throughout the FLUSA.

Traffic Documents Produced

- *Quantitative Indirect and Cumulative Effects Memos 1, 2 and 4 – November 2017*

ALTERNATIVE CONCEPTS (FIRST TIER) SCREENING REASSESSMENT AND TRAFFIC REASSESSMENT

Traffic Analysis Objectives

The traffic analysis objective for this task was to provide data for use in a reassessment of the 2011 first tier screening outcomes and data for use in determining whether a full, project-level future no-build scenario would need to be prepared as part of the evaluation of the no-build alternative.

Methods

As described previously, the study's indirect and cumulative effects analysis generated a set of "project-specific" socioeconomic data that excluded the effects the Complete 540 project might have on future growth. The availability of this data set, along with the fact that a new travel demand model had been adopted, prompted NCDOT to reassess the results of the first tier screening (originally conducted in 2011) using these updated elements.

This reassessment was conducted by running the updated model for each alternative concept and applying the same measures of effectiveness that were used in the original screening. By comparing the model outputs for the alternative concepts developed using the existing CAMPO-generated socioeconomic data to the no-build alternative developed using the project-specific data, NCDOT could re-create quartile rankings to determine if the original decisions made as part of the first tier screening (for alternative concepts) remain valid.

These travel demand model outputs were also used for what was, in effect, a sensitivity analysis—carried out to determine if a future year, project level no-build traffic forecast was warranted. This was accomplished by comparing the forecasted 2040 *build* condition to two different forecasted 2040 *no-build* conditions. One of the no-build scenarios used socioeconomic data developed by CAMPO for the regional model (i.e., the same method as the earlier 2011 analysis); the other used the socioeconomic data developed to remove the possible effects of the Complete 540 project (developed during the previously explained quantitative indirect and cumulative effects analysis). By comparing these two different no-build data sets to the build data, the NCDOT could determine if use of the newer data would vary the outcome enough to warrant a full project-level future no-build forecasting effort.

As a further step, the mass transit, transportation demand management, and transportation system management concepts were examined using a more robust methodology than was earlier available, providing a more detailed quantitative screening for those options than had been done in 2011.

Results/Discussion

Reassessment of First Tier Screening findings — After re-screening, three alternative concepts were found to meet the project's purpose of improving mobility and two were found to meet the purpose of reducing congestion. Only one, however, was found to meet both purposes: the New Location Highway concept. These findings thus reaffirmed (and strengthened) the conclusions reached in the original 2011 assessment.

Assessing the need for a future year project-level no-build forecast — By comparing the results of the two 2040 no-build scenarios (against each other, and against the results of the 2040 build scenario), the effect of removing the Complete 540 project's potential influence on area no-build traffic conditions could be assessed. Because the comparison of the two 2040 no-build scenarios showed

only minor differences in traffic conditions in the project study area, NCDOT and FHWA determined that (1) the congestion and mobility problems identified with the original 2011 no-build scenario analysis remained after the new, project-specific data set was applied, and (2) the degree of variation between the two analyses was small enough that preparation of a full, project level future no-build forecast was not required.

Based on those results, and on the results of the three-tier analysis described in the previous section, NCDOT and FHWA concluded that that development of a 2040 no-build project-level traffic forecast, using either MPO-adopted or project-specific socioeconomic data, would not result in any substantive change in the traffic forecasts used to support the project decisions. As a result, NCDOT and FHWA further concluded that preparation of such a forecast was not necessary.

Traffic Documents Produced

- *First Tier Alternative Concepts Screening & Traffic Reassessment – December 2017*

2018

CONNECT 2045 REGIONAL FORECASTS MEMO, TRM V5 AND TRM V6 TRAFFIC SENSITIVITY ANALYSIS, AND ACCESS2040 CLAIMS AND PERFORMANCE ASSESSMENT

Following the approval of the Final EIS, in late 2017, and prior to preparation of the Record of Decision, additional analyses were required for three specific purposes: (1) to consider the potential project-related implications of the Connect 2045 forecast prepared by Triangle J COG and CAMPO; (2) to evaluate the possible project implications resulting from CAMPO's adoption of a new regional travel demand model (TRM, Version 6); and (3) to assess a new alternative concept that was proposed by an environmental advocacy group after publication of the Final EIS. Each of these topics is discussed in its own section, below.

CONNECT 2045 REGIONAL FORECASTS MEMO

Analysis Objectives

In February 2018, CAMPO approved the 2045 Metropolitan Transportation Plan, and with it the socioeconomic forecasts generated by the Connect our Future 2045 Initiative (Connect 2045). The Complete 540 project's transportation objective was to examine the new socioeconomic forecasts to determine if they could alter the project's Quantitative Indirect and Cumulative Effects analysis findings on watershed impacts.

Methods

The 30-Year growth forecasts for employment and dwelling units were compared for each of the watersheds in the Future Land Use Study Area (FLUSA). For the six FLUSA watersheds predicted to have higher growth, a sensitivity analysis was carried out to examine the changes in impervious surface in those watersheds using Connect 2045 data.

Results/Discussion

The results of this analysis showed that the differences in the total amount of impervious surface between the forecasts are well within the margin of error for long-range regional forecasts at the jurisdictional level (even more so for a subdivision of jurisdictions such as the FLUSA). The analysis further indicated that the new forecasts in all watersheds analyzed result in reductions, or marginal net differences, in impervious surface. The one possible exception is in the Poplar Creek-Neuse River watershed. This watershed has an estimated upper-limit net increase in impervious surface of 6 percent and a lower-limit estimated net increase of 2 percent under the new forecasts. Although the root cause of the change is an increase in the dwelling unit forecast, the differences still fall within the margin of error for a sub-county long-range socioeconomic forecast. The Connect 2045 forecast is less than the forecast used in the Quantitative Indirect and Cumulative Effects analysis. Therefore, the prior analysis is a conservative scenario (erring on the side of higher environmental impacts) overall. The findings of sensitivity analysis indicate that the conclusions of the original Quantitative Indirect and Cumulative Effects analysis remain valid and no further analysis is required.

Document Produced

- *Connect 2045 Regional Forecasts Memo*

TRM V5 AND TRM V6 TRAFFIC SENSITIVITY ANALYSIS

Analysis Objectives

In February 2018, CAMPO approved the 2045 Metropolitan Transportation Plan, and with it, the Triangle Regional Model, Version 6 (TRM V6). The objective of this sensitivity analysis was to compare TRM V6 results to the TRM V5 results NCDOT used in making decisions related to the project's purpose and need and screening of alternative concepts. This comparison could then be used to determine if the new model results in changes of a magnitude that could alter the prior analysis findings.

Methods

In this analysis, the measures of effectiveness that were previously used in the study for the build and no-build conditions were compared using both TRM V5 and TRM V6 for the traffic study area.

Results/Discussion

The analysis showed that the relative changes between TRM V5 and TRM V6 are nearly identical for the no-build condition and the build condition. The additional five years of the new model's time frame shows that congestion will continue to increase, which tends to further support the need for the project to help reduce congestion in the traffic study area. The findings indicated that the conclusions of the previous traffic and alternative concept screening analyses remain valid and do not require further analysis.

Document Produced

- *TRM V5 and TRM V6 Traffic Sensitivity Analysis*

ACCESS2040 CLAIMS AND PERFORMANCE ASSESSMENT

Analysis Objectives

In February 2018, as part of an environmental advocacy group's comments on the Final EIS, an alternative concept was submitted for consideration in a document entitled "Access2040." This concept was based on planned improvements identified in the 2040 locally-adopted transportation plan, then adds other projects that are identified locally for implementation beyond 2040, and also includes other transportation improvements that are not in part of the local transportation plan. The Complete 540 project's traffic analysis objective was to examine the claims made in the Access2040 document and evaluate the new alternative concept contained in it.

Methods

Access 2040's authors claim that their alternative concept would achieve the benefits of an alternative concept previously dismissed in the Complete 540 study (Improve Existing 3 – Arterials) with less environmental impact, fewer relocations, at a far cheaper cost. In order to adequately evaluate these claims, the alternative concept was added to the TRM V5 model and was analyzed using the same measures of effectiveness that were used earlier in the study when assessing alternative concepts.

Results/Discussion

The results of this analysis showed that the Access2040 alternative concept would not achieve results comparable to the Improve Existing 3 – Arterial concept. Additionally, when the Access2040 alternative concept was ranked with the Complete 540 project's other alternative concepts, the Access2040 alternative scored near the bottom. Using the same evaluation criteria as previously used for screening alternative concepts, the Access2040 alternative concept

was shown to meet neither of the project primary purposes (improving mobility and reducing congestion in the project study area).

Document Produced

- *Access2040 Claims and Performance Assessment*

TRAFFIC ANALYSIS TIME LINE

