
SANTA CLARA VALLEY
TRANSPORTATION AUTHORITY

CONGESTION MANAGEMENT PROGRAM

# TRANSPORTATION OPERATIONS ANALYSIS GUIDELINES

FIRST ADOPTED JUNE 2023

UPDATED OCTOBER 2024

Valley Transportation Authority

*Solutions that move you*

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# INTRODUCTION

## Introduction

The Traffic Operations Analysis Guidelines is a companion document to VTA's Transportation Impact Analysis Guidelines that provides guidance on the methodologies to be used for assessing traffic conditions on the designated Congestion Management Program (CMP) roadway facilities in Santa Clara County (i.e, urban arterials, freeways, and rural highways). This document supersedes the Level of Service Guidelines adopted by the VTA Board of Directors in June 2003, and assumes the user has sufficient knowledge to use the prescribed software identified in this guideline document. Basic instructions on how to use the software is available on the vendor's website.

California's Congestion Management Agency (CMA) legislation (Government Code 65088) requires that all CMAs develop uniform methods to evaluate traffic operations performance in their respective counties. The use of uniform methods provides the CMA and local jurisdictions with a common basis to make capital improvement, land development and transportation planning decisions for CMA roadway facilities.

### Senate Bill 743 (SB 743, Environmental Impact Analysis) and Level of Service

VTA recognizes and supports the implementation of SB 743 to promote the following goals and actions:

- Reduce greenhouse gas emissions to address climate change
- Develop multimodal transportation networks to improve public health through active transportation
- Encourage infill development and diversity of land uses instead of urban sprawl

While SB 743 suggests using Vehicle Miles Traveled (VMT) instead of Level of Service (LOS) as a standard metric for evaluating the effects of land use developments on the roadway network, SB 743 also preserved local government authority to make planning decisions. Local jurisdictions can still use Level of Service (LOS) and measures of congestion for issues not related to the California Environmental Quality Act review requirements. To date, VTA and its member agencies have not identified an acceptable uniform methodology for measuring VMT for CMP analysis purposes. More information is available on Caltrans SB 743 Implementation Resources website: https://dot.ca.gov/programs/esta/sb-743/resources (as of 3-01-2024).

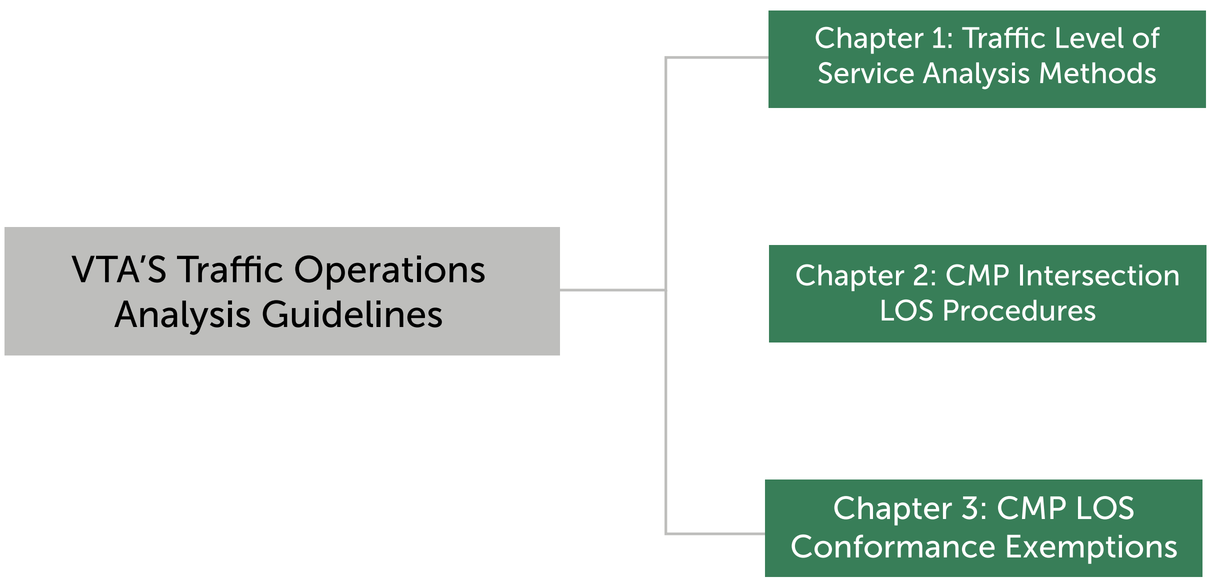
The intent of the LOS analysis as described in the Traffic Operations Analysis Guidelines is to define consistent methodologies for measuring the quality of traffic flow operations on the designated Congestion Management Program (CMP) roadway facilities in Santa Clara County. This LOS analysis methodology can then be implemented as part of the Transportation Analysis (TAs), for which there is a separate guiding document. The intent for TAs is to measure the effects of land use development projects on traffic flow on the designated CMP roadway facilities in Santa Clara County. More information is available on VTA website: https://www.vta.org/search?search=Traffic+Study+Guidelines.

A detailed description for implementing SB 743 in VTA's Congestion Management Program (CMP) is described in Chapter 3 – Transportation Analysis Standards Element of the 2023 Congestion Management Program Document adopted on March 7, 2024.

Chapter 1 of this document describes the methodologies that must be used to evaluate traffic LOS for urban arterials, freeways and rural highways that are part of the CMP roadway network in Santa Clara County. Chapter 2 describes the use of software, VISTRO, approved by VTA as the standard traffic LOS analysis software package to analyze CMP signalized intersections. Chapter 3 describes types of traffic and related situations that are excluded or exempt from the requirements of the CMA legislation.

Overview of VTA's Traffic Operations Analysis Guidelines is shown in **Figure 1**.

**Figure 1 | Overview of VTA's Traffic Operations Analysis Guidelines**




In addition to these Traffic Operations Analysis guidelines, VTA has also adopted guidelines for assessing the transportation operational impacts of land use decisions, guidelines for assessing the consistency of local transportation models with VTA's countywide transportation demand model and guidelines for preparing local deficiency plans. These technical guidelines are available on VTA.org website, search words: Congestion Management Program Technical Resources. https://www.vta.org/programs/congestion-management-agency (accessed on 3-01-2024) on VTA's website at https://www.vta.org/

# 1

# CMP TRAFFIC LEVEL OF SERVICE ANALYSIS METHODS

# 1. CMP TRAFFIC LEVEL OF SERVICE ANALYSIS METHODS

This chapter presents historic overview as well as the current status of the traffic LOS methodologies adopted by VTA for evaluating CMP roadway facilities, including Urban Arterials, Freeway Segments and Rural Highways.

## 1.1 Adoption of Uniform LOS Analysis Methodology

The CMA legislation requires the use of uniform methods to evaluate LOS for CMA roadway facilities. The legislation gives CMAs the choice in the LOS analysis method adopted.

In 1991, the Santa Clara County CMA[1] adopted the 1985 Highway Capacity Manual[2] methods to evaluate LOS on CMP roadway facilities. The CMA's decision to adopt the 1985 HCM methods was based upon an evaluation of several potential methods. The primary reason for the adoption of the 1985 HCM methods for Santa Clara County was that these methods were the most current and widely accepted methods at the time.

In 1995, methods for evaluating Santa Clara County CMP roadway facilities were refined and documented in the Traffic Level-of-Service Analysis Guidelines[3].This document maintained analysis consistent with the 1985 HCM even though an update to the 1985 HCM, the 1994 HCM[4] had been published.

In 1997, methods for evaluating Santa Clara County CMP roadway facilities were further refined and documented in the Traffic Level of Service Analysis Guidelines. That update resulted in the use of higher ideal freeway capacities and the rural highway LOS analysis methods outlined in the 1994 HCM. However, the decision was made to stay with the 1985 HCM operational method for evaluation of LOS for signalized intersections.

In 2003, methods for evaluating Santa Clara County CMP roadway facilities were updated again to be consistent with the HCM2000[5]. Signalized intersection LOS was calculated using the methodology outlined in Chapter 16 of HCM2000. The primary measure for freeway LOS was density, but with deviations from the LOS thresholds in HCM2000. Rural highway LOS was calculated using the methodology from Chapter 20 of HCM2000.

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1 *The Santa Clara County CMA was the predecessor to Santa Clara Valley Transportation Authority as Santa Clara County's designated congestion management agency.*

2 *Highway Capacity Manual, Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., 1985*

3 *Traffic Level-of-Service Analysis Guidelines, Santa Clara County Transit District, Congestion Management Program, January 5, 1995.*

4 *Highway Capacity Manual, Special Report 209, Third Edition, Transportation Research Board, National Research Council, Washington, D.C., 1994.*

5 *Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, D.C., 2000*

The major change in this 2024 update of the guidelines is the migration of LOS analysis criteria and methodology from HCM2000 to the most current version of the Highway Capacity Manual, which is currently HCM 7th Edition[6], and the use of LOS analysis software from TRAFFIX to PTV VISTRO. To clarify, as the HCM is updated over time, the most current version is considered to the adopted methodology. This change in methodology from HCM2000 to HCM 7th Edition results in several changes for intersection analysis, however, there is no change in methodology for freeways and two-lane rural highways as documented in the 2003 guidelines since the methodology for HCM2000 is similar to HCM 7th Edition for freeways and rural highways.

**Figure 2 | HCM2000 to HCM 7th Edition or the Most Current HCM Version**

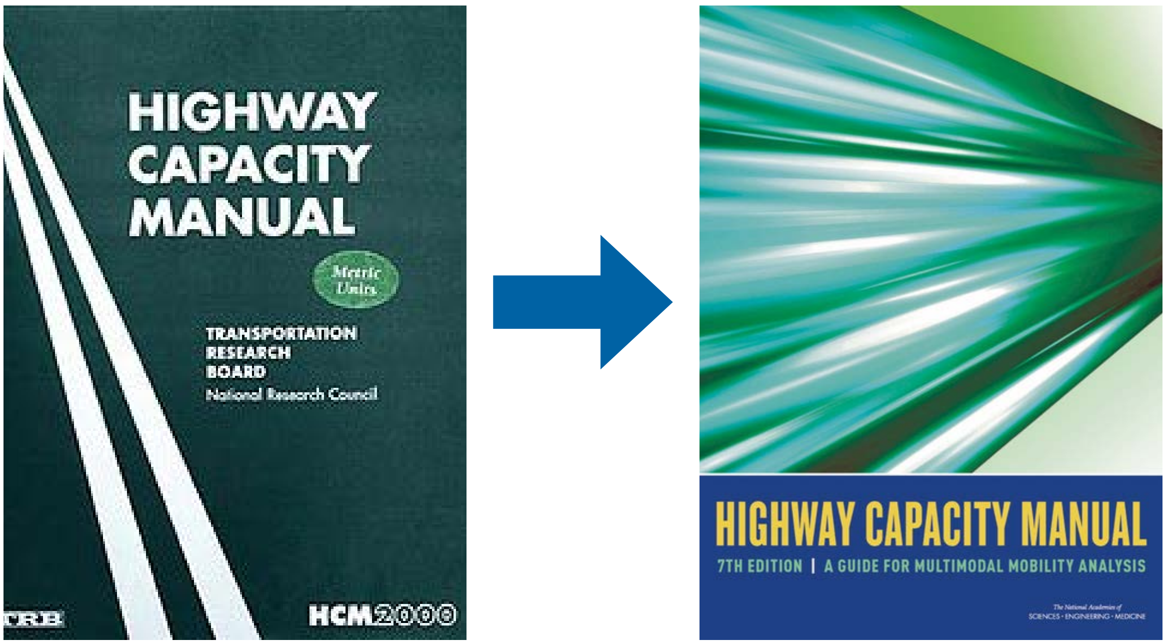
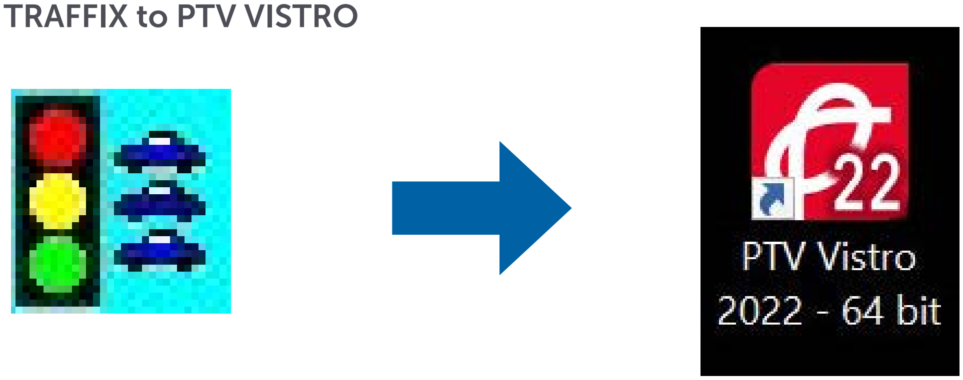



**Figure 3 | TRAFFIX to PTV VISTRO**




6 *Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, D.C., Seventh Edition, 2022.*

The remainder of this section describes the adopted LOS analysis method for each type of CMP roadway facility (i.e., urban arterials, freeways and rural highways). Particular details regarding the application of the LOS analysis methods for CMP monitoring purposes and preparing transportation impact studies are also provided.

## 1.2 Urban Arterials

The level of service on CMP urban arterials is determined by evaluating the LOS at designated signalized intersections using the operational method detailed in Chapter 19 of HCM 7th Edition or the latest HCM version. This method determines LOS for signalized intersections on the basis of average control delay. Average control delay includes not only the delay while stopped at an intersection, but also delays due to oversaturation queues, movements at slower speeds and stops and slow downs on intersection approaches as vehicles move in queues or slow down upstream of an intersection. One deviation from the HCM 7th Edition or the latest HCM version operation analysis is that specific VTA default saturation flow rates are used instead of using adjustment factors to calculate saturation flow rates. This is discussed in depth in Section 2.

In order to ensure that CMP intersections are evaluated in a uniform manner throughout Santa Clara County, VISTRO has been adopted as the standard software package. VISTRO is a traffic analysis software by PTV Group used for analyzing signalized intersections. The latest version of VISTRO should be used for traffic analysis.

The adopted LOS criteria is based on calculated average control delay (in seconds per vehicle). On the following page, **Table 1** identifies the average control delay ranges and the corresponding LOS grades for signalized intersections. The delay ranges in **Table 1** are based on those provided in Chapter 19 of HCM 7th Edition, with the addition of the plus/minus grades to provide more depth to the LOS grade. For example, the LOS B+ to B- range in **Table 1** is the same as the LOS B range in HCM 7th Edition. The average control delay threshold between LOS E- and LOS F is 80 seconds per vehicle.

**Table 1 | Signalized Intersection LOS Criteria**

| Level of Service | Average Control Delay (seconds/vehicle) |
|---|---|
| A | delay ≤10.0 |
| B+ | 10.0 < delay ≤12.0 |
| B | 12.0 < delay ≤18.0 |
| B- | 18.0 < delay ≤20.0 |
| C+ | 20.0 < delay ≤23.0 |
| C | 23.0 < delay ≤32.0 |
| C- | 32.0 < delay ≤35.0 |
| D+ | 35.0 < delay ≤39.0 |
| D | 39.0 < delay ≤51.0 |
| D- | 51.0 < delay ≤55.0 |
| E+ | 55.0 < delay ≤60.0 |
| E | 60.0 < delay ≤75.0 |
| E- | 75.0 < delay ≤80.0 |
| F | delay > 80.0 |

**Annual Monitoring Program** - Each Member Agency has the option to monitor traffic LOS on CMP urban arterials biannually by evaluating designated signalized intersections within its jurisdiction using the operational method from Chapter 19 of HCM 7th Edition or the latest HCM version. Member Agencies can also elect to have the VTA conduct the analysis as part of the biannual signalized intersection monitoring program. This analysis of signalized intersection LOS for biannual monitoring must be completed using the VISTRO software with the procedures and standard values outlined in Chapter 2 of this document. Analysis for CMP intersections are documented biannually in the annual CMP Monitoring and Conformance Report. **Figure 4** and **Figure 5** show the CMP Roadway Network and intersections, respectively.

Traffic volume data are to be collected biannually by VTA during September and October during the PM peak period on Tuesdays, Wednesdays, or Thursdays of normal commuter traffic days when school is in session.

**Transportation Impact Analyses** - Member Agencies are responsible for evaluating the impact of development projects on traffic conditions on urban arterials using VISTRO and the procedures and standard values outlined in Chapter 2 of this document. More details on evaluating LOS at signalized intersection for TA purposes are available in VTA's Transportation Analysis Guidelines.

Figure 4 | CMP Roadway Network

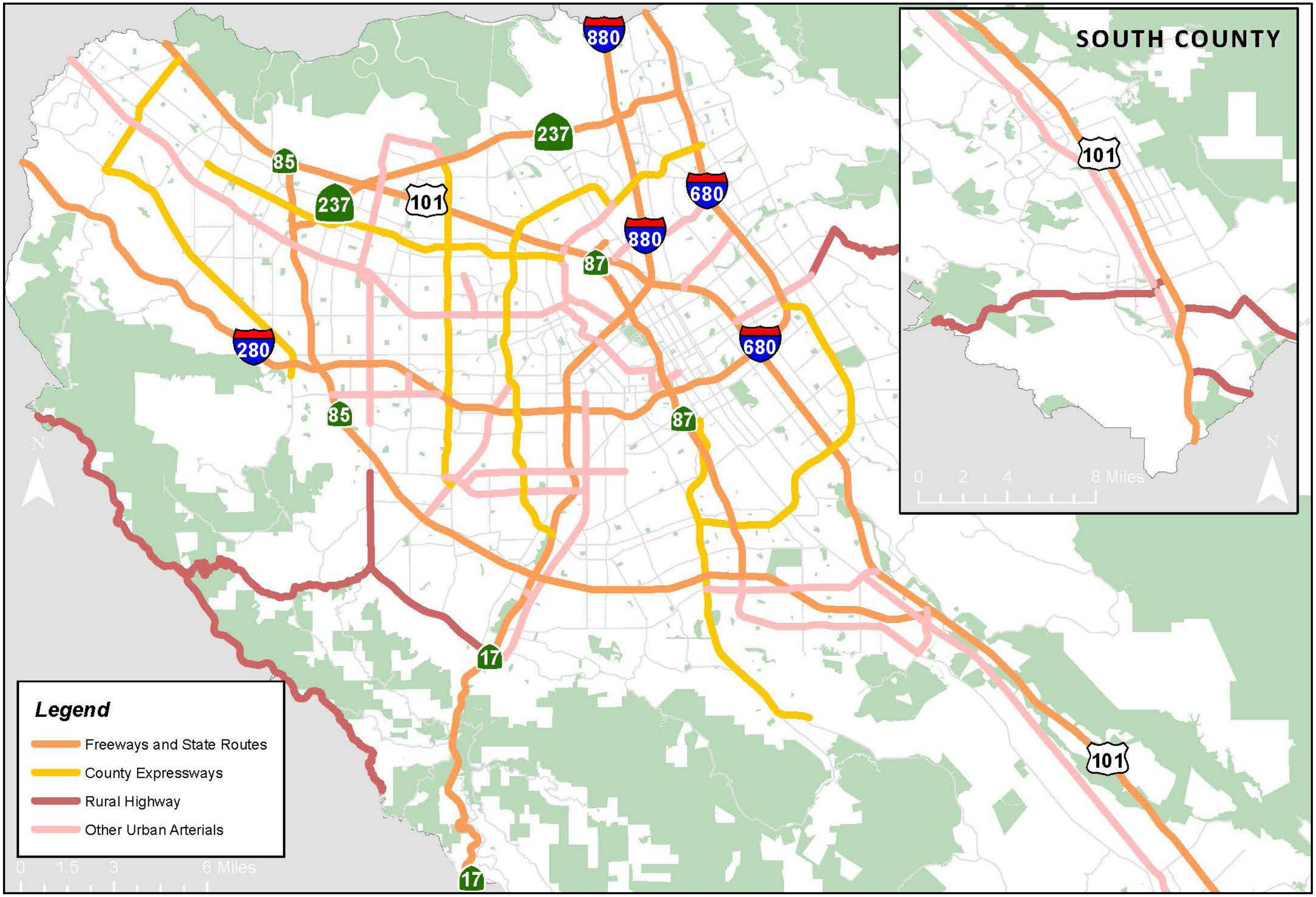
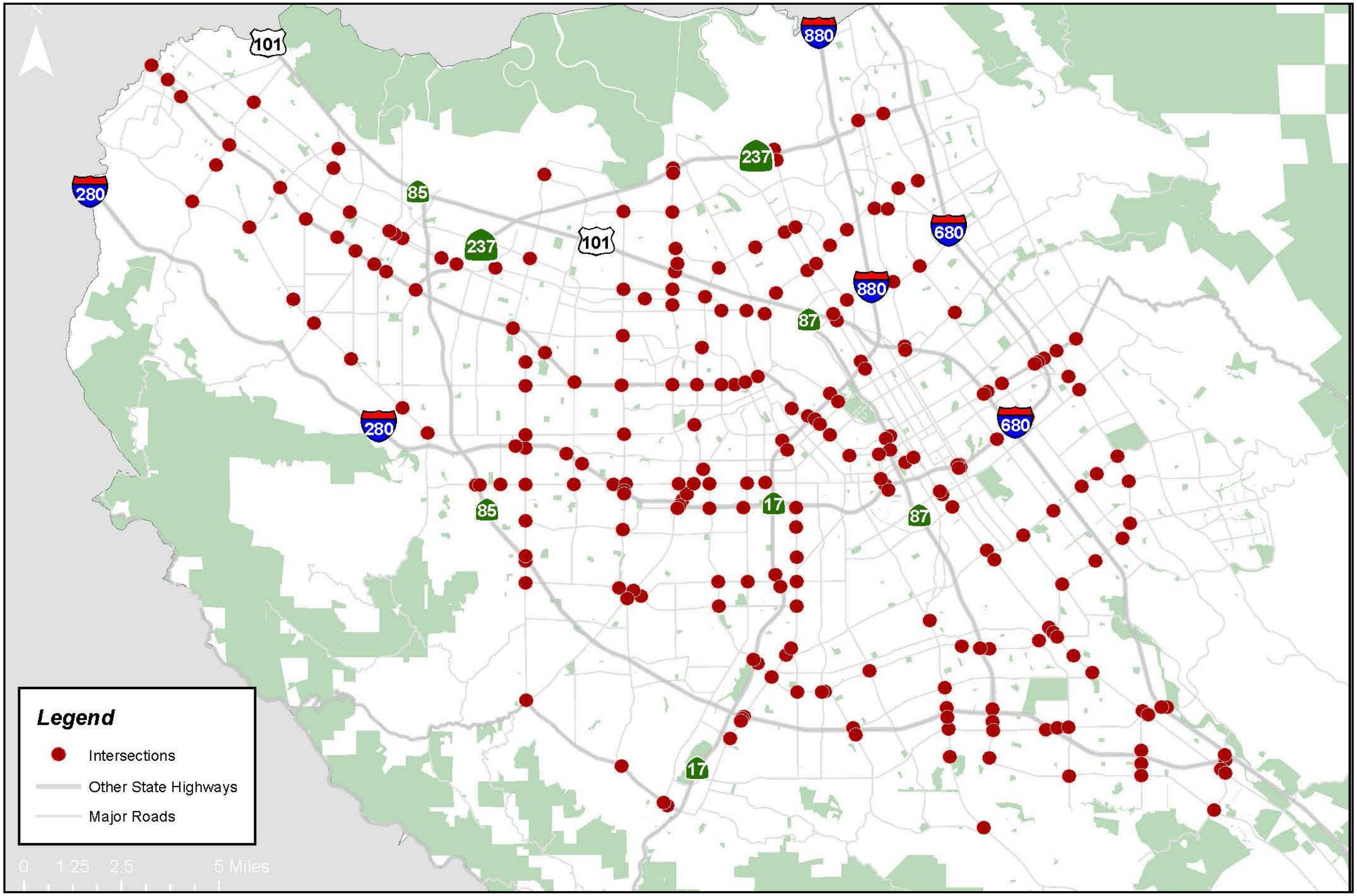


Figure 5 | CMP Intersections



## 1.3 Freeway Segments

The HCM method for evaluating LOS of freeway segments is based on density, expressed as passenger cars per mile per lane (pcpmpl). The adopted parameter for freeway LOS in Santa Clara County is density, as correlated by vehicle speed.

From 1997 to 2016, aerial photography was used to estimate congestion levels by calculating the density based on speed and distance which was used to correlated to LOS, expressed as grades (A to F). In 2017, VTA started using "big data" from INRIX, a traffic data source provider. INRIX provides vehicle speed data, which aggregates traffic data from GPS-enabled vehicles and mobile devices, road sensors and hundreds of other sources. This vehicle speed data is filtered leaving only real-time data points collected on normal commuter traffic days.

A study in 2013 by Kittelson & Associates calibrated the relationship between VTA's LOS density thresholds and the prevailing speed using freeway sensor data at four freeway locations in Santa Clara County.

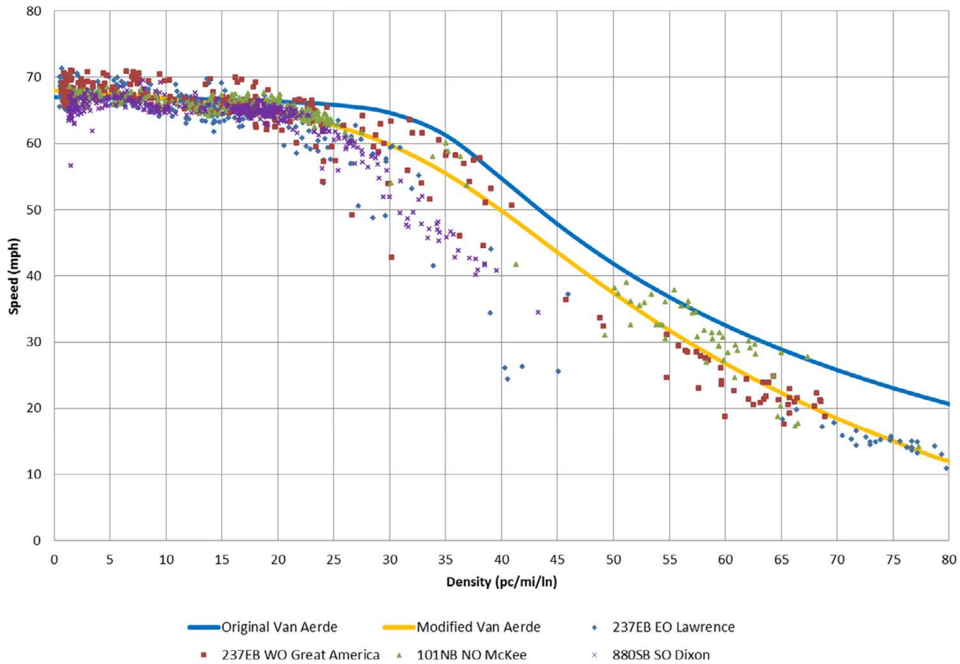
The adopted LOS criteria based on density are provided in **Table 2**, which includes the corresponding speed ranges for the density ranges based on this chart. The density values for the LOS A/B, and B/C thresholds are based on values from HCM2000, which is the same as HCM 7th Edition. The LOS D/E and E/F threshold are different from the HCM 7th Edition and are based on density studies of Santa Clara County conditions. These threshold values are nearly the same as those in the 1997 Traffic LOS Analysis Guidelines document.

**Table 2 | Freeway LOS Criteria**

| Level of Service | Density (passenger cars/mile/lane) | Speed (miles/hour) |
|---|---|---|
| A | density ≤ 11.0 | 67.0 ≤ speed |
| B | 11.0 < density < 18.0 | 65.0 < speed < 67.0 |
| C | 18.0 < density < 26.0 | 62.0 < speed < 65.0 |
| D | 26.0 < density < 46.0 | 42.0 < speed < 62.0 |
| E | 46.0 < density < 58.0 | 30.0 < speed < 42.0 |
| F | 58.0 < density | speed < 30.0 |

**Annual Monitoring Program** - VTA is responsible for the annual freeway LOS monitoring program. All freeways in Santa Clara County are evaluated annually in the AM and PM peak periods for CMP monitoring purposes. All CMP monitoring programs after the 2002 monitoring program use the density ranges provided in **Table 2** for determining freeway LOS. Vehicle speed data for the CMP monitoring program is provided by INRIX. These data are tabulated and graphed in the annual CMP Monitoring and Conformance Report. **Figure 6** shows the Van Aerde Curve to correlate speed and density.

## Figure 6 | Speed vs Density Graph




**Transportation Impact Analyses** - One criterion for assessing the impact of a development project on freeways is LOS. As in the CMP monitoring program, density is the parameter for determining LOS for freeway segments in TAs. The relationship between density, speed and volume (or flow rate) is described as follows:

$$d = \frac{V}{N \times S}$$

Where: d = density (passenger cars per mile per lane, pcpmpl)
V = peak hour volume (passenger cars per hour, pcph)
N = number of travel lanes (lanes)
S = average travel speed (miles per hour, mph)

A new density for the "Project" scenario can be calculated using the above equations by adding the appropriate project trips to the base traffic volumes (as documented in the CMP monitoring report of record) for affected freeway segments. Additional details regarding freeway LOS evaluation for transportation impact studies are contained in VTA's Transportation Analysis Guidelines.

## 1.4 Rural Highways

Traffic level of service on rural highways is typically based upon percent time spent following (PTSF) and average travel speed. The analysis methodology described in Chapter 20 of HCM2000 is similar to the methodology in HCM 7th Edition (Chapter 15).

The LOS on a two-lane rural highway is determined by computing the follower density, PTSF and average travel speed from the average flow rate and assumptions for directional distribution of traffic, percentage of heavy vehicles, lane widths, shoulder widths, type of terrain, percentage of no passing zones, free flow speed, highway classification, segment length, and the number of access points per mile. The adopted LOS criteria based on density are provided in **Table 3** on the following page.

**Table 3 | Rural Highway LOS Criteria**

| Level of Service | Follower Density (followers/mi/ln) | |
|---|---|---|
| | Higher Speed Highways | Lower Speed Highways |
| | Posted Speed Limit >50 mi/h | Posted Speed Limit <50 mi/h |
| A | ≤ 2.0 | ≤ 2.5 |
| B | > 2.0 – 4.0 | > 2.5 – 5.0 |
| C | > 4.0 – 8.0 | > 5.0 – 10.0 |
| D | > 8.0 – 12.0 | > 10.0 – 15.0 |
| E | >12.0 | >15.0 |
| F | Demands exceeds capacity | |

**Annual Monitoring Program** - VTA is responsible for evaluating LOS on rural highways biannually as part of its annual monitoring program. The biannual analysis of rural highways includes the evaluation of 12 rural highway segments. Analysis assumptions for the 12 segments are documented in the biannual CMP Monitoring and Conformance Report.

**Transportation Impact Analyses** - One criterion for assessing the impact of a development project on a rural highway is LOS. In many cases, it is appropriate for the TA to use the two-lane highway LOS segment analysis method as described above; however, it may also be appropriate to evaluate adjacent rural highway intersections using the appropriate methods from the HCM 7th Edition to determine intersection impacts by the project.

## 1.5 Annual LOS Monitoring and Conformance Report

VTA publishes an annual summary of traffic LOS. Every other year the analysis includes a report on the entire CMP System including intersections, freeways, and rural highways. In the alternate years, the analysis includes freeways only. This summary is included in the CMP's Annual Monitoring and Conformance Report, which is published after VTA Board of Director's adoption of final conformance findings. The report also includes information on land-use approvals during the subject year.

# 2

# CMP INTERSECTION LEVEL OF SERVICE ANALYSIS PROCEDURES

# 2. CMP INTERSECTION LEVEL OF SERVICE ANALYSIS PROCEDURES

To ensure uniform evaluation of CMP intersections, VTA has developed standardized analysis procedures and adopted a standard intersection LOS analysis software package. In 2021, VTA approved VISTRO as the standard software for evaluating LOS at CMP signalized intersections in Santa Clara County.

VTA initially purchased licensed copies of VISTRO 2021 for each Member Agency in 2021. In 2023, VTA upgraded to VISTRO 2022 for each Member Agency. VISTRO 2022 offers many new features beyond those available in VISTRO 2021, including methodologies from the HCM 7th Edition. VISTRO is continually updated as the developer implements new features and corrects bugs. To take advantage of these improvements and ensure more accurate analysis, the latest version of VISTRO is required for intersection LOS analysis.

The remainder of this chapter describes the use of VISTRO 2022 to evaluate LOS for CMP intersections in Santa Clara County. This information aims to provide guidance on the required data and the basic use of VISTRO in accordance with VTA requirements. For a more detailed description of the software, please refer to the VISTRO User's Manual.

Understanding the nuances of conducting level of service analysis requires education, training, or experience in traffic engineering. This document is not intended to replace this foundational knowledge. Therefore, it is recommended that this analysis be conducted under the supervision of an experienced traffic engineer.

The VTA guidelines for intersection LOS evaluation are based on current HCM standards with specific parameters unique to Santa Clara County. This chapter details the necessary geometric, volume, and signal timing data to be entered into VISTRO for conducting a LOS evaluation, including VTA default values for analysis parameters per VTA guidelines.

An Appendix containing the VISTRO 2022 user manual is included for ease of reference. However, if a newer version of VISTRO is used, please consult with the Lead Agency staff and refer to the corresponding manual for data input instructions.

## 2.1 VISTRO Database

The CMP Intersection network for Santa Clara County has been created in VISTRO and saved as a .VISTRO file. This file contains all the necessary data for analysis, including the network, roadway geometry, traffic volume, intersection control, and signal timing data.

To conduct LOS evaluations for CMP intersections, open the Santa Clara County CMP Intersection VISTRO database. This can be done by left-clicking on "File" in the menu bar and selecting "Open" from the drop-down menu, then navigating to the location of the CMP database on your computer.

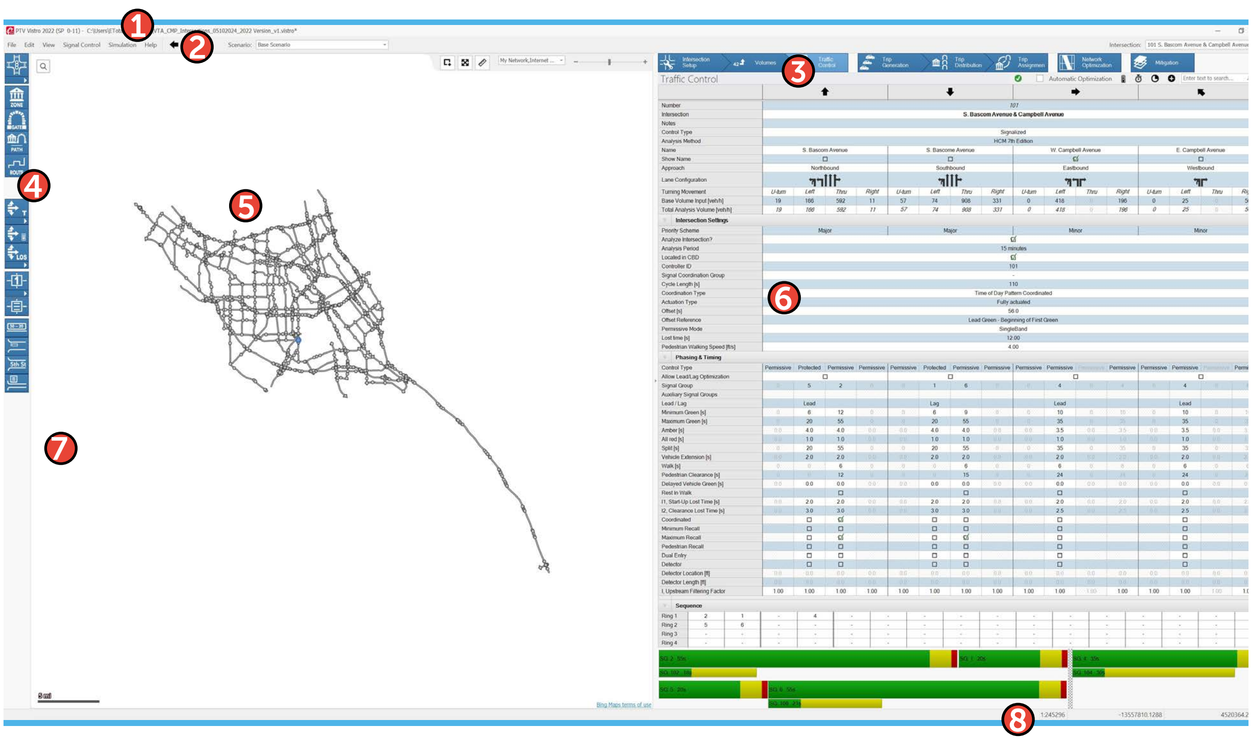
The first step should be to save this database under a different name to ensure the original CMP database remains unchanged. To do this, left-click "File" in the menu bar and select "Save As" from the drop-down menu.

VISTRO stores data in a geographical information system (GIS) format, linking data for each intersection to a mapped graphical representation. Upon loading VISTRO, a start-up screen will appear. The background network image serves as the visual foundation for drawing the street network, including intersection placement and roadway geometry. You can select the type of background using the "Map Layers" drop-down menu in the upper right corner of the network window. For more information or detailed instructions, refer to the VISTRO manual.

## 2.2 VISTRO Interface & Global Settings

Once the CMP database is opened, an interface with various features is displayed. For a comprehensive overview of all the features, refer to the VISTRO manual. This section outlines the basics of navigating the VISTRO interface to conduct an intersection LOS analysis based on CMP standards. On the following page, **Figure 7** illustrates the key features of the VISTRO interface.

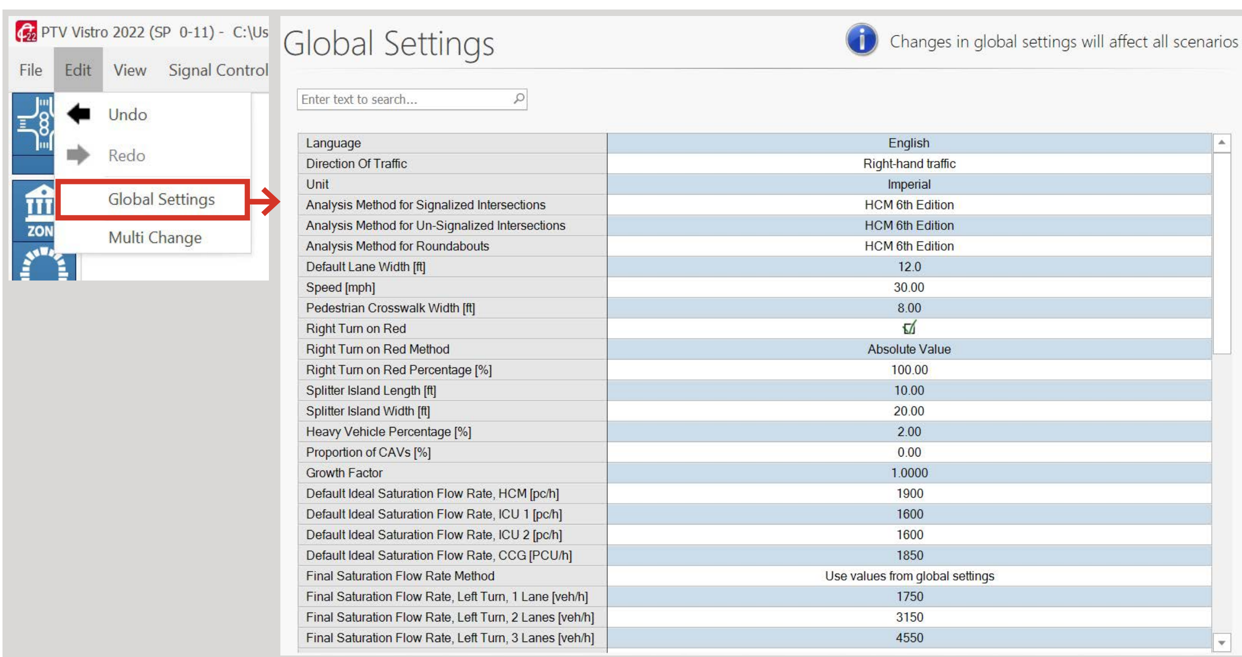
### Figure 7 | VISTRO Interface



| | | |
|---|---|---|
| 1 | **Header** | Shows the Program Title, Version, Service Pack number, and Network Filename |
| 2 | **Menu Bar** | Contains drop-down menus, undo/redo shortcuts, scenario selector, intersection selector and the Vissim previewer. |
| 3 | **Workflow Panel** | Contains the tabs for data entry and analysis for various stages of the project workflow. A search field allows the current table to be filtered to a search item. |
| 4 | **Toolbar** | Contains the tools for adding network objects. |
| 5 | **Network Window** | Displays the currently opened network, including the background map/image and representation of the roadway geometry. In this window, you can build and edit the network structure graphically. You can also move and adjust the display using the zoom and windowing tools, as well as the measuring tool. |
| 6 | **Data Window** | In this window, data is shown for the relevant task button selected. This will reflect associated data tables and functions specific to each task. Selection of a workflow Task Button results in the display of the related workflow table in the Data Window. |
| 7 | **Graphics Selector** | Contains various graphical displays for the network window. |
| 8 | **Status Bar** | Displays:<br>• the Scale Ratio : 1:115763506 Current scale ratio display of the Network Area<br>• the Coordinates : -9724651.4109 3523527.1009 x-y coordinates of the mouse location in the Network Area using the Spherical Mercator coordinate system. |

The Global Settings menu is crucial as it sets the base parameters for many components of the analysis, so it is important to verify these settings before starting the analysis. To open Global Settings, click on **Edit > Global Settings**. When edits are made to the global settings in the Base Scenario, the edited values are applied to all new network objects, whether in the Base Scenario or any other scenario. When edits are made in a different scenario, the edited values are applied to all new network objects in that specific scenario until the active scenario is changed. Edits in the global settings only apply to newly created network objects and are not retroactively applied to existing objects. **Figure 8** shows the global settings for editing the network.

## Figure 8 | Global Settings



## 2.3 Creating Intersections

Typically, creating a new intersection is unnecessary when using the CMP Network VISTRO file. However, if new intersections are needed, this section provides basic instructions. For more detailed instructions, please refer to the VISTRO manual. Drawing networks in VISTRO is a simple point-and-click operation, similar to most modern Windows-based programs. The network background provides the visual foundation for drawing the roadway network. To add intersections to the network in the appropriate location, select the intersection icon from the Toolbar, activate the desired intersection type, and then left-click on the network map to place the intersection in the correct location.

Set-up the intersection legs before assigning the lane configurations on each approach to simplify the process. To delete a leg, use the **Delete** key on your keyboard or right-click on the leg grip to access the context menu and select "**Delete Link and Legs**". To add a leg, right-click on the intersection's larger center node grip and select "**Add leg**". Once, the leg is in place, left-click and drag the leg handle to the appropriate position. VISTRO can accommodate up to eight-legs per intersection. If you have more than four legs on an approach, move additional legs to a 45-degree angle to make directional movement identification easier when setting up the lane configurations.

Once the network structure is complete, the necessary data can be entered to complete the model and analyze the operations. In VISTRO, this process is organized into three workflow tables, accessed via the first three tabs in the Workflow Panel:

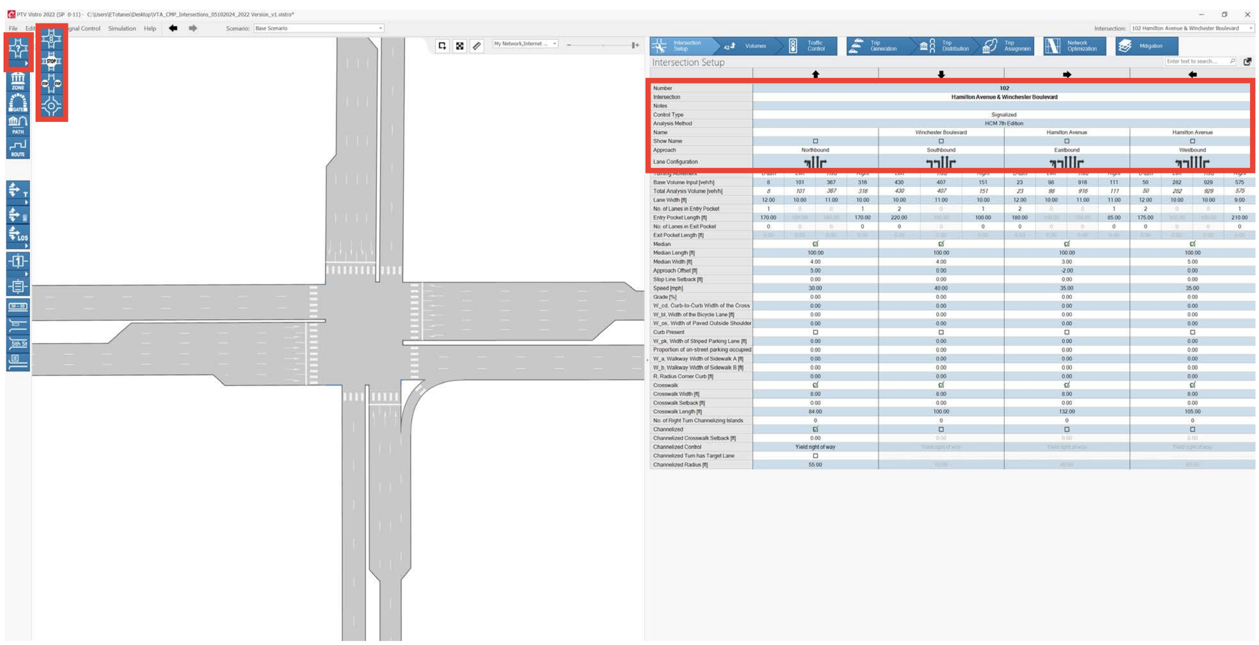
- Intersection: Enter all physical and geometric information for each intersection,
- Volumes: Input base volumes and any volume adjustments,
- Traffic Control: Enter traffic signal timing data.

## 2.4 Intersection Setup

The first step in the workflow is to define the geometric and physical parameters of each intersection in the Intersection Setup table. Click on the first blue tab in the Workflow Panel to access the Intersection Setup table.  To select an intersection to set up, either click on it in the network map or use the Intersection drop-down menu in the upper-right corner. The relevant parameters for CMP intersection LOS analysis are as follows **Figure 9**:

**Number:** This represents the CMP Identification Number for the intersection.
**Intersection:** The name of the CMP intersection, which consists of the cross streets.
**Control Type:** The type of traffic control device used to control the intersection. For CMP intersections, the typical selection is signalized, though this can change (e.g., to a roundabout).
**Analysis Method:** The VTA standard is to select the most current HCM edition, currently HCM 7th Edition.
**Name:** It is highly recommended to name each leg of the intersection for quick identification in the approach parameters in all tables.
**Approach:** The direction of travel for each approach. Eight approaches are possible (NB, SB, EB, WB, NW, NE, SW, SE).

**Figure 9 | VISTRO Intersection Set-Up Table**



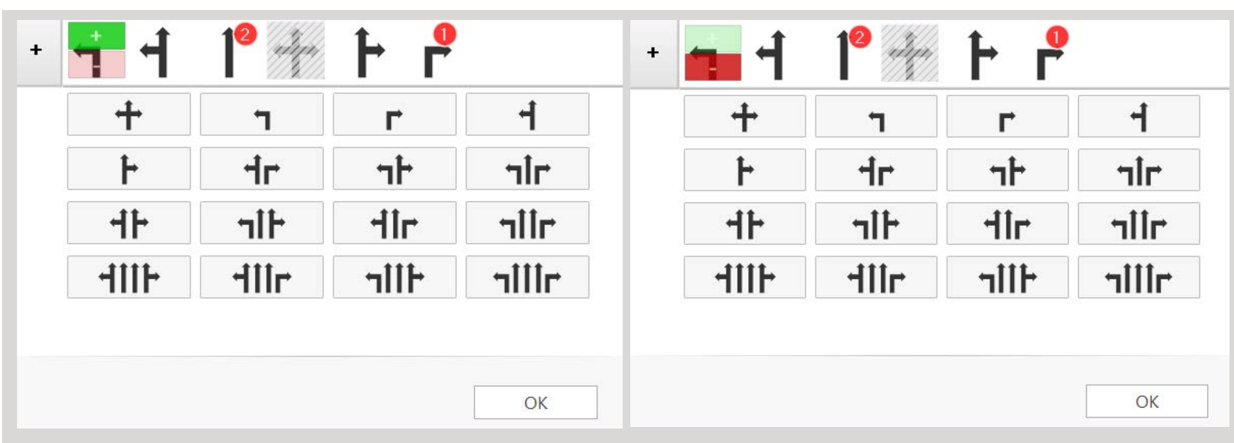
## 2.4.1 Geometry Data

Intersection geometry data are needed for conducting a LOS evaluation. VISTRO offers a graphical representation of the lane configuration, which can be defined using pre-defined templates or customized with full flexibility to define the specific lane configuration. Google Maps is the primary source for obtaining geometric data for intersections. To define the Lane Configuration for each approach:

- Click on the Lane Configuration graphic to bring up the dialog for that specific approach.
- Click on any of the templates in the window to add the lane to the top row to be selected. To see all movement arrow possibilities for the approach, click on the "+" sign to the left of the top row of lane graphics.
- Within the top row, you can add or subtract specific movement arrows by hovering over the arrow and clicking on the green "+" or red "-" buttons. The green button is located within the top half of the lane graphic, and the red button is located within the bottom half. As you change this, you will see the number of lanes associated with that movement arrow currently defined for the approach. As you select the desired movement arrows, other movement arrows will become unavailable if they conflict with the current selection (see **Figure 10** below).

Click outside of the Lane Configuration dialog to exit and save. To cancel, click the "x" in the bottom left corner.

**Figure 10 | VISTRO Intersection Lane Geometry Setup**




CMP requirements for geometric data demand as much detailed information as possible to ensure an accurate LOS analysis. To obtain the intersection measurements below, the Measure Tool in Google Maps is a reliable and quick source. Using the satellite view in Google Maps, right-click on the starting point of the feature to be measured, select "Measure Distance," and then click on the end point.

The data for the following items should be entered on the Intersection Setup table:

**Lane Width:** This is the measured lane width.  The default width is 12 feet.
**No. of Lanes in Pocket:** If the intersection has turn-lane pockets at the approach, this is the number of pocket lanes at the approach. The pocket lanes are always defined to either the left or right of the through movement. The length of the pocket lane can be entered into Pocket Length row just below.
**No. of Lanes in Exit Pocket:** The number of outbound exit pocket lanes on the receiving leg. Pockets can be defined left or right of the thru movement or as inside or outside exit pockets. Exit pockets are automatically added when intersection legs are connected.
**Approach Offset:** If the intersection has a leg with an offset approach, enter the number of feet as measured from the center of the intersection.
**Speed:** This is the speed limit for each approach. The default is 30 mph.
**Crosswalk:** Check this box to identify a crosswalk on the selected approach.
**Crosswalk Width:** The width of the crosswalk in feet. The default is 8 feet.
**Channelized Control:** If the intersection has a channelized turn lane, select the control type for entering the mainline traffic. Options include SC (Signal Control), Stop, Yield, and Target Lane (free).

Additional geometric considerations are available as parameters for analysis. Use professional judgment to determine if any of these additional parameters are critical to the LOS analysis of an intersection based on actual intersection operations. For further guidance, refer to the VISTRO manual.

## 2.5 Traffic Volume Data

Traffic volume data are entered by selecting the intersection and then choosing Volume Setup in the Workflow Panel. **Figure 11** on the following page highlights the key areas where data are needed. The following items are highlighted in **Figure 11** and are to be considered and entered on the Volumes table:

**Base Volume Input:** This is where the peak hour volumes from the actual traffic counts are entered for each movement. Use the TAB key to move to the next data field. When there are more than four legs, it is possible to have more than one left or right turn for a particular movement. In this case the adjacent turn movement will be appended with number two. For example, an approach to five other legs may show Left2, Left, Thru, Right, Right2.

**Base Volume Adjustment Factor:** The default value is 1.0 to represent no adjustment. An adjustment is only used in specific circumstances to adjust the collected peak hour traffic volumes.  The most common instance is to account for County Expressway intersections with high occupancy vehicle (HOV) lanes. The reason for this adjustment is to remove HOV vehicle traffic as well as the HOV lane from the LOS analysis. The Base Volume Adjustment Factor represents the percentage of the total counted traffic volume that is not HOV traffic. This Base Volume Adjustment Factor reduces the Base Volume to calculate the Final Base Volume. **Figure 11** shows the location for editing the volumes.

## Figure 11 | VISTRO's Volumes Table

Volumes

Enter text to search...

| | ⬆ | | | | ⬇ | | | ➡ | | | | ⬅ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 102 | | | | | | | | | | | | |
| Intersection | Hamilton Avenue & Winchester Boulevard | | | | | | | | | | | | |
| Notes | | | | | | | | | | | | | |
| Control Type | Signalized | | | | | | | | | | | | |
| Analysis Method | HCM 7th Edition | | | | | | | | | | | | |
| Name | | | | | Winchester Boulevard | | | Hamilton Avenue | | | | Hamilton A | |
| Show Name | ☐ | | | | ☐ | | | ☐ | | | | ☐ | |
| Approach | Northbound | | | | Southbound | | | Eastbound | | | | Westbou | |
| Lane Configuration | | | | | | | | | | | | | |
| Turning Movement | U-turn | Left | Thru | Right | Left | Thru | Right | U-turn | Left | Thru | Right | U-turn | Left |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Total Analysis Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Base Volume Adjustment Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Final Base Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Heavy Vehicles Percentage [%] | 0.00 | 1.00 | 2.00 | 1.00 | 1.00 | 2.00 | 2.00 | 0.00 | 1.00 | 1.00 | 0.00 | 2.00 | 1.00 |
| Proportion of CAVs [%] | 0.00 | | | | | | | | | | | | |
| Growth Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| **TIA Demand** | | | | | | | | | | | | | |
| In-Process Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Background Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Site-Generated Trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diverted Trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pass-by Trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Existing Site Adjustment Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Net new site trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Total Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Right Turn on Red | ☑ | | | | ☑ | | | ☑ | | | | ☑ | |
| Right Turn on Red Method | Absolut | Absolut | Absolut | Absolut | Absolute | Absolute | Absolute | Absolut | Absolut | Absolut | Absolut | Absolut | Absolut |
| Right Turn on Red Percentage [%] | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Right Turn on Red Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hourly Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Peak Hour Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Other Adjustment Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Total 15-Minute Volume [veh/h] | 2 | 25 | 92 | 79 | 108 | 102 | 38 | 6 | 25 | 229 | 28 | 13 | 71 |
| Total Analysis Volume [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 |
| Presence of On-Street Parking | ☐ | | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☐ | |
| On-Street Parking Maneuver Rate [/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Local Bus Stopping Rate [/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v_do, Outbound Pedestrian Volume cros | 3 | | | | 7 | | | 3 | | | | 6 | |
| v_di, Inbound Pedestrian Volume crossin | 3 | | | | 6 | | | 3 | | | | 7 | |
| v_co, Outbound Pedestrian Volume cros | 7 | | | | 9 | | | 10 | | | | 7 | |
| v_ci, Inbound Pedestrian Volume crossin | 7 | | | | 10 | | | 9 | | | | 7 | |
| v_ab, Corner Pedestrian Volume [ped/h] | 0 | | | | 0 | | | 0 | | | | 0 | |
| Bicycle Volume [bicycles/h] | 3 | | | | 1 | | | 0 | | | | 0 | |

**Heavy Vehicle Percentage:** This data is collected as part of the traffic count data collection effort for CMP intersections. It is expressed as a percentage of the total vehicles that are defined as heavy vehicles. The default value is 2% and this can also be set in the Global Settings.

**Right Turn On Red (RTOR):** A checked box turns on right turn on red for right turn movement. This feature is used to account for vehicles that turn right during a red phase. This should be coded based on the field observations and google maps. Check the box if the number of right turns on red is significant enough to impact the LOS analysis and there are observed traffic counts that specifically count RTOR. Adjusting for RTOR reduces the Total Analysis Volume for the right turn movement since these vehicles are not subject to the capacity constraints of the signalized intersection.

**Right Turn on Red Method, Right Turn on Red Percentage & Right Turn on Red Volume:** If the RTOR box is checked, then the RTOR method must be selected. VISTRO has two options to calculate RTOR. If the RTOR method is set to Absolute, the RTOR hourly volume from observed traffic counts can be entered. If the RTOR is set to percentage, a RTOR percentage value can be entered. This value will calculate Right Turn on Red volume based on a percentage of the movement's Future Total Volume. Global settings or Multi Change tool bar can be used to set a default Right Turn on Red Percentage. See **Figure 12** on the following page for location of data to be entered on Volume Table.

## Figure 12 | VISTRO Volume Table for Right Turn on Red

Volumes

Enter text to search...

| | ↑ | | | | ↓ | | | → | | | | ← | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 102 | | | | | | | | | | | | | | |
| Intersection | Hamilton Avenue & Winchester Boulevard | | | | | | | | | | | | | | |
| Notes | | | | | | | | | | | | | | | |
| Control Type | Signalized | | | | | | | | | | | | | | |
| Analysis Method | HCM 7th Edition | | | | | | | | | | | | | | |
| Name | | | | | Winchester Boulevard | | | Hamilton Avenue | | | | Hamilton Avenue | | | |
| Show Name | ☐ | | | | ☐ | | | ☐ | | | | ☐ | | | |
| Approach | Northbound | | | | Southbound | | | Eastbound | | | | Westbound | | | |
| Lane Configuration | | | | | | | | | | | | | | | |
| Turning Movement | *U-turn* | *Left* | *Thru* | *Right* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 | 929 | 575 |
| Total Analysis Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 | 929 | 575 |
| Base Volume Adjustment Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Final Base Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Heavy Vehicles Percentage [%] | 0.00 | 1.00 | 2.00 | 1.00 | 1.00 | 2.00 | 2.00 | 0.00 | 1.00 | 1.00 | 0.00 | 2.00 | 1.00 | 1.00 | 0.00 |
| Proportion of CAVs [%] | 0.00 | | | | | | | | | | | | | | |
| Growth Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| **TIA Demand** | | | | | | | | | | | | | | | |
| In-Process Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Background Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Site-Generated Trips [veh/h] | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| Diverted Trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pass-by Trips [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Existing Site Adjustment Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Net new site trips [veh/h] | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| Other Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Total Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Right Turn on Red | ☑ | | | | ☑ | | | ☑ | | | | ☑ | | | |
| Right Turn on Red Method | Absolut | Absolut | Absolut | Absolut | Absolute | Absolute | Absolute | Absolut | Absolut | Absolut | Absolut | Absolut | Absolut | Absolut | Absolut |
| Right Turn on Red Percentage [%] | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Right Turn on Red Volume [veh/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hourly Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Peak Hour Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Other Adjustment Factor | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Total 15-Minute Volume [veh/h] | *2* | *25* | *92* | *79* | *108* | *102* | *38* | *6* | *25* | *229* | *28* | *13* | *71* | *232* | *144* |
| Total Analysis Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| Presence of On-Street Parking | ☐ | | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☐ | | | ☐ |
| On-Street Parking Maneuver Rate [/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Local Bus Stopping Rate [/h] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v_do, Outbound Pedestrian Volume cros | 3 | | | | 7 | | | 3 | | | | 6 | | | |
| v_di, Inbound Pedestrian Volume crossin | 3 | | | | 6 | | | 3 | | | | 7 | | | |
| v_co, Outbound Pedestrian Volume cros | 7 | | | | 9 | | | 10 | | | | 7 | | | |

**Peak Hour Factor:** The VTA default peak hour factor is 1.0. This value is defined in the Global Settings and 1.0 is the default setting in VISTRO. It is not recommended to change this value independently without consulting VTA staff.

**Presence of On-Street Parking & On-Street Parking Maneuver Rate:** This box is checked if there is high density and high turnover of on-street parking close enough to the intersection that interferes with the capacity of the intersection. Selecting this box will allow the entry of the On-Street Parking Maneuver Rate in the following row. This value is the number of parking maneuvers per hour that conflict with the corresponding lane movement.

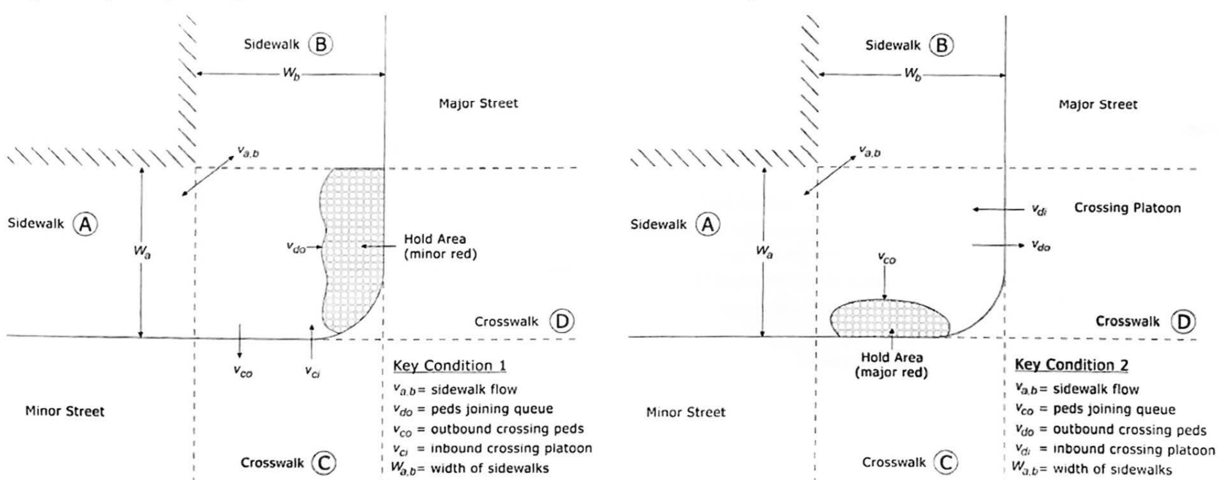
**Pedestrian Volumes:** Directional pedestrian crossing data is collected as part of the CMP traffic volume data collection effort. There are five rows of data for hourly pedestrian volumes as follows:

- v_do: Outbound Pedestrian Volume crossing major street
- v_di: Inbound Pedestrian Volume crossing major street
- v_co: Outbound Pedestrian Volume crossing minor street
- v_ci: Inbound Pedestrian Volume crossing minor street
- v_ab: Corner Pedestrian Volume

**Figure 13** illustrates the path of travel for each of these directional pedestrian counts. The pedestrian volumes are all oriented to the subject corner, which is the corner adjacent to the approach lanes. The outbound pedestrian volume crossing the major street refers to the number of pedestrians that start at the subject corner and then cross the major street. The inbound pedestrian volume crossing the major street refers to the number of pedestrians that cross the major street and end up at the subject corner. This same logic is applied to determine the number of pedestrians crossing to and from the subject corner across the minor street. The corner pedestrian volumes is not used to calculate intersection LOS.

**Figure 13 | VISTRO Pedestrian Volumes**

Highway Capacity Manual, 6th Edition's Pedestrian Inputs (Exhibit 19-29 and 19-30)




**Bicycle Volumes:** Bicycle on approach data is collected as part of the traffic volume data collection effort. The number of bicycles that are counted on each approach during the peak hour is entered here.

## 2.6 Traffic Control

For CMP intersections, the Traffic Control parameters usually pertain to traffic signal timing data, which can be found on the signal timing programming sheet for the traffic controller of the intersection. All the data in this section is sourced from the signal timing sheet. There are many parameters involved in setting up traffic signals, which can be complex. This manual is not meant to be an exhaustive resource for all signal timing situations. For comprehensive guidance on all functionality and customization of traffic signal controls in VISTRO, please refer to the VISTRO manual.

Traffic control data are entered by selecting the intersection and then choosing Traffic Control in the Workflow Panel. When the Traffic Control table is first opened, all sections of data entry fields are exposed. The first several rows of data are carried over from the Intersection Setup and Volumes tables. To condense the Traffic Control table by section, click on the light grey arrow to the left of the bold header. This allows each section to be evaluated individually.

The Traffic Control table, shown in **Figure 14** on the following page, has several sections as follows:

- Intersection Settings
- Phasing & Timing
- Exclusive Pedestrian Phase
- Lane Group Calculations*
- Saturation Flow
- Capacity Analysis*
- Lane Group Results*
- Movement, Approach & Intersection Results*
- Other Modes*

**indicates sections that show calculations or results and no data entry is required.*

**Figure 14 | VISTRO Traffic Control Table (condensed)**

Traffic Control — Automatic Optimization — Enter text to search...

| | ↑ | | | | ↓ | | | → | | | | ← | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 102 | | | | | | | | | | | | | | |
| Intersection | **Hamilton Avenue & Winchester Boulevard** | | | | | | | | | | | | | | |
| Notes | | | | | | | | | | | | | | | |
| Control Type | Signalized | | | | | | | | | | | | | | |
| Analysis Method | HCM 7th Edition | | | | | | | | | | | | | | |
| Name | | | | | Winchester Boulevard | | | Hamilton Avenue | | | | Hamilton Avenue | | | |
| Show Name | ☐ | | | | ☐ | | | ☐ | | | | ☐ | | | |
| Approach | Northbound | | | | Southbound | | | Eastbound | | | | Westbound | | | |
| Lane Configuration | | | | | | | | | | | | | | | |
| Turning Movement | *U-turn* | *Left* | *Thru* | *Right* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 | 929 | 575 |
| Total Analysis Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |

▹ **Intersection Settings**
▹ **Phasing & Timing**
▹ **Exclusive Pedestrian Phase**
▹ **Lane Group Calculations**
▹ **Saturation Flow**
▹ **Capacity Analysis**
▹ **Lane Group Results**
▹ **Movement, Approach, & Intersection Results**
▹ **Other Modes**

## 2.6.1 Intersection Settings

The section of the Traffic Control table covers traffic signal parameters that apply to the intersection as a whole. This data is sourced from the traffic signal timing sheet for the intersection. **Figure 15** highlights the location of each of these parameters on the Traffic Control table.

**Figure 15 | VISTRO Intersection Settings Section of Traffic Control Table**

Traffic Control — Automatic Optimization — Enter text to search...

| | ↑ | | | | ↓ | | | → | | | | ← | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 102 | | | | | | | | | | | | | | |
| Intersection | **Hamilton Avenue & Winchester Boulevard** | | | | | | | | | | | | | | |
| Notes | | | | | | | | | | | | | | | |
| Control Type | Signalized | | | | | | | | | | | | | | |
| Analysis Method | HCM 7th Edition | | | | | | | | | | | | | | |
| Name | | | | | Winchester Boulevard | | | Hamilton Avenue | | | | Hamilton Avenue | | | |
| Show Name | ☐ | | | | ☐ | | | ☐ | | | | ☐ | | | |
| Approach | Northbound | | | | Southbound | | | Eastbound | | | | Westbound | | | |
| Lane Configuration | | | | | | | | | | | | | | | |
| Turning Movement | *U-turn* | *Left* | *Thru* | *Right* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* | *U-turn* | *Left* | *Thru* | *Right* |
| Base Volume Input [veh/h] | 8 | 101 | 367 | 316 | 430 | 407 | 151 | 23 | 98 | 916 | 111 | 50 | 282 | 929 | 575 |
| Total Analysis Volume [veh/h] | *8* | *101* | *367* | *316* | *430* | *407* | *151* | *23* | *98* | *916* | *111* | *50* | *282* | *929* | *575* |
| **Intersection Settings** | | | | | | | | | | | | | | | |
| Priority Scheme | Major | | | | Major | | | Minor | | | | Minor | | | |
| Analyze Intersection? | ☑ | | | | | | | | | | | | | | |
| Analysis Period | 15 minutes | | | | | | | | | | | | | | |
| Located in CBD | ☑ | | | | | | | | | | | | | | |
| Controller ID | 102 | | | | | | | | | | | | | | |
| Signal Coordination Group | - | | | | | | | | | | | | | | |
| Cycle Length [s] | 160 | | | | | | | | | | | | | | |
| Coordination Type | Time of Day Pattern Coordinated | | | | | | | | | | | | | | |
| Actuation Type | Fully actuated | | | | | | | | | | | | | | |
| Offset [s] | 10.0 | | | | | | | | | | | | | | |
| Offset Reference | Lead Green - Beginning of First Green | | | | | | | | | | | | | | |
| Permissive Mode | SingleBand | | | | | | | | | | | | | | |
| Lost time [s] | 12.00 | | | | | | | | | | | | | | |
| Pedestrian Walking Speed [ft/s] | 4.00 | | | | | | | | | | | | | | |

The following are the key parameters:

__Analyze Intersection:__ A check box indicates this intersection will be included in the reports.

__Analysis Period:__ This refers to the time period for the analysis. The CMP standard analysis period of 15 minutes is used in the VTA analysis approach.

__Located in Central Business District (CBD):__ A check box indicates the intersection is in a central business district. This value is not utilized in the CMP LOS analysis since default saturation flow rates are used. When active, this would typically reduce the saturation flow rate by 10%, but since the VTA default saturation flow rates are used, this is not used to reduce those values.

__Controller ID:__ For the purposes of CMP Intersection analysis, this field is populated with the unique CMP Intersection ID number.

__Cycle Length:__ This is the maximum time in seconds it will take for each signal group to cycle once. The signal cycle length for the peak hour of analysis should be entered in the Cycle Time data field.

**Coordination Type:** The method of how the traffic signal controller holds phases is defined in the coordination type. The three options are Free, Time of Day Pattern Coordinated, or Time of Day Pattern Isolated. The following describes coordination methods:

- **Free-Running:** Traffic signal controller does not have a set cycle length and is running with fully actuated detection.
- **Time-of-day Coordinated:** Sets a cycle length and places the controller in coordination with other signals in the same coordination group.
- **Time-of-day Isolated:** Sets a cycle length but does not place the controller in coordination with other signals.

**Actuation Type:** The method of how the traffic signal controller calls phases is defined by the actuation type. There are three options such as:

- **Fixed time (pre-time):** Consists of pre-determined signal timing values not based on detection.
- **Fully actuated:** If the Coordination Type is not Free Running, the fixed time signal plan is used to calculate the Force-Off Points of the non-coordinated phases. This control type sets detection on all lanes that influences signal operations.
- **Semi-actuated:** Contains some lanes with detection that influences signal operations. Often, the major street through lanes do not operate with detection to generate phase calls.

**Offset:** This applies when the signal is running coordinated with other signals. The local cycle timer will be offset from the master cycle timer by the defined offset time relative to the reference point.

**Offset Reference:** This applies when the signal is running coordinated with other signals. This is the point in the cycle where the master cycle timer will be equal to the defined Offset time when the controller is coordinated and not in transition (offset seeking). Detailed explanations can be found in NCHRP Report 812 Signal Timing Manual.

**Permissive Mode:** This applies when the signal is running coordinated with other signals. This setting defines the permissive mode for the coordination pattern. The permissive mode controls the method in which permissive periods are opened and closed for all non-coordinated signal groups. The controller will only yield to signal groups that are permissive following the end of green on each coordinated signal group.

**Lost Time:** This is the total time per cycle not effectively being used due to driver reaction time, acceleration, and deceleration at the start and end of active signal groups. The minimum amount of loss time for CMP analysis is three seconds per critical phase. The number of critical phases for an intersection is dependent on the signal phasing. The minimum loss time values for the possible intersection phasing scenarios are shown in **Table 4.**

**Table 4 | Minimum Loss Times for Signalized Intersections**

| Signal Phasing Scenario | # of Critical Phases | Loss Time (seconds) |
|---|---|---|
| One phase for each street | 2 | 6 |
| T-intersection with no left turn phase | 2 | 6 |
| T-intersection with left turn phase | 3 | 9 |
| Left turn phasing on one street and second street with one phase for all movements | 3 | 9 |
| Left turn phasing on one street and second street with split phasing | 4 | 12 |
| Left turn phasing on all four intersection approaches | 4 | 12 |

## 2.6.2 Phasing & Timing

This section of the Traffic Control table is focused on basic traffic signal operations related to movement phases and timing criteria. **Figure 16** illustrates the location of each of these parameters. This data is found on the traffic signal timing data sheet.

**Figure 16 | VISTRO Phasing & Timing Section of Traffic Control Table**

| Phasing & Timing | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Control Type | Permiss | Protecte | Permiss | Permiss | Protected | Permissive | Permissive | Permiss | Protecte | Permiss | Permiss | Permiss | Protecte | Permiss | Per |
| Allow Lead/Lag Optimization | | ☐ | | | | ☐ | | | | ☐ | | | | ☐ | |
| Signal Group | 0 | 3 | 8 | 8 | 7 | 4 | 4 | 0 | 5 | 2 | 2 | 0 | 1 | 6 | |
| Auxiliary Signal Groups | | | | | | | | | | | | | | | |
| Lead / Lag | - | Lead | - | - | Lead | - | - | - | Lead | - | - | - | Lag | - | |
| Minimum Green [s] | 0 | 11 | 9 | 9 | 11 | 11 | 11 | 0 | 11 | 8 | 8 | 0 | 11 | 9 | |
| Maximum Green [s] | 0 | 26 | 42 | 42 | 30 | 46 | 46 | 0 | 20 | 58 | 58 | 0 | 30 | 68 | 6 |
| Amber [s] | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 0.0 | 4.0 | 4.3 | 4.3 | 0.0 | 4.0 | 4.3 | 4 |
| All red [s] | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 1.0 | 1.0 | 1.0 | 0.0 | 1.0 | 1.0 | 1 |
| Split [s] | 0 | 26 | 42 | 42 | 30 | 46 | 46 | 0 | 20 | 58 | 58 | 0 | 30 | 68 | 6 |
| Vehicle Extension [s] | 0.0 | 0.0 | 2.0 | 2.0 | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 3.0 | 3.0 | 0.0 | 0.0 | 1.0 | 1 |
| Walk [s] | 0 | 0 | 6 | 6 | 0 | 6 | 6 | 0 | 0 | 6 | 6 | 0 | 0 | 6 | |
| Pedestrian Clearance [s] | 0 | 0 | 30 | 30 | 0 | 30 | 30 | 0 | 0 | 22 | 22 | 0 | 0 | 27 | 2 |
| Delayed Vehicle Green [s] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Rest In Walk | | | ☐ | | | ☐ | | | | ☐ | | | | ☐ | |
| I1, Start-Up Lost Time [s] | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 2.0 | 2.0 | 2.0 | 0.0 | 2.0 | 2.0 | 2 |
| I2, Clearance Lost Time [s] | 0.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 0.0 | 3.0 | 3.3 | 3.3 | 0.0 | 3.0 | 3.3 | 3 |
| Coordinated | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☑ | | | ☐ | ☐ | |
| Minimum Recall | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☐ | | | ☐ | ☐ | |
| Maximum Recall | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☑ | | | ☐ | ☑ | |
| Pedestrian Recall | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☐ | | | ☐ | ☐ | |
| Dual Entry | | ☐ | ☑ | | ☐ | ☑ | | | ☐ | ☐ | | | ☐ | ☐ | |
| Detector | | ☐ | ☐ | | ☐ | ☐ | | | ☐ | ☐ | | | ☐ | ☐ | |
| Detector Location [ft] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Detector Length [ft] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| I, Upstream Filtering 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 | 1.00 | 1.00 | 1. |

**Signal Control Type:** The type of signal control for each approach of the intersection is selected here. There are five options: permissive, protected, protected/permissive, split phase, and overlap. The following describes the situations for using each of the options:

- **Permissive:** Should be selected to specify an approach with left turns moving permissively with opposing through movements.
- **Protected:** Should be selected to specify an approach with protected left turn operation.
- **Protected/Permissive:** Should be selected to specify an approach with left turns given an exclusive phase first, followed by a permitted period where left turns must use gaps in the opposing traffic stream to pass through the intersection.
- **Split Phase:** Should be selected to specify an approach with all movements moving at the same time.
- **Overlap Phase:** Should be selected with two or more movements moving at the same time. Common example is when a right turn movement has an overlap phase running concurrently with the "shadowing" left-turn movement on the cross-street.

**Allow Lead/Lag Optimization:** Checking this box allows the software to optimize for lead/lag operations.

**Signal Group:** The signal group is the signal phase number as it relates to the ring barrier diagram.

**Auxiliary Signal Groups:** This is usually needed when there is an overlap control type and allows for the selections of any phases with which this movement overlaps.

**Lead/Lag:** For lead/lag signal phasing, this allows for the selection for a protected left-turn phase as either Lead or Lag.

**Minimum Green:** The minimum green time for vehicular traffic should be coded based on the signal timing sheets. If timing sheets were not available, then set according to the defaults shown in **Table 5**. The minimum green times are based on the signal control type for an intersection approach. The minimum green time for movements that do not exist at an intersection should be set to zero.

Determining whether minimum green time should be based on the minimum phase time for pedestrians depends on engineering judgment. If there are very few activations of the pedestrian signals, the vehicular minimum green times in **Table 5** should be used. For movements with substantial amounts of pedestrian activity, the minimum green time should be set to the time required to service the pedestrian traffic, which is the sum of the Walk and Flashing Don't Walk (FDW) intervals set in the signal controller. This information can be found on the signal timing card for the intersection.

**Table 5 | Minimum Green Time**

| Signal Control Type | Minimum Green Time | | |
|---|---|---|---|
| | Left Turn | Through | Right Turn |
| Protected | 7 | 10 | 10 |
| Split Phase | 10 | 10 | 10 |
| Permitted | 10 | 10 | 10 |
| Protected+Permitted | 7 | 10 | 10 |
| Permitted+Protected | 7 | 10 | 10 |

**Minimum Green Time for Bicycles:** The CA MUTCD 2014 Edition, within section 4D.109 (CA), requires that minimum green time be sufficient for a stopped bicycle to cross the road when the light turns green at locations where bicycle detection exists. Even where bicycle specific detection does not exist, it is recommended the minimum green be sufficient for bicycles crossing at locations with dedicated bicycle lanes or locations without detection. Therefore, the minimum green times were reviewed based on the following methodology:

$$G_{min} + Y + R_{clear} > 6 \text{ sec} + (W + 6 \text{ ft})/14.7 \text{ ft/sec}$$

Where:

G = Length of minimum green interval (sec)
W= Distance from limit line to far side of last conflicting lane (ft)
R = Length of red clearance interval (sec)
Y = Length of yellow interval (sec)

More information is available on Caltrans website: https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/rev8/camutcd2014-rev8-all.pdf

**Maximum Green:** This is the maximum time that the signal group will be allowed to extend before it will max-out. A max-out will make a signal group eligible to terminate, even though it may not have gapped-out. Please note that with the exception to Free-Running Coordination Types, the Max Green value needs to be updated manually when the optimized split is determined.

**Amber:** This is the amber (or yellow) interval time in seconds per phase.

**All Red:** This is the all red interval time in seconds per phase.

**Split:** This is the maximum split times in seconds per phase. The split time includes the time it will take the green, yellow, and red intervals to time for each signal group. The split should at least accommodate the signal group Min Green plus Yellow Clearance plus Red Clearance time, but it does not necessarily need to accommodate the full pedestrian service time for an actuated pedestrian signal group. The sum of the splits of all signal groups in each ring should add up to the Cycle Length.

**Vehicle Extension:** This is the allowed time between successful vehicle extensions before a signal group will gap out. This parameter may be referred to as passage in some controllers and does not affect the capacity calculation. The vehicle extension times for vehicular traffic should be coded based on the signal timing sheets. If timing sheets were not available, then set as zero.

**Walk:** This is the minimum time in seconds a signal group will display a walk indication before advancing to the pedestrian clearance interval (flashing don't walk). This should be coded based on the signal timing sheets. If timing sheets were not available, then use California Manual on Uniform Traffic Control Devices (CA MUTCD) standards.

**Pedestrian Clearance:** Pedestrian clearance is the amount of time in seconds required for a pedestrian to cross the intersection using a rate of 3.5 or 4.0 feet per second, depending upon the jurisdiction. This governs the length of the flashing don't walk clearance interval. This is calculated by measuring the length (in feet) of the pedestrian path in the crosswalk from curb to curb and dividing this length by the appropriate crossing rate.

Delayed Vehicle Green: The value in this data field represents the Lead Pedestrian Intervals in seconds. This value allows the pedestrian walk interval to start before vehicle green. This should be coded based on the signal timing sheets. If timing sheets were not available, then use CA MUTCD standards.

Coordinated: The entry in this data field should be set to reflect whether the signal is coordinated. If this field is set to "unchecked," then the program will not calculate progression adjustment factors. This should be coded based on the signal timing sheets.

Minimum Recall: Signal groups flagged for this option will receive an automatic vehicle call regardless of actuation and time for at least its minimum green time. The green time may extend beyond the minimum if demand is present. If this field is set to "unchecked," then the green time would not extend for that signal phase. This should be coded based on the signal timing sheets.

Maximum Recall: The maximum green timer will unconditionally begin timing at the beginning of green. Normally, the maximum green timer will only time if there are opposing calls to the signal group. This should be coded based on the signal timing sheets.

Pedestrian Recall (Pedestrian push-button): Signal groups flagged for this option will receive an automatic pedestrian call and time for the full walk plus pedestrian clearance time. This should be coded based on the signal timing sheets.

Note: This box does not need to be checked with fixed time signals to recall pedestrians, as this is automatically assumed. For non-fixed time signals, if this box is not checked and crosswalks are present, VISTRO will automatically assume that this intersection has a pedestrian push button or pedestrian detector to activate a pedestrian call.

Dual Entry: When a signal group has a call in the next barrier group, concurrent phases in that barrier group may not have a call. In such case both the signal group with the call and the signal group with no call will begin timing when the barrier is crossed if both signal groups are flagged with Dual Entry. This feature is often used for through movement signal groups such that if one signal group is called, the signal group in the opposite direction will automatically serve, even if it does not have a call. This should be coded based on the signal timing sheets.

Detector: Checkbox to choose detector for each group. This should be coded based on the signal timing sheets.

## 2.6.3 Exclusive Pedestrian Phase

This section of the Traffic Control Table is applicable only if the traffic signal is programmed to have a pedestrian only phase. This information is gathered from the signal timing sheets.

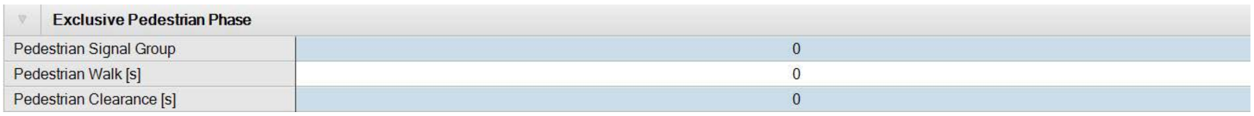
Pedestrian Signal Group: This is signal phase number for the exclusive pedestrian phase. This should be coded based on the signal timing sheets.

Pedestrian Walk: This is the minimum time in seconds that the exclusive pedestrian phase will display a walk indication before advancing to the flashing don't walk indication.

**Pedestrian Clearance:** This is the maximum amount of time the flashing don't walk indication will be displayed before advancing to don't walk indication. If there are multiple pedestrian routes, the longest route should be selected. This data is coded based on the signal timing sheets.

**Figure 17** shows the VISTRO's traffic control setup window for editing the signal timing parameters.

**Figure 17 | VISTRO Exclusive Pedestrian Phase Section of Traffic Control Table**




## 2.6.4 Saturation Flow Rates

This section provides parameters typically used to customize the saturation flow rate for an intersection. However, VTA has identified default saturation flow rates to be used for CMP intersection LOS analysis. In the Saturation Flow section of the Traffic Control table, much of this section is greyed out to indicate that the adjustment factors are not utilized in the analysis since the default saturation flow rates are defined in the Global Settings.

The default VTA saturation flow rates, presented in **Table 6**, are based on a local saturation flow rate study. These default rates are to be used instead of the standard HCM saturation flow rate calculation method.

The saturation flow rate for multiple turn lanes is calculated by applying an 80 percent reduction to the single lane saturation flow rate for each additional turn lane. The saturation flow rates for turning movements in **Table 6** apply to protected movements only, i.e., when the movement can proceed unopposed with its own signal phase.

**Table 6 | Default VTA Saturation Flow Rates**

| Movement | Default Saturation Flow Rate (vph) | | | |
|---|---|---|---|---|
| | 1 Lane | 2 Lanes | 3 Lanes | 4 Lanes |
| Left Turn | 1750 | 3150 | 4550 | |
| Left-Through | 1800 | | | |
| Through | 1900 | 3800 | 5700 | 7600 |
| Right-Through | 1800 | | | |
| Right Turn | 1750 | 3150 | 4550 | |
| Left-Through-Right | 1750 | | | |

**Final Saturation Flow Rate:** The Final Saturation Flow Rates are populated based on the Global Settings of the CMP Intersection Network which should be set to the default saturation flow rate in **Table 6**. Using the VISTRO database with VTA default values predefined in an analysis will result in the use of these default saturation flow rates. If the analysis output sheet does not include these default saturation flow rates, the analysis should be rechecked.

**Override Calculated Saturation Flow Rate:** In specific circumstances that should be brought to the attention of the VTA for approval for CMP intersections, the default saturation flow rate can be overridden. Click the check box for any movement and code the saturation flow rate in **User Defined Saturation Flow Rate**. This is an intersection specific adjustment and will not impact the default saturation flow rate at other intersections.

**Arrival Type (1 to 6):** Arrival Type is the quality of signal progress and it is needed to calculate the Progression Adjustment Factor (PF). This is accomplished by entering a value of 1 (very poor progression) to 6 (exceptional progression) in each of the four arrival type fields. Values for PFs based on the arrival type and the proportion of green time available to a movement (green to cycle length ratio, g/C) are provided in Chapter 19 of HCM 7th Edition. The VTA default is to not include the use of PFs in the analysis (i.e., the default arrival type is 3 to set PF to 1.00). Changes to arrival type in an analysis of a CMP intersection should be reviewed first with the jurisdictional local agency and/or VTA.

## 2.7 LOS Results

The average delay and LOS for each intersection, approach, and movement are displayed at the bottom of the Traffic Control table under the Movement, Approach & Intersection Results. These results reflect any changes made to the traffic parameters above. To view the LOS result for each intersection:

- Click on the intersection to make it active.
- Navigate to Traffic Control in the Workflow Panel.
- Scroll to the bottom of the table to see the LOS summary.

## 2.7.1 Printing the LOS Results

LOS evaluation results can be printed by following these steps:

- Select **File > Print Report** from the top menu in VISTRO.
- In the dialogue box that appears, customize the report print layout.

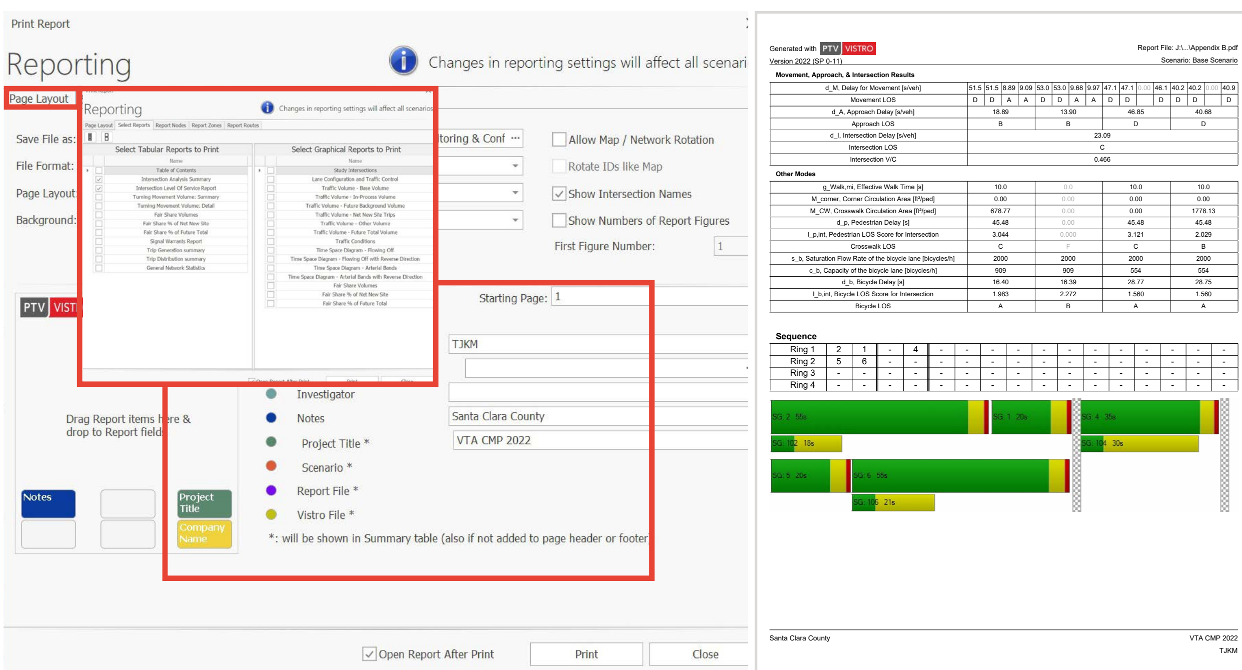
Specify a title for each analysis conducted. For instance, an analysis for the CMP monitoring program could have a title such as "2023 CMP Monitoring Program - [Agency Name] - PM Peak Hour." This information can be entered under File on the menu bar by selecting Print Report.

It's recommended to include the name of the evaluator and the date of evaluation in the Investigator field of the Titles screen.

VISTRO provides a comprehensive set of report-ready tables and figures designed for efficiency, easy reading, and jurisdictional review. See **Figure 18** for details on creating and describing your report and its generated outputs.

In the Select Reports tab, you can choose between the Intersection Analysis Summary (which includes only delay and LOS results) or the complete Intersection LOS Report.

### Figure 18 | VISTRO Printing LOS Results



# 3

# TRAFFIC LOS CONFORMANCE EXEMPTIONS

# 3. Traffic LOS Conformance Exemptions

Certain types of traffic and situations are exempt from the analysis of traffic LOS for conformance based on the exclusions defined in the CMA legislation. Excluding traffic from LOS calculations is not commonly performed in traffic engineering studies; however, there are many possible ways in which types of traffic and situations could be excluded from analysis. This chapter describes the traffic situations exempt from LOS conformance and a methodology for excluding specific traffic and situations from conformance for Santa Clara County CMP roadways.

It should be emphasized that, while technically the traffic problems caused by these situations are exempt from LOS conformance based on the CMA legislation, local jurisdictions should try to develop solutions to improve traffic problems caused by these situations on the CMP network. CMP staff will assist local jurisdictions in this effort.

## 3.1 Legislative Exclusions

The CMA legislation excludes certain types of traffic from the traffic LOS conformance requirements. According to the California Government Code Section 65089.4 (b):

> *The agency shall calculate the impact subject to exclusion pursuant to subdivision (f) of this section, after consultation with the regional agency, the department, and the local air quality management district or air pollution control district. If the calculated traffic level of service following exclusion of these impacts is consistent with the LOS standard, the agency shall make a finding at a publicly noticed meeting that no deficiency plan is required and so notify the affected local jurisdiction.*

Section 65089.4 was added by AB 1963 in 1994. This addition was recommended by a statewide task force organized to recommend changes to the CMA Statute. This text was taken from the section on monitoring and conformance with traffic LOS standards (65089.3) and included in a new section on deficiency plans. This change was an effort to update the state CMA requirements to more closely resemble the federal Congestion Management System (CMS) requirements. Subdivision (f) of 65089.4 includes the same exclusions originally included in 65089.3 with some additional language included in the definition of high density housing. Specifically, Section 65089.4 (f) states:

> *The analysis of the cause of the deficiency prepared pursuant to paragraph (1) of subdivision (c) shall exclude the following:*
>
> - *Inter-regional travel*
> - *Construction, rehabilitation, or maintenance of facilities that impact the system*
> - *Freeway ramp metering*
> - *Traffic signal coordination by the state or multi-jurisdictional agencies*
> - *Traffic generated by the provision of low and very low income housing*
> - *Traffic generated by high density residential development located within one-fourth of a mile of a fixed rail passenger station.*
> - *Traffic generated by any mixed use development located within one-fourth of a mile of a fixed rail passenger station, if more than half of the land area, or floor area, of the mixed use development is used for high density residential housing, as determined by the agency.*

For the purposes of Section 65089.4 (g), the following terms have the following meanings:

- *High density means residential density which contains a minimum of 24 dwelling units per acre and a minimum density per acre which is equal to or greater than 120 percent of the maximum residential density allowed under the local general plan and zoning ordinance. A project providing a minimum of 75 dwelling units per acre shall automatically be considered high density.*
- *Mixed use development means development that integrates compatible commercial or retail uses, or both, with residential uses and which due to the proximity of job locations, shopping opportunities, and residences, will discourage new trip generation.*

**Exemption of Facilities Affected by Transit Operations** - In addition to the specific exclusions identified in the CMA legislation, VTA offers an exemption for facilities affected by priority control for transit operations. This exemption allows local jurisdictions to exclude the effect of priority treatment for transit operations in the calculation of traffic LOS. In other words, traffic operations at an intersection with transit priority can be analyzed as if priority treatment for transit did not exist. This exemption, as it promotes transit use, is consistent with the intent of the CMA legislation.

**Exemption of Infill Opportunity Zone** - In 2013, the CMP legislation was amended to avoid a potential issue that could encourage new development in outlying areas contributing to urban sprawl. Section 65088.4 was amended to allow cities and counties to designate an infill opportunity zone (IOZ) consistent with the general plan and in a transit priority area with a sustainable community strategy. The CMP LOS standards shall not apply to streets and highways within an infill opportunity zone. The City of San Jose is the only VTA Member Agency that has taken action to designate IOZs. These 40 CMP intersections in the IOZ in the City of San Jose are no longer held to the CMP LOS standard.

## 3.2 Structure of Traffic LOS Exclusions

It is useful to think of the legislative exclusions in terms of:

- **Situations** in which the CMP traffic LOS standards do not apply, including: construction, freeway ramp metering, traffic signal coordination, and priority treatment for transit operations, and
- **Types of Traffic** that are excluded from the CMP traffic LOS conformance standards, including traffic from: inter-regional travel, low and very low income housing, high density development within one-quarter mile of a fixed rail transit station, and mixed-use development within one-quarter mile of a fixed rail transit station.

The traffic type and situation exemptions each require a different strategy for addressing the legislative mandate to exclude them from the LOS calculations. There are two important points to understand regarding the traffic LOS exclusion process:

First, it should be understood that while some CMP network facilities are legislatively exempted from meeting CMP traffic LOS conformance standards, in all cases these facilities must be analyzed and monitoring data must be provided to the CMP. It is critical that the CMP have information on all parts of the CMP Roadway Network.

Second, traffic LOS standard conformance is important in two different parts of the CMP: the annual traffic LOS monitoring program and the TIA process. Traffic LOS exclusions are carried out differently for these two parts of the CMP, as well as for each traffic type or situation excluded. Methods for each exclusion type and situation are presented in the following two sections.

## 3.3 Methodology for Situations Excluded from CMP Traffic LOS Conformance Standards

This section describes how LOS should be calculated in the annual traffic LOS monitoring program and for transportation impact analyses, when there are situations exempted from the CMP traffic LOS conformance process.

**Traffic LOS Monitoring** - On parts of the CMP Roadway Network that are affected by the situations (construction, freeway ramp metering, or traffic signal coordination) identified in the CMA legislation or VTA's exemption for priority control for transit vehicles, the following process should be followed as part of the Member Agency's review of the traffic LOS monitoring process:

- Step 1: Member Agency calculates traffic LOS for the CMP roadway facility using the CMP's uniform method of analysis for the particular facility type
- Step 2: If the LOS for the facility is unacceptable, and one of the identified situations applies, then the Member Agency's review of the monitoring report should include the following:
  - A statement to the CMP that LOS on the specific facility was affected by an exempted situation
  - Specification of the particular exempted situation
  - Show LOS with the exempted situation
  - Show LOS without the exempted situation

The following specific methodologies should be used for each exempted situation:

<u>Construction:</u> There are two ways in which a facility can be affected by construction: first, part of the facility can be closed to allow construction; and second, construction traffic from a major project could add traffic to the facility or divert traffic from another facility on a temporary basis. The method for addressing these situations is described as follows:

If part or all of a facility is closed by construction or if the facility is affected by construction traffic from another project or diverted traffic caused by construction, the Member Agency may request an exemption from the calculation of traffic LOS during construction. The Member Agency must make this request in writing to VTA's CMP. VTA's Technical Advisory Committee and its Systems Operations and Management Working Group will review the request and make a recommendation to the CMP. The recommendation will be to grant an exemption or to not grant an exemption, and provide an approach for calculating LOS.

Ramp Metering: If the facility is affected by freeway ramp metering, the Member Agency should provide an analysis of how the traffic impacts of ramp metering in the particular situation can be minimized. This requirement will help meet the intent of the legislation to improve transportation conditions. The analysis should show that without ramp metering, the facility would operate within the CMP traffic LOS standard.
The Member Agency should provide VTA's CMP with copies of the LOS analysis using actual measured volumes with the exempted situation and LOS analysis with adjustments to estimate traffic conditions without ramp metering.

Traffic Signal Coordination: The Member Agency should show that without traffic signal coordination the intersection would operate within the CMP traffic LOS standard.

The Member Agency should provide VTA's CMP with copies of the LOS analysis using actual measured volumes and LOS analysis with adjustments to estimate traffic conditions without coordinated signal operations.

Priority Control for Transit Operations: Priority control for transit is used in Santa Clara County. For example, preferential treatment is given to light rail vehicles where they cross intersections; and signal preemption is used where Caltrain crosses intersections. The traffic signals at these intersections may be interconnected with other traffic signals on the road or expressway, or the traffic signal may be an isolated traffic signal (uncoordinated with other traffic signals).

If the facility is affected by priority treatment for transit, LOS should be evaluated as if the priority treatment for transit did not exist. For example, a traffic signal with priority control for light rail vehicles should be evaluated as if there were no priority treatment. The analysis should show that without the transit priority control, the intersection would operate within the CMP traffic LOS standard.

In order to analyze LOS at an intersection with a traffic signal with priority control for transit vehicles, the following procedures shall be followed:

- If the traffic signal at the intersection is coordinated with other traffic signals, then the intersection LOS should be calculated using the coordinated signal cycle using the VISTRO program as outlined in Chapter 2 of these guidelines or be calculated according to any exemptions that are granted. The appropriate progression adjustment factors should be used.
- If the traffic signal is not coordinated with other traffic signals, then the intersection LOS should be calculated using a measured average cycle length using the VISTRO program as outlined in Chapter 2 of these guidelines. The appropriate progression adjustment factors should be used.

It should be emphasized that the above processes should be followed only if a facility is found **not** to conform to the CMP traffic LOS standard. If the facility conforms to the standard, no action is required of the Member Agency, even if one of the situations applies.

**Transportation Impact Analysis** - Some of the situations outlined above could affect traffic LOS forecasts included in a TIA prepared for a development project. In most cases, the process that should be used to evaluate traffic LOS is the same as for traffic LOS monitoring. The following specific information is noted:

Construction: The TIA should show that when the construction is complete, the facility would operate within the CMP traffic LOS standard.

Ramp Metering: The TIA should show that without ramp metering, the intersection would operate within the CMP traffic LOS standard.

Traffic Signal Coordination: The TIA should show that without the coordination program, the intersection would operate within the CMP traffic LOS standard.

Priority Treatment for Transit Vehicles: The TIA should show that without priority treatment for transit vehicles, the intersection would operate within the CMP traffic LOS standard.

## 3.4 Exclusion of Traffic Types from LOS Conformance Standards

The CMP legislation lists four types of traffic to be excluded from CMP traffic LOS conformance: inter-regional travel, traffic generated by low and very low income housing, high density development within one-quarter mile of a fixed rail transit station, and mixed-use development within one-quarter mile of a fixed rail station. The methods for addressing these traffic type exclusions are more complicated than those used to address the excluded situations.

The legislative intent in providing these traffic type exclusions is two-fold: first, to exclude from the CMP traffic LOS standard the impact of trips that are not under the control of Member Agencies; and second, to encourage certain types of development (e.g., low and very low income housing, high-density housing near fixed rail transit stations, and mixed use projects near fixed rail transit stations). Each of these types of exclusions are described separately below.

**Inter-regional Travel** - For CMP purposes, inter-regional trips are defined by statute as trips that pass through the County (external to external) and trips that originate outside the County and end inside the County (external to internal).

The CMA legislation gives the Metropolitan Transportation Commission, Caltrans, and the Bay Area Air Quality Management District power to assist in the traffic exclusion process. Because these agencies currently have data on inter-regional travel, estimates provided by these agencies will be used to estimate inter-regional traffic volumes.

VTA's intent is to improve traffic conditions and this means taking into account all the traffic on the area roadways. VTA's method for addressing inter regional travel in monitoring and transportation impact analyses is presented below.

Traffic LOS Monitoring: The freeway segment analysis procedures based on density outlined in Chapter 1 of these guidelines should be used to evaluate LOS without inter-regional traffic volumes. The calculations shall be based on reduced traffic volumes and travel speeds measured in the field during the LOS monitoring process.

Transportation Impact Analysis: The same process as mentioned above for traffic LOS monitoring should be used for evaluating traffic conditions with inter-regional travel excluded.

**Encouraged Development Types** - The CMA legislation excludes traffic from low and very low income housing, from high density housing within one-quarter mile of a fixed rail transit station, and from mixed use development within one-quarter mile of a fixed rail transit station from the traffic LOS standard conformance calculation. The exemption of these development types from the CMP traffic LOS standard means that a local jurisdiction could approve one of these types of projects without imposing mitigation measures necessary to maintain the CMP traffic LOS standard.

Since the intent of excluding traffic from these types of development from the CMP traffic LOS standard seems to be to encourage this type of construction, only traffic from new development should be excluded from the traffic LOS standard conformance. New development is defined as development that is constructed and occupied within the year of the current monitoring program.

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# APPENDIX

VISTRO 2022

MANUAL