

STATE OF NEW HAMPSHIRE
INTRA-DEPARTMENT COMMUNICATION

FROM: John D. Butler, P.E. ^{JDB}
Geometrics Engineer

DATE: October 2, 2020
AT (OFFICE): Bureau of Highway Design

SUBJECT: MISC. ENG DISTRICT 5
1832-I
Hudson, NH Route 3A (Lowell Road)
Proposed Logistics Center (Amazon)

TO: Brian A. Desfosses, P.E.
Assistant District Engineer

MEMORANDUM

The Bureau of Highway Design has completed a review of the following materials relative to the proposed Hudson Logistics Center (Amazon) on the west side of NH Route 3A (Lowell Road), on the current Green Meadow golf course property:

- “Traffic Impact Study” (TIS) prepared by Langan, dated “April 2020, Revised September 2020”.
- “Traffic Impact Study Supplement” prepared by Langan, dated September 2020
- Synchro files associated with the TIS, received from Langan on September 9, 2020
- “VISSIM Evaluation of Merge and Weave Segments Along Sagamore Bridge Road” memo prepared by Stantec, dated August 20, 2020, and associated video clips of the VISSIM microsimulation
- “Potential Peak Season Trip Generation” memo prepared by Langan, dated September 22, 2020.

The proposed development consists of:

- Three “e-commerce fulfillment center warehouse buildings” with the following approximate building footprints:
 - Lot A – 1,079,660 sf
 - Lot B – 1,005,480 sf
 - Lot C – 529,844 sf

Access is proposed via two existing access points on the west side of NH 3A (Lowell Road). Both access points are existing signalized intersections.

- Shared driveway with the existing Sam’s Club private driveway.

- Shared driveway with the current private driveway to Mercury Systems. This access point is envisioned to become a town road called Green Meadow Drive.

Our review focused on the NH 3A (Lowell Road) corridor within NHDOT jurisdiction (Sagamore Bridge Road intersection southerly through the Dracut Road/Steele Road intersection), and on the Sagamore Bridge Road (Circumferential Highway) corridor between NH 3A and the FE Everett Turnpike.

We have the following comments:

NH 3A (Lowell Road) Corridor

1. In general, we concur that the proposed geometric modifications and adaptive signal control at the four NHDOT signalized intersections will adequately mitigate the development's traffic; however, we have specific concerns noted below.
 2. Two alternatives were presented at the Dracut Road/Steele Road intersection: a 2-lane roundabout and a redesignation of the southbound lane use for dual left turns onto Dracut Road. We prefer the alternative to redesignate the southbound lane use. According to Table 10 of the TIS, this alternative results in significant improvement (Build vs. No Build) in the PM peak hour (LOS F to LOS C), and essentially no change in the AM peak hour (LOS B). If the roundabout were to be pursued, we would need to do a more thorough review of the geometrics but some initial concerns include a relatively small inscribed diameter (175') for a 2-lane roundabout, and the very poor deflection angle for the Dracut Road approach due to the skew.
 3. The proposed geometry along NH 3A results in three "trap" lanes (where a through lane becomes an exclusive turning lane):
 - Northbound through lane at Walmart Boulevard becomes an exclusive left turn lane at Sagamore Bridge Road
 - Southbound through lane at Walmart Boulevard becomes an exclusive right turn lane at Green Meadow Drive
 - Southbound through lane at Green Meadow Drive becomes an exclusive left turn lane at Dracut Road.
- Trap lanes are undesirable from a safety perspective. The consultant should investigate ways to eliminate the trap lane geometry. If this is not feasible, measures to mitigate the safety concern should be presented.
4. The next iteration of plans should include more detailed geometry including:
 - Alignments with curve data for NH 3A and all side roads
 - Lane, shoulder, and median widths
 - All lane and shoulder taper rates and lengths

Some unacceptably abrupt lane tapers are shown on the concept plans, such as on Dracut Road. See plan markups.

5. Several areas where widening is proposed lack adequate shoulder width. Where widening, paved shoulders should be a minimum of 4' wide if uncurbed, and 5' wide if curbing or guardrail is present.
6. Eleven-foot-wide travel lanes would be acceptable.
7. There appears to be several areas along NH 3A where right-of-way or easement acquisitions may be required from adjacent properties. Where widening is proposed, a minimum width from the edge of pavement to the right-of-way line needs to be provided for snow storage, signing, utilities, etc. We defer to District 5 as to what that minimum width should be in this particular location, but given the width of the road we would recommend at least 5' to 7', with 10' preferred. The developer would be responsible to acquire the necessary right-of-way or easements to accommodate their improvements.

Given the critical nature of the existing right-of-way lines, the developer should consider having their location certified by a licensed land surveyor.

8. The consultant needs to consider stormwater treatment needs along NH 3A. Given the proposed widening and additional impervious surface, and the fact that Hudson is an MS4 community, the expectations from NHDES for stormwater treatment will likely be significant, and may require right-of-way acquisition. District 5 should comment on maintenance expectations for any stormwater treatment areas.
9. It is unclear if the plans call for bringing the eastbound right turn lane from Sagamore Bridge Road into its own lane on NH 3A. This would be a benefit in terms of processing the heavy right turn volume but would create a potential safety concern with vehicles looking to weave over to turn left at Walmart. Recommend additional internal discussions with Bureau of Traffic and District 5 as to why the existing situation is a yield.
10. Need more details of the proposed triple left geometry at Sagamore Bridge Road. Concerns include more width needed on Sagamore Bridge Road to accept the triple left, and an unusual turning path as depicted on the concept plan (part tangent, part curve) which will not be intuitive if the cat tracks are obliterated or snow covered.
11. Confirm with Bureau of Traffic, but I believe they will require that all intersection approaches with five or more lanes will require advance overhead lane use signage. Sign supports within the median island would not be acceptable. Span wire might be acceptable.
12. Two of the intersections currently have at least some of the signal heads on span wires as opposed to mast arms. Coordinate with Bureau of Traffic as to if mast arms are required.

13. The concept plans show creating a third northbound through lane immediately north of the Rena Avenue intersection. We recommend that the creation of the third lane occur a short distance to the north so that there is no confusion as to which lanes the dual lefts from Green Meadow Drive or the dual northbound through lanes on NH 3A line up with.
14. NH 3A (River Road) southbound south of the Dracut Road/Steele Road intersection should be restriped to a single lane as there would now be only one lane feeding it.
15. There are several areas where existing shoulders are being partially repurposed as travel lanes. The consultant will need to investigate the current structural section in the shoulders to determine if it is adequate to serve as a travel lane.
16. While not required for purposes of the TIS, there is a fifth leg to the Dracut Road/Steele Road intersection that serves a driveway. This will need to be accounted for when developing formal signal plans.
17. Dracut Road is incorrectly noted to be a local (town) road. It is a State owned/maintained road. Also, NH 3A (Lowell Road) is incorrectly noted to be a State road throughout the project area. It is only a State road to the south of the Sagamore Bridge Road intersection, it is a local (town) road north of there.

Sagamore Bridge Road (Circumferential Highway) Corridor

1. Analysis of ramp merge, diverge, and weaving sections was done both by Langan using Highway Capacity Manual (HCM) software and by Stantec using VISSIM microsimulation. Based on the information provided to date, we are unsure as to if mitigation should be required. See comments below.
2. We are concerned with the statement in the Stantec memo regarding the VISSIM modeling calibration that says that they developed “*a specific driver behavior profile for merging and weaving segments that reflect cooperative lane changes which are typical for this area*”. This implies that default driver behavior parameters were manipulated to produce better results. It seems unlikely that drivers in this area are unusually polite. What are the results if standard driver behavior parameters are used? Further explanation required.
3. The section between NH 3A and the ramps to the DW Highway is technically a weaving area; however, it is quite long and probably better analyzed by the VISSIM analysis rather than by conventional HCM software. The VISSIM video clips and results summarized in Table 2 of the Stantec memo show that this area functions reasonably well in the 2032 Build condition. The westbound weave does show a relatively small increase in density, but the Build condition is a LOS C. The eastbound approach to NH 3A does show significant queuing, but it is improved over the No Build condition due to the added intersection capacity provided by the northbound triple left.

- The westbound and eastbound weaving sections between the DW Highway ramps and the Everett Turnpike ramps have relatively conventional geometry. As such, we would expect the HCM software to produce reasonably reliable results; however, the HCM results from Langan and the VISSIM results from Stantec are vastly different. No explanation was provided.

Langan (September 2020 TIS Supplement):

	2032 No Build		2032 Build	
	LOS (AM/PM)	Density (AM/PM)	LOS (AM/PM)	Density (AM/PM)
Westbound weave	E/E	38.6/38.5	E/F	41.6/>43
Eastbound weave	C/E	25.7/41.7	D/F	29.2/>43

Stantec (August 20, 2020 memo):

	2032 No Build		2032 Build	
	LOS (AM/PM)	Density (AM/PM)	LOS (AM/PM)	Density (AM/PM)
Westbound weave	B/B	19.06/18.56	C/C	20.22/20.67
Eastbound weave	B/B	14.82/16.07	C/C	21.04/22.49

Synchro/SimTraffic/VISSIM Comments

- Green Meadow Drive and Rena Avenue are coded with concurrent phasing in both the No Build and Build condition. With the large increase in volume on Green Meadow Drive in the Build condition, these approaches may need to be split phased for safety reasons. Coordinate with Bureau of Traffic.
- Synchro reports show the Sagamore Bridge Road eastbound right turn movement coded as “free”, but it is currently under yield control.
- All analyses show no right turn overlap for the Walmart and Sam’s Club approaches during the NH 3A northbound/southbound left turn phase. Is this accurate? If so, coordinate with Bureau of Traffic as to why not.
- Synchro model: The Dracut Road and northbound NH 3A (River Road) approaches at the Dracut Road/Steele Road intersection are not drawn long enough to contain the queuing observed in SimTraffic, making the SimTraffic queuing results inaccurate.

5. Very few trucks are observed in the SimTraffic and VISSIM micosimulations. Synchro is coded with only 1% or 2% trucks. Seems very low, even for the peak hours. Does field data support this?
6. The TIS notes that due to non-NEMA or atypical phasing at some intersections, Synchro cannot produce the typical HCM 6th Edition or HCM 2010 reports. We agree with this; however, our typical fall-back would be to use HCM 2000 report results for delay, LOS and v/c ratios. Langan chose to use the "Synchro Percentile Delay" results from the Lanes/Volumes/Timings reports in their summary tables. We are willing to accept this; however, we would want to discuss this up front if Langan is involved in future traffic impact studies for NHDOT.

cc: W. Cass W. Lambert
 W. Oldenburg N. Sanders
 R. Radwanski M. O'Donnell
 N. Spaulding J. Mathews

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Memorandum

Langan Engineering & Environmental Services, Inc.
888 Boylston Street, Suite 510 Boston, MA 02199 T: 617.824.9100 F: 617.824.9101

To: Brian Desfosses/NHDOT

From: John D Plante, PE

Info: Brian Groth/Town of Hudson
 Elvis Dhima/Town of Hudson
 Marty Kennedy/VHB Peer Review
 John Graves/Hillwood
 Gary Frederick/Hillwood
 John Smolack/Smolack & Vaughan
 Nate Kirschner/Langan

Date: October 9, 2020

Re: Response to TIS Comments
 Hudson Logistics Center
 Hudson, NH
 Langan Project No.: 151010101

Below are the applicant's responses to comments made in an Intra-Department Communication from John Butler to Brian Desfosses, dated October 2, 2020. Below please find each comment followed by our response in ***bold and italics***.

NH 3A (Lowell Road) Corridor:

1. In general, we concur that the proposed geometric modifications and adaptive signal control at the four NHDOT signalized intersections will adequately mitigate the development's traffic; however, we have specific concerns noted below.

LANGAN RESPONSE: Noted.

2. Two alternatives were presented at the Dracut Road/Stele Road intersection: a 2-lane roundabout and a redesignation of the southbound lane use for dual left turns onto Dracut Road. We prefer the alternative to redesignate the southbound lane use. According to Table 10 of the TIS, this alternative results in significant improvement (Build vs. No Build) in the PM peak hour (LOS F to LOS C), and essentially no change in the AM peak hour (LOS B). If the roundabout were to be pursued, we would need to do a more thorough review of the geometrics but some initial concerns include a relatively small inscribed diameter (175') for a 2-lane roundabout, and the very poor deflection angle for the Dracut Road approach due to the skew.

LANGAN RESPONSE: We understand the NHDOT's preferred improvement at this location is the redesignation of lanes and not the roundabout. We will proceed with this recommended improvement.

3. The proposed geometry along NH 3A results in three "trap" lanes (where a through lane becomes an exclusive turning lane):
- Northbound through lane at Walmart Boulevard becomes an exclusive left turn lane at Sagamore Bridge Road
 - Southbound through lane at Walmart Boulevard becomes an exclusive right turn lane at Green Meadow Drive
 - Southbound through lane at Green Meadow Drive becomes an exclusive left turn lane at Dracut Road.

Trap lanes are undesirable from a safety perspective. The consultant should investigate ways to eliminate the trap lane geometry. If this is not feasible, measures to mitigate the safety concern should be presented.

LANGAN RESPONSE: We will look to eliminate this type of lane arrangement if at all possible, and mitigate (signage, pavement markings, etc) the conditions that cannot be eliminated. These three turning lanes cited accommodate large volumes of traffic, which is the main reason these lanes are provided. We believe the value of these additional lanes significantly improve the existing operations of the Lowell Road corridor.

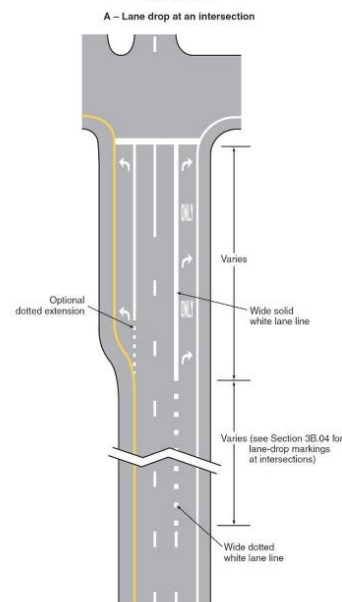
Northbound through lane at Walmart Boulevard becomes an exclusive left turn lane at Sagamore Bridge Road. The TIS proposed overhead advance lane use signing for the approach to the triple left turn lane to Sagamore Bridge Road. The signing was patterned off what exists on South Willow Road approaching the triple left turn to the Mall of NH.

Southbound through lane at Walmart Boulevard becomes an exclusive right turn lane at Green Meadow Drive. There is not enough room between Walmart Boulevard and Green Meadow Drive to drop the through lane prior to developing an exclusive right turn lane. However, there is enough room to provide advance signing and marking according to Figure 3B-11 A – Lane Drop at an

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2009 Edition

Figure 3B-11. Examples of Applications of Conventional Road Lane-Drop Markings (Sheet 1 of 2)



intersection. The design involves a wide dotted lane line and a sign indicating two through lanes, a right turn only lane and a left turn only lane ahead. In addition, an attempt will be made to provide a traffic island on the Green Meadow approach that will further alert southbound motorists of the right turn only lane ahead. Southbound through lane at Green Meadow Drive becomes an exclusive left turn at Dracut Road. The roadway curvature between Green Meadow Drive and Dracut Road may facilitate restriping the Lowell Road to appropriately drop the outside through lane and develop two left turn lanes off the continuous inside through lane.

4. The next iteration of plans should include more detailed geometry including:
- Alignments with curve data for NH 3A and all side roads
 - Lane, shoulder, and median widths
 - All lane and shoulder taper rates and lengths

Some unacceptably abrupt lane tapers are shown on the concept plans, such as on Dracut Road. See plan markups.

LANGAN RESPONSE: The appropriate detail will be provided in the next design submission and the applicable design standards will be implemented and documented.

5. Several areas where widening is proposed lack adequate shoulder width. Where widening, paved shoulders should be a minimum of 4' wide if uncurbed, and 5' wide if curbing or guardrail is present.

LANGAN RESPONSE: See response to comment 7 below.

6. Eleven-foot-wide travel lanes would be acceptable.

LANGAN RESPONSE: Noted. It was discussed that if necessary ten-foot-wide, single, exclusive left-turn lanes can be utilized, if accompanied by a two-foot-wide inside shoulder.

7. There appears to be several areas along NH 3A where right-of-way or easement acquisitions may be required from adjacent properties. Where widening is proposed, a minimum width from the edge of pavement to the right-of-way line needs to be provided for snow storage, signing, utilities, etc. We defer to District 5 as to what that minimum width should be in this particular location, but given the width of the road we would recommend at least 5' to 7', with 10' preferred. The developer would be responsible to acquire the necessary right-of-way or easements to accommodate their improvements.

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LANGAN RESPONSE: *Noted, appropriate shoulder widths will be addressed in the design. Based on the discussion at the October 6, 2020, the design will reflect 4 or 5 foot shoulders adjacent to through lanes and where it can be accommodated; if needed, 2 foot shoulders adjacent to right-turn lanes will be provided; areas within the right-of-way will be provided to accommodate signs, utility poles, signal equipment, etc. Revised Conceptual Improvement plans will reflect shoulder widths.*

Upon receipt of detailed ground survey, we will design the widening to maximize the space available for snow and to accommodate utilities. Every effort will be made to provide a 7' panel where possible but anticipate the width may have to be reduced to 5' in these areas.

Given the critical nature of the existing right-of-way lines, the developer should consider having their location certified by a licensed land surveyor.

LANGAN RESPONSE: *A corridor survey is currently underway, however it is not available for use with the conceptual design.*

8. The consultant needs to consider stormwater treatment needs along NH 3A. Given the proposed widening and additional impervious surface, and the fact that Hudson is an MS4 community, the expectations from NHDES for stormwater treatment will likely be significant, and may require right-of-way acquisition. District 5 should comment on maintenance expectations for any stormwater treatment areas.

LANGAN RESPONSE: *Noted and will be incorporated into the design. Our stormwater management and treatment facilities will need to be reviewed and accepted by the Town and NHDOT for compliance with their respective MS4 permits, as well as approval of an Alteration of Terrain (AoT) permit through New Hampshire Department of Environmental Services. Our intent is to set up a scoping meeting to discuss these requirements with the impacted parties to ensure everyone is on the same page and the necessary steps are clear to gaining those approvals. We are in the process of obtaining additional property to potentially site a water quality BMP, understanding there will be a significant volume of runoff to be treated.*

9. It is unclear if the plans call for bringing the eastbound right turn lane from Sagamore Bridge Road into its own lane on NH3A. This would be a benefit in terms of processing the heavy right turn volume but would create a potential safety concern with vehicles looking to weave over to turn left at Walmart. Recommend additional internal discussions with Bureau of Traffic and District 5 as to why the existing situation is a yield.

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LANGAN RESPONSE: This item was discussed at a meeting with NHDOT on October 6, 2020. Langan pledged to work with the state to develop their preferred solution for this movement.

10. Need more details of the proposed triple left geometry at Sagamore Bridge Road. Concerns include more width needed on Sagamore Bridge Road to accept the triple left, and an unusual turning path as depicted on the concept plan (part tangent, part curve) which will not be intuitive if the cat tracks are obliterated or snow covered.

LANGAN RESPONSE: Noted, a more refined alignment will be developed for these movements as the design progresses.

11. Confirm with Bureau of Traffic, but I believe they will require that all intersection approaches with five or more lanes will require advance overhead lane use signage. Sign supports within the median island would not be acceptable. Span wire might be acceptable.

LANGAN RESPONSE: Noted.

12. Two of the intersections currently have at least some of the signal heads on span wires as opposed to mast arms. Coordinate with Bureau of Traffic as to if mast arms are required.

LANGAN RESPONSE: Noted and it was conveyed at the meeting on October 6, 2020 that the NHDOT's preference are mast arms.

13. The concept plans show creating a third northbound through lane immediately north of the Rena Avenue intersection. We recommend that the creation of the third lane occur a short distance to the north so that there is no confusion as to which lanes the dual lefts from Green Meadow Drive or the dual northbound through lanes on NH 3A line up with.

LANGAN RESPONSE: Agreed, will be revised

14. NH 3A (River Road) southbound south of the Dracut Road/Steele Road intersection should be restriped to a single lane as there would now be only one lane feeding it.

LANGAN RESPONSE: Noted.

15. There are several areas where existing shoulders are being partially repurposed as travel lanes. The consultant will need to investigate the current structural section in the shoulders to determine if it is adequate to serve as a travel lane.

LANGAN RESPONSE: A geotechnical investigation program will be part of the design process.

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16. While not required for purposes of the TIS, there is a fifth leg to the Dracut Road/Steele Road intersection that serves a driveway. This will need to be accounted for when developing formal signal plans.

LANGAN RESPONSE: Noted.

17. Dracut Road is incorrectly noted to be a local (town) road. It is a State owned/maintained road. Also, NH 3A (Lowell Road) is incorrectly noted to be a State road throughout the project area. It is only a State road to the south of the Sagamore Bridge Road intersection, it is a local (town) road north of there.

LANGAN RESPONSE: Noted.

Sagamore Bridge Road (Circumferential Highway) Corridor

1. Analysis of ramp merge, diverge, and weaving sections was done both by Langan using Highway Capacity Manual (HCM) software and by Stantec using VISSIM microsimulation. Based on the information provided to date, we are unsure as to if mitigation should be required. See comments below.

LANGAN/STANTEC RESPONSE: *The results of the VISSIM modeling shows that all weaving, merge, and diverge segments would operate at an acceptable LOS in the future conditions; thus, no additional mitigation would be required. The responses to specific concerns are provided below.*

2. We are concerned with the statement in the Stantec memo regarding the VISSIM modeling calibration that says that they developed "a specific driver behavior profile for merging and weaving segments that reflect cooperative lane changes which are typical for this area". This implies that default driver behavior parameters were manipulated to produce better results. It seems unlikely that drivers in this area are unusually polite. What are the results if standard driver behavior parameters are used? Further explanation required.

LANGAN/STANTEC RESPONSE: *Specific driving behaviors are necessary for most VISSIM analyses because the default driving behaviors for arterials are relatively aggressive, resulting in saturation flow rates of 2,400 vehicles per hour per lane, which is not typical for most arterials. In order to obtain a saturation flow rate that is more typical of a signalized arterial (1,900 – 2,000 vehicles per hour per lane), Stantec utilizes a research paper written by Andrew Warren of the Arkansas Department of Transportation entitled, "Calibration of Microsimulation Models to Field-Measured Saturation Flow Rates on Signalized Arterials".*

Furthermore, default freeway behaviors do not account for cooperative lane changes at merge, diverge, and weave segments, resulting in vehicles “getting stuck” in the model. Cooperative lane changes mean that vehicles can change their speed (either faster or slower) or change lanes in advance of merge area to allow merging vehicles to enter the freeway mainline, which is typical in most freeway analyses and actual behaviors. Many states such as Wisconsin DOT, Virginia DOT, Maryland DOT, and Louisiana DOT, among others identify this as an important factor for merge, diverge and weave segments in their modelling guidance. For example, MDOT VISSIM Modeling Guidance states, “It is recommended this option (cooperative lane change) be selected for all behaviors as it smooths transitions into more realistic driving behaviors.”

In order to set driver behavior parameters for specific projects, the model needs to be created and modified to reflect actual field conditions. Stantec conducted an iterative process in the base model, in this case the 2022 No Build condition, based on the field information that was available for the study area for pre-COVID conditions, such as local knowledge of the study area operations, typical traffic conditions as shown in Google maps, and video feeds from the turning movement counts. Stantec started with small adjustments to the behaviors, evaluated the model runs, and then continued to make adjustments as necessary until the model more accurately approximated field conditions. As a result, three driver behaviors were created for this analysis:

- ***NH Freeway/NH Freeway Merge/Weave: Adjusted to include cooperative lane change settings to represent field driver behaviors. This was applied to Sagamore Bridge Road westbound for the entire modeled length and Sagamore Bridge EB between the ramps from US 3 and the on-ramp from Daniel Webster Highway.***
- ***NH Local Roadways: Changed BxAdd and BxMult, values used in VISSIM to described how vehicles space themselves on the roadway network, to result in an approximate saturation flow rate of 2,000 vehicles per hour per lane. Applied to all arterial segments except for NH 3A between Walmart Boulevard and Wason Road.***
- ***NH 3A CF Int: Modified the NH Local Roadways behavior to decrease spacing between vehicles (decrease BxAdd and BxMult values) and incorporate cooperative lane changes, resulting in a slightly more aggressive behavior profile which is common as vehicles approach areas where large volumes are changing lanes. Without these modifications to the NH Local Roadways behavior, the model would gridlock in the PM peak hour, even in the No Build condition. This behavior was applied to NH 3A between Walmart Boulevard and Wason Road.***

Other factors, such as reduced speed areas around turns and lane change distances (the distance at which vehicles start to change lanes to make a turn or use a ramp),

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were adjusted to approximate pre-COVID conditions. It is important to note that the same factors and behaviors were carried across all scenarios so that the No Build and Build conditions can be compared directly.

- The section between NH 3A and the ramps to the DW Highway is technically a weaving area; however, it is quite long and probably better analyzed by the VISSIM analysis rather than by conventional HCM software. The VISSIM video clips and results summarized in Table 2 of the Stantec memo show that this area functions reasonably well in the 2032 Build condition. The westbound weave does show a relatively small increase in density, but the Build condition is a LOS C. The eastbound approach to NH 3A does show significant queuing, but it is improved over the No Build condition due to the added intersection capacity provided by the northbound triple left.

LANGAN/STANTEC RESPONSE: Noted.

- The westbound and eastbound weaving sections between the DW Highway ramps and the Everett Turnpike ramps have relatively conventional geometry. As such, we would expect the HCM software to produce reasonably reliable results; however, the HCM results from Langan and the VISSIM results from Stantec are vastly different. No explanation was provided.

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	2032 No Build		2032 Build	
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Westbound weave	B/B	19.06/18.56	C/C	20.22/20.67
Eastbound weave	BI	14.82/16.07	C/C	21.04/22.49

LANGAN/STANTEC RESPONSE: Differences between the Highway Capacity Software (HCS) analyses and the results of this VISSIM analyses are quite common,

particularly in areas with unique merge, diverge, or weaving segments, or where there is a mix of signalized intersections, unsignalized intersections, and freeway segments. These differences are primarily due to the difference between how each software analyzes freeway segments. HCS calculates density based on formulas contained in the Highway Capacity Manual, while VISSIM results are obtained through the measurement of simulated vehicles. Unlike VISSIM, HCS cannot account for how vehicles arrive to a merge, diverge, or weaving segment, which is often an important factor in density. For example, the westbound Sagamore Bridge Road weaving segments are greatly impacted by the metering of the signal at NH 3A. The metering results in fluctuations in density with each signal cycle. Platoons of vehicles from the signal temporarily increase density, but then density reduces significantly after the platoon passes, resulting in a lower average density that is more reflective of anticipated field conditions, than is calculated by the HCS software.

HCS is also primarily intended for basic types of weave, merge, and diverge segments and has difficulty analyzing unique situations such as the eastbound weave between US 3 and the off-ramp to Daniel Webster Highway. A traditional weaving segment consists of mainline through lanes with a ramp lane that enters the freeway and then departs further downstream. However, in the case of the eastbound weave, there is no entering mainline, rather, there are two ramps coming together to form the mainline, and then a separate exit lane that comes off of the right-most through lane from the US 3 northbound ramp. Thus, in our opinion, this weaving segment is not typical and a microsimulation model, such as VISSIM would provide more reliable results.

Synchro/SimTraffic/VISSIM Comments

1. Green Meadow Drive and Rena Avenue are coded with concurrent phasing in both the No Build and Build condition. With the large increase in volume on Green Meadow Drive in the Build condition, these approaches may need to be split phased for safety reasons. Coordinate with Bureau of Traffic.

LANGAN RESPONSE: *Noted and this phasing will be evaluated.*

2. Synchro reports show the Sagamore Bridge Road eastbound right turn movement coded as "free", but it is currently under yield control.

LANGAN RESPONSE: *Yes, the Synchro model is coded as "free" for this movement under the timing settings. This movement is also modeled as "Yield" for the right-turn movement under the volume settings, which allows Synchro to model the turn essentially as a 'right-turn on red' for volume and capacity calculations. This eastbound right turn movement at the Sagamore Bridge Road intersection is able*

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to flow free for the majority of the cycle length for the signal and is only required to stop during the southbound through movement green time.

3. All analyses show no right turn overlap for the Walmart and Sam's Club approaches during the NH 3A northbound/southbound left turn phase. Is this accurate? If so, coordinate with Bureau of Traffic as to why not.

LANGAN RESPONSE: The state signal timing plans and traffic signal plans indicate there is no overlap indicated. Our analyses evaluated the intersection with this condition, providing conservative (less efficient) results. During the design process we will work with NHDOT to evaluate providing overlap at this location.

4. Synchro model: The Dracut Road and northbound NH 3A (River Road) approaches at the Dracut Road/Steele Road intersection are not drawn long enough to contain the queuing observed in SimTraffic, making the SimTraffic queuing results inaccurate.

LANGAN RESPONSE: This will be revised to indicate the appropriate lane storage.

5. Very few trucks are observed in the SimTraffic and VISSIM microsimulations. Synchro is coded with only 1% or 2% trucks. Seems very low, even for the peak hours. Does field data support this?

LANGAN RESPONSE: Yes, the truck percentages used in the analyses is based on actual counts determined during the data collection program conducted in 2019. The trucks projected for the development were included in the Build traffic volumes.

6. The TIS notes that due to non-NEMA or atypical phasing at some intersections, Synchro cannot produce the typical HCM 6" Edition or HCM 2010 reports. We agree with this; however, our typical fall-back would be to use HCM 2000 report results for delay, LOS and v/c ratios. Langan chose to use the "Synchro Percentile Delay" results from the Lanes/Volumes/Timings reports in their summary tables. We are willing to accept this; however, we would want to discuss this up front if Langan is involved in future traffic impact studies for NHDOT.

LANGAN RESPONSE: Noted.