16-10-1 Overview of Available Traffic Analysis Tools — April 2025

The Federal Highway Administration (FHWA) Office of Operations - Traffic Analysis Tools Program provides substantial background and guidance on the available types of tools and careful selection of the right tool for the task. FHWA's *Traffic Analysis Toolbox Volume II (TAT II)* (1) was prepared to assist traffic engineers and planners in selecting the most appropriate traffic analysis tool. For more information on the FHWA guidance, visit the Traffic Analysis Tools homepage and refer to the set of documents in the Traffic Analysis Toolbox series.

1.1 Categories of Traffic Analysis Tools

The primary categories of traffic analysis tools utilized at WisDOT include:

- HCM-based deterministic tools
- Signal optimization tools
- Work zone analysis tools
- Traffic simulation tools
- Dynamic traffic assignment (DTA) tools
- Travel-time reliability analysis tools

The following provides guidance on selecting the appropriate tool category before selecting from the WisDOT-supported software packages.

1.2 HCM-Based Deterministic Tools

The Highway Capacity Manual (HCM) provides several analytical or deterministic methodologies that can estimate roadway or intersection capacity, delay, density, and other performance measures for various elements of the street and highway system.

The HCM methodologies are based on the standard relationship between flow, speed, and density of the traffic stream. Since the HCM methodologies are deterministic, a fixed set of inputs will yield a single set of outputs. As such, tools that implement the HCM methodologies are typically simplistic and easy to utilize and *should* be the first choice for most traffic analyses.

Although the HCM procedures are good for analyzing the performance of isolated and non-congested facilities they do have limitations. For example, the HCM models do not have the ability to account for interactions between network elements (e.g., they cannot reflect a queue backup at a ramp terminal within the adjacent freeway operations) and they may under predict the extent of congestion in oversaturated conditions. Consider the strengths and limitations of the HCM methods when deciding if an HCM-based tool is appropriate for a specific analysis or study.

The *Highway Capacity Manual, 7th Edition: A Guide for Multimodal Mobility Analysis (HCM7)* (2) is the most current version of the HCM. Unless the WisDOT regional engineer provides prior authorization, the traffic analysis shall follow the HCM7 methodologies. For project analysis initiated prior to January 1, 2023, it may be acceptable to continue to follow the *HCM6* (3) methodologies. Coordinate with the regional traffic engineer or Bureau of Traffic Operations, Traffic Analysis and Safety Unit (BTO-TASU) to verify whether to continue using the HCM6 methodologies or whether to update to the HCM7 methodologies.

The WisDOT-supported tools that implement the HCM methodology for capacity analysis are:

- Highway Capacity Software (HCS), McTrans
- Synchro, Trafficware
- SIDRA, Akcelik and Associates (supported only for roundabout analyses)
- Vistro, PTV Group (requires prior approval from the WisDOT regional traffic engineer)

Refer to the BTO Traffic Analysis, Modeling and Data Management Program area webpage for the version and build of the above software that WisDOT currently supports.

Although WisDOT does support the use of Vistro for the analysis of signalized and stop-controlled intersections, acceptance of Vistro is up to the discretion of the WisDOT regional office. See TEOpS 16-10-5 for additional guidance on how to select the most appropriate traffic analysis tool for a specific project and refer to TEOpS 16-15 for additional details on conducting HCM-based deterministic analyses.

1.3 Signal Optimization Tools

Signal optimization tools help identify the optimal signal cycle lengths, phase times, splits, and offsets for signal systems ranging from isolated signals to coordinated signal systems. Typically, the process begins with the analyst setting up a network representing the geometric layout and traffic demand in the intersection or corridor of interest. The software then tries thousands of different combinations of cycle length, split, and offset to determine the "optimal" signal timing.

In this context, the word "optimal" has a strict mathematical definition called the objective function, which typically tries to minimize the total delay per vehicle. The analyst can impose policy- or experience-based constraints on the signal phasing, such as the minimum green time provided to minor movements, to influence the optimization.

Use professional judgment to fine-tune the results from signal optimization efforts when deciding on new or updated traffic signal timing and phasing; this is particularly important when a corridor includes unsignalized intersections or major driveways that affect operations.

The WisDOT-supported tools that perform signal optimization are:

- Synchro, Trafficware
- Vistro, PTV Group (requires prior approval from WisDOT regional traffic engineer)

Refer to the BTO Traffic Analysis, Modeling and Data Management Program area webpage for the version and build of the above software that WisDOT currently supports.

Although WisDOT does support the use of Vistro for signal optimization, acceptance of Vistro is up to the discretion of the WisDOT regional office. See TEOpS 16-10-5 for additional guidance on how to select the most appropriate traffic analysis tool for a specific project.

WisDOT previously supported HCS for signal optimization, however, recent studies found that the optimization features in HCS tended to underestimate the phase and cycle length requirements, especially for coordinated signal systems. As such, the analyst *should not* utilize HCS when optimizing signal timing plans for field implementation. Analysts may continue to utilize the optimization features of HCS for the evaluation, assessment, and comparison of the capacity/operation of alternative scenarios.

1.4 Work Zone Analysis Tools

Specialty tools are available for analyzing traffic in highway construction zones. These analysis tools typically provide a way to compare travel times with and without construction and compute the resulting work zone queue length, delay, and road user cost. Other frequently occurring issues that the analyst may need to assess for construction on rural and urban highways and freeways include, but are not limited to, the following:

- Selecting appropriate hours for lane closures
- Assessing the use of two-way, one-lane operation
- Identifying construction staging needs
- Quantifying the amount of traffic that could divert to alternate routes
- Evaluating potential mitigation measures (e.g. providing a temporary bridge to maintain traffic during construction), including cost-benefit analyses

The work zone traffic analysis tool (WZTAT) should be used for all freeway and expressway construction projects to determine queuing, delay and road user costs based on the capacity. Refer to FDM 11-50-30 and coordinate with the WisDOT regional work zone engineer or BTO Work Zone Engineers for assistance in determining work-zone related delay, queue, and road-user costs for freeways and highways as appropriate.

1.5 Traffic Simulation Tools

There are three primary categories of traffic simulation tools: macroscopic, mesoscopic, and microscopic simulation. Simulation tools usually provide visual animation of the traffic flow; however, it is possible to have a simulation tool without the visual component. The following describes each of these simulation tools in more detail.

1.5.1 Macroscopic Traffic Simulation

Macroscopic traffic simulation tools assess the operation/capacity of a facility or network utilizing the deterministic relationships of flow, speed, and density of the traffic stream. The simulation analyzes the movement of vehicles on a section-by-section basis. Travel demand models (TDMs) are an example of a macroscopic tool. The policy within this chapter does not cover macroscopic simulation tools or TDMs. Refer to the Transportation Planning Manual (TPM) for additional details regarding TDMs.

1.5.2 Mesoscopic Traffic Simulation

Mesoscopic traffic simulation tools analyze the movement of individual vehicles or vehicle cells as they travel through a simulated network using predefined capacity and speed-density relationships. Mesoscopic models incorporate a level of network and operational detail comparable to microsimulation models with the route choice flexibility of macroscopic simulation models (TDMs). Most mesoscopic simulation models incorporate dynamic traffic assignment (DTA), thus, this policy utilizes the term DTA model throughout to represent mesoscopic simulation models. Refer to TEOpS 16-10-1.6 for additional discussion on DTA tools.

1.5.3 Microscopic Traffic Simulation

Microscopic traffic simulation or microsimulation, refers to tools that analyze the movement of individual vehicles as they travel through a network. As the simulation progresses, it updates factors such as each vehicle's position and its need to increase/decrease speed or change lanes several times a second. As a result, these tools are suitable for evaluating the interaction of different components of the transportation network, such as queues from an intersection that cause lane blockage upstream or complex weaving and merging behaviors. Additionally, the visual animation of traffic flows can make microsimulation traffic models useful for public outreach and stakeholder presentations.

Microscopic modeling work typically requires significantly more time, data, and effort than other tools. In addition, improperly calibrated microsimulation models can provide misleading outputs, such as showing congestion where none exists, or free-flowing traffic where there is congestion. When using the model outputs to make critical decisions, the project manager should insist on crosschecking with simpler tools to assure that microsimulation outputs are reasonable. WisDOT supports the use of microscopic simulation models, but prior to utilizing microsimulation, the WisDOT project team should first assess whether an HCM-based deterministic tool could sufficiently accommodate the traffic analysis needs of the project.

The WisDOT-supported programs that perform microscopic simulation are:

- Vissim, PTV Group
- SimTraffic, Trafficware

Refer to the BTO Traffic Analysis, Modeling and Data Management Program area webpage for the version and build of the above software that WisDOT currently supports.

SimTraffic is only applicable for arterial analysis and is best suited for signalized corridors. WisDOT does not currently support the use of SimTraffic for roundabout analysis; however, contingent on approval from the WisDOT regional traffic staff, it may be acceptable to use SimTraffic to gauge how a roundabout might interact with an adjacent traffic signal. The analyst will often use SimTraffic to observe driver behavior and conduct a "reality check" on the Synchro outputs. SimTraffic may also be beneficial for reporting the vehicle queues, especially when vehicles spill out of the turn lane and block through traffic. If the primary purpose of the SimTraffic model is to conduct "reality checks", calibration and validation of the traffic model may not be necessary. However, prior to using the model outputs from SimTraffic for critical design decisions, the analyst shall calibrate and validate the SimTraffic model (TEOpS 16-20).

Prior to January 1, 2018, WisDOT supported the use of Paramics. As such, projects that initiated the microsimulation traffic analysis using Paramics prior to January 1, 2018 may continue to use Paramics for the duration of the project. However, if there is a need to make major revisions to the traffic models (e.g., use of different base year conditions), the analyst should consider switching the traffic models over to Vissim. Consult with the WisDOT regional traffic contact or BTO-TASU to determine whether it is appropriate to switch software programs.

See TEOpS 16-10-5 for additional guidance on how to select the most appropriate traffic analysis tool for a specific project and refer to TEOpS 16-20 for additional details on conducting microsimulation analyses.

1.6 Dynamic Traffic Assignment (DTA)

DTA is a modeling approach that captures the relationship between dynamic route choice behaviors (path and start time) and transportation network characteristics (travel speeds, signal timings, level of congestion, etc.) It is possible to incorporate DTA into any level of simulation models (macroscopic, mesoscopic, microscopic); however, the most common application of DTA is for mesoscopic simulation models. Therefore; this policy assumes all DTA models are mesoscopic models.

DTA tools are useful for analyzing roadway networks with parallel routes, especially when there is a need to evaluate potential diversion traffic. Other scenarios where a DTA model may be beneficial include those that involve shifts in the temporal distribution of traffic (i.e., peak spreading or contraction).

WisDOT does not currently support any DTA tools. However, BTO-TASU is willing to consider the use of DTA if the project needs support/justify its use. Coordinate with WisDOT regional traffic staff and BTO-TASU and obtain prior approval before utilizing DTA.

1.7 Travel-Time Reliability Analysis Tools

Travel-time reliability analysis tools allow the analyst to assess how travel times along a corridor fluctuate over time in response to various traffic, roadway, and weather conditions. The analysis considers both recurring and nonrecurring delays where nonrecurring delays are associated with crashes, work zone activities, and event activities, among other unexpected or atypical conditions.

Travel-time reliability analysis is data intensive in that it requires details on weather conditions, work zone activity, incident/crash data, and variation in traffic demands for a period of several days or more (ideally, the reliability analysis would cover one-year worth of data). As such, prior to conducting travel-time reliability analysis, the WisDOT project team *should* assess whether reliability is critical to meeting the goals and needs of the project. Review of the National Performance Management Research Data Set (NPMRDS) can provide insight into the variability of travel times along the corridor. If the roadway network is congested but has reliable travel times (i.e., the travel time along the corridor is always the same), there would be little benefit to performing reliability analysis. However, if the travel time along the corridor is highly unreliable (i.e., there is considerable variation in travel time along the corridor from one day to the next), then it may be necessary to evaluate travel-time reliability performance measures. Coordinate with WisDOT regional traffic staff to determine whether to conduct travel-time reliability analysis for a specific project.

The WisDOT-supported tool that performs reliability analysis is:

- HCS, McTrans

Refer to the BTO Traffic Analysis, Modeling and Data Management Program area webpage for the version and build of the above software that WisDOT currently supports.

16-10-5 Traffic Analysis Tool Selection — September 2019

There is no “one size fits all” traffic analysis tool. The tools used for each analysis vary in their data requirements, capabilities, methodology, and output. Tools that are more powerful require greater time and effort, so it is important to match the analysis methods with the scale, complexity, and technical requirements of the project. HCM-based deterministic tools *should* typically be the first choice for most traffic analyses. However, when the analysis requirements do not fit within the confines of the HCM-methodology or when there is a need to provide supplemental information, it may be necessary to utilize an alternative analysis tool such as microsimulation. Oftentimes, it is necessary to use a combination of multiple traffic analysis tools to meet the project goals and needs (e.g., the analyst may utilize Vissim as the primary analysis tool but may utilize HCS or Synchro at spot locations or to provide another reference point to aid in calibration of the Vissim model).

Attachment 5.1 provides a flowchart to help navigate and select the most appropriate WisDOT-supported traffic analysis tool(s) based on the type of traffic flow (uninterrupted or interrupted). If the project consists of both uninterrupted and interrupted flow facilities, follow the path for each type of flow independently. Utilize the tool that will best address both flow regimes and will result in the most efficient use of resources. This may require the use of the most comprehensive tool (Vissim) or it may require the use of multiple traffic analysis tools.

If the project does not justify the use of microsimulation analyses, but there is a need or desire for visualization or simulation of the traffic operations, the analyst may utilize the SimTraffic component of Synchro or the built-in Vissim module of Vistro. The resulting visualization can allow the analyst to observe driver behavior to conduct “reality checks” of the Synchro and Vistro outputs. Note that SimTraffic and the built-in Vissim module of Vistro are uncalibrated microsimulation models, so use caution when presenting the results.

Use the flowchart in Attachment 5.1 as a guide only. The final determination of the most appropriate traffic analysis tool depends on the specific details, needs, and goals of the project. Professional judgment and coordination with WisDOT regional traffic staff need to factor into the selection of the most cost effective and efficient traffic analysis tool. If unsure of which traffic analysis tool to utilize, contact BTO-TASU (DOTTrafficAnalysisModeling@dot.wi.gov).

Document the rationale for choosing the selected traffic analysis tool(s) in the Traffic Analysis Tool Selection memoranda and submit to the WisDOT regional traffic staff for approval.

LIST OF ATTACHMENTS

Attachment 5.1 Traffic Analysis Tool Selection

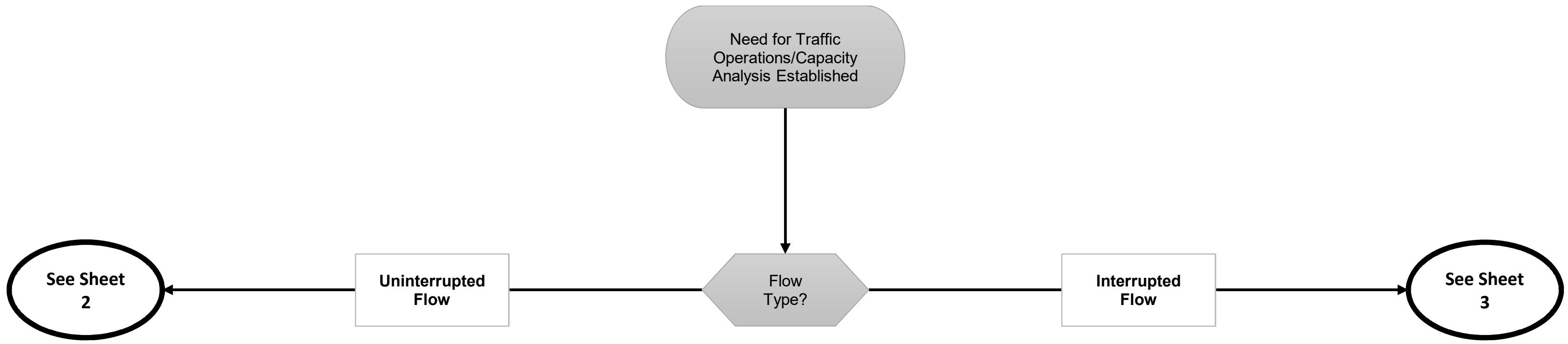
16-10-20 References April 2025

1. **Federal Highway Administration.** *Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools*. 2004. FHWA-HRT-04-039.

2. **Transportation Research Board.** *Highway Capacity Manual, 7th Edition: A Guide For Multimodal Mobility Analysis.* Washington, D.C. National Academy of Sciences, 2022. ISBN 978-0-309-08766-7.

3. **Transportation Research Board.** *Highway Capacity Manual, 6th Edition*. Washington D.C. National Academy of Sciences, 2016. ISBN 978-0-309-36997-8.

Attachment 5.1   Traffic Analysis Tool Selection

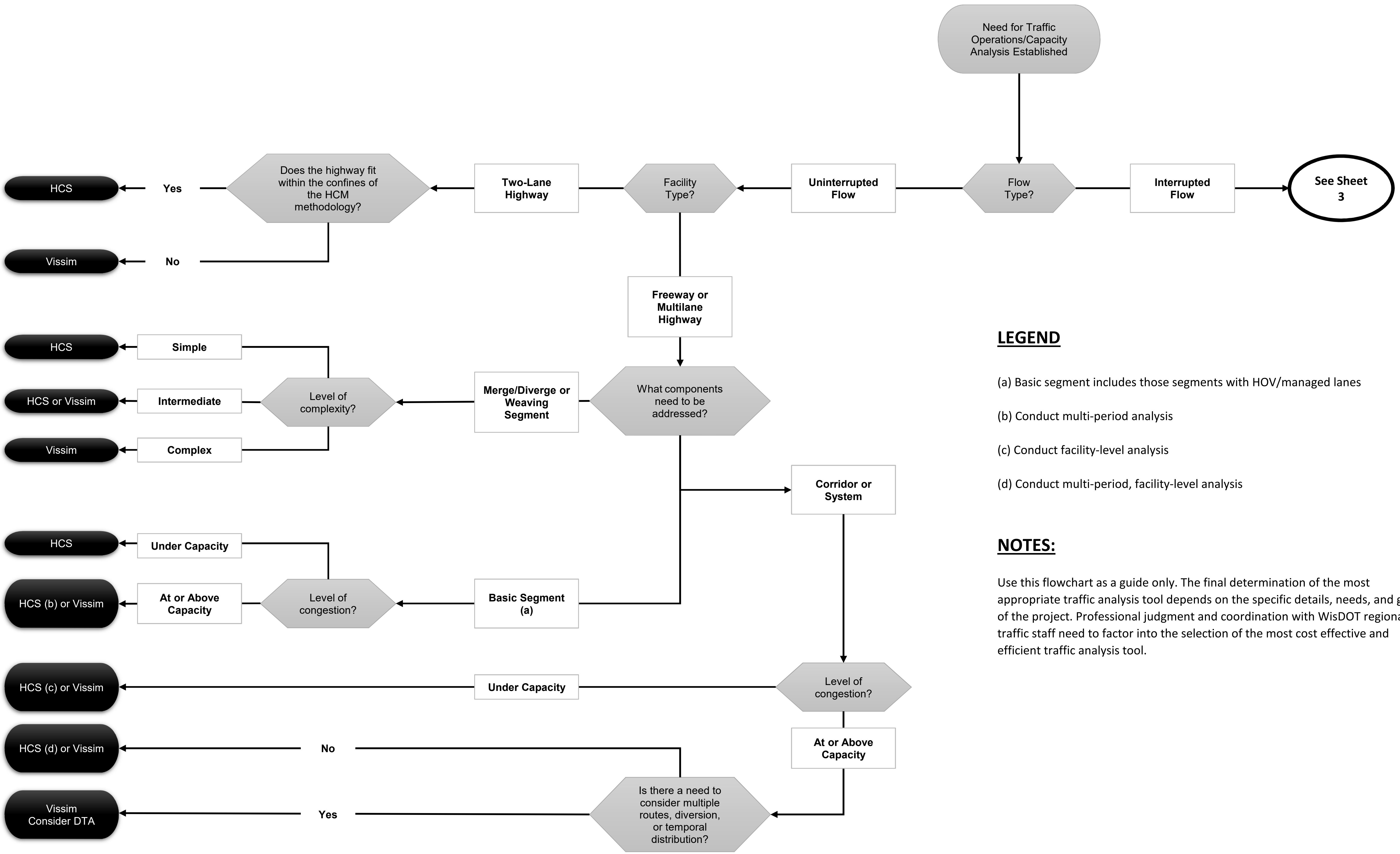


NOTES:

1. If the project consists of both uninterrupted and interrupted flow facilities, follow the path for each type of flow independently. Utilize the tool that will best address both flow regimes and will result in the most efficient use of resources. This may require the use of the most comprehensive tool (Vissim) or it may require the use of multiple traffic analysis tools.

2. Use this flowchart as a guide only. The final determination of the most appropriate traffic analysis tool depends on the specific details, needs, and goals of the project. Professional judgment and coordination with WisDOT regional traffic staff need to factor into the selection of the most cost effective and efficient traffic analysis tool.

Attachment 5.1 Traffic Analysis Tool Selection



LEGEND

(a) Basic segment includes those segments with HOV/managed lanes

(b) Conduct multi-period analysis

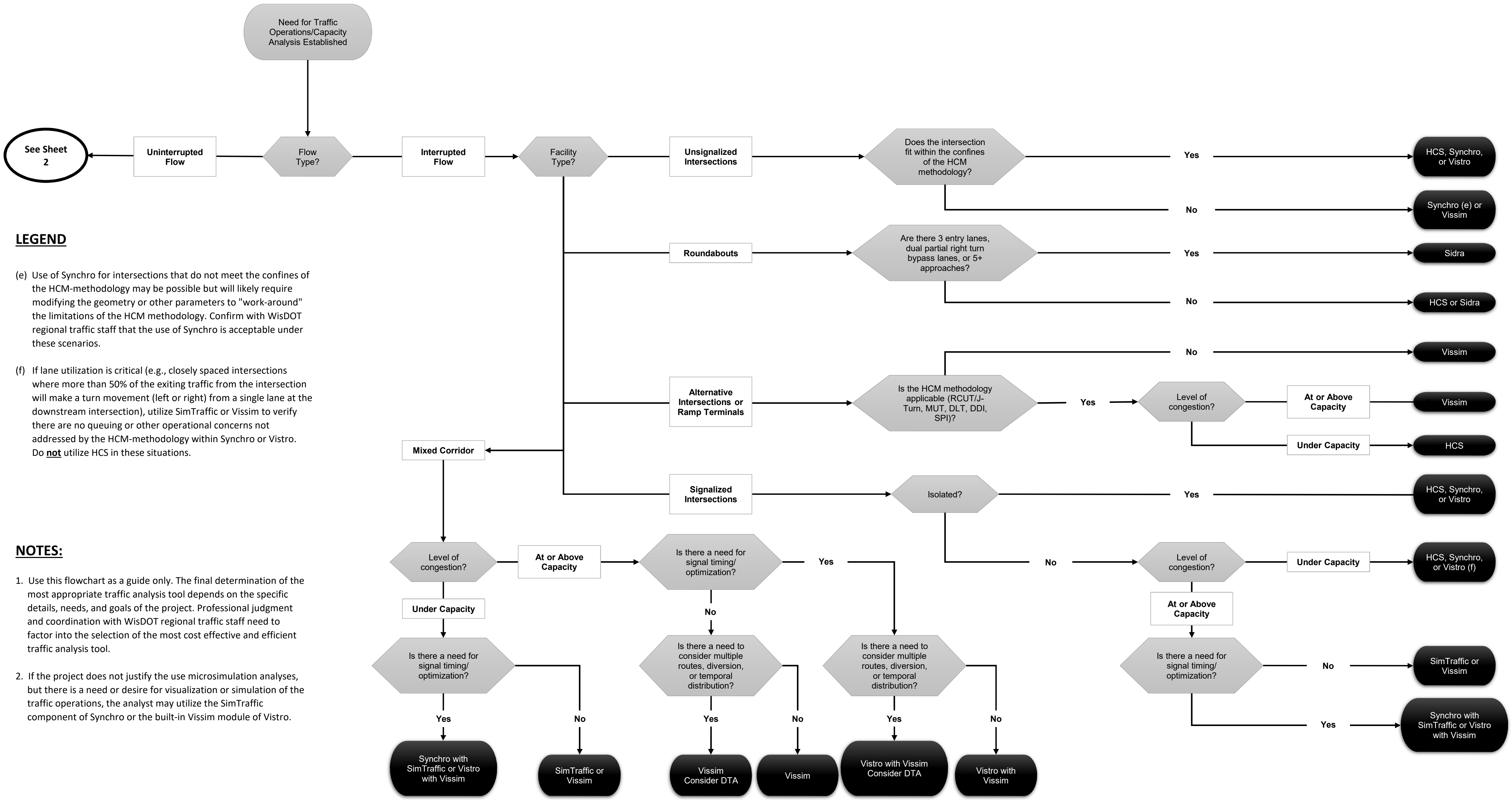
(c) Conduct facility-level analysis

(d) Conduct multi-period, facility-level analysis

NOTES:

Use this flowchart as a guide only. The final determination of the most appropriate traffic analysis tool depends on the specific details, needs, and goals of the project. Professional judgment and coordination with WisDOT regional traffic staff need to factor into the selection of the most cost effective and efficient traffic analysis tool.

Attachment 5.1 Traffic Analysis Tool Selection



LEGEND

(e) Use of Synchro for intersections that do not meet the confines of the HCM-methodology may be possible but will likely require modifying the geometry or other parameters to "work-around" the limitations of the HCM methodology. Confirm with WisDOT regional traffic staff that the use of Synchro is acceptable under these scenarios.

(f) If lane utilization is critical (e.g., closely spaced intersections where more than 50% of the exiting traffic from the intersection will make a turn movement (left or right) from a single lane at the downstream intersection), utilize SimTraffic or Vissim to verify there are no queuing or other operational concerns not addressed by the HCM-methodology within Synchro or Vistro. Do **not** utilize HCS in these situations.

NOTES:

1. Use this flowchart as a guide only. The final determination of the most appropriate traffic analysis tool depends on the specific details, needs, and goals of the project. Professional judgment and coordination with WisDOT regional traffic staff need to factor into the selection of the most cost effective and efficient traffic analysis tool.
2. If the project does not justify the use microsimulation analyses, but there is a need or desire for visualization or simulation of the traffic operations, the analyst may utilize the SimTraffic component of Synchro or the built-in Vissim module of Vistro.