Traffic Modeling Guidebook

Office of Safety and Mobility

Bureau of Maintenance and Operations

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Contents

Purpose and Need

The Maine Department of Transportation (MaineDOT) requires consistent, transparent, and field-validated traffic modeling practices across all relevant projects. This guidebook allows for a common baseline for all engineers independent of experience and/or familiarity and allows for easier review and validation of the analysis results. This guide is intended to be used as a guideline for most scenarios; however, some scenarios may require a non-typical approach to accurately model and analyze traffic conditions and it is up to the engineer to document deviations from these guidelines.

The goal of this guidebook is to ensure that all engineers produce results that are:

- **Realistic** – calibrated to observed conditions, replicating how traffic behaves.
- **Reproducible** – structured so results can be independently validated by MaineDOT staff.
- **Balanced** – considering both mobility and safety in project evaluation.

MaineDOT's philosophy emphasizes that traffic modeling is not simply about generating level of service (LOS) grades or delay estimates. Instead, it is about creating a defensible, data-driven basis for decision-making that integrates operational performance, safety benefits, and long-term cost-effectiveness.

When Traffic Modeling is (and is not) Required

Traffic modeling is not intended for every project. The level of analysis should match the scale and complexity of the proposed improvements.

Modeling is generally required when:

- A project introduces a new traffic control (e.g., signals, roundabouts) or other major geometric changes, including lane additions or reductions.
- A development or land use change is expected to generate significant new trips or alter travel patterns.
- A corridor study involves coordinated signals or progression that must be evaluated.
- Queues currently or are expected to spill back and affect adjacent intersections.
- MaineDOT staff determine that simulation is needed to accurately capture operational or safety impacts.

Modeling is generally not required when:

- The project is focused only on pedestrian, bicycle, or transit improvements with no direct effect on vehicle operations.
- Striping or signing changes are proposed that do not alter capacity or control type.
- The study area includes low-volume intersections or roadways where performance can be reasonably assessed using Highway Capacity Manual methods.
- The work involves maintenance or safety upgrades (e.g., resurfacing, lighting, signage) that do not affect traffic operations.

The intent is to balance consistency in analysis with practicality. Modeling should be applied where it adds value in understanding operational or safety outcomes, and simpler methods may be used where appropriate.

Software Tools and Requirements

The Traffic Modeling Guidebook is specific to the Trafficware Synchro Studio.

Preferred tools

- Synchro: Macroscopic analysis, HCM-based LOS, and signal optimization.
    - Highway Capacity Manual/Highway Capacity Software methodologies are used as the primary analysis tool for roundabout and all-way stop analysis, as SimTraffic does not model these scenarios accurately using default settings. The HCM reports provided by Synchro are acceptable for determining Highway Capacity Manual/Highway Capacity Software results.
- SimTraffic: Microscopic simulation, queuing, denied entries, and dynamic performance measures.

Alternate Tools

Alternative software (e.g., VISSIM, SIDRA, TransModeler) may only be used with MaineDOT approval. Consultants must document:

- Calibration and validation methodology.
- Compatibility of outputs with MaineDOT's reporting expectations.

Version Requirements

MaineDOT uses the latest version of Trafficware Synchro Studio, which at the time of this document is **Synchro Studio 12**. Previous versions of Synchro Studio are acceptable only with approval from MaineDOT. Deliverables must state clearly which software and version were used to produce the reported results.

Required Scenarios

The following are the expected scenarios for common use cases of Synchro Studio. All projects shall consider additional scenarios depending on the design hours for the AM, PM, Weekend, or other peak hours based on the particular characteristics of the roadway.

- **Alternatives Analysis:** Projects evaluating the effects of various alternative roadway and intersection configurations for the purpose of evaluating the performance or feasibility of those alternatives.
  - Base Year, Existing Conditions
  - Base Year, Proposed Alternative(s)
  - Future Year, Existing Conditions
  - Future Year, Proposed Alternative(s)

  The Future Year traffic volumes shall represent estimated traffic conditions using a 20-year projection. Additional scenarios may be required to separately evaluate Minimum-Impact Alternatives and Major Alternatives, as defined below:
  - Minimum-Impact Alternatives: e.g., lane reconfigurations, signal optimization, all-way stop control.
  - Major Alternatives: e.g., new traffic signals, new roundabouts, or major geometric changes.
- **Traffic Impact Studies:** Projects evaluating the effects of new or changing patterns in traffic volumes, typically as the result of new development or changing land use of existing developments.
  - Base Year, Existing Conditions
  - Base Year, Build Conditions
  - Base Year, Build Conditions with Proposed Mitigation
  - Future Year, Existing Conditions
  - Future Year, Build Conditions
  - Future Year, Build Conditions with Proposed Mitigation

  The Future Year traffic volumes shall represent estimated traffic conditions using a 3-year projection, unless the Proposed Mitigation is considered a Major Alternative and as such shall use a 20-year projection.
- **Traffic Operations Evaluation:** Projects that are evaluating operations of an existing intersection, corridor, or section of roadway with the purpose of determining existing conditions or for the purpose of optimizing traffic signal operations.
  - Base Year, Existing Conditions
  - Base Year, Proposed Conditions

Study Area

The study area shall be determined using the following guidelines for each common use case:

- Alternative analysis projects shall include all major intersections, signalized and unsignalized, that are impacted by the proposed alternatives. The study area shall also include key intersections on parallel or intersection routes that may be impacted by shifting traffic or any major intersections within a reasonable distance from the impacted intersections that could influence, or be influenced by, the flow of traffic into or out of the impacted intersections.
- Traffic impact studies shall follow the Study Area requirements in Part 6 Section 1.G and Part 6 Section 7 of the 17-229 Department of Transportation Chapter 305: Rules and Regulations Pertaining to Traffic Movement Permits, with the change in traffic distribution being evaluated considered as "Traffic attributable to the proposed Development" for the purpose of interpreting the rules.
- Traffic operations evaluations shall include all major intersections within the evaluation area relative to the goals of the evaluation.

If any project has signalized intersections that are part of a coordinated corridor, all coordinated intersections shall be included with the study area so that progression and end-to-end performance are fully represented. The study area for every project shall also consider any traffic signals that are nearby that may result in platooning of vehicles or otherwise abnormal vehicle flow into the study area.

Data Requirements

Traffic Volumes

Depending on the source of volume information, either volume information can be directly entered into the Synchro model or a UTDF volume file can be used to import the data into Synchro and used as the volume input in SimTraffic. *The UTDF volume file allows for each approach to fluctuate naturally throughout the simulation rather than relying on the Peak Hour Factor (PHF). Additionally, the UTDF Volume File is required as a volume source for simulations greater than one hour.*

Traffic Volume Criteria:

- Use the most recent 24-hour counts (≤5 years old).
- Incorporate turning movement counts when available.
- Adjust all counts to a common base year using MaineDOT-provided growth factors.
- Apply seasonal adjustment factors where appropriate.
- Ensure volumes are balanced between intersections. Volume imbalances >5% require justification.

Turning movement counts can be obtained from MaineDOT Traffic Monitoring (or Drakewell public map), Metropolitan Planning Organization (MPO), or requested through MaineDOT Office of Safety and Mobility. Straight-line growth projections can be obtained from MaineDOT Office of Safety and Mobility.

Geometry and Roadway Features

Model geometry must include:

- Street names
- Number and configuration of lanes
- Lane widths
- Storage and taper lengths
- Intersection control type

Field verification, MaineDOT plan sets, and aerial imagery shall be used to ensure accuracy to field conditions.

Signal Timings

For existing signalized intersections, the minimum required information depends on if the existing signal(s) are coordinated.

- If they are coordinated then the time-of-day scheduling (Schedule, Day Plan, Action Plan), pattern information (Cycle Length, Offset, Sequence, Split Number, Sync Point, Force Off Strategy), and split programing (Split Time, Coordinated Phases, Phase Recalls) will be required.
- If the signal is not coordinated, then the maximum green times for each phase will be required.

For both cases the active phases, phase assignment, phase sequence(s), detector configuration, dual entry, and phase recalls will be required.

In addition to the minimum required timing information the minimum green time, yellow clearance, red clearance, pedestrian walk time, and pedestrian clearance time shall be gathered. Otherwise, these values can be assumed using the recommended values from the FHWA Signal Timing manual and the ITE and MUTCD clearance calculations.

If signal timing information is not available, it is acceptable to use optimized signal timings for the existing conditions scenarios.

Pedestrian volumes

Given the variance and unpredictability of pedestrian volumes, engineering judgement should be used to determine if pedestrian volumes will have a notable effect on the results of the evaluation and any assumptions shall be documented in the deliverable. The following are reasonable for assumed pedestrian activations, where pedestrian volumes are unavailable and the effects of pedestrians are considered in the evaluation:

- Urban: 8 pedestrian calls/hour
- Rural: 4 pedestrian calls/hour

Supplemental Analysis

Projects that include the following proposed alternatives or mitigation require supplemental analysis that shall be included as part of the deliverable:

- Proposing a traffic signal requires a Traffic Signal Warrant Analysis consistent with the latest version of the Manual on Uniform Traffic Control Devices.
- Proposing additional turning lanes require a Turning Lane Warrant Analysis consistent with NCHRP 745 Left-Turn Accommodations at Unsignalized Intersections and NCHRP 279 Intersection Channelization Design Guide.
- Proposing an all-way stop requires an All-Way Stop Control Warrant Analysis consistent with the latest version of the Manual on Uniform Traffic Control Devices.

Synchro Model Development

Initial Model Setup Procedure

MaineDOT expects all Synchro models to follow standard setup practices. Note that the steps assume a general familiarity with the software and location of settings and/or tools; if this is not the case, please refer to the appropriate Synchro Manual for your version.

Fields other than those detailed in the following steps shall not be modified without first consulting MaineDOT staff. Driver, vehicle, and behavior parameters must remain at Synchro/SimTraffic defaults unless MaineDOT specifically approves a change. Deviations from default values can compromise repeatability, affect reported results, and prevent MaineDOT from validating the analysis. Any approved deviations must be clearly identified and documented.

1. Open Synchro and create a new file. The file should be saved to the location identified in Data Organization with an appropriate name.
2. Using the map navigation tools, path the Bing map to the desired location and then lock the map to the model's coordinate system.

   If you don't lock the map, the next time you open the file the map will likely reset to its default location. If at any point the map becomes unlocked, when you try to pan in the model the map will remain stationary and your modeled intersection(s) will pan instead.

   Note that Synchro's X,Y,Z coordinates for the nodes do not reflect the position relative to the displayed Bing map. As such two models could be built in the same relative position in the world based on the Bing map, however be in very different locations in Synchro's coordinate system. This is only a concern if models need to be combined or separated. When combining files, it is important that the coordinate systems are considered, typically by having a common node.
3. Using "Add Link" tool draw the mainline corridor using the Bing map as a guide. Continue to draw your minor approaches using the "Add Link" tool to create nodes for each major intersection. Once the nodes are created, move them to roughly the center of each intersection and adjust the links as needed using the Bing map as a guide.

   Use dummy nodes only when necessary (e.g., lane drops or additions). Avoid placing them within influence areas of major intersections. SimTraffic evaluates the volume balance and tracks performance data on a link-by-link basis, and the presence of dummy nodes can have a notable impact on the reported results.
4. Within "Lane Settings", for each node set the lane use, street name, link speed, lane width, storage lanes, and storage length for each approach.

   For signal corridors, the street name needs to be consistent through the mainline corridor for the Time Space Diagram and Arterial Report to function correctly.

   Synchro and SimTraffic use the 50th percentile speed for the entered link speed which is not consistent with how speed limits are set within the State of Maine. Engineering judgement will be required to determine the appropriate speeds for each link to ensure that the model nearly matches field conditions. Any significant deviation from the posted speed shall be discussed with MaineDOT staff.
5. Refine lane geometries by adding curvature, recentering nodes, and adjusting the intersection layouts in the "Simulation Settings" for median width, link offset, and crosswalk width, as

necessary. Care should be taken so that the stop bar locations and intersection widths are accurate to field conditions.

> *Note that the node locations and link curvatures may need to be adjusted to get the desired lane use; care should be taken to ensure that the depicted lane uses match how the lanes are utilized by drivers. Both Synchro and SimTraffic treat turning movements, slight turning movements, and through movements differently and the reported results will reflect changes in the lane use.*

6. From the map view, the node settings can be accessed by clicking on the node.
    a. The Node # should match the intersection number. Either reassign your primary nodes as 1,2,3, etc. or use the node # from a traffic management system, such as ATMS.now, if appropriate.
    b. The zone should be used to identify a coordinated corridor or group of intersections and all nodes within the corridor or group should share the same Zone ID.
    c. The control type should match the intersection type.
7. If a UTDF Volume File is being utilized, please follow the **UTDF Procedure**. Otherwise, in the "Volume Settings" set the Traffic Volumes, Peak Hour Factors, Growth Factors, and Heavy Vehicles % for each movement/approach.
8. For each signalized node, follow the steps in the **Signalized Intersection Procedure**.
9. If the Scenario Manager is being utilized, follow the steps in the **Scenario Manager Procedure**.
10. The Volume Balance shall be corrected between the nodes following the guidance in the **Volume Balance Procedure**.
11. The Synchro file should be reviewed at this point for accuracy in inputted information and consistency with these steps. Once the file is reviewed, continue to **SimTraffic Simulation Calibration and Set Up**.

UTDF Procedure

The “Volume.CSV” file is used to store traffic volumes so that they can be quickly and easily imported into Synchro and SimTraffic files.

Using a UTDF Volume File in SimTraffic allows for real volumes to be used for each interval, rather than relying on an average based on the hourly volume adjusted by the peak hour factor; there is an advantage to using UTDF Volume Files in complicated, near/overcapacity intersections or for generating realistic demand on minor low volume movements. Additionally, a UTDF Volume file is required for realistic volumes in simulations greater than 1 hour.

A UTDF Volume File can be generated following the steps below once step 6 in the **Initial Model Setup** procedure has been completed.

1. Click on the “Transfer” tab within the ribbon.
2. Click on “Read/Write” and then select “UTDF Write Volumes”.
3. Use the UTDF Database Access Window to detail the following:
    a. The “Volume.csv” file location can be set using the “Select” in the top right of the window.
    b. The scope of the intersections included within the UTDF “Volume.csv” file can be set using the “Scope” settings in the bottom of the window.
4. Click on “Write” to create the “Volume.csv” file at the selected location.
5. Open the “Volume.csv” file in Microsoft Excel or equivalent spreadsheet-based file editor.
6. Change the second line from “60 Minute Counts” to “15 Minute Counts”.
7. Enter the traffic volume information in the rows for each 15-minute interval per the movements noted in the columns in the third line. Note the Date, Time, and Intersection ID formats detailed in the first three columns.
8. Return to the UTDF Database Access Window.
    a. Click on the “Read Volumes” tab in the top left of the window.
    b. Click on the “Select” button to indicate the desired “Volume.csv”.
    c. Select the desired date and time for the active scenario using the settings available in the “Limit Records By” section in the middle of the window.
    d. If multiple days are selected in the “Limit Records By” section, then the desired averaging method can be selected using the “Read Option” section below the “Limit Records By” section.
    e. Make sure the “Set PHF” check box is checked to ensure the peak hour factors are automatically calculated. Note that peak hour factors will only be calculated if single hours’ worth of data is selected in the “Limit Records By” section.
    f. The scope of the intersections imported using the UTDF “Volume.csv” file can be set using the “Scope” settings in the bottom of the window.
9. Click on “Read” to import the volumes from the UTDF “Volume.csv” into the synchro model. Note that this will need to be completed for each scenario

Signalized Intersection Procedure

1. In “Timing Settings”, define the protected movements, permitted movements, detector phases, minimum initial, minimum split, total split, yellow time, all red time, and recall mode for each movement.
2. If the traffic signal is coordinated, in “Node Settings” set the referenced to, reference phase, master intersection, and yield point fields.
3. Set phase sequence in “Ring and Barrier Designer”.
4. Under “Phasing Settings” set pedestrian phase, walk time, flash don’t walk, and pedestrian calls. If pedestrian volumes are unknown, engineering judgement will be required to determine if the pedestrian traffic has a notable impact to vehicular traffic and whether pedestrians should be included in the model.

   > *Note that SimTraffic is unable to model scenarios where concurrent pedestrian clearance times exceed the split time of the vehicle phase and this may be a significant limitation when modeling field conditions.*

5. If known, in the “Detector Settings” the detector number and location shall be configured to match existing conditions. If not known, 40’ stop bar detection should be assumed and under “Phase Settings” the Vehicle Extension and Minimum Gap should be set per guidance in the FHWA “Traffic Signal Timing Manual” for a maximum allowable headway of 3 seconds.

Scenario Manager Procedure

Scenario Manager allows for saving multiple scenarios to a single Synchro file.

Synchro 12 allows for all model modifications to be changed between scenarios. In previous versions of Synchro Studio some of the settings were shared between scenarios, such as model geometry, and the shared settings were noted by the symbol to the left of the input description – one circle signifies that the input only changes in the active scenario, and two linked circles indicate that the field affects all the scenarios.

It is expected that Consultants use Scenario Manager when possible to organize multiple scenarios in a single Synchro file (if using Synchro 12). If Synchro 11 is used, multiple files may be required but must be named consistently.

1. While in the map view the "Scenario Manager" can be found on the left side of the window. Upon expanding the scenario manager there will be a list of all the currently configured scenarios. Within each scenario there are options to delete, save, duplicate, or copy data from a scenario.
2. From the scenario list you can rename the default scenario and fill out the appropriate fields. Note that SimTraffic utilizes the Scenario Name to generate the ".HST" files for each run and as such the Scenario Name cannot use any characters that are not allowed by Windows when naming files and/or folders such as "." or "/". Further the Scenario Name is used in the SimTraffic report header and as such the name should clearly identify the Scenario purpose; the description and analyst fields are also used in the SimTraffic reports.
3. New scenarios can be created using the Duplicate tool. Fill out all the fields and then the tool will duplicate the Active Scenario with the new field information.
4. Scenarios can also be activated by using the drop down in the top center of the Synchro Window, above the tool ribbon.

Volume Balancing Procedure

Volume balancing ensures that vehicle flows across intersections are internally consistent. Volume imbalance will result in inaccurate delay per vehicle results as the added and removed vehicles are still counted within the results of the simulation. For instance, if there is a negative volume balance, requiring vehicles to be removed, the delay for these removed vehicles is still counted towards the total delay and volume for the approach. These added or removed vehicles will have the effect of reducing the overall average, with the removed vehicles having a much greater effect as their delay is essentially zero. The current volume balance can be seen visually within Synchro by selecting the "VB" Link setting under the Display Results tools. The following list outlines typical scenarios that can cause volume imbalance.

- Driveways, roads, and entrances not included within the Synchro model.
- Errors within the traffic count such as missed or double counted vehicles.
- Traffic counts collected on different dates or at different times.
- Different design peak hours used at adjacent intersections.
- Averaging traffic volumes over multiple days.
- Using percentage-based adjustment may skew higher volume movements.
- If not using a UTDF Volume file then the PHF Adjust and AntiPHF Adjust settings within SimTraffic may create volume imbalance if the peak hour factors are not consistent over all movements and/or intersections. Note that this case of imbalance would not be visualized in the Synchro interface.
- Heavy vehicle volumes based on a percentage of the approach volume is particularly difficult to calibrate correctly and will likely result in some level of volume imbalance within the simulation as heavy vehicles are generated and removed to meet the percentage requirement.
- If any part of the model is over capacity resulting in lower-than-expected volumes downstream of an intersection, then SimTraffic will automatically generate traffic downstream of the intersection to meet the demands of the downstream intersections. Vehicles will then be removed from upstream traffic once it exits the overcapacity approach to "balance" the demand. This doesn't affect the net volume balance over the hour; however, it will have a similar effect on the delay/vehicle results as if there was a volume imbalance.

The following steps detail the general methodology for correcting volume imbalance. This information is intended for traditional volume inputting methods using Synchro and not using a UTDF file, however the concepts are the same and the following should be reviewed before balancing a UTDF volume file.

1. Determine what volume data is likely the most accurate. In general, newer data is typically more accurate than older and data averaged volumes over multiple weeks collected from video detection is better than an average over a few days of data collected using traditional methods, which is better than a single day count.
2. There are a few options for how to balance a model depending on the pattern of imbalance in between adjacent intersections. For either of the first two options it is best to start at an intersection(s) with the best data and then work outward through the model. Each scaling method has its pros and cons and are briefly described in the following statements.

- Intersection based scaling is used by adjusting the Growth Factor setting, under the Volume Settings, equally for all movements to minimize the volume balance. This method works best when the volume balance for each link is positive in one direction and negative in the other with similar magnitudes and best addresses volume balance issues caused by traffic counts collected on different days, averaging traffic volumes over multiple days, and using a percentage-based adjustment. If the volume imbalance isn't positive in one direction and negative in the other then intersection-based scaling will negatively impact one of the directions and it may not be possible to minimize the volume imbalance. Note that using the Growth Factor setting will also growth any development generated trips implemented through the built in TIA module.
- Directional scaling is used by adjusting the Growth Factor setting, under the Volume Settings, individually for movements going into and out of the links. All movements going into or out of a link should have a consistent Growth Factor setting. Consideration should be given to also adjusting movements adjacent to the movements going into or out of links especially if those movements are immediately leaving the model; for example, if adjusting a left or right turn that enters a link by 10% then the thru movement should also likely be increased by 10%. Directional scaling best addresses volume imbalance caused by errors within the traffic count itself and will more often result in minimized or complete correction of volume imbalance. The major negative to directional scaling is the relative ratio of movements on an approach are not preserved.
- Percentage based distribution fixes the traffic entering the network or fixes the traffic entering and exiting a single intersection and uses the relative ratios between the movements for each approach to distribute the traffic to the network. This method is the most involved as it requires recalculating the volumes at each intersection, however this method both achieves fully removing the volume imbalance and preserves the relative ratios of the movements on each approach. Ideal applications of utilizing a percentage based distribution are when you are confident in the accuracy of the traffic volumes entering the network or if there is a single intersection that has significantly more reliable data than the rest.

3. The volumes should be adjusted at least until the negative volume balances are minimized or corrected as these have the largest impact to the delay/vehicle results.
4. If there are still negative volume imbalances or there are positive volume imbalances greater than 5% of the relative link directional volume and the maximum queue extends past the midpoint of the link, then consideration should be given to placing redundant nodes around the maximum queue of the link to correct the volume imbalance using right turns. It is important that these redundant nodes are not placed within the maximum queue length reported through SimTraffic as the total delay for the approach will only consider vehicles within the approach link to the actual intersection downstream of the redundant node. The speeds of the right turns should be adjusted to minimize the delay caused by these movements.

SimTraffic Simulation Setup and Calibration

SimTraffic Setup

SimTraffic utilizes an existing Synchro model for baseline information and as such the **Initial Model Setup** procedure needs to be completed prior to continuing with this procedure. Any deviations from this procedure should be noted in the Deliverable.

1. SimTraffic should be launched from the Synchro window. If SimTraffic detects that either this is the first launch of SimTraffic for that Synchro File or if the Synchro File has been saved then it will require you to rerun the initial ".HST" file before proceeding, which is used to display the simulation while using the software.
2. On the first launch of SimTraffic, the Data Options and Interval Options will need to be verified or configured within the SimTraffic Parameters.
    - Under the "Data Options" tab, If using UTDF Volume or UTDF Timing files, these files can be identified by pathing to the desired file which should be located in the folder identified in the **Data Organization** section.
    - Under the Intervals tab, for a typical 1-hour analysis there should be five fifteen-minute intervals.
        - The first interval should be named "Seeding" and the field should all be No with the exception of the Growth Factor Adjust which will be Yes.
        - The other four intervals should be named "Recording" and the Record Statistics and Growth Factor Adjust fields should be Yes. If a UTDF Volume file was used then the PHF Adjust and AntiPHF Adjust should be set to No. If a UTDF Volume file was not used then the PHF Adjust should be set to Yes only for the second Recording Interval and the Anti PHF Adjust should be set to Yes for only the first, third, and forth Recording Intervals.
        - If a UTDF Timing file is used then the Timing Plan ID should be set to match the desired Timing Plan for each interval or the Timing Plan ID can be set to "(default)" and the default Timing Plan ID can be set in the "Data Options" tab.
        - The Random Number Seed should be set to 1. A different starting seed number can be chosen If one of the seeds is identified as being an outlier or a failed run. However, care should be taken that the same starting seed number is used for all scenarios for consistency. Random Seed numbers are not recommended as the repeatability of the simulation can not be ensured. It shall be noted within the traffic impact study if a Random Number Seed different than 1 was used.
    - For a multiple hour analysis utilizing a UTDF Volume file, typically used for time of day planning, there should be one 15 minute seeding interval and then 16 30 minute intervals; the intervals should be ordered: 7 before the peak hour, 2 for the peak hour, and 7 after the peak hour. The interval order can be adjusted to ensure adequate overlap between peak hours. The above interval settings for a typical 1-hour analysis should be applied to the multiple hour analysis intervals.
3. Do not make any changes to the Vehicle or Driver Parameters without first consulting MaineDOT Staff. If the situation requires changes to these parameters, then any modifications shall be well documented and disclosed as any deviation from the default values can have significant effects on the results and in turn the repeatability/consistency of the reported values.
4. The SimTraffic history file should be rerecorded to reflect any changes in the Data Options and Interval Options.

Calibration and Validation

Calibration is more than checking that delay values match expectations—it ensures the simulated network behaves like the real-world system. MaineDOT expects consultants to validate models using both quantitative measures and qualitative, field-based observations.

SimTraffic runs should "look right" when observed:

- Travel speeds through the corridor and for turning traffic should "look" consistent and reasonable. If there are obvious idiosyncrasies then the speeds should be adjusted based on Engineering Judgement sourcing from the TRB "Highway Capacity Manual" and the AASHTO "A Policy on Geometric Design of Highways and Streets".
- Traffic signals should sequence correctly and each approach should be serviced each cycle if demand is present. If approaches are not being serviced, check the movement assignment, volumes, and detector settings to confirm that everything is configured as desired.
- If the nodes were volume balanced correctly then it should be rare for vehicles to disappear and reappear on links, especially if using a UTDF Volume file. If there are a noticeable number of disappearing and appearing vehicles then check the volume balance, peak hour factors, and truck percentage.
- Proposed traffic signal timings should be optimized based on Engineering Judgement and the "optimize" tools within Synchro should only be used as a starting point. Within the simulation model the simulation should be observed for progression through the corridor, split/queue failures, and queueing.
- The simulation shall be representative of field conditions, including driver gap acceptance, travel speeds, queuing, coordination progression, and traffic patterns. If a model doesn't appear to represent field conditions, MaineDOT staff should be consulted to determine the best methodologies to correct the model.
- The queued traffic on open ended links at the edges of the model or at proposed entrances should not exceed the link distance. Vehicles that try to enter into the model on a fully saturated link will count as Denied Entry vehicles and will not be considered in the reporting until they enter the model and will negatively impact the accuracy of the reported performance measures. Links at the edge of the model or at proposed entrances should be extended so that the link is long enough to capture the maximum queue and the space where vehicles slow down to enter the queue; it is ok to extend these links beyond field conditions as long as they are not excessively extended.

Engineering judgment is critical in making these assessments. Where posted speed limits and modeled speeds differ, adjustments must be documented. If queues or delays in the model diverge significantly from field observations, consultants should reconcile those differences with MaineDOT before finalizing results.

Deviations, assumptions, and manual overrides must always be documented so MaineDOT reviewers understand how the model was calibrated and validated.

Reporting Requirements

Accurate and transparent reporting is as important as the modeling itself. MaineDOT relies on clear documentation to validate results, compare alternatives, and make informed decisions. Which measures of effectiveness (MOEs) must be reported, the formats in which results shall be submitted, and how consultants should organize their files are highlighted below. The goal is to ensure MaineDOT reviewers can easily trace reported outcomes back to model assumptions and field conditions.

It is expected that Consultants submit complete, transparent results produced using the following steps and guidance.

1. Multiple runs shall be recorded using the "Multiple Simulation Runs" tool.
   - The number of runs should be based on the natural variation of the runs determined using the Performance Report set to Approach, Run Number; any outliers should be noted in the Traffic Study and consideration should be given to using a different Random Number Seed to minimize the number of outliers. Ideally, the number of runs should be selected so that the 95% confidence interval for approach delay is less than roughly +/- 2 seconds.
   - The following is adequate for most traffic studies. However, it is still recommended that the variation be checked against 20 runs for any final report.
     - An isolated unsignalized intersection – 10 Runs
     - An isolated under capacity signalized intersection – 10 Runs
     - An isolated over capacity signalized intersection – 20 Runs
     - Multiple Hour Analysis – 10 Runs
     - A coordinated corridor – 20 Runs
2. The report window can be launched through the "Create Report" button. The information included in the reports may very project to project; the following detail a typical report set up for most scenarios.
   - Simulation Summary, Queuing Information, Actuated Timings, and Performance Report should be all checked.
   - Under Performance Report Options MOEs: Total Delay, Delay/Vehicle, Stops/Vehicle, Vehicles Entered, Avg Speed, Total Distance Traveled, and Density should be highlighted.
   - Under Selection, Columns, "Intersection, Movement" should be selected for most reports. "Approach, Run Number" is commonly used for comparing results from multiple runs and to identify if one of the seeds produces an outlier. The easiest way to quickly compare different timing plans for a multiple hour analysis is to use "Intersection, Approach" with the "Detail Intervals" option selected.
   - If there are coordinated signalized intersections, then the Arterial Report should be checked and the coordinated corridor should be selected.
   - The scope of the report can be narrowed by selecting either a single intersection or a zone.
3. The Header and Footer should follow the following:
   - Header Top Left: %report_title% = SimTraffic Performance Report
   - Header Top Right: User Inputted Report Title
   - Header Bottom Left: %alternative%

    - Header Bottom Right: %date%
    - Footer Top Left: %scenario_name% %description%
    - Footer Top Right: SimTraffic Report
    - Footer Bottom Left: %analyst%
    - Footer Bottom Right: Page %page%
4. The report should be saved either by printing the PDF and/or saving the text to the location identified in Data Organization.

Deliverables are expected to include the following information:

- SimTraffic PDF reports.
- Text based outputs.
- Summary tables (Excel, PowerBI, etc.)
- Scenario comparison tables (Excel, PowerBI, etc.)

A level of service degradation of two or more levels or unexplained level of service improvements between existing and proposed conditions shall be noted and explained in the deliverable.

Reporting by Movement vs. Approach

Approach-level reporting aggregates performance measures across all lanes on a given approach and should be used for:

- Planning-level studies and high-level evaluations.
- Comparing no-build vs. build conditions.
- Reporting benefit-cost analyses.
- Public-facing reports for NEPA documentation.

Typical metrics reported by approach include:

- Average delay per vehicle (sec/veh).
- Level of Service (LOS) grade.
- Volume-to-capacity (v/c) ratio for the approach.
- 95th percentile queue length where lanes operate similarly.

Movement-level reporting breaks down the results for individual lane groups or movements (e.g., left-turn, thru, and right-turn separately) and should be used for:

- Traffic Impact Studies and Traffic Operations Evaluations
- Design-level analyses where lane-by-lane operations are critical.
- Signal timing optimization and split allocation.
- Evaluating storage adequacy for turn lanes.
- Assessing lane imbalance issues.
- Identifying movement-specific safety problems.

Typical metrics reported by movement include:

- Delay per movement.
- 95th percentile queue lengths for each lane group.

- Vehicles denied entry.
- Movement-level volume and saturation flow rates.

Scenario	Approach-Level Reporting	Movement-Level Reporting
High-level planning/NEPA studies	Yes	Sometimes
Alternatives comparisons	Yes	Yes
Intersection design	Sometimes	Yes
Signal timing optimization	Sometimes	Yes
Storage length evaluation	No	Yes
Safety analysis by crash type	Sometimes	Yes
MaineDOT SimTraffic summary outputs	Delay + LOS	Queues + Denied Entries

Data Organization

Outside of special circumstances, when Synchro Studio files are requested by MaineDOT staff, the files should be provided in a compressed folder structure (preferably ".zip" format) and should be organized based on the following:

- All Synchro ".SYN" files should be in the base compressed folder. The number of ".SYN" files should be minimized as much as possible to limit redundant and/or potentially confusing information.
- Any traffic count or volume information should be stored in a subfolder in the base compressed folder under "Traffic Counts". If applicable subfolders should be utilized and should clearly indicate the source and date of the data.
- Any Text based reports or outputs should be stored in a subfolder in the base compressed folder under "Text". Additionally, any UTDF output/input files should be located in the "Text" folder. If used, the UTDF Volume file should be accompanied by a "Volume Key" text file that includes a short description of the organization of the volume file. If applicable, subfolders should be utilized and should clearly indicate the source of information.
- Any PDF based reports should be stored in a subfolder in the base compressed folder under "Reports". If applicable subfolders should be utilized and should clearly indicate the source of the information.
- ".hst" files should <u>not</u> be provided in the compressed folder structure. MaineDOT staff will regenerate ".hst" files following the procedures outlined in this document to validate the results provided in the reports.

Safety and Mobility Integration

MaineDOT considers both mobility and safety when evaluating transportation projects. Improvements that enhance traffic flow but may compromise safety are generally discouraged, while projects that improve safety with some reduction in mobility may still be considered feasible.

This section provides guidance on integrating Highway Safety Manual (HSM) methodologies with traffic modeling, outlining MaineDOT's expectations for documenting safety and mobility trade-offs, and clarifying typical thresholds for LOS, queues, and system reliability.

MaineDOT encourages that safety and mobility be evaluated together.

- Safety analysis shall use HSM methodologies and MaineDOT's 10-year observed crash analysis procedure, or other approved analyses, in coordination with the MaineDOT Office of Safety and Mobility.
- Mobility analysis shall evaluate LOS, queues, and delay.

Key Principles:

- Roundabouts shall not be simulated in SimTraffic without prior coordination with MaineDOT. In most cases, analyses shall rely on Highway Capacity Manual (HCM)-based reporting in Synchro, manual HCM calculations, or Highway Capacity Software (HCS).
- Safety and mobility considerations should be weighed against one another when identifying preferred alternatives.
- LOS D may be considered acceptable in some contexts, while LOS F with a volume-to-capacity ratio greater than 1.0 will typically require additional review and justification.

In some cases, an alternative may result in higher delays or longer queues but still be acceptable if the predicted safety benefits are substantial. MaineDOT encourages consultants to document these trade-offs clearly, quantifying both safety and mobility impacts in parallel. The intent is to ensure decision-making reflects overall value, not just operational performance.

Benefit-Cost Analysis

Benefit-cost analysis (B/C) provides a consistent framework to compare the effectiveness of alternatives. By quantifying both mobility benefits (such as delay reduction) and safety benefits (such as crash reduction), MaineDOT ensures that decisions are based on overall value rather than a single metric. This section describes how to calculate annualized benefits, convert them to present worth, and apply MaineDOT's thresholds to evaluate whether an alternative is feasible or preferred.

Benefit-cost ratios (B/C) quantify the combined value of safety and mobility improvements relative to project costs.

Mobility Benefits

- Calculate peak-hour delay savings per vehicle.
- Apply MaineDOT's mobility benefit multipliers to estimate annual delay savings.
- Monetize using value of time for passenger vehicles and trucks.

Safety Benefits

- Estimate crash reduction benefits using predictive HSM methods.
- Convert annual crash reduction benefits into present worth.

Benefit-Cost Thresholds

- B/C < 1.0 → Project not feasible.
- 1.0 < B/C < 2.0 → Feasible but less favorable.
- B/C ≥ 2.0 → Preferred.

All benefits must be converted to present worth using MaineDOT's standard 6% discount rate, unless otherwise directed. This ensures consistency across projects and allows MaineDOT to compare alternatives on an equal financial basis. Consultants shall document the discounting method, assumed analysis period, and all unit values applied in the analysis.

Deliverables and Validation

Validation:

- All models must be calibrated to field conditions.
- Signal timing and phasing may only be optimized for new and future signals.
- All required MOEs must be reported.

Deliverables Checklist:

- Synchro .syn files (organized by scenario).
- UTDF volume files and volume keys (if applicable).
- SimTraffic reports (PDF and text)
- Summary tables (LOS, queues, delay)
- Safety analysis documentation.
- Scenario comparison tables (LOS, queues, delay, safety, B/C ratios)

Appendices

Appendix A: Example Data Request Letter

TRAFFIC DATA REQUEST

CITY/TOWN: ______________________________

DATE REQUESTED: ______________________________

REQUESTED BY: ______________________________

CONTACT INFORMATION: ______________________________

REASON FOR STUDY: ______________________________

DATA COLLECTION TIMEFRAME: ______________________________

TYPE OF DATA NEEDED

TRAFFIC COUNT ☐ VEHICLE CLASSIFICATION ☐ TURNING MOVEMENT ☐

SPEED STUDY ☐ HEADWAY ☐ GAP ☐ QUEUE ☐

PEDESTRIAN ☐ BICYCLE ☐

OTHER ☐ ______________________________

LOCATION OF INTERSECTION OR COUNT: ______________________________

____

PLEASE PROVIDE A MAP OF THE LOCATION(S)

Appendix B: Synchro Setup Screenshots

Lane Settings

Lane Settings	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	6	43	64	47	20	5	140	278	51	14	529	6
Future Volume (vph)	*6*	*43*	*64*	*47*	*20*	*5*	*140*	*278*	*51*	*14*	*529*	*6*
Street Name	Chapman Street			Northgate Plaza			Auburn Street			Auburn Street		
Link Distance (ft)	—	176	—	—	128	—	—	470	—	—	386	—
Link Speed (mph)	—	30	—	—	30	—	—	30	—	—	30	—
Set Arterial Name and Speed	—	EB	—	—	WB	—	—	NB	—	—	SB	—
Travel Time (s)	—	4.0	—	—	2.9	—	—	10.7	—	—	8.8	—
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type CBD	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Storage Length (ft)	0	—	0	0	—	0	225	—	0	125	—	0
Storage Lanes (#)	—	—	—	—	—	—	1	—	—	1	—	—
Right Turn Channelized	—	—	None	—	—	None	—	—	None	—	—	None
Curb Radius (ft)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Right Turn Factor	—	0.924	—	—	1.000	0.850	1.000	1.000	0.850	1.000	0.998	—
Left Turn Factor (prot)	—	0.997	—	—	0.966	1.000	0.950	1.000	1.000	0.950	1.000	—
Saturated Flow Rate (prot)	—	1720	—	—	1835	1615	1770	1863	1583	1752	1841	—
Left Turn Factor (perm)	—	0.973	—	—	0.765	1.000	0.950	1.000	1.000	0.950	1.000	—
Right Ped Bike Factor	—	*0.993*	—	—	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	—
Left Ped Factor	—	*1.000*	—	—	*0.999*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	—
Saturated Flow Rate (perm)	—	1679	—	—	1453	1615	1770	1863	1583	1752	1841	—
Right Turn on Red?	—	—	☑	—	—	☑	—	—	☑	—	—	☑
Saturated Flow Rate (RTOR)	—	70	—	—	0	145	0	0	85	0	1	—
Link Is Hidden	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Hide Name in Node Title	—	☐	—	—	☐	—	—	☐	—	—	☐	—

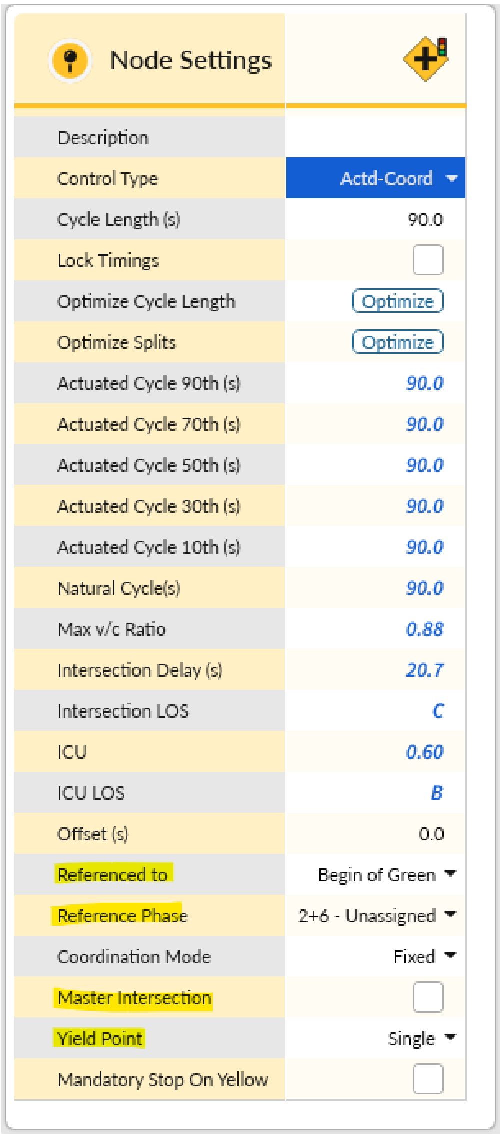
Simulation Settings

Simulation Settings	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	0	0	0	37	0	41	0	127	10	557	141	0
Future Volume (vph)	*0*	*0*	*0*	*37*	*0*	*41*	*0*	*127*	*10*	*557*	*141*	*0*
Storage Length (ft)	0	—	0	0	—	75	0	—	0	0	—	0
Storage Lanes (#)	—	—	—	—	—	1	—	—	—	—	—	—
Taper Length (ft)	—	—	—	—	—	50	—	—	—	—	—	—
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Median Width (ft)	—	12	—	—	12	—	—	12	—	—	12	—
Link Offset (ft)	—	0	—	—	0	—	—	0	—	—	0	—
Crosswalk Width (ft)	—	16	—	—	16	—	—	16	—	—	16	—
TWLTL Median	—	☐	—	—	☐	—	—	☐	—	—	☐	—
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15	—	9	15	—	9	15	—	9	15	—	9
Mandatory Distance (ft)	—	200	—	—	200	—	—	200	—	—	200	—
Positioning Distance (ft)	—	1539	—	—	1539	—	—	1539	—	—	1539	—
Mandatory Distance 2 (ft)	—	1026	—	—	1026	—	—	1026	—	—	1026	—
Positioning Distance 2 (ft)	—	2052	—	—	2052	—	—	2052	—	—	2052	—

Timing Settings

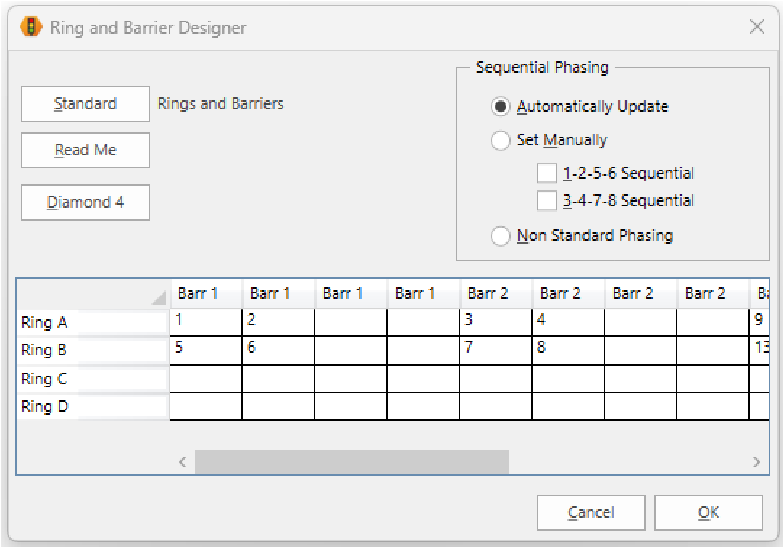
Timing Settings	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	0	0	0	37	0	41	0	127	10	557	141	0	—	—
Future Volume (vph)	*0*	*0*	*0*	*37*	*0*	*41*	*0*	*127*	*10*	*557*	*141*	*0*	—	—
Turn Type	—	—	—	Perm	—	Perm	—	—	—	Perm	—	—	—	—
Protected Phases	—	—	—		—		—	4	—		8	—		
Permitted Phases				6		6				8			—	—
Permitted Flashing Yellow	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Detector Phases				6		6		4		8	8		—	—
Switch Phase	0	0	0	0	0	0	0	0	0	0	0	0	—	—
Leading Detector (ft)	—	—	—	20	—	20	—	100	—	—	100	—	—	—
Trailing Detector (ft)	—	—	—	0	—	0	—	0	—	—	0	—	—	—
Minimum Initial (s)	—	—	—	5.0	—	5.0	—	5.0	—	5.0	5.0	—	—	—
Minimum Split (s)	—	—	—	22.5	—	22.5	—	22.5	—	22.5	22.5	—	—	—
Total Split (s)	—	—	—	23.0	—	23.0	—	67.0	—	67.0	67.0	—	—	—
Yellow Time (s)	—	—	—	3.5	—	3.5	—	3.5	—	3.5	3.5	—	—	—
All-Red Time (s)	—	—	—	1.0	—	1.0	—	1.0	—	1.0	1.0	—	—	—
Lost Time Adjust (s)	—	—	—	0.0	—	0.0	—	0.0	—	—	0.0	—	—	—
Lagging Phase?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Allow Lead/Lag Optimize?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Recall Mode	—	—	—	Min	—	Min	—	None	—	None	None	—	—	—
Speed limit (mph)	—	35	—	—	35	—	—	35	—	—	35	—	—	—
Actuated Effct. Green (s)	—	—	—	*7.4*	—	*7.4*	—	*42.0*	—	—	*42.0*	—	—	—
Actuated g/C Ratio	—	—	—	*0.12*	—	*0.12*	—	*0.71*	—	—	*0.71*	—	—	—
Volume to Capacity Ratio	—	—	—	*0.18*	—	*0.19*	—	*0.11*	—	—	*0.85*	—	—	—
Control Delay (s)	—	—	—	*31.2*	—	*13.0*	—	*2.4*	—	—	*17.1*	—	—	—

Node Settings



Node Settings	
Description	
Control Type	Actd-Coord
Cycle Length (s)	90.0
Lock Timings	☐
Optimize Cycle Length	Optimize
Optimize Splits	Optimize
Actuated Cycle 90th (s)	90.0
Actuated Cycle 70th (s)	90.0
Actuated Cycle 50th (s)	90.0
Actuated Cycle 30th (s)	90.0
Actuated Cycle 10th (s)	90.0
Natural Cycle(s)	90.0
Max v/c Ratio	0.88
Intersection Delay (s)	20.7
Intersection LOS	C
ICU	0.60
ICU LOS	B
Offset (s)	0.0
Referenced to	Begin of Green
Reference Phase	2+6 - Unassigned
Coordination Mode	Fixed
Master Intersection	☐
Yield Point	Single
Mandatory Stop On Yellow	☐

Ring and Barrier Designer



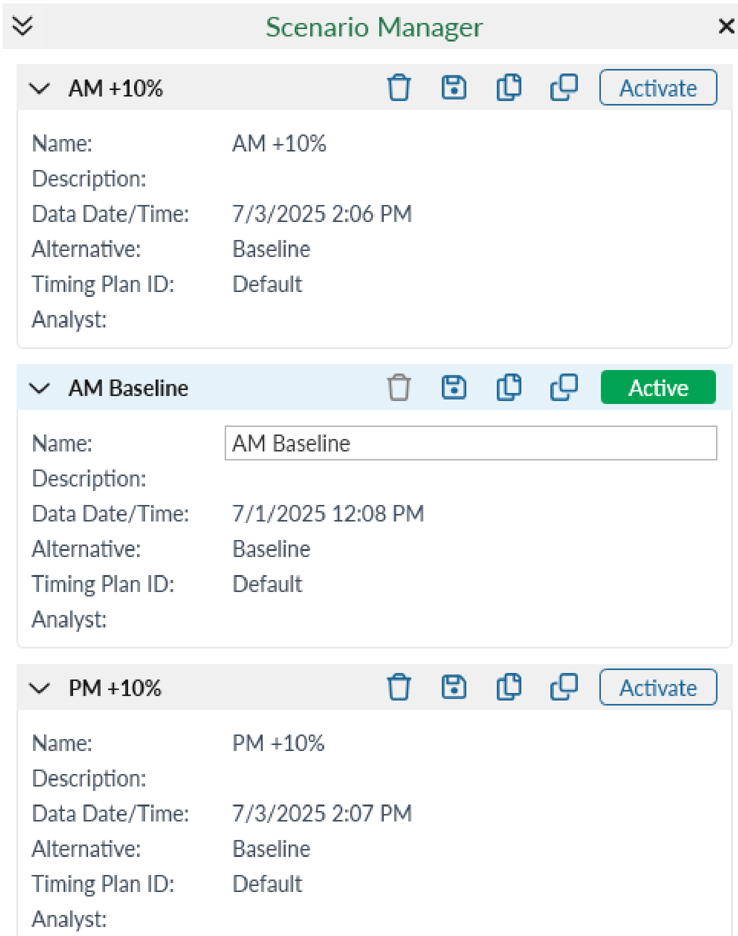
Phasing Settings

Phasing Settings	4-NET	6-SBL	8-SWTL
Minimum Initial (s)	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5
Maximum Split (s)	67.0	23.0	67.0
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0
Lagging Phase?	—	—	—
Allow Lead/Lag Optimize?	—	—	—
Optimize Phs Weights - Delays	1.0	1.0	1.0
Vehicle Extension (s)	3.0	3.0	3.0
Minimum Gap (s)	3.0	3.0	3.0
Time Before Reduce (s)	0.0	0.0	0.0
Time To Reduce (s)	0.0	0.0	0.0
Recall Mode	None	Min	None
Pedestrian Phase	✓	✓	✓
Walk Time (s)	7.0	7.0	7.0
Flash Don't Walk (s)	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0	0	0
Dual Entry?	✓	✓	✓
Fixed Force Off?	✓	✓	✓
90th %ile Green Time (s)	*63 hd*	*10 gp*	*63 mx*
70th %ile Green Time (s)	*56 hd*	*8 gp*	*56 gp*
50th %ile Green Time (s)	*42 hd*	*7 gp*	*42 gp*
30th %ile Green Time (s)	*32 hd*	*6 gp*	*32 gp*
10th %ile Green Time (s)	*23 hd*	*6 gp*	*23 gp*

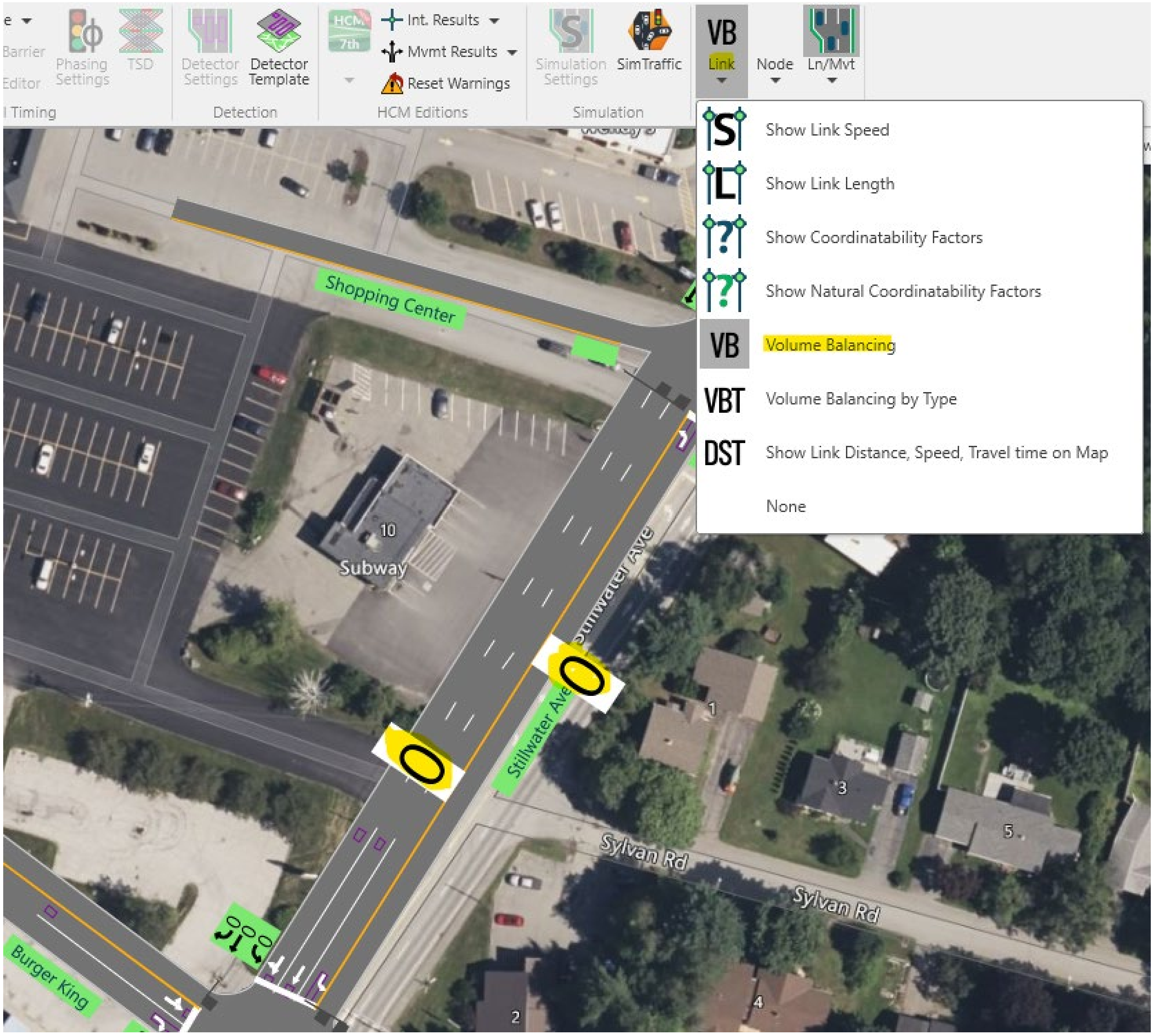
Detector Settings

Detector Settings	NBT	SBL	SBT	SBR	NET	SWT
Lanes and Sharing (#RL)						
Traffic Volume (vph)	0	37	0	41	127	141
Future Volume (vph)	*0*	*37*	*0*	*41*	*127*	*141*
Number of Detectors (#)	2	1	2	1	2	2
Detector Phases	None	6	None	6	4	8
Switch Phase	0	0	0	0	0	0
Leading Detector (ft)	100	20	100	20	100	100
Trailing Detector (ft)	0	0	0	0	0	0
Detector Template	Thru	Left	Thru	Right	Thru	Thru
Add/Update Template						
Detector 1 Position (ft)	0	0	0	0	0	0
Detector 1 Size (ft)	6	20	6	20	6	6
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channels						
Detector 1 Extend	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay	0.0	0.0	0.0	0.0	0.0	0.0
Detector 2 Position (ft)	94	—	94	—	94	94
Detector 2 Size (ft)	6	—	6	—	6	6
Detector 2 Type	Cl+Ex	—	Cl+Ex	—	Cl+Ex	Cl+Ex
Detector 2 Channels		—		—		
Detector 2 Extend	0.0	—	0.0	—	0.0	0.0

Scenario Manager



Volume Balancing



Appendix C: UTDF Files

Example UTDF File

Turning Movement Count													
15 Minute Counts													
DATE	TIME	INTID	SWL	SWR	SWT	NER	NET	NEL	SER	SET	SEL	NBR	NBL
8/29/2024	1545	2	104	1	45	12	30	3	4	1	1		
8/29/2024	1600	2	121	1	36	11	26	1	2	3	1		
8/29/2024	1615	2	113	1	38	5	40	1	1	1	1		
8/29/2024	1630	2	141	1	39	12	29	3	1	1	1		
8/29/2024	1645	2	93	1	51	15	25	3	1	1	1		
8/29/2024	1700	2	121	1	35	17	37	2	1	1	1		
8/29/2024	1715	2	121	1	41	15	34	[illegible]	1	1	1		

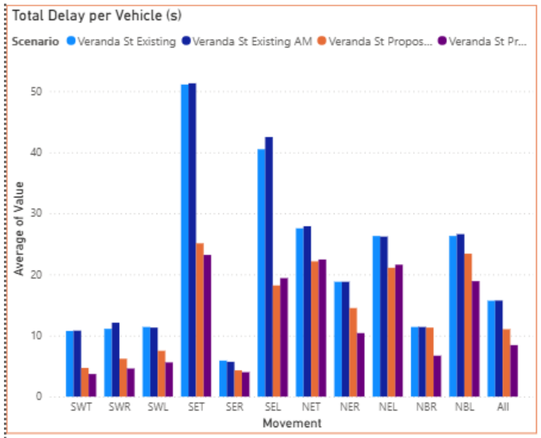
Appendix D: Example Output Summaries

SimTraffic Alternatives Comparison by Approach, Excel

Delay Information for Alternatives						
			Alternative			
Node	Direction		PM Baseline	Alt 2	Alt 3	Alt 4
Entire System		Entering Volume	2708	-	-	-
		Vehicles Denied Entry	1	-	-	-
		Total Del/Veh (s)	2.0	-	-	-
		Travel Distance (mi)	2071	-	-	-
		Travel Time (hr)	101	-	-	-
		Total Delay (hr)	3.0	-	-	-
1. Intersection 1		Intersection Type	sig.	sig.	sig.	sig.
	NB	Total Del/Veh (s)	21.0	-	-	-
	SB	Total Del/Veh (s)	-	-	-	-
	EB	Total Del/Veh (s)	3.1	-	-	-
	WB	Total Del/Veh (s)	12.0	-	-	-
	NB	Approach LOS	C	-	-	-
	SB	Approach LOS	-	-	-	-
	EB	Approach LOS	A	-	-	-
	WB	Approach LOS	B	-	-	-
	All	Total Del/Veh (s)	6.5	-	-	-
		Overall Intersection LOS	A			
2. Intersection 2		Intersection Type	unsig.	unsig.	unsig.	unsig.
	NB	Total Del/Veh (s)	-	-	-	-
	SB	Total Del/Veh (s)	75.9	-	-	-
	EB	Total Del/Veh (s)	0.8	-	-	-
	WB	Total Del/Veh (s)	12.0	-	-	-
	NB	Approach LOS	-	-	-	-
	SB	Approach LOS	F	-	-	-
	EB	Approach LOS	A	-	-	-
	WB	Approach LOS	B	-	-	-
	All	Total Del/Veh (s)	21.6	-	-	-
		Overall Intersection LOS	C			
3. Intersection 3		Intersection Type	sig.	sig.	sig.	sig.
	NB	Total Del/Veh (s)	-	-	-	-
	SB	Total Del/Veh (s)	55.0	-	-	-
	EB	Total Del/Veh (s)	12.0	-	-	-
	WB	Total Del/Veh (s)	79.0	-	-	-
	NB	Approach LOS	-	-	-	-
	SB	Approach LOS	D	-	-	-
	EB	Approach LOS	B	-	-	-
	WB	Approach LOS	E	-	-	-
	All	Total Del/Veh (s)	35.0	-	-	-
		Overall Intersection LOS	C			

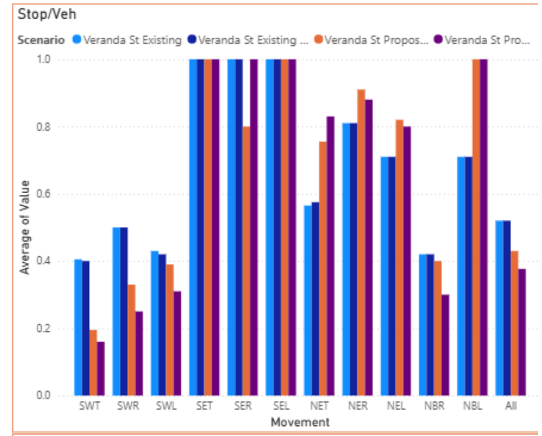
95th Queue (ft)						
Intersection: 1 Description	EB	TR	1	-	-	-
	EB	LTR	-	-	-	-
	WB	L	2	-	-	-
	WB	T	3	-	-	-
	NB	L	18	-	-	-
	SB	LTR	4	-	-	-
Intersection: 2 Description	NB	L	112	-	-	-
	NB	T	136	-	-	-
	SB	T	146	-	-	-
	SB	R	50	-	-	-

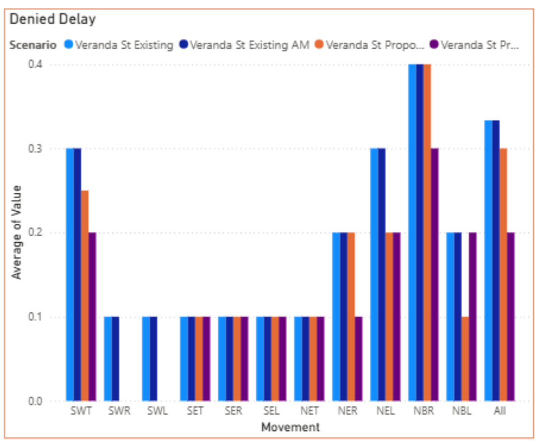
SimTraffic Delay and Performance by Movement, PowerBI

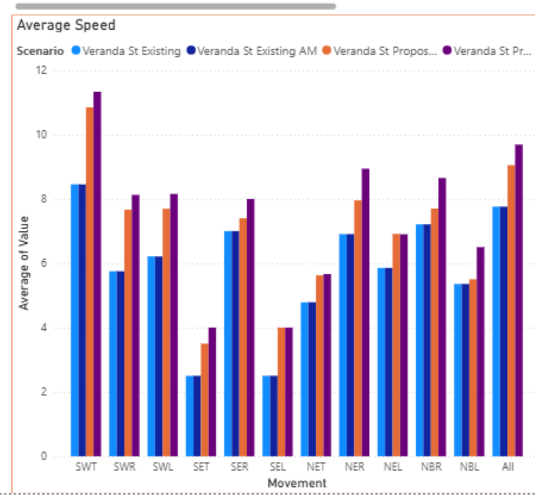


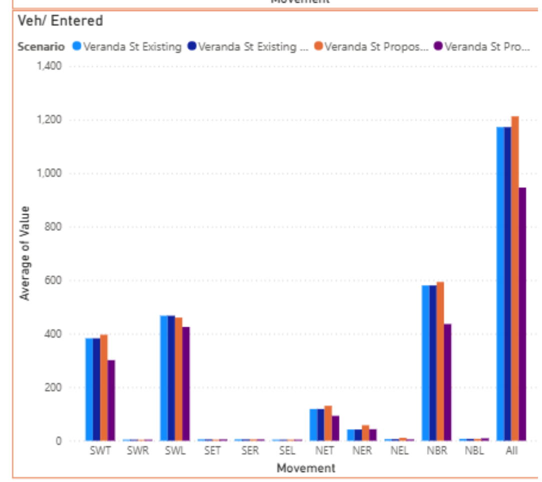
Total Delay Per Vehicle Table

Scenario	All	NBL	NBR	NEL	NER	NET	SEL	SER
⊟ **Veranda St Existing**	**15.70**	**26.30**	**11.40**	**26.30**	**18.80**	**27.55**	**40.50**	**5.90**
Total Network Performance	20.40							
Veranda St & I-295 NB Off Ramp	11.50	26.30	11.40			26.70		
Veranda St & Wordsworth St	15.20			26.30	18.80	28.40	40.50	5.90
⊟ **Veranda St Existing AM**	**15.73**	**26.60**	**11.40**	**26.20**	**18.80**	**27.90**	**42.50**	**5.70**
Total Network Performance	20.50							
Veranda St & I-295 NB Off Ramp	11.60	26.60	11.40			27.00		
Veranda St & Wordsworth St	15.10			26.20	18.80	28.80	42.50	5.70
⊟ **Veranda St Proposed**	**11.03**	**23.40**	**11.30**	**21.10**	**14.50**	**22.15**	**18.20**	**4.30**
Total Network Performance	14.60							
Veranda St & I-295 NB Off Ramp	7.90	23.40	11.30			22.00		
Veranda St & Wordsworth St	10.60			21.10	14.50	22.30	18.20	4.30
⊟ **Veranda St Proposed AM**	**8.43**	**18.90**	**6.70**	**21.60**	**10.40**	**22.45**	**19.40**	**4.00**
Total Network Performance	11.20							
Veranda St & I-295 NB Off Ramp	5.60	18.90	6.70			22.80		
Veranda St & Wordsworth St	8.50			21.60	10.40	22.10	19.40	4.00
Total	**12.73**	**23.80**	**10.20**	**23.80**	**15.63**	**25.01**	**30.15**	**4.98**

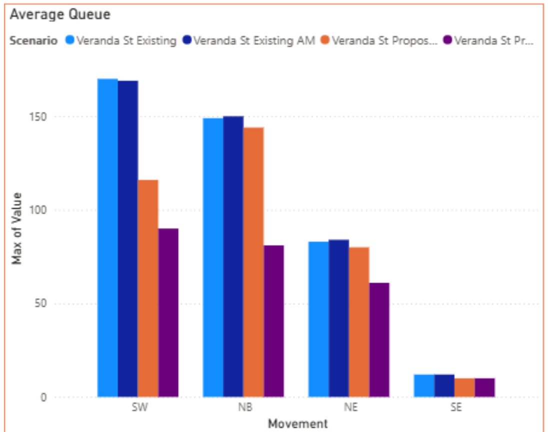




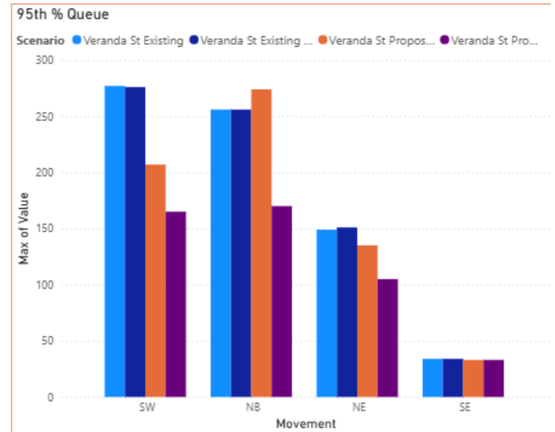


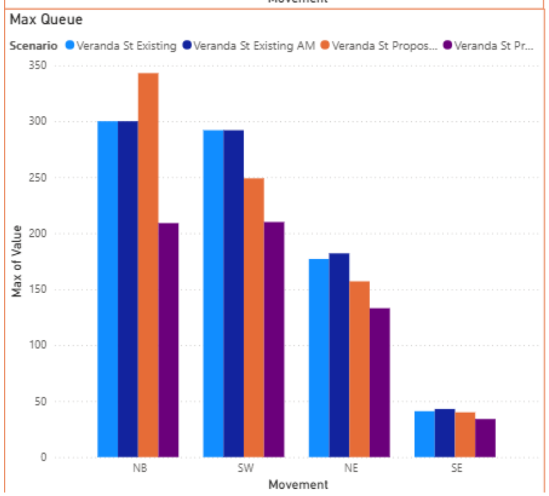


SimTraffic Queues by Movement, PowerBI



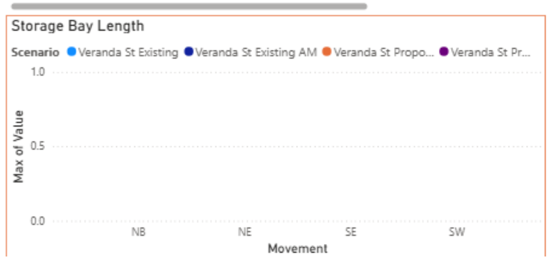
Scenario	95th Queue (ft)	Average Queue (ft)	Link Distance (ft)	Ma
Veranda St Existing	**1,043.00**	**591.00**	**3,709.00**	
Veranda St & I-295 NB Off Ramp	583.00	326.00	2,356.00	
Veranda St & Wordsworth St	460.00	265.00	1,353.00	
Veranda St Existing AM	**1,043.00**	**593.00**	**3,709.00**	
Veranda St & I-295 NB Off Ramp	582.00	328.00	2,356.00	
Veranda St & Wordsworth St	461.00	265.00	1,353.00	
Veranda St Proposed	**855.00**	**435.00**	**3,718.00**	
Veranda St & I-295 NB Off Ramp	480.00	229.00	2,359.00	
Veranda St & Wordsworth St	375.00	206.00	1,359.00	
Veranda St Proposed AM	**667.00**	**317.00**	**3,718.00**	
Veranda St & I-295 NB Off Ramp	364.00	156.00	2,359.00	
Veranda St & Wordsworth St	303.00	161.00	1,359.00	
Total	**3,608.00**	**1,936.00**	**14,854.00**	

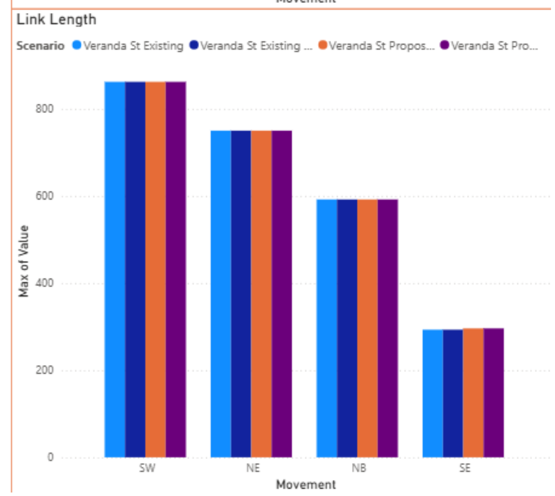




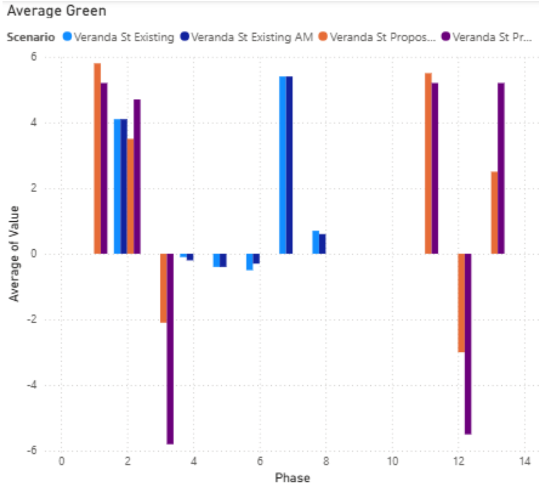
95th % Table

Movement	NB			NE			SE		S
Scenario	L	R	**Total**	LTR	T	**Total**	LTR	**Total**	L
Veranda St Existing	23.00	256.00	**256.00**	149.00	81.00	**149.00**	34.00	**34.00**	
Veranda St Existing AM	22.00	256.00	**256.00**	151.00	81.00	**151.00**	34.00	**34.00**	
Veranda St Proposed	27.00	274.00	**274.00**	135.00	107.00	**135.00**	33.00	**33.00**	
Veranda St Proposed AM	30.00	170.00	**170.00**	105.00	97.00	**105.00**	33.00	**33.00**	
Total	**30.00**	**274.00**	**274.00**	**151.00**	**107.00**	**151.00**	**34.00**	**34.00**	**2**

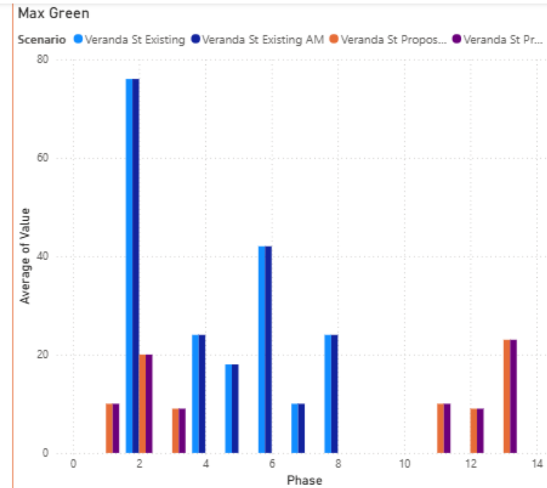


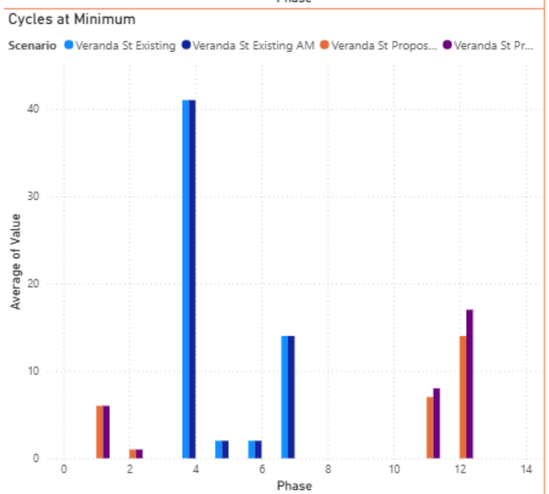


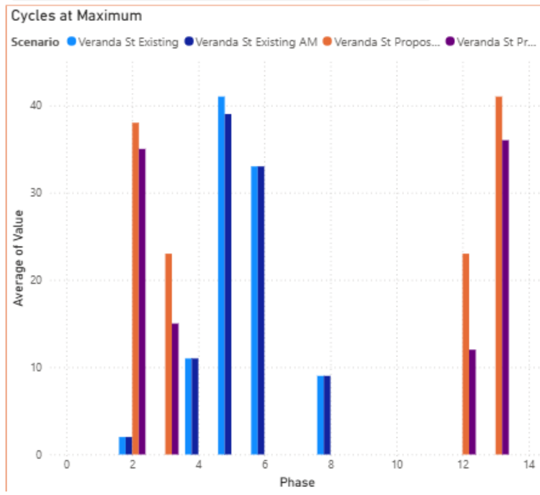
SimTraffic Signal Operations, PowerBI

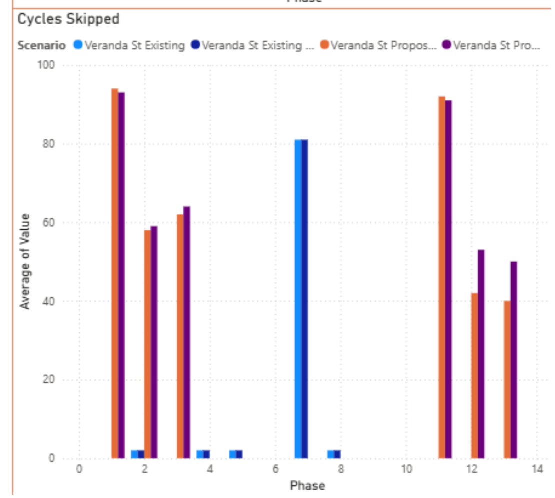


Scenario	Cycles @ Minimum (%)	Cycles Maxed Out (%)	Cycles Skip
⊟ **Veranda St Existing**	**9.83**	**16.00**	
⊞ Veranda St & I-295 NB Off Ramp	9.83	16.00	
⊟ **Veranda St Existing AM**	**9.83**	**15.67**	
⊞ Veranda St & I-295 NB Off Ramp	9.83	15.67	
⊟ **Veranda St Proposed**	**4.67**	**20.83**	
⊞ Veranda St & I-295 NB Off Ramp	4.67	20.83	
⊟ **Veranda St Proposed AM**	**5.33**	**16.33**	
⊞ Veranda St & I-295 NB Off Ramp	5.33	16.33	
Total	**7.42**	**17.21**	









SimTraffic Delay, LOS, and Queue by Movement, Excel

Intersection Movement	Existing AM Peak Hour 07:45-08:45		Proposed AM Peak Hour 07:45-08:45		Existing PM Peak Hour 16:30-17:30		Proposed PM Peak Hour 16:30-17:30	
	Delay (LOS)	95th% Queue	Delay (LOS)	95th% Queue	Delay (LOS)	95th% Queue	Delay (LOS)	95th% Queue
Veranda St & I-295 NB Off Ramp								
Veranda St NB T	27 (C)	81'	22.8 (C)	97'	26.7 (C)	81'	22 (C)	107'
I-295 NB Ramp L	26.6 (C)	22'	18.9 (B)	30'	26.3 (C)	23'	23.4 (C)	27'
I-295 NB Ramp R	11.4 (B)	256'	6.7 (A)	170'	11.4 (B)	256'	11.3 (B)	274'
Veranda St SB T	8.4 (A)	223'	1.2 (A)	67'	8.3 (A)	223'	1.4 (A)	72'
Total	11.6 (B)	-	5.6 (A)	-	11.5 (B)	-	7.9 (A)	-
Veranda St & Wordsworth St								
Veranda St NB L	26.2 (C)	-	21.6 (C)	-	26.3 (C)	-	21.1 (C)	-
Veranda St NB T	28.8 (C)	151'	22.1 (C)	105'	28.4 (C)	149'	22.3 (C)	135'
Veranda St NB R	18.8 (B)	-	10.4 (B)	-	18.8 (B)	-	14.5 (B)	-
Wordsworth St EB L	42.5 (D)	-	19.4 (B)	-	40.5 (D)	-	18.2 (B)	-
Wordsworth St EB T	51.3 (D)	34'	23.2 (C)	33'	51.1 (D)	34'	25.1 (C)	33'
Wordsworth St EB R	5.7 (A)	-	4 (A)	-	5.9 (A)	-	4.3 (A)	-
Veranda St SB L	11.3 (B)	-	5.6 (A)	-	11.4 (B)	-	7.5 (A)	-
Veranda St SB T	13.2 (B)	276'	6.2 (A)	165'	13.2 (B)	277'	8 (A)	207'
Veranda St SB R	12.1 (B)	-	4.6 (A)	-	11.1 (B)	-	6.2 (A)	-
Total	15.1 (B)	-	8.5 (A)	-	15.2 (B)	-	10.6 (B)	-

Appendix E: Safety HSM Spreadsheet

Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections

General Information		Location Information	
Analyst	KAA	Roadway	US 302
Agency or Company	MaineDOT	Intersection	US 302 @ US 202
Date Performed	10/04/17	Jurisdiction	Windham, Maine
		Analysis Year	2016

Input Data		Base Conditions	Site Conditions			
Intersection type (3ST, 4ST, 4SG)		--	4SG			
$AADT_{major}$ (veh/day)	$AADT_{MAX}$ = 25,200 (veh/day)	--	13,470			
$AADT_{minor}$ (veh/day)	$AADT_{MAX}$ = 12,500 (veh/day)	--	6,100			
Intersection skew angle (degre [If 4ST, does skew differ for minor legs?]	No	0	for Leg 1 (All):	20	Skew for Leg 2 (4ST only):	0
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)		0	4			
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)		0	2			
Intersection lighting (present/not present)		Not Present	Present			
Calibration Factor, C_i		1.00	0.55			

Maine Calibration Factors for Intersections on Rural Two-Lane Two-Way Roadway Intersections: 4ST=0.38 3ST=0.54 4SG=0.55

Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections

(1)	(2)	(3)	(4)	(5)
CMF for Intersection Skew Angle	CMF for Left-Turn Lanes	CMF for Right-Turn Lanes	CMF for Lighting	Combined CMF
CMF_{1i}	CMF_{2i}	CMF_{3i}	CMF_{4i}	CMF_{COMB}
from Equations 10-22 or 10-23	from Table 10-13	from Table 10-14	from Equation 10-24	(1)*(2)*(3)*(4)*(6)
1.00	0.45	0.92	0.94	0.39

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	$N_{spf\ 3ST,\ 4ST\ or\ 4SG}$	Overdispersion Parameter, k	Severity Distribution	$N_{spf\ 3ST,\ 4ST\ or\ 4SG}$ by Severity Distribution	Combined CMFs	Calibration Factor, C_i	Predicted average crash frequency, $N_{predicted\ int}$
	from Equations 10-8, 10-9, or 10-10	from Section 10.6.2	from Table 10-5	$(2)_{TOTAL}$ * (4)	from (5) of Worksheet 2B		(5)*(6)*(7)
Total	10.157	0.11	1.000	10.157	0.39	0.55	2.169
Fatal and Injury (FI)	--	--	0.340	3.453	0.39	0.55	0.737
Property Damage Only (PDO)	--	--	0.660	6.703	0.39	0.55	1.431

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type$_{(TOTAL)}$**	**$N_{predicted\ int\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type$_{(FI)}$**	**$N_{predicted\ int\ (FI)}$ (crashes/year)**	**Proportion of Collision Type$_{(PDO)}$**	**$N_{predicted\ int\ (PDO)}$ (crashes/year)**
	from Table 10-6	$(8)_{TOTAL}$ from Worksheet 2C	from Table 10-6	$(8)_{FI}$ from Worksheet 2C	from Table 10-6	$(8)_{PDO}$ from Worksheet 2C
Total	1.000	2.169	1.000	0.737	1.000	1.431
		$(2)x(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)x(7)_{PDO}$
SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.003	0.007	0.008	0.006	0.000	0.000
Overturned	0.003	0.007	0.008	0.006	0.000	0.000
Ran off road	0.021	0.046	0.008	0.006	0.028	0.040
Other single-vehicle collision	0.016	0.035	0.007	0.005	0.020	0.029
Total single-vehicle crashes	0.043	0.093	0.031	0.023	0.048	0.069
MULTIPLE-VEHICLE						
Angle collision	0.390	0.846	0.415	0.306	0.378	0.541
Head-on collision	0.000	0.000	0.000	0.000	0.000	0.000
Rear-end collision	0.497	1.078	0.531	0.392	0.480	0.687
Sideswipe collision	0.068	0.147	0.015	0.011	0.094	0.135
Other multiple-vehicle collision	0.002	0.004	0.008	0.006	0.000	0.000
Total multiple-vehicle crashes	0.957	2.075	0.969	0.714	0.952	1.363

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections

(1)	(2)	(3)
Crash severity level	**Crash Severity Distribution** (proportion)	**Predicted average crash frequency (crashes / year)**
	(4) from Worksheet 2C	(8) from Worksheet 2C
Total	1.000	2.17
Fatal and Injury (FI)	0.340	0.74
Property Damage Only (PDO)	0.660	1.43

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	**Predicted average crash frequency (crashes/year)**			**Observed crashes,** $N_{observed}$ (crashes/year)	**Overdispersion Parameter, k**	**Weighted adjustment, w**	**Expected average crash frequency,**
	$N_{predicted}$ (TOTAL)	$N_{predicted}$ (FI)	$N_{predicted}$ (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
INTERSECTIONS							
Intersection	2.169	0.737	1.431	9.70	0.110	0.807	3.62

Worksheet 3B -- Site-Specific EB Method Summary Results		
(1)	(2)	(3)
Crash severity level	$N_{predicted}$	$N_{expected}$
Total	$(2)_{COMB}$ from Worksheet 3A	$(8)_{COMB}$ from Worksheet 3A
	2.169	3.62
Fatal and Injury (FI)	$(3)_{COMB}$ from Worksheet 3A	$(3)_{TOTAL} * (2)_{FI} / (2)_{TOTAL}$
	0.737	1.23
Property Damage Only (PDO)	$(4)_{COMB}$ from Worksheet 3A	$(3)_{TOTAL} * (2)_{PDO} / (2)_{TOTAL}$
	1.431	2.39

Crash Costs and Benefits of Intersection Alternatives

Intersection Alternative	Intersection Type 3ST (3-leg, 1-stop) 4ST (4-leg, 2-stop) 4SG (4-leg, signal)	Total Crashes per Year			Crash Estimate to Compare	Crashes per Year for Comparison			Unit Crash Costs ($)		Crash Costs ($)		Benefits ($)
		Observed	Estimated Predicted	Estimated Expected		Total	FI (fatal and injury)	PDO (property damage only)	FI	PDO	Annual	Pres Worth (based on 20 years)	Present Worth
Baseline		12.70	9.00	9.70	Expected	9.70	1.46	7.54	199000	10600	370087.2	4244871	-
Alt 1	4SG	-	3.23	4.92	Predicted	3.23	1.10	2.13	243200	10600	290098	3327401	917470
Alt 2	4SG	-	4.82	6.51	Predicted	4.82	1.64	3.18	243200	10600	432556	4961383	-716512
Alt 3	4SG	-	5.24	6.87	Predicted	5.24	1.78	3.46	243200	10600	469572	5385954	-1141083
		-			Expected	0.00			243200	10600	0	0	0
		-			Expected	0.00			243200	10600	0	0	0
		-			Expected	0.00			243200	10600	0	0	0
		-			Expected	0.00			243200	10600	0	0	0
Worksheet Source		3A	3A	3A			3B	3B			Discount Rate		6%

Appendix F: Safety-Mobility Benefit Summary and B/C Ratio

Benefit/Cost Summary

Alternative	Present Worth of Benefits ($)			Cost ($)	B/C Ratio	Net Benefit ($)
	Safety	Mobility	Combined			
No-Build						
R-4: Rotary Upgrade	$ 617,685	$ 2,205,339	$ 2,823,024	$ 200,000	14.1	$ 2,623,024
S-5B Signalized Intersection	$ 2,006,791	$ 1,576,544	$ 3,583,335	$ 2,600,000	1.4	$ 983,335