NCDOT Capacity Analysis Guidelines

Standards

NCDOT Congestion Management Section

This document provides standard values to ensure consistent traffic analysis. **It is an expectation that all analysis documents shall adhere to the Guidelines, and deviation from these standards requires explanation, justification, and approval by key NCDOT and local stakeholders before analysis document submittal, otherwise the analysis document may not be accepted.** By reviewing reports, plans, and submittals, the North Carolina Department of Transportation (NCDOT) in no way relieves the analyst of possible claims or additional work resulting from errors or omissions.

Submittal Requirements

TIA	TIP
Executive Summary of Results	
Approved Scoping Doc.	
Site Plan	Traffic Forecasts
Traffic Counts and Forecasts	Traffic Breakouts (Existing, No Build, Build)
Existing Lane Figure	
Existing Traffic Figure (incl. Growth)	Base Year No Build Figure
Approved Development Traffic Figures	Traffic Adjustments and Reroutes)
Background (Future No-Build) Traffic Figure	
Unadjusted Trip Generation Table	
Trip Gen. Reductions	
Trip Distribution Figure	
Site Traffic Figure(s)	
Total Projected (Future Build) Traffic Figure	
Recommended Lane Figure	
Assumptions Used in Analysis	
Variations from these Guidelines	
Analysis of All Scenarios (including analysis files)	

- In TIAs, perform TIP Design Year analysis if it is proven the site traffic was not included in TIP traffic forecast when an impacted TIP project is:
  - In the planning phase
  - In the design phase
  - During construction
  - Within 5 years after construction

Strategic Transportation Corridors (STC)

- Conform to the vision of the STC and Comprehensive Transportation Plan (CTP) and if in an urban area the Metropolitan Transportation Plan (MTP). Support the proposed facility type and allowable access types recommended in the CTP/MTP.

Median and Control-of-Access (C/A) Breaks

- Requests for either initiated by District Engineer
- Approval of C/A break changes comes from the Right-of-Way Disposal and C/A Committee
- Approval of new or modified median crossovers is by:
  - State Traffic Engineer or designee for existing roadways
  - The Project Engineer for active TIP projects
  - Exceptions to the Median Crossover Guidelines through the State Highway Design Engineer on active TIP projects

Interstate Interchanges

- New and modified interchanges may require Interchange Justification/ Modification Reports for federal approval

Trip Generation and Adjustments (TIA)

- Use *ITE TRIP GENERATION MANUAL and HANDBOOK* for guidance on trip generation and adjustments such as pass-by or internal capture
- Use *Rate vs Equation* spreadsheet on Congestion Management website for standard land use codes, variables methods, maximum allowable pass-by percentages, etc.

Internal Capture

- Requires justification and approval on a case by case basis
- Transit, bike, pedestrian, or other trip reductions beyond internal capture must be explained, justified and approved by using local data
- Estimate using NCHRP 684 spreadsheet referenced in current *HANDBOOK*
  - Do not use transit or non-motorized splits in spreadsheet
  - Vehicle occupancy "1.1" (NC averages)
  - Use Walking Distance between land uses of 4000' *or* the calculated maximum distance between a given pair of land use categories in the proposed site
- Limit to land use categories and time periods in the current *HANDBOOK*
- Only applicable to sites or subdivisions of sites that are accessible without using or crossing public streets
- Internal capture reduction is applied before the pass-by trips are calculated

Pass-By

- Limit to retail land uses in *HANDBOOK*

General Analysis Requirements

Scenario	TIA	TIP
Existing Base Year	Yes	Yes
No-Build Design Year	Yes	Yes
Design Year Build without Improvements	When Specified in Scope	N/A
Intermediate Years Build with Improvements for all Alternatives	When Specified in Scope	When Specified in Scope
Design Year Build with Improvements for all Alternatives	Yes	Yes

- Include AM and PM Peak Hour analysis (minimum) for all reports
- Lanes and storage identical for all time periods within the same scenario
- Signal phasing remains consistent for all analyzed time periods

Default Values

- Base Saturation Flow Rate in accordance with the *Highway Capacity Manual* (HCM)
- Peak Hour Factor (PHF) of 0.90 for future conditions (may be used for existing conditions)
  - Where schools are present, follow requirements in the *MSTA School Calculator*
- Total flow period of 60 minutes
- Peak flow period of 15 minutes

Lane and Storage Recommendations

- Provide for all exclusive turn lanes
- Provide for all add or drop through lanes
- Use the 95th percentile queue from analysis or the maximum observed queue from a simulation (whichever is larger) to determine the storage lane length
- Round up to nearest 25 feet with a minimum of 100 feet for both right-turn and left-turn lanes
- Use default taper length of 100 feet in analysis for all added lanes unless longer specific taper lengths are known
- Include recommended Internal Protected Stem lengths at proposed driveways
- Clarify which parties are to provide additional improvements identified “by others”

Measures of Effectiveness

- Address all poor levels of service and/or excessive queuing in the analyses and analysis document

Signalized Intersections

Left-Turn Treatment

- For analysis of future operations, use protected-only phasing not protected/permitted phasing
- For analysis, generally use protected left-turn treatment instead of permitted when:
  - Dual left-turn lanes are present
  - Hourly volume exceeds 240 cars
  - Left-turn lanes are crossing three or more opposing through lanes of traffic
  - When a condition is satisfied in the following table:

Number of Opposing Lanes (Through and Right)	Condition
1	**Left-Turn Volume * Opposing Volume > 50,000**
2	**Left-Turn Volume * Opposing Volume > 90,000**
3 or more	**Left-Turn Volume * Opposing Volume > 110,000**

Right-Turn Treatment

- For analysis of future operations, do not use Right-Turn-On-Red (RTOR) operation
- To provide for a proper comparison, do not use RTOR for existing conditions

Coordinated Signal Systems

- Use the same cycle lengths for individual intersections in coordinated systems
- Double or half cycles can be used if the minimum cycle lengths are accommodated

Reduced Conflict Intersections

- Analyze main street as parallel one-way streets (see Best Practices document for additional guidance)

Signal Phasing and Timing

Recommended Timing Settings for Analysis of Future Conditions*	
Timing Setting	**Time (seconds)**
Minimum Initial Green Time, Protected Left Turns and All Side Street Movements	7
Minimum Initial Green Time, Major Street Through Movements	10 if speed limit ≤ 35 mph 12 if speed limit 36-45 mph 14 if speed limit > 45 mph
Yellow Time**	5
All-Red Time**	2
Lost Time Adjustment (Synchro)	-2
Total Lost Time**	5
Minimum Split	Minimum Initial Green Time *** + Yellow Time + All-Red Time

* Timing settings may be used for Existing Conditions
** Increase clearance and lost time as needed for large cross sections such as single point urban interchanges
*** Or Pedestrian Walk + Clearance Time

Recommended Minimum Cycle Lengths by Phase for Future Analysis*	
Number of NEMA Phases	**Minimum Recommended (seconds)****
2	60
3	90
4 or more*	120

* Cycle lengths may be used for Existing Conditions.
** Maximum recommended cycle length is 180, but circumstances may warrant cycle lengths up to 240

Roundabouts

- Provide a flow-scale analysis to determine the expected failure year of the proposed roundabout based on a maximum v/c (degree of saturation) of 0.85
- Include the Movement Summary table with Sidra roundabout analysis submittals
- Use 25 mph maximum circulating speed
- For single-lane roundabout analysis:
  - 120 feet (min) roundabout diameter
  - 16-foot circulating lanes
  - 88-foot inside diameter
- For dual-lane roundabout analysis:
  - 150 feet (min) roundabout diameter
  - 15-foot circulating lanes
  - 90-foot inside diameter

Analysis Software

- Required to be based on HCM methods.
- Ensure turn lane storage lengths and node distances are appropriately coded into analysis
- Extend link termini 1000' or more

Synchro

- Code intersection approaches by cardinal directions (north, south, east, and west)
- Code zero, one, two, or three volume movements to four vehicles (min.) per hour for all allowable movements.
- Ensure link speed used in analysis represents the posted or proposed speed limit of the actual roadway
- Run "Coding Error Check" before finalizing the analysis, and justify or correct any errors or warnings before activating SimTraffic
- Do not code U-turn and Right-turn overlap conflict

SimTraffic

- Run SimTraffic simulation with Synchro analysis
- Review overall network operations during the simulation, and address any significant queuing, starvation, spillback, or gridlock
- Include "Queuing and Blocking Report" for the network
- Address all instances where the SimTraffic Maximum Queue length (maximum observed queue) exceeds the Storage Bay Distance
- Determine recommended storage lane lengths by the SimTraffic Maximum Queue or Synchro 95th Percentile Queue, whichever is higher
- Review excessive queuing in SimTraffic for appropriateness and possible unrealistic lane blockages
- Record maximum queue distances that extend beyond adjacent nodes appropriately in the analysis document
- Seed networks for a period long enough to traverse the two most distant points of the network including stops prior to recording
  - Default seed time is 10 minutes
- Use recording interval duration of 60 minutes unless otherwise justified
  - For analysis of schools, follow requirements in the *MSTA School Calculator*

HCS

Default Values

- Use Operational Analysis to obtain levels of service
- Enter driver population factor f_P = 1.00, unless in a tourist area, then use 0.95
- In absence of local data, approximate typical average grades by the terrain shown:

	Freeway Grades**	Non-Freeway Grades**
Level	2% or less	3% or less
Rolling	Between 2% and 6%	Between 3% and 7%
Mountainous	6% or more *	7% or more *

* Consider mountainous terrain where heavy vehicles operate at crawl speeds

** Use average grade for the entire facility

- All truck/bus and RV equivalents (E_T or E_R) and similar calculated adjustments remain at HCM defaults
- Base percentage of trucks on where the traffic flow is heading towards (e.g. ramps and weaving analyses)
- Review LOS F segments or junctions since these oversaturated conditions could further cause poor network operations for adjacent segments or junctions
- Use measured speeds if available; estimate Free Flow Speed (FFS) by HCM methods when measured field data is unavailable

Freeway Weaving

- Provide ramp-to-ramp volume (V_{B-D}) assumptions
- Base truck and bus percentages on the freeway/ mainline value; use the higher percentage
- Check "Limitations on Weaving Segments" to ensure that none of the limitations specified are exceeded. Where any limits are exceeded, consult the appropriate notes near the bottom of the output. Eliminate these situations where feasible and address in the included report; HCS may provide values that are too short
- The resultant density does not apply if V_{FO}, V_F, or V_R = LOS F

Ramps and Ramp Junctions

- Perform Freeway Analysis for high speed ramp segments with two or more lanes that begin/end as merge/diverge segments
- Typical Free Flow Speed for Ramps = 45 mph, and for Loops = 25 mph; adjust as needed based upon designs if that information is available
- Base freeway truck and bus percentages on freeway/mainline values, and base ramp truck and bus percentages on minor/crossing street values, unless specific information is available
- If V_{12} or VR_{12} exceed the available capacity indicated, but the other capacity checks are under capacity, the computed density and LOS A-E applies; if other or multiple capacity checks are over capacity, LOS F results and do not indicate any density values in the results
- If a ramp section exceeds two lanes, document assumptions for the analysis volume of the two inside ramp lanes
- If HCS Ramp and Ramp Junction analysis cannot be performed, evaluate ramp operations based on volume-to-capacity ratios

Multilane Highways

- Do not use this methodology and use Urban Streets methodology (Synchro or HCS Arterials) if:
  - Signal spacing is 2.0 miles or less
  - Significant presence of on-street parking
  - Heavily used bus stops
  - Significant pedestrian activity
- Use existing and proposed driveways and intersections where known. If the access point density is not known, use the following table:

Section Description	Density (access points per mile*)
Rural	8
Low Density Suburban	16
High Density Suburban	25

* Right side only; use this value on both sides for a one-way roadway

Two-Lane Highways

- Do not use this methodology and use Urban Streets methodology (Synchro or HCS Arterials) if signalized intersections spaced at 2.0 miles or less
- Class I highways are primary US/NC highways, primary arterials, or commuter routes that serve long-distance trips where mobility is critical
- Class II highways are access routes to Class I highways, local roads, or scenic routes that serve relatively short trips where mobility is less critical
- Use caution when analyzing Class I highways with low speed limits as low levels of service may result solely based on lower travel speeds
- Enter 100% no passing zones unless the presence of passing zones is known

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