A CLOSER LOOK AT US 74: CHALLENGES & OPPORTUNITIES
O’Connell & Lawrence, Inc., prepared this report at the request of the Southern Environmental Law Center to assist in their review of the proposed Monroe Bypass. O’Connell & Lawrence is a multidisciplinary firm which provides construction consulting, civil engineering, and surveying services to a broad range of both public and private sector clients. Its staff consists of an experienced group of registered engineers, surveyors, and construction specialists with expertise in a wide variety of disciplines. The Southern Environmental Law Center is a non-profit organization dedicated to protecting natural resources and public health in the South.

For additional copies of this report, or for more information about SELC, please visit our website or contact:

Southern Environmental Law Center
Chapel Hill Office
601 West Rosemary Street, Suite 220
Chapel Hill, NC 27516-2356
Phone 919-967-1450
Fax 919-929-9421
SouthernEnvironment.org

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The conclusions and opinions expressed in this report were reached with a reasonable degree of engineering certainty.

The Stantec report, commissioned by the North Carolina Department of Transportation, highlights potential improvements to US 74, including signal timing optimization, modifications to signal phasing, turn lane storage expansion/addition, and lane modification, that are projected to significantly reduce overall delay.

The proposed revisions are projected to provide substantial time-delay benefits to local residents over an eight-year window. Stantec’s study should be expanded to determine if delay benefits will sustain over a longer timeframe.

O’Connell & Lawrence, Inc. recommends the Wilbur Smith Associates origin-destination study be modified by increasing the number of survey collection points and increasing the time spent collecting origin-destination data. OCL also recommends a separate commercial driver origin-destination study be performed to highlight the differences between passenger vehicle and commercial vehicle traffic patterns.

Information obtained in Stantec’s updated delay study and WSA’s revised Origin-Destination study should be provided to local decision-makers so an informed decision about the long-term viability of US 74 as a means of providing high-speed, reliable transportation in the area southeast of Charlotte, NC, can be made. Additional study is required to determine if improvements to US 74 could assist in addressing the stated purposes of the Monroe Connector/Bypass.
INTRODUCTION

Description of US 74 and Associated Reports

US 74, an existing multi-lane divided highway, travels southeast of the city center of Charlotte, NC, in the direction of Wilmington, NC. US 74 is part of the North Carolina Department of Transportation (NCDOT) Strategic Highway Corridor (SHC) and is known as Corridor 24. The section of US 74 reviewed in this report stretches through Union County, NC, from the intersection with I-485 (the Charlotte Outerbelt) to just beyond Wingate, NC. The reviewed location of US 74 is shown in Figure 1 below. The surrounding area is developed with residential, commercial and industrial properties and site/traffic improvements accompanying such development.

Stantec Consulting Services, Inc. (Stantec) prepared a study of existing US 74 in 2007 entitled the “US 74 Corridor Study” (Stantec report). This study was commissioned by NCDOT. In this study, Stantec reviewed an existing stretch of US 74 from the Charlotte Outerbelt to Highway 601 South. Stantec developed a series of short-term and long-term recommendations for the corridor with the goal of extending the long-term viability of US 74. Stantec used overall delay, defined as the total time spent by a vehicle in queue and lost by having to accelerate and decelerate, and Level of Service (LOS), a common metric used to provide a description of the level of flow at various intersections, as their metric for determining whether the recommendations would provide overall benefits to local users of US 74. O’Connell & Lawrence, Inc. reviewed Stantec’s recommendations, detailed later in this report, and provided recommendations on how the study should be improved and expanded.

WSA prepared a report entitled “Final Report – Proposed Monroe Bypass/Connector Comprehensive Traffic and Revenue Study” for the North Carolina Turnpike Authority (NCTA). This report, dated October 22, 2012, details the Origin-Destination Study (O-D Study), a traffic study performed to determine the travel patterns of a local populace, conducted by WSA personnel. OCL reviewed the O-D Study performed by WSA and has commented on both the overall quality/thoroughness of the study and proposed recommendations.
for improvements to the WSA study to provide better data about who is on local roads, where drivers are going, and which routes drivers choose to take.

These two studies were performed as part of studies for the Monroe Bypass/Connector Project, a proposed four/six-lane, controlled-access facility with an approximately 300’ right-of-way width. The proposed project is located to the north of, and roughly parallel to, existing US 74. The selected alternative of the Monroe Bypass/Connector will stretch from Stallings, NC, to just beyond Wingate, NC, and will start and end at interchanges with US 74. The location of the Monroe Bypass/Connector is shown as a bold red line in Figure 2. According the “Statement of Purpose and Need,” prepared by PBS&J for the NCDOT and the NCTA in February 2008, the purpose of the proposed project is to “construct a facility that allows for safe, reliable, high-speed regional travel in the US 74 Corridor between I-485 in Mecklenburg County and the Town of Marshville in Union County, in a manner consistent with the North Carolina Strategic Highway Corridors Vision Plan for US 74 and the designation of US 74 on the North Carolina Intrastate System” and to “improve mobility in the US 74 corridor within the project study area, while maintaining access to properties along existing US 74.” The Monroe Bypass/Connector is projected to have substantial economic, environmental and societal impacts on local areas.

OCL reviewed the Stantec and WSA studies related to US 74 to determine if modifications to existing US 74 could help meet some of the purposes specified for the Monroe Bypass/Connector and to determine if the information currently available to local decision makers is sufficient to make substantial transportation decisions. A full description of OCL’s statement of assignment may be found in Appendix A of this report.

Approaches to Congestion Relief

Road congestion is a common problem faced by transportation planners and road designers. Congestion occurs for several reasons, but often occurs when more vehicles travel on a stretch of road than the road is designed to carry. Traffic congestion is commonly cited as a major source of frustration for road users.

Planners and local leaders have the task of providing congestion relief for local residents while maintaining budgets and minimizing adverse environmental and/or societal effects. As a result, new alternatives for cost-effective congestion relief with limited negative impacts are always being explored.

One common approach to providing congestion relief is to simply add additional driving lanes on congested routes, providing additional vehicle capacity. However, adding lanes and/or roads is often expensive and can create other impacts, including right-of-way acquisition opposition and environmental impacts. Planners often look at other solutions, such as managing existing infrastructure, to try and maximize the efficiency of these existing roads.
As planners have eased away from adding pavement, new approaches to congestion relief have been implemented by planners. Signal timing optimization is one strategy to attempt to reduce overall congestion. Jurisdictions will modify the timing of traffic signals to create an ideal flow situation for vehicles. Several consecutive traffic signals will be modeled and timed together to encourage efficient traffic flow and minimize queuing delay. Planners will make adjustments to signal timing based on road-use data and will run software models to determine projected delay. Signal timing optimization needs to be consistently maintained and adjusted over the long term to maintain the benefits from the original optimization process.

Another common method of congestion relief is phase management for traffic signals. Traffic signals provide “phases,” meaning times when certain movements are permitted. By reviewing intersection data and allocating differing amounts of time for different movements based on this data, planners can work to maximize intersection efficiency by minimizing queuing time for turning/through movements. See Figure 3 for a typical vehicular and pedestrian movement diagram. Like signal timing optimization, signal phase management needs to be periodically updated to remain effective. It also needs to be based on relevant traffic data, as the developed phase times are predicated on the demand for individual traffic movements.

Adding a left turn phase will not provide an overall benefit to the delay and level of service at a site if no vehicles need to turn left. Present or future models must be based on quality data.

A third means of congestion relief is to modify lane length or revise lane movements. By revising the amount of stacking space in certain lanes or providing additional turning/through lanes, planners can help reduce overall delay at certain intersections by keeping cars making turning movements out of dedicated through lanes, and keeping cars going straight through intersections out of turning lanes, through traffic still may be blocked by a turning vehicle in a through/turn lane. If these lanes are separated, through traffic can continue while turning vehicles wait for safe passage. Software models can project delay based on new intersection configurations, and this data can be compared to determine if the overall delay will be reduced. It is assumed that if this delay is reduced, and the LOS is improved, congestion relief will naturally occur.

Additional means of congestion relief are available to transportation planners, and new, alternative designs are consistently being studied to determine if the assumed effect on congestion can help balance proposed impacts and proposed cost. Newer designs, such as superstreet facilities, roundabouts, and high-occupancy toll facilities can also be considered as a means for overall congestion relief. When dealing with a congestion relief problem, planners should review multiple means and collect reliable data prior to making final decisions so a quality solution can be found for the congestion problem.

One means of congestion relief briefly discussed in the Stantec report is the concept of a superstreet design. Stantec defines a “superstreet-type facility” as “intersections that do not allow left turns from side streets, but require vehicles to turn right and then make a U-turn at an adjacent median opening.”
According to NCDOT’s SHC page, a superstreet also prohibits through movements on side-streets, forcing all traffic to turn right and make the necessary U-turn at the next intersection. Superstreet design removes left-turning movements from the side streets; by doing this, transportation designers can remove a movement from intersections that either creates a protected phase (causing delay for all other drivers) or causes delay to left-turners who are unable to find a break in which to make a safe turn. See Figure 4 for an illustration of a superstreet median crossover. There are generally two main requirements for this to potentially reduce delay. The first requirement is adequate left turn lane length at adjacent intersections along the corridor to address both left-turners from the main road and left-turners from the side street. The second requirement is that intersections are close enough that delay experienced from going the “wrong way” on the main road will be less than the saved time from the potential left turning movement. Modeling is required of a length of corridor to determine if these time savings will be felt by the average driver.

Superstreet design is currently under study in North Carolina and in several other locations around the country; the states of North Carolina and Maryland have led this development as an adequate means of traffic and delay control. According to a 2011 study entitled “Operational Effects of Signalized Superstreets in North Carolina” by Dr. Joseph Hummer, a professor at North Carolina State University, studies at intersections with an implemented superstreet design have shown a “20 percent overall reduction in travel time compared to similar intersections that use conventional travel design.” This study indicates that superstreet design should be further explored as a means of providing for turning movements in a safe and time-effective manner. Figure 5 shows a constructed superstreet in Michigan.
OCL primarily reviewed and assessed two reports as part of this assignment and has provided comment on these reports herein.

**Detailed Review of the Stantec Report**

**Summary**

OCL performed a thorough review of Stantec’s US 74 Corridor Study. Based on OCL’s review of the Stantec report, OCL believes additional study is required to thoroughly “complete” the study. The current Stantec report provides information on the overall delay vehicles on US 74 experience. This delay is based on software models incorporating proposed short-term and long-term transportation recommendations into the existing US 74 corridor.

Overall, OCL believes the recommendations made by Stantec will have a positive impact on drivers on US 74. However, the recommendations made by Stantec are only projected to 2015. To provide a true long-term study, OCL recommends Stantec revise its study to project proposed time delay to travelers on US 74 several years beyond 2015. OCL also recommends Stantec incorporate two existing interchanges into its software model and re-evaluate its traffic projections to better provide a long-term delay model to local decision makers.

OCL’s task in reviewing the Stantec report was to determine the overall feasibility of the proposed upgrades/recommendations and to assess the ability of the stated recommendations to provide short-term and long-term benefits to local residents. Additionally, OCL was tasked with commenting on whether these recommendations could be expanded to provide longer-term benefits to local residents. OCL did not provide an assessment of the study methodology used by Stantec; rather, OCL focused on the intersection improvement recommendations made by Stantec.

**Stantec’s Study Methodology**

Stantec’s report was commissioned by NCDOT and was completed in 2007. Stantec’s stated goal of its study is as follows:

*The ultimate goal of the study is to extend the long-term viability of US 74. Study goals were to identify and develop improvements that, where possible, would provide a LOS of D or better at each signalized intersection for projected 2015 traffic volumes. Because of development along the study corridor and agency budgetary constraints, LOS goals were not attainable at all locations. Where LOS goals could not be attained, reasonable improvements were recommended within the study constraints.*

According to Stantec, multiple intersections along US 74 would operate at an unacceptable LOS (defined as either LOS “E” or “F”) by 2015 if existing travel conditions are maintained. This point is supported by Stantec’s models. The proposed upgrades would be necessary to keep many of the intersections along US 74 operating at an acceptable LOS.

Stantec provided recommendations for 23 intersections along US 74, using existing traffic volumes measured in 2007 as a baseline. Stantec modeled the average delay for each intersection in the study. This average existing conditions delay (2007 delay) was charted for individual intersections. Stantec then projected traffic volumes in 2015 using an annual growth rate of 3% and updated its existing conditions model with these revised traffic volumes, yielding a new average delay (no-build delay) for each intersection. This model assumed that no new modifications had been made to US 74.

Stantec then prepared a series of recommendations for improvements to the US 74 corridor. Stantec split these recommendations into short-term improvements and long-term improvements, defining short-term improvements as remedies that could be implemented within a timeframe of roughly one year and at a cost of less than $250,000, and long-term improvements as improvements requiring several years to implement and at a cost greater than $250,000. Stantec then inserted the proposed short-term and long-term improvements in its software and re-ran the model for each situation using the proposed 2015 traffic volume.
Stantec charted the proposed delay for each situation at individual intersections, yielding delay statistics for the proposed short-term recommendations (short-term delay) and the proposed long-term recommendations (long-term delay).

**Short-Term Recommendations**

In general, Stantec’s short-term recommendations focus on optimizing traffic signal timing, modifying traffic signal phasing, increasing storage length of certain turn lanes, and modifying existing lane alignments for certain intersections. Stantec recommended continuous operations review and maintenance along the corridor to monitor and maintain this reduction in delay. Stantec also recommended eliminating split-side movements and allowing protected-permitted left turn movements where protected-only movements may be warranted. Stantec estimated the total cost of the proposed short-term improvements, excluding right-of-way acquisition and traffic control costs, at $3,100,000.

Per OCL’s review, Stantec’s short-term recommendations for these intersections are realistic and feasible to complete. Signal timing optimization is included as a short-term improvement for each intersection reviewed by the Stantec study.

Stantec recommends the conversion of an existing traffic signal to an eight-phase traffic signal in four locations. An eight-phase traffic signal provides green time for protected left turns to drivers on all intersection approaches. The Stantec Report does not provide information on the exiting signal timing for these intersections; however, OCL has assumed that Stantec is proposing to expand the total number of phases included at each signal.

A reduction in delay resulting from a signal phase change is documented at the intersection of US 74 and Stallings Road, where the proposed 2015 no-build scenario is projected to have an LOS of F in both the AM and PM Peak Hours, with delays of 138.60 seconds and 197.50 seconds, respectively. If an eight-phase signal modification (along with the signal timing optimization for the entire corridor) is implemented as a short-term improvement, the delay at this intersection is projected to be reduced to 58.10 seconds in the AM peak hour and 99.30 seconds in the PM peak hour. Though the LOS for 2015 short-term situation will still be “E” in the AM and “F” in the PM, the overall reduction in delay time is substantial. The total sum of the differences in delay between the 2015 no build model and the 2015 short-term model is 66.3 seconds for the AM peak hour and 356.4 seconds for the PM peak hour. This is shown in Figure 6.

![Figure 6 – Recommended Short-Term Improvements, US 74 and Stallings Road](Stantec, US 74 Corridor Study, Final Report, Section 6.3.1 US 74 at Stallings Road)

In order to implement the new phasing timing, a current traffic study is required to determine the total length of the phases for individual traffic movements. New traffic signals may need to be installed if the existing signals do not have the appropriate left-turn signalization hardware. Maintenance and evaluation of the phase timing is also required to ensure the timing provided for each phase is in line with the traffic usage. However, this installation could be done in a short period of time and could quickly provide delay benefits to local residents.

Stantec makes several short-term recommendations for the addition of turning lanes or adding lane length for the expansion of existing turning lanes. The fol-
The following table illustrates the proposed short-term lane addition/lengthening for certain intersections along the US 74 corridor:

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Proposed Short-Term Improvement(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unionville-Indian Trail Road</td>
<td>Add eastbound left turn lane on US 74</td>
</tr>
<tr>
<td>Wesley Chapel-Stouts Road/Sardis Church Road</td>
<td>Increase northbound Wesley Chapel-Stouts Road left turn lane storage to 250 ft.</td>
</tr>
<tr>
<td>Hanover Drive</td>
<td>Increase the westbound US 74 left turn lane storage to 200 ft.</td>
</tr>
<tr>
<td>Secrest Short Cut Road</td>
<td>Increase the southbound Secrest Short Cut Road left turn lane storage to 300 ft.</td>
</tr>
<tr>
<td>Morgan Mill Road</td>
<td>Increase the Morgan Mill Road left turn and right turn lane storage to 200 ft.</td>
</tr>
<tr>
<td>Walkup Avenue</td>
<td>Extend the Westbound US 74 left turn lane to 300 ft.; add an additional left turn lane on US 74; extend the left turn and right turn lane storage on Walkup Avenue to 200 ft.</td>
</tr>
</tbody>
</table>

Additionally, Stantec also recommended modifying specific lane assignments in several locations. The following table illustrates the proposed short-term lane modifications for certain intersections along the US 74 corridor:

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Proposed Short-Term Improvement(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Trail-Fairview Road</td>
<td>Modify the southbound approach of Indian Trail-Fairview Road from the existing right turn, left turn, and left turn/through lane configuration to a left turn lane (with 300 ft of storage), dedicated through lane, and right turn lane</td>
</tr>
<tr>
<td>Unionville-Indian Trail Road</td>
<td>Modify the northbound approach on Unionville-Indian Trail Road from the existing configuration (right turn lane, left turn/through lane) to a new configuration (right turn/through lane and left turn/th rough lane)</td>
</tr>
<tr>
<td>Hanover Drive</td>
<td>Convert the existing right turn lane on the westbound US 74 approach to a right turn/through lane</td>
</tr>
</tbody>
</table>

Finally, Stantec proposes installing 17 left-overs and closing a single median crossover along US 74. A left-over is a proposed left turn lane protected by a concrete island; a traffic signal is not provided at a left-over. The purpose of a left-over is to provide space for stacking vehicles wishing to make a left turn so vehicles do not stop in the main through lanes while trying to turn left.

Overall, the recommendations for the addition of lanes/storage space or modification of movements in lanes should offer a degree of delay relief to local residents. Most recommendations made by Stantec provide additional storage in turning lanes or dedicated through lanes for drivers. Stantec’s overall intent appears to be separate turning traffic from through traffic as often as possible.

The addition of turning lane storage will help alleviate problems resulting from turning vehicles stacking into through lane storage and delaying through traffic. Adding lane capacity and providing protected left turns will reduce delay for turning drivers, and moving these turning drivers out of through lanes will reduce delay for through drivers. New dedicated through lanes will provide additional highway capacity, allowing more vehicles to pass certain lights without being stopped and delayed.

In OCL’s opinion, the principles behind this short-term recommendation methodology are sound and should help to reduce short-term delay. This opinion is supported by Stantec’s delay statistics. The chart on the next page highlights the total delay across the study corridor for the no-build and short-term scenario:
The proposed recommendations made by Stantec offer proposed delay benefits to local residents. Only the AM peak hour delay for the 2015 long term, when compared with the 2015 no-build situation (excluding Stallings Road, Indian Trail-Fairview Road, and Unionville-Indian Trail Road) indicated a minor increase in delay as a result of completion of Stantec’s proposed recommendations. The AM peak hour delay reduction for the short-term improvements was 50.3 seconds. Thus, the short-term recommendations offered a small amount of delay relief to local residents.

Significant time savings are projected for the PM peak hour. Upon completion of the short-term recommendations, the average PM peak hour delay for vehicles reduces by 655.5 seconds, a total of nearly 11 minutes. Stantec’s short-term recommendations offer real benefits to local residents over this time frame.

The short-term recommendations are relatively easy to evaluate; it is assumed that the recommendations, due to the ease/speed with which they could be installed, could provide benefits whenever NCDOT chooses to implement them.

### Long-Term Recommendations

Stantec’s long-term recommendations include the conversion of a certain section of US 74 to a superstreet facility, the addition of lanes to several intersections, and the addition of lane storage length in multiple locations. Stantec also recommends the optimization of signal timing and modification of signal phases as individual long-term recommendations. Several of the recommendations mirror the proposed short-term recommendations; however, the overall cost and time of implementation make these recommendations a more time-consuming process that may require additional study. Stantec estimated the total cost of the proposed long-term improvements at $10,200,000.

Stantec recommends signal timing optimization as a long-term recommendation at 15 of the 23 studied intersections, even after proposing signal timing optimization at all 23 intersections for short-term recommendations. In OCL’s opinion, signal optimization would likely provide long-term delay benefits to the overall corridor; the long-term benefits are also more pronounced than the short-term recommendations. At certain intersections, this improvement would be significant. The intersection of Pageland Highway and US 74 is shown in Figure 7.

At Pageland Highway, the 2015 long-term LOS, through just the implementation of signal timing optimization, is projected to improve from “E” to “C,” with a delay savings of over 44 seconds at the PM peak travel hour. However, the intersection directly to the east of the Pageland Highway intersection, Franklin Street, shows an increase in delay between the 2015 no-build and 2015 long-term delay of over 12 seconds. The 2015 no-build LOS is a “C,” while the 2015 LOS with the proposed long-term improvement is “D.” Delay at certain intersections is increased by signal timing optimization, while other intersections experience reductions in delay from the optimization process.

### Situation

<table>
<thead>
<tr>
<th>Situation</th>
<th>AM Peak Delay</th>
<th>PM Peak Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 No-Build Situation</td>
<td>766.0 seconds</td>
<td>1,600.4 seconds</td>
</tr>
<tr>
<td>2015 Short Term</td>
<td>715.7 seconds</td>
<td>944.9 seconds</td>
</tr>
</tbody>
</table>

Figure 7 – Intersection of US 74 and Pageland Highway

However, the overall benefit to the corridor by the optimization is real and is a feasible solution that can offer delay relief to local residents. For the ten intersections where Stantec solely proposed optimization of signal timing as a long-term improvement, the projected PM peak delay for the long-term improvement is reduced by a total of 57.58 seconds from the 2015 no-build option. Of these ten intersections, five will experience an improvement in LOS as a result of this optimization. Two of the ten intersections will have an LOS that is worsened. Though certain intersections may experience an increase in delay, OCL believes signal timing optimization will benefit the US 74 corridor, provided it is maintained properly.

Stantec also makes a long-term recommendation to convert existing traffic signals to an eight-phase traffic signal. This recommendation is made at five intersections along US 74. OCL anticipates this recommendation to have a positive effect on local drivers for the same reasons as described in the short-term section. This is backed up by Stantec’s provided data. The total sum of the reductions in delay between the 2015 no build model and the 2015 long-term model for these five intersections is 34.4 seconds for the AM peak hour and 367.87 seconds for the PM peak hour.

In addition to the previously-described short-term recommendations, Stantec makes several long-term recommendations for the addition of turning lanes/lane length. The following table illustrates the proposed long-term lane addition/lengthening for certain intersections along the US 74 corridor:

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Proposed Long-Term Improvement(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wesley Chapel-Stouts Road/Sardis Church Road</td>
<td>Add a right turn lane with 250 ft. of storage on the southbound Sardis Church Road approach; add a second left turn lane on the northbound Wesley Chapel-Stouts Road approach; add a right turn lane along eastbound US 74</td>
</tr>
<tr>
<td>Chamber Drive</td>
<td>Add a right turn lane with 175 ft. of storage on Chamber Drive</td>
</tr>
<tr>
<td>Rocky River Road</td>
<td>Add a through/right turn lane on the northbound and southbound approach on Rocky River Road with 250 ft. of storage in the left turn lane on the northbound approach and 275 ft. of storage in the left turn lane on the southbound approach</td>
</tr>
<tr>
<td>Roland Drive/Round Table Road</td>
<td>Add a through lane along eastbound and westbound US 74</td>
</tr>
<tr>
<td>Williams Road</td>
<td>Add a through lane along eastbound and westbound US 74</td>
</tr>
<tr>
<td>Hanover Drive</td>
<td>Add a through lane along eastbound and westbound US 74; increase the westbound US 74 left turn lane storage to 200 ft.</td>
</tr>
<tr>
<td>Secrest Short Cut Road</td>
<td>Increase the southbound Secrest Short Cut Road left turn lane storage to 300 ft.</td>
</tr>
<tr>
<td>Morgan Mill Road</td>
<td>Increase the Morgan Mill Road left turn and right turn lane storage to 200 ft.</td>
</tr>
<tr>
<td>Walkup Avenue</td>
<td>Extend the westbound US 74 left turn lane to 300 ft; add an additional left turn lane to the eastbound approach of US 74; extend the left turn and right turn lane storage on Walkup Avenue to 200 ft.</td>
</tr>
</tbody>
</table>
Additionally, Stantec also recommended modifying specific lane assignments in several locations. The following table illustrates the proposed long-term lane modifications for certain intersections along the US 74 corridor:

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Proposed Improvement(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wesley Chapel-Stouts Road/</td>
<td>Convert the existing through/right turn lane on the southbound approach of Sardis Church</td>
</tr>
<tr>
<td>Sardis Church Road</td>
<td>Road to a Dedicated Through Lane (Proposed in Conjunction with the Addition of a New</td>
</tr>
<tr>
<td></td>
<td>Right Turn Lane)</td>
</tr>
<tr>
<td>Chamber Drive</td>
<td>Convert the existing right turn/left turn lane on the southbound approach of Chamber Drive</td>
</tr>
<tr>
<td></td>
<td>to a dedicated left turn lane (proposed in conjunction with the addition of a new right</td>
</tr>
<tr>
<td></td>
<td>turn lane)</td>
</tr>
<tr>
<td>Hanover Drive</td>
<td>Convert the existing right turn lane on the westbound US 74 approach to a right turn/</td>
</tr>
<tr>
<td></td>
<td>through lane (listed both in ST and LT improvements)</td>
</tr>
</tbody>
</table>

These recommendations are quite similar to those made in the short term, and the expected benefits are similar. The addition of this turning lane storage in the long term will continue to alleviate problems resulting from turning vehicles stacking into through lane storage and delaying through traffic. Adding lane capacity and providing protected left turns in the long term will continue to reduce delay for turning drivers, and moving these turning drivers out of through lanes will continue to reduce delay for through drivers. Essentially, the same benefits will be provided to local drivers. These implementations will simply take longer and are more expensive than the short-term recommendations.

Once again, Stantec’s data backs up these assertions. The following chart highlights the total delay across the study corridor for the no-build and long-term scenarios. The No-Build total for this chart excludes three intersections (US 74 with Stallings Road, Indian Trail-Fairview Road, and Unionville-Indian Trail Road) as long-term delays were not provided in the Stantec report for these intersections.

<table>
<thead>
<tr>
<th>Situation</th>
<th>AM Peak Delay</th>
<th>PM Peak Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 No Build (Excluding Stallings Road, Indian</td>
<td>538.0 seconds</td>
<td>1,147.6 seconds</td>
</tr>
<tr>
<td>Trail-Fairview Road, and Unionville-Indian Trail Road)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015 Long Term</td>
<td>538.9 seconds</td>
<td>658.5 seconds</td>
</tr>
</tbody>
</table>

As can be seen from this chart, the construction of the long-term recommendations will provide a PM peak delay reduction of approximately 489.11 seconds for drivers traveling the length of the corridor. The AM peak delay will remain roughly the same. Stantec’s long-term recommendations offer delay benefits to local residents over this time frame; residents traveling on US 74 will save substantial time driving US 74 in the PM hours if Stantec’s long-term recommendations are implemented.

Stantec also discusses the possibility of converting a portion of US 74 into a “superstreet” as a long-term recommendation. This modification is recommended for the intersections of US 74 with Stallings Road, Indian Trail-Fairview Road, and Unionville-Indian Trail Road. As previously stated, Stantec defines a “superstreet-type facility” as “intersections that do not allow left turns from side streets, but require vehicles to turn right and then make a U-turn at an adjacent median opening.” The purpose of this design is to remove left-turning movements from side streets, eliminating an operation that often creates delay for through traffic and right turns on side streets. The concept is reliant on local left turn lanes along the main road having enough stacking space to accommodate travelers wishing to make left and U-turn movements.

No long-term delay figures for these three intersections are provided in the portion of the report reviewed by OCL; according to the Stantec report, LOS, delay, and travel time results from superstreet design implementation is found in Appendix VIII of the
report, which was not readily available to OCL personnel. OCL believes this is a design solution worth studying as a means of further reducing delay.

**Evaluation of Recommendations**

Stantec’s recommendations, as made to NCDOT, should benefit local residents by saving driving time along the US 74 corridor. However, Stantec’s long-term projections extend only to 2015, eight years later than the existing conditions, and only two years away from the publication of this report. The Monroe Bypass/Connector is proposed as a long-term solution to transportation concerns southeast of Charlotte. In order to accurately determine if US 74 and the proposed recommendations would help solve local, long-term transportation problems, the recommendations for upgrading US 74 should be evaluated over a longer timeframe. While it is clear that the proposed solutions do offer substantial benefits to residents, it remains unclear if these benefits project over an additional 20 years in the future.

In OCL’s opinion, Stantec has provided valid recommendations that could be used to provide delay relief to local residents using US-74 at lesser cost than the proposed Monroe Bypass/Connector project (projected to cost between $749.1 and $824.3 million according to the NCDOT “Monroe Bypass/Connector Final EIS Fact Sheet”). OCL believes it is reasonable to assume that some benefits would extend over a longer term that matches the Monroe Bypass/Connector timeline; therefore, Stantec’s report should be projected further in the future to determine if these recommendations could provide necessary long-term relief to residents in a cost-effective manner. These data could help determine if improvements to US 74 are a viable long-term solution that could help meet the goal of high-speed, safe transportation in the US 74 area while still providing local access to properties along US 74.

**Interchange Evaluation**

The subject stretch of US 74 reviewed by Stantec includes two larger interchanges that are not discussed in the Stantec report. The larger of the two interchanges is located at the crossing of Skyway Drive (State Highway 75) and US 74 in Monroe, NC, and is shown in Figure 8. State Highway 75 passes over US 74, and several exit ramps allow for movement between the two roads. Concord Avenue, northwest of State Highway 75, also crosses over of US 74 and is shown in Figure 9, on the next page. Access is provided between the two roads through two sign-controlled intersections along Concord Avenue. Access is provided to both traveling directions of US 74 via exit ramps. Traffic is allowed to accelerate/decelerate and merge into US 74 from Concord Avenue in dedicated lanes.

![Figure 8 – Intersection of Skyway Dr. and US 74, Monroe, NC](U.S. Department of the Interior U.S. Geological Survey, 2007)

OCL did not perform any engineering analysis on these interchanges. However, based on a visual evaluation, OCL believes delay may occur on US 74 at the Concord Avenue interchange. Inadequate acceleration/deceleration lane length space may cause drivers from Concord Avenue to enter US 74 at speeds below...
the posted speed limit, forcing drivers in the far right lane of US 74 to brake for below-speed drivers or slow down to allow for merging activity. Additionally, the access ramps from US 74 appear short. Drivers turning onto Concord Avenue may stack onto US 74, creating additional delay on US 74. One potential solution to this inadequate lane length is to extend the length of the acceleration/deceleration lanes, allowing drivers to perform full acceleration/deceleration prior to entering/exiting US 74; this should be investigated as either a long-term recommendation. Additional solutions, such as increasing the lengths of the on/off ramps or modifying the interchange configuration, should also be investigated. This interchange should be included in the expanded Stantec study to determine if total overall total delay will be impacted by the current intersection configuration.

Based on a visual review of the interchange between US 74 and State Highway 75, it appears there is an adequate amount of car storage space and acceleration/deceleration lane length; OCL does not believe this interchange, as currently configured, will create undue delay on US 74. However, for the purposes of thoroughness, this interchange should also be included in the revised Stantec report to accurately model overall corridor delay. Notable amounts of congestion resulting from movements at this intersection should be included in this review and in local transportation evaluation.

Clearly, there is some additional information needed to fully evaluate the potential for Stantec’s recommendations to alleviate traffic problems found on US 74. An expanded study should be performed on these interchanges to adequately determine whether recommendations are needed at these interchanges to improve overall movement on US 74.

Detailed Review of the Wilbur Smith Associates Report

OCL reviewed the WSA report entitled “Final Report – Proposed Monroe Bypass/Connector Comprehensive Traffic and Revenue Study,” prepared for the NCTA by WSA. This report is dated October 22, 2012. In reviewing this report, OCL concluded that the WSA report did not thoroughly answer certain questions and needs to have additional detail added to provide the best possible information to local decision makers. In particular, the information gathered for the O-D Study needs to be expanded and gathered in revised manner to provide useful data on local and regional transportation patterns.

From 2009-10, WSA completed several studies in relation to the Monroe Bypass/Connector project. WSA completed an O-D Study in the area of the proposed Monroe Bypass/Connector using a mail-back survey procedure. A sample survey card is depicted in Figure 10. The O-D Study was performed to catalogue travel patterns and trip characteristics of local residents. This data was later used by WSA to develop a local value of time.

OCL reviewed this report to comment on the relevance and thoroughness of the O-D Study and the need for additional traffic/transportation study. OCL was also asked to comment on the importance of a full O-D Study and limitations of current studies without complete O-D information.

In the report, WSA indicated that the O-D Study was performed based on 3,611 valid surveys returned to WSA from 23,807 distributed surveys. These surveys were distributed to drivers at ten locations in the area
of US 74 in Union County and included queries on starting and ending location of trips, frequency of the trips, types of vehicle making the trip, and the home zip code of the driver. Using this data, WSA created charts showing the trip purpose, frequency, occupancy, and vehicle class based on peak and off-peak hours. WSA also developed overall charts showing origin-destination pairs gleaned from the survey.

In reviewing WSA’s O-D Study, OCL noted the locations of the survey drop-off points. All points were located outside of the existing I-485 Charlotte Outerloop. However, no surveys were provided to travelers in Charlotte, Matthews, or other towns within the Charlotte Outerloop. The survey locations are shown in Figure 11 on the next page. OCL recommends providing surveys to drivers at a location nearer to Charlotte. The need for this is indicated by the disparity between the number of trips originating and ending in Charlotte, which is the dominant employment and population center in the region. Only 5.6% of both peak hour and non-peak hour trips used in the O-D Study originated in Charlotte; however, 26.8% of the trips in the study ended in Charlotte. This substantial disparity indicates that the location of the handout locations should have been adjusted to provide a better cross-section of drivers. OCL understands that O-D survey methodologies are not an exact science. However, an accurate representation of the local culture and travel patterns needs to be obtained, and the best way to obtain this accurate information is to survey an accurate cross-section of the local populace.

In OCL’s opinion, it is important for the O-D survey to provide an accurate breakdown of the numbers of trucks and passenger vehicles traveling along this stretch of US 74. OCL also considered the types of vehicles selected for this survey. WSA indicated that 98.4% of all peak period trips were made by drivers in two-axle passenger vehicles. 96.1% of the off-peak hour trips were made by drivers in two-axle passenger vehicles. According to Table 2-8 of the WSA report (Figure 12 on the next page), passenger vehicles constitute an average of 91.6% of vehicles in the area.
For the purposes of this report, OCL assumed that “single unit” trucks, as listed in Table 2-8, corresponds with 2-axle, 6-wheel trucks (or trucks with more axles) from the O-D Study. Therefore, the O-D Study vehicle sample shows a difference of several percentage points from the measured vehicle percentages. OCL believes WSA should either collect additional data sets or adjust its data to more accurately model the true vehicle representation patterns in the area; this adjustment would provide a better representation of commercial traffic and thus, better information to evaluate local travel patterns. A better option would be to perform an O-D study on solely

**Figure 11 – Travel Pattern Survey Locations**
North Carolina Turnpike Authority Final Report, "Proposed Monroe Connector/Bypass Comprehensive Traffic and Revenue Study," Wilbur Smith Associates, Chapter 3 - Travel Pattern Survey, Figure 3-1 – Travel Pattern Survey Locations, October 22, 2010

**Figure 12 – Table 2.8 Vehicle Classifications at Selected Locations**
North Carolina Turnpike Authority Final Report, "Proposed Monroe Connector/Bypass Comprehensive Traffic and Revenue Study," Wilbur Smith Associates, Chapter 2 – Existing Travel Conditions, Table 2-8 Vehicle Classifications at Selected Locations, October 22, 2010
commercial vehicles to truly measure travel patterns of commercial drivers.

The O-D Study performed by WSA indicated that surveys were distributed at individual locations on either one or two specific days for each of the ten survey locations. General O-D study principles indicate that data should be captured every day of the week for a substantial period of time. This longer collection period accounts for travel variations with changes in days, months, and seasons. Though WSA later tries to normalize this data based on trends associated with travel across the months of the year, OCL believes projections should be made based on accurately-assembled data that takes these variations of travel into account.

OCL recognizes that O-D data can be difficult to collect due to limited funds and public participation. However, it appears that WSA could have expanded its study to include additional information that would have yielded more accurate results. It is troubling that WSA collected data for only one day at individual locations; it indicates to OCL that the study was conducted very quickly. The speed of this study may have been done at the expense of completeness.

Overall, OCL recommends WSA revise its O-D Study in the following three ways:

- Perform individual commercial traffic and passenger vehicle traffic O-D studies
- Expand the data collection area to include sites inside the Charlotte Outerloop, including locations in Matthews, Charlotte, and other population centers
- Expand the amount of time spent collecting data to account for variations in travel patterns by collecting data at each location for at least one month

OCL believes a study with additional survey location points and additional study length must be performed to accurately model the trip patterns of the local population. Collecting a larger sample size of data over a longer period of time will help normalize outlying trends and provide an accurate data set.

A complete and accurate O-D study is essential to determine who is driving on US 74, the purposes of their trips, and the starting/ending destinations for their trips. Accurate projections using this data must be made based on Stantec’s proposed recommendations to US 74 to determine if Stantec’s recommendations will help to alleviate delay on US 74. This information must be considered to determine if US 74 can be improved to provide a long-term solution to local transportation concerns and provide effective transportation in this corridor at an effective price.
CONCLUSION

Based on OCL's review, a thorough O-D study with high-quality data has not been performed for the area of North Carolina the Monroe Bypass is expected to service. The overall lack of a quality O-D study limits the conclusions that can be drawn from the studies reviewed by OCL.

It is essential for all stakeholders to know and understand the quality of data used to develop conclusions about future transportation projects and the wisest way to spend limited transportation dollars. OCL believes Stantec has provided NCDOT with good ideas about how to reduce delay along the US 74 corridor; these ideas simply need to be expanded over a longer time frame. Additionally, OCL recommends a more comprehensive O-D Study be performed and plugged into the methodologies proposed in the WSA study to accurately model the local population and provide decision makers with better data for moving forward.

Overall, OCL believes the reviewed reports could be improved and could provide better data to those making transportation decisions for the residents of North Carolina. The impacts of modifications to US 74 should be accurately quantified in a long-term fashion so the best decisions about future transportation planning can be made by local authorities. The best information that can be obtained should be made available to those wishing to benefit the drivers of North Carolina.

Moving forward, new studies should be conducted by the NCDOT to accurately assess the potential use of US 74 as a means of travel in the future. An O-D study that adequately models the local travel patterns should be used in conjunction with a software model and the recommendations proposed in the Stantec report to extend Stantec's shortened time frame over a longer period to accurately determine US 74's ability to function as a long-term congestion solution in the area of Charlotte, NC. This should be performed, and this information should be provided to local decision makers and the local populace prior to any further decisions being made on future transportation projects.

This report was prepared under my direct supervision.

Kenneth J. O'Connell, Ph.D.
State of North Carolina Professional Engineer #22824
O’Connell & Lawrence, Inc. (OCL) is a consulting firm which provides construction consulting, construction management, engineering, and surveying services. OCL’s staff is comprised of engineers, project managers, construction inspectors, surveyors, information system specialists, as well as support personnel. OCL is located in the Baltimore/Washington, D.C., suburb of Olney, Maryland, and has worked on projects throughout the United States. OCL has extensive experience in heavy civil, highway, transportation, industrial and commercial construction. OCL routinely reviews project documents and completes third-party reviews of proposed projects and/or design documents. OCL routinely performs engineering/surveying projects and prepares construction documents. As part of the preparation of these documents, OCL routinely reviews multiple options for individual design problems and effectively determines the most advantageous solution based on individual site characteristics.

OCL was retained by the Southern Environmental Law Center (SELC) to perform an independent and thorough evaluation of the proposed Monroe Bypass/Connector project, to be located southeast of Charlotte, NC, in both Union and Mecklenberg Counties. In particular, OCL was retained by SELC to review several documents prepared for NCDOT and NCTA regarding the proposed project. OCL reviewed the “US 74 Corridor Study,” prepared by Stantec for the NCDOT and received from SELC on August 30, 2012. OCL reviewed a report entitled “Indirect and Cumulative Impact Analysis – R-2559 & R-3329 Monroe Bypass/Connector,” prepared by HNTB North Carolina P.C. (HNTB). OCL also reviewed the “Final Report – Proposed Monroe Bypass/Connector Comprehensive Traffic and Revenue Study” prepared for the NCTA by WSA and dated October 22, 2012. OCL reviewed the “Monroe Bypass/Connector Administrative Action Record of Decision,” dated August 2010 and prepared by the NCTA. Finally, OCL reviewed other publicly available documentation associated with the Monroe Bypass/Connector project to obtain a full picture of the proposed highway. This list is not all-inclusive. OCL personnel visited the subject area on August 29, 2012. Kenneth O’Connell, Ph.D., P.E., and Douglas Tilley, P.E., traveled to the Charlotte, NC, area with personnel from SELC and personally examined existing US 74 from the intersection with I-485 to Marshallville, NC, beyond the proposed Monroe Bypass/Connector tie-in point with existing US 74.

OCL reviewed the US 74 Corridor Study, prepared by Stantec, and provided commentary on the effectiveness and feasibility of the proposed upgrades/recommendations. Stantec’s report focused on providing spot improvements to local roads, most particularly US 74 and its cross-streets, in the area of the proposed Monroe Bypass/Connector. The Stantec Report covers proposed improvements along US 74 from Stallings Road to Highway 601; this stretch of highway travels from just southeast of the intersection of I-485 and US 74 to the center of Monroe, NC. It should be noted that this stretch of road does not fully parallel the proposed Monroe Bypass/Connector; this section of US 74 studied by Stantec parallels roughly half of the proposed Monroe Bypass/Connector, which is proposed to re-intersect with US 74 in the area of Wingate, NC.

The Stantec report is based on a traffic study performed between January and March 2007. Stantec personnel obtained traffic data, determined the AM and PM peak hour periods, and utilized CORSIM, Version 5, a traffic simulation program, to determine total time delay and LOS for each of the studied 23 intersections. Using this information, Stantec developed short-term and long-term improvements for individual intersections to reduce vehicular delay along existing US 74. The Stantec report makes recommendations to improve intersections along this stretch of road so as many of the 23 intersections as possible will function at a LOS of D or better. In this report, OCL comments on the ability of the recommendations made in Stantec’s report to provide both short- and long-term benefits to local residents living in the vicinity of the

APPENDIX: STATEMENT OF ASSIGNMENT
US 74 project whether these recommendations could be expanded to a longer time frame. Stantec did not propose improvements to the interchanges of US 74 and State Highway 75 and Concord Avenue. OCL will comment on these unchanged interchanges, providing an assessment of the decision to leave these intersections untouched and suggesting potential recommendations for future interchange improvements that may assist local residents in the long term.

OCL also performed a thorough review of the WSA report, which detailed an O-D Study performed in March and April 2009. This O-D Study was used to determine local travel patterns in the area of the proposed Monroe Bypass/Connector. OCL reviewed this report for completeness, thoroughness, and relevance. In addition, OCL reviewed whether additional traffic generation/travel information is required to make an educated decision regarding the need for the Monroe Bypass/Connector project and provided comment on the importance of a full and complete set of Origin-Destination data prior to making costly road construction decisions.

Finally, OCL has provided comment on the need for additional studies and/or data collection prior to making final decisions on the need for the Monroe Bypass/Connector project. OCL believes additional information is required to make an educated decision on the need for the Monroe Bypass/Connector; the reasoning behind this belief may be found in this document.

The principal for this assignment is Kenneth J. O’Connell, Ph.D, P.E. Dr. O’Connell is registered Professional Engineer #22824 in the state of North Carolina.