

## APPENDIX 12/13A SOFTWARE AND SETTINGS FOR INTERSECTION ANALYSIS

There are many software programs and tools for traffic analysis of intersections. This is a brief discussion on a few common tools and key settings. For more information on appropriate tool selection, see the FHWA Traffic Analysis Toolbox, Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools.



*The settings discussed in this chapter are generally applicable to recent software versions. Slight differences may be encountered as version changes can be frequent; however most settings are not affected by version changes.*

A crosswalk between common signal timing sheet terms and major signalized intersection software analysis packages are shown in Figure 1. This should help to translate timing terms from signal timing sheets or between different software packages.

**Figure 1 Signalized Intersection Parameters Software Crosswalk**

Signal Timing Sheet	Synchro	Vistro	SIDRA	HCS
Phase Timing	Phase	Signal Group	Phase	Phase
Veh Recall	Recall Mode	Max/Min Recall	n/a	Recall Mode
Max Green	n/a	Max Green	Maximum Green	n/a
Walk	Walk	Walk	Minimum Walk Time	Walk Interval
Flash DW	Flashing Don't Walk	Pedestrian Clearance	Minimum Clearance Time	Pedestrian Clear Interval
Min Green	Minimum Initial	Min Green	Minimum Green	Minimum Green
TBR	TBR	n/a	n/a	n/a
TTR	TTR	n/a	n/a	n/a
n/a	Minimum Split	Split	Phase Time	Phase Split
Passage	Vehicle Extension	Vehicle Extension	Gap Setting	Passage Time
Min Gap	Minimum Gap	n/a	n/a	n/a
Yellow	Yellow Time	Amber	Yellow Time	Yellow Change
Red Clear	All-Red Time	All Red	All-Red Time	Red Clearance
n/a	Lost Time Adjust	(Intersection) Lost Time; Start-Up & Clearance Lost Time	Start Loss & End Gain	Start-up Lost Time & Extension of Effective Green

### **Synchro/SimTraffic**

Synchro optimizes signal timing and implements HCM methodologies for unsignalized intersections as well. Synchro and SimTraffic consider operational effects of adjacent intersections. ODOT has researched Synchro analysis and documented procedures. Synchro is a complete software package for modeling and optimizing traffic signal timings. Synchro implements methods of the HCM from HCM 2000 to HCM 6: Urban Streets, Signalized Intersections, and Unsignalized Intersections and reports both results.

Synchro is one of the better tools for analysis of signalized arterials and for areas where surrounding intersection operations can influence each other, as it will consider the effects of the

coded transportation network on each intersection. This software is also suggested for projects where traffic simulation will be desired, because the street network and operational parameters used can be directly transferred to the SimTraffic program or other simulation programs. ODOT has conducted extensive research on the use of Synchro for analyzing state facilities and has documented several procedures for implementation and default values, which are provided in the next section.



*While Synchro can model freeway systems it will not do merge/diverge analysis and SimTraffic does not properly model freeway operations unlike Vissim. Synchro is very consistent with HCM methodology and will not analyze non-standard intersections. SIDRA should be considered on projects with many non-standard intersections. Synchro roundabout analysis is also limited. Supplemental analysis of roundabouts either with SIDRA, Vistro or a manual method is necessary to obtain valid results.*



*Many of these procedures also apply to other programs such as Vistro and SIDRA and should be used where applicable.*

This section shows ODOT Synchro settings organized by window. The Simulation Settings Window is only used by SimTraffic and is covered in Chapter 15. The bullet points below only cover the important inputs.

## Global Settings

The Synchro/SimTraffic templates incorporate the global settings for both programs. These were created as a tool to both save time and reduce errors when starting Synchro analysis. Please see the template readme file for the specific values. The templates are located under the [Technical Tools](#) section that can be accessed off of the APM web page.

## Lane Settings Window

- **Ideal Saturated Flow Rate** – default is 1900 pcphg which is used for Portland, Salem and Eugene; however, ODOT’s default for urban areas with population less than 200,000 is 1750 pcphg (see Chapter 3). See Appendix 6B for saturation flow rates when CAVs are being considered. The best way to determine the Saturated Flow Rate is to measure it in the field. (See HCM)
- **Lane Utilization Factor,  $FLU$** , – is calculated by Synchro, but may be overridden and can have a large impact on the movement saturation flow rate. This factor shall be calculated by the analyst if groups of two or more lanes exist including through and turn lanes that might be affected by uneven lane distribution. Uneven lane distribution can either occur

with nearby downstream turn movements or where through lanes drop or add. Lane distribution at critical locations can be obtained from field observation or from signal controller count data if available.

$$F_{LU} = 1/(n * (\text{Proportion in Heaviest Travel Lane}))$$

where

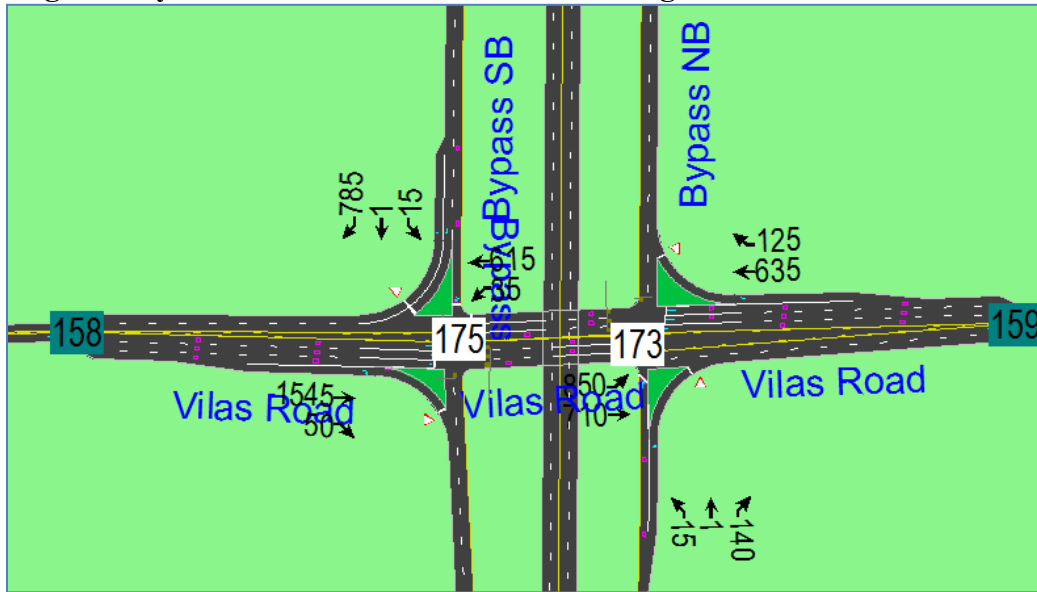
n= number of lanes in lane group

### Volume Settings Window

- **Link OD Volumes** – This setting allows for adjustment of origin and destination volumes between two closely spaced intersections, such as between ramp terminals at an interchange. This setting is useful to reduce unlikely turning movement combinations, such as vehicles at an interchange making a u-turn by turning left from the off-ramp and left again at the on-ramp. For example at the downstream ramp terminal left turn, the unlikely source would be from the upstream ramp left turn. Synchro estimates the source volume in proportion to turning movements, but allows it to be changed. In this example, the ramp left turn source volume is manually zeroed out so that Synchro re-assigns the source volume to the upstream through movement.

Figure 2 shows a Synchro model of a diamond interchange. It is desired to have zero volumes turning left from the southbound ramp terminal and left again to the northbound ramp terminal. This is accomplished using the Link OD setting. Figure 3 shows the volume settings window for the eastbound link between the ramp terminals.

**Figure 2 Synchro Model of Diamond Interchange**



**Figure 3 Volume Settings Window**

VOLUME SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)	↑↑	↑			↑↑↑	↑		↑	↑			
Traffic Volume (vph)	850	710	0	0	635	125	15	1	140	0	0	0
Development Volume (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Combined Volume (vph)	850	710	0	0	635	125	15	1	140	0	0	0
Future Volume (vph)	850	710	0	0	635	125	15	1	140	0	0	0
Conflicting Peds. (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting Bicycles (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth 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
Adjusted Flow (vph)	895	747	0	0	668	132	16	1	147	0	0	0
Heavy Vehicles (%)	10	10	10	10	10	10	20	20	20	20	20	20
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Parking Maneuvers (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Traffic from mid-block (%)	0	0	0	0	0	0	0	0	0	0	0	0
Link OD Volumes	EB			WB			NB			SB		
Traffic in shared lane (%)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	895	747	0	0	668	132	0	17	147	0	0	0

The settings for the eastbound direction are displayed by clicking on the EB Link OD settings button, as shown in Figure 4.

**Figure 4 Link OD Settings Before Adjustment**

	Total	Sink	EB-Tot	EBL	EBT	EBR
Link Total	1560	0	1560	850	710	0
From Midblock Volume	0	0	0	0	0	0
From Midblock Weight	—	1.00	—	1.00	1.00	1.00
Total From Upstream	1560	0	1642	895	747	0
From SBL Volume	15	0	16	9	7	0
From SBL Weight	—	1.00	—	1.00	1.00	1.00
From EBT Volume	1545	0	1626	886	740	0
From EBT Weight	—	1.00	—	1.00	1.00	1.00
From NBR Volume	0	0	0	0	0	0
From NBR Weight	—	1.00	—	1.00	1.00	1.00

Close      Default      Volume Weights

As shown, a southbound left origin volume is shown as 9 vph. This is zeroed out as shown in Figure 5.

**Figure 5 Link OD Settings After Adjustment**

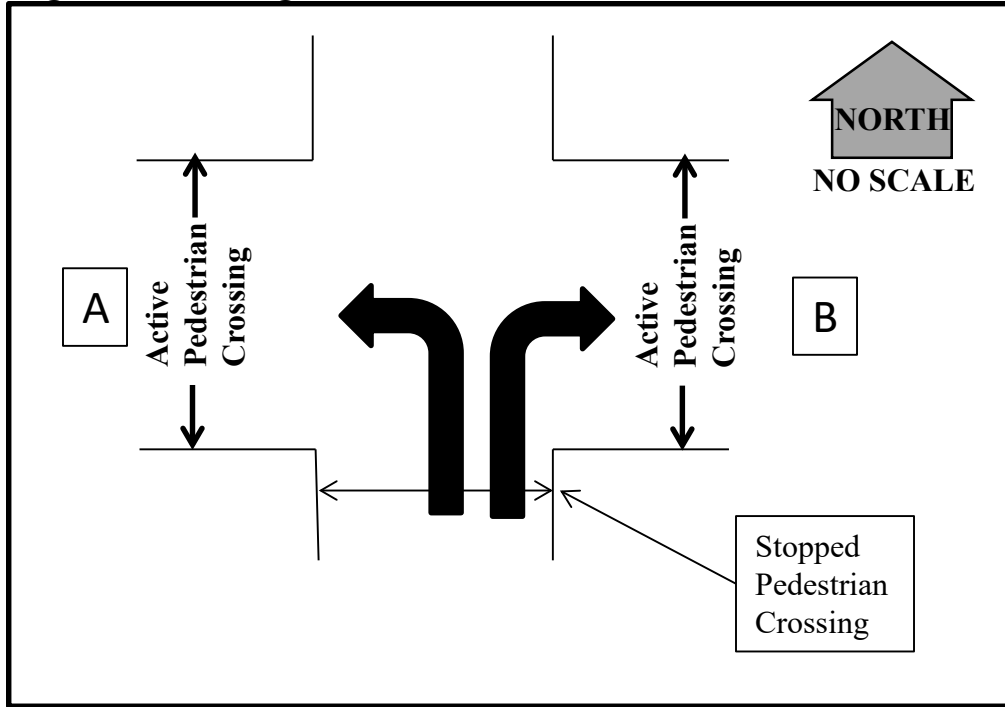
	Total	Sink	EB-Tot	EBL	EBT	EBR
Link Total	1560	0	1560	850	710	0
From Midblock Volume	0	0	0	0	0	0
From Midblock Weight	—	1.00	—	1.00	1.00	1.00
Total From Upstream	1560	0	1642	895	747	0
From SBL Volume	15	0	16	0	16	0
From SBL Weight	—	1.00	—	0.00	1.00	1.00
From EBT Volume	1545	0	1626	895	731	0
From EBT Weight	—	1.00	—	1.00	1.00	1.00
From NBR Volume	0	0	0	0	0	0
From NBR Weight	—	1.00	—	1.00	1.00	1.00

As a result of the adjustment, all of the left turn volume at the southbound ramp terminal is destined to the eastbound through movement at the northbound ramp terminal. Likewise, all of the eastbound left turn volume at the northbound ramp terminal originates from the eastbound through movement at the southbound ramp terminal.

- **Conflicting Peds** – enter the number of pedestrians that conflict with the permissive right turn movements and the permissive left-turn movements. This value will generate pedestrians in SimTraffic for unsignalized intersections, so this value should only be coded for actual pedestrian paths.

In Figure 6, pedestrians in Crosswalk A conflict with the northbound lefts and pedestrians in Crosswalk B conflict with the northbound rights. Pedestrians will not reduce the saturation flow rate for protected turn movements or through movements.

**Figure 6 Conflicting Pedestrian Movements**



- **Peak Hour Factor (PHF)** – Refer to Section 5.8 for guidance on existing and future peak hour factors.
- **Heavy Vehicles** – enter the percentage of trucks and buses for the hour being analyzed for each approach or movement. These values should match the classification count information.
- **Adjacent Parking Lane** – if there is on street parking for this approach, check the box for the adjacent parking lane and enter the number of parking maneuvers per hour. Enter parking maneuvers for each lane group that is affected. Note that parking with zero parking maneuvers per hour is different from no parking as the adjacent parking lane still has an impact. Figure 7 shows typical parking scenarios and shows the affected lane groups.



**Figure 7 Parking Coding**

Lane Configurations		Affected Lane Groups		
		Left	Through	Right
	1 Through, 1 Right Long Storage			X
	2 Through		X	
	1 Left, 1 Through, 1 Right Long Storage	X		X
	1 Left Long Storage, 1 Through, 1 Short Right Storage	X	X	X
	2 Through		X	

- Traffic From Mid-Block** – this is the proportion of traffic that comes from driveways and minor unsignalized intersections. If intersection volumes are 100% balanced there will be no traffic from mid-block. If it is not appropriate to balance 100%, this parameter should be included. This field should be used instead of trying to code multiple adjacent driveways which will result in excessive congestion. For example, if 300 vehicles leave an upstream intersection and 400 vehicles arrive at the downstream intersection, the proportion of traffic from mid-block should be 25%.

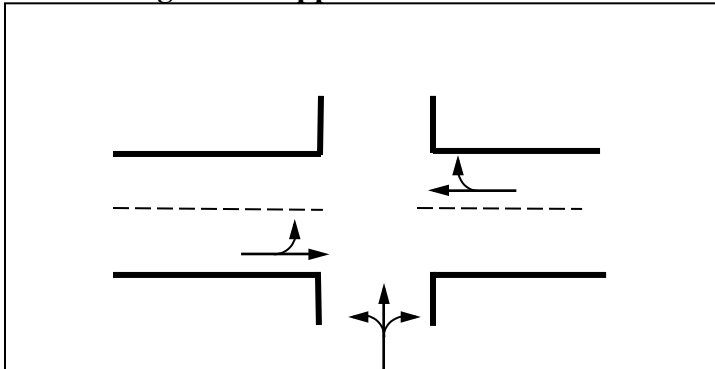
## Timing / Signing Window

### Signing

When unsignalized controller type is selected, the Timing Window becomes the Signing Window. The below bullet points pertain to the Signing Window.

- **TWLTL Median:** Used to indicate whether a section is a two-way left-turn lane versus a regular median section. This will show the typical TWLTL striping on the screen, but Synchro will not analyze TWLTL operation. Using this setting will assume two-stage gap operation for the side-street even though this movement may not be compatible with a TWLTL. Two-stage gaps should only be coded if actual field observations show such behavior. New build alternatives should not be designed with two-stage gaps. However, the HCM considers wide medians where vehicles stop perpendicular to the mainline also to be a two-stage gap. Use this setting with caution.
- **Critical Gap(s)** – Leave the Synchro calculated default unless the unsignalized intersection is at an interchange ramp terminal or start of a one-way grid section where there are four legs but only three approaches. Synchro does not use the proper gap times for an unsignalized intersection with a one-way minor street such as at an interchange ramp terminal. Synchro is using the gap times appropriate for a four-legged intersection with four approaches, however, one-way minor street intersections have four legs but only three approaches (see Figure 8 below).

**Figure 8 Four-Leg Three-Approach Intersection Illustration**




The critical gap times ( $t_c$ ) need to be changed for the minor street left turn only. The value is different depending on how many lanes are on the major street (see Figure 9). All other critical gap times stay the same. After the value is changed it will be in red to indicate a user-overridden value. Deleting the value out and pressing “Enter” will restore the value back to the default setting.

**Figure 9 Critical Gaps for Four-Leg Three-Approach Intersections**

	Two-Lane Major Street	Four/Six-Lane Major Street
Critical Gap $t_c$ (s)	6.4	6.8

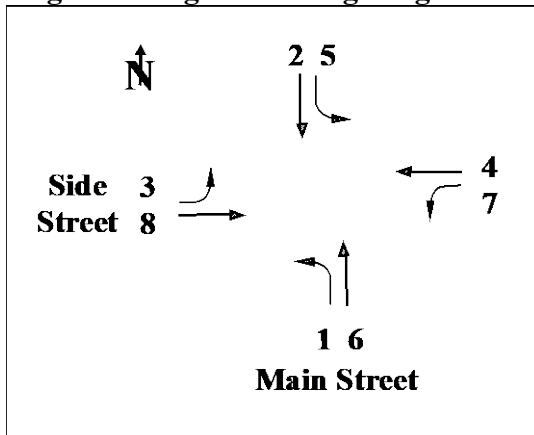
**Timing**



*Clustered signals that share a single controller cannot necessarily be reported out with HCM 2010 or later methodologies because of NEMA phasing requirements. HCM 2000 reports may need to be used.*

Figure 10 shows the ODOT default for signal phasing. This is different from the Synchro defaults. (Alternatively, if Main Street ran E-W, phase 6 would be WB.) This needs to be appropriately set for each intersection to have the signal operation work correctly.

**Figure 10 Signal Phasing Diagram**



- **Description** – This field can be used to record changes to settings when modifying alternatives, timing, calibrating simulations, or when reviewing other’s files.
- **Controller Type:**
  - Actuated-Uncoordinated – This is the primary controller type used by ODOT in isolated situations. When analyzing for a new isolated signal, this is generally the correct controller type to assume;
  - Actuated-Coordinated – This is the primary controller type used by ODOT in progressed network situations;
  - Pretimed – This is used primarily in grid network situations (i.e. downtown networks) or older controllers on city streets;
  - Semi Actuated-Uncoordinated – No longer used by ODOT for permanent controller types, but it may be found on city or county facilities.
  - Unsignalized – Stopped controlled intersections;

○ Roundabouts – Synchro 8 and later versions will analyze single-lane roundabouts using the current HCM methodology.

For existing networks, the type of controller can be determined by observation or through contacting your Region Traffic office. In new construction, the analysis will determine what controller type will be necessary.

- **Cycle Length (s):** guidance for maximum cycle is by the number of phases: two phase = 60 s, three phase = 90 s, four phase = 120 s.
- **Referenced to:** ODOT standard is set to “Beginning of yellow” For 170 signal controllers and 2070 controllers use “Beginning of Green.” This specifies the phase the offset is referenced to.
- **Reference Phase:** coordinated phases for an actuated signal. ODOT uses the mainline phases 2 and 6.
- **Yellow and All-Red Time:** ODOT defaults as shown in Figure 11 when grades do not exceed 3 percent. For grades that do exceed 3 percent, the ITE formula below should be used for the yellow clearance intervals. Left turns may be treated as 25 mph approaches.

ITE Yellow Clearance Intervals

$$y = t + \frac{v}{2a + 2Gg}$$

Where:

y = length of the yellow interval, to the nearest 0.1 sec

t = driver perception-reaction time, recommended as 1.0 sec

v = velocity of approaching vehicle, in ft/sec (or m/sec)

a = deceleration rate, recommended as, 10 ft/sec<sup>2</sup> (3.05 m/sec<sup>2</sup>)

g = acceleration due to gravity, 32 ft/sec<sup>2</sup> (9.8 m/sec<sup>2</sup>)

G = grade of approach (3% downgrade would appear as -0.03)

- **Lost Time Adjust:** ODOT default for lost time is 4.0 seconds (unless unusual conditions exist that would warrant a longer time). Synchro 7 and later versions redefined the lost time calculation so it is necessary to adjust the lost time up or down to match the default. The lost time adjustment is equal to the difference between the sum of the yellow and all-red times and the lost time default. See Figure 11 for the default lost time adjustments.

**Figure 11 Recommended Yellow, All-Red & Lost Time Adjustment Values\***

<b>85<sup>th</sup> Percentile Speed (mph)</b>	<b>Yellow (s)</b>	<b>All Red (s)</b>	<b>Lost Time Adjustment (s)</b>
25	3.5	0.5	0.0
30	3.5	0.5	0.0
35	4.0	0.5	-0.5
40	4.3	0.5	-0.8
45	4.7	0.7	-1.4
50	5.0	1.0	-2.0
55	5.0	1.0	-2.0

\* These yellow and all-red values are generally applicable where downgrades are less than or equal to 3 percent

- **Lagging Phase?** – Checking this box will set this phase to lag the corresponding phases. This is generally for left turns, but can also be set for through and right turns, provided that separate phases exist.

*Note: With “Dog-house” type permissive-protected left turn signals, lagging left turns are not allowed. Otherwise, a lagging left turn creates the “left-turn trap/yellow trap” where during the change from permissive movements in both directions to a lagging through phase in a single direction, opposing movement does not stop as may be expected by a driver in the left-turn lane.*

- **Recall Mode** – Defines what phases the signal can skip. There are four options: None, Min, Ped and Max. None will allow the phase to be skipped; Min requires the phase to occur for at least the minimum green and cannot be skipped. Ped requires a walk and flashing don’t walk time to occur (i.e. in a downtown area) and Max (functionally equivalent to pre-timed) requires the phase to occur for the maximum green and cannot be skipped. Recall settings will only work correctly if consistent with mainline/side-street phase settings. Incorrect phase settings may result in a signal not giving green time to certain moves.

For:

- Major protected lefts & minor movements – Set to None;
- Major through movements – Set to Min (Minimum).
- Intersections that are at the junction of two progressed systems – Set to Min for all legs.

## Node Settings / Signing Window

This window has a pull down to select control type: roundabout, unsignalized, and signalized.

### Control Type:

- **Unsignalized: stopped controlled**

- Refer to the HCM 2010/6<sup>th</sup> window for HCM 2010/6<sup>th</sup> edition analysis for the auto mode. Depending on the configuration, some intersections can only be analyzed with HCM 2000 as HCM2010 and later editions have limitations on the number of lanes. This window carries in information from the other windows, so no new information is required. The pedestrian mode is not used as these are analyzed with ODOT's preferred Chapter 14 methodologies.
- Roundabouts – Synchro will analyze single and multi-lane roundabouts using current HCM methodology. Synchro has some analysis limitations especially with partial multilane roundabouts and the overall results do not match well with the HCM or other software programs. It is recommended that the Synchro analysis be backed up with Vistro, SIDRA, or the manual methodology. Please refer to Chapter 12 and the following Vistro and SIDRA sections. Synchro does not have the capability of directly modifying the capacity equation coefficients, so if CAVs are to be considered (Version 11 or earlier), use Vistro or SIDRA instead. The only setting that is required is the number of roundabout (circulating) lanes. Radii and circulating speed can be entered but these are only used in SimTraffic. If any part of the roundabout is or will be a multilane roundabout, then it is important to input “2” for the number of roundabout lanes. After this go to the HCM 2010/6<sup>th</sup> edition Roundabout Window and enter the actual number of conflicting circular lanes for each approach.
- HCM 2010 / HCM 6<sup>th</sup> Roundabout Window - This window carries over inputs from the node settings window and has further settings that describe the roundabout:
  - Entry lanes
  - Conflicting Circle Lanes
  - Exit Lanes
  - Right Turn Channelized (bypass lane)
  - Lane Assignment
  - Ped Vol Crossing Leg (#/hr)
    - If needed, the critical and follow-up headways can be adjusted if a previously calibrated roundabout equation exists for a jurisdiction (such as for Bend single-lane roundabouts). Lane assignments and related movements can also be fine-tuned.

- **Signalized**
  - Refer to the HCM 2010/6<sup>th</sup> edition window for HCM 2010/6<sup>th</sup> edition analysis for the auto mode. The pedestrian and bicycle modes are not used as these are analyzed with ODOT’s preferred Chapter 14 methodologies. Detectors are required at 2’ from the stop bar to enter the HCM 2010/6<sup>th</sup> edition signalized window. The settings in this window will be carried over from the other windows so generally just a review of the data is necessary. The detailed HCM 2010/6<sup>th</sup> edition node settings can be left as default or changed if data is available.

## Phasing Window

Pedestrian Timing can have a significant impact on an intersection operation. Timing can be obtained from the signal timing sheets or the Region Traffic offices. Otherwise, the walk time is 7 seconds and the curb-to-curb “Flashing Don’t Walk” time is generally calculated at 3.5 ft/sec for the length of the crosswalk. Areas with more pedestrians or older pedestrians may have different timings, so please check with Region Traffic or Traffic-Roadway Section.

Changing the defaults for the actuated signal phasing settings are only required if a calibrated simulation or actuated signal timing plans will be created. Figure 12 shows the required Phasing Window settings. These factors have a significant impact on the calibration. These settings can come either from signal timing (preferred) or from Figure 12.

These settings are defined as:

- **Minimum Initial** - Minimum green time
- **Minimum Split** - Minimum green + yellow + all-red + walk + flashing don’t walk times. Leave higher values otherwise errors will result.
- **Vehicle Extension** (also known as “Passage” on a timing sheet) – Time that a detector extends the green time up to the maximum time available for that phase.
- **Minimum Gap** – Gap time after reduction until end of phase.
- **Time Before Reduce (TBR)** – Time elapsed before gap time is reduced
- **Time To Reduce (TTR)** - Time elapsed during gap time reduction to minimum.

**Figure 12 ODOT Phasing Settings Defaults\***

Parameter (s)	Left Turns (s)	Mainline Through's (s)	Side Street Through's (s)
Minimum Initial (Green)	4.0	10.0	6.0
Minimum Split	13.0 min.	14.0 min.	13.0 min.
Vehicle Extension	2.5	4.0	2.5
Minimum Gap	2.0	2.7	2.0
Time Before Reduce	8.0	10.0	8.0
Time To Reduce	4.0	13.0	4.0

\*The values in this table are the general phasing settings from the Traffic-Roadway Section (TRS) except for the minimum gap for left turns and side streets. The TRS minimum gap values for these movements are 0.5 seconds. SimTraffic is too sensitive with the 0.5 second value because it does not allow enough time to adequately represent field conditions and a longer time is needed to prevent excessive queues and gap outs. The 0.5 second value should be retained for signal timing plan construction.

Note that these changes in the Phasing Window, especially minimum split times, might change the cycle length and maximum splits (especially for left turns and side streets), so the system optimization should be re-run.

## Detector Window

If timing plans that involve actuated signals or a SimTraffic simulation needs to be created, the Detector Window data must be entered. Synchro uses this data to model actuated signal operation. Correct detector settings are critical to a successful simulation. If actuated signal operation or simulation is not going to be utilized, the Synchro default detector settings can be used.

- **Number of Detectors** – Enter in number of detectors (1 to 3) for a given lane type.
- **Detector Phases** – Phase that is triggered by detection zone. This value is carried over from the Timing Window.
- **Leading and Trailing Detectors** – Not used in Synchro other than to maintain backwards compatibility with earlier versions. These values are automatically updated as more detailed detector position and size data is entered. The Leading Detector is the first detector that a vehicle encounters on an approach (furthest from the stop bar) while the Trailing Detector is the last detector on an approach and closest to the stop bar. **Warning: Do not modify these values if specific detector information is being entered as these will overwrite the detector data and create many errors.**
- **Detector Templates** – While all of the detector data can be added individually, it is very repetitive and the use of the Detector Template can quickly add the correct ODOT detector settings for new or existing signals in Synchro. The TPAU Analysis Tools web page has default Synchro template files that contain the full base ODOT detector settings.
- **Detector Position (ft)** – Enter distance to stop bar. Detector 1 is closest to the stop bar. Position varies by speed on approach and lane type.



- **Detector Type** – Synchro has three detector types – Call, Extend, or Call + Extend. ODOT uses the third type: Call + Extend (Cl+Ex). The detectors are capable of being both a “Call” or a “Extension” detector depending on the signal state. The call function occurs during the red time for phases that require a “call” for a green placed to the signal controller when a vehicle triggers the detector. The extend (or extension) function occurs during the green time and is used to extend the green time to allow vehicles to smoothly flow through the intersection approach.
- **Detector Size (ft)** – Enter size of detector. ODOT standard is a 6 foot diameter loop so enter “6” feet for all extension detectors. Detection on the side street is a pair of loops tied together, so these are coded as a single 16 foot detector.
- **Detector Delay** – Only used for side street exclusive right turn lanes to delay the detection call to the controller. This will limit the number of times that the side street phases will need to come up. This value is usually 10 seconds.



*ODOT’s detector settings are incompatible with the HCM 2010/6<sup>th</sup> Edition as the maximum distance from the stop-bar is 20 feet. A stop-bar detector for the mainline will need to be added (not ODOT standard). Signalized intersection analyses will need to separately calculate the intersection v/c ratio. When a HCM 2010 (or later) -only analysis is desired for local non-state intersections where the intersection v/c ratio is not necessary, the detector placement is limited to the side-street placement style (one 16’ detector at two feet from the stop-bar). All analyses that will use simulation ultimately, regardless of jurisdiction, will need to use the full detector settings.*

## Detector Settings

There is a difference between ODOT detector placement standards which measure to the center versus Synchro which measures to the leading edge of the detector. Figure 13 shows the ODOT Synchro detector placement. The values in Figure 13 have been incorporated into the detector templates loaded in the Synchro template file. If desired, these can be loaded separately into an existing Synchro file (see the template readme file).

If turn bays are shorter than 72’ then eliminate Detector 2 as Synchro will give an error as the detection zone will exceed the storage length. Synchro may have trouble showing detectors in the Map Window in shorter turn bays, so it may be necessary to adjust the detector spacing or turn bay length. Short turn bays in the field likely only have a single detector (verify in the field).

If exclusive right-turn lanes on the mainline exist, there is only one detector at 137' from the stop bar. If the turn bay is shorter than 137' then adjust the distance to approximately 2/3 of the total bay distance, but do not put the detector at the extreme end of the turn bay as turning vehicles may miss the detector or through vehicles may trigger it.

Detectors for ramps are based on whether the ramp is a low speed ramp, such as a loop ramp (<45 mph), or a high speed ramp, such as a diagonal ramp (≥45 mph).

**Figure 13 Synchro-Adjusted ODOT Detector Type and Position**

Lane Type	Speed (mph)	Number of Detectors	Position (distance from stop bar to leading edge of detector, in feet)		
			Detector 1	Detector 2	Detector 3
Side or Left	All	2	2	72	
Right	All	1	137		
Ramp	<45	3	2	72	132
High-speed Ramp	45+	3	2	107	207
Mainline Through	25	1	137		
	30	1	177		
	35	2	107	217	
	40 & 45	2	157	317	
	50	2	187	377	
	55	2	222	447	

It is possible that detector type/placement differs in the field (i.e. call detectors at the stop bar on the mainline), so customization may be necessary. Local intersections can use the ODOT Side Street detector settings or default Synchro data, but should be field-checked for accuracy. Detector spacing can also be modified to fit video detection zones for intersections that have cameras.

### Optimizing Signal Operations

Existing conditions (base year) need to be optimized if the timing did not come exclusively from timing sheets. The only exception is when a calibrated existing condition analysis is being used for simulation. Short-term analyses may require optimization even if timing sheets were used. All future no-build conditions and future build alternatives must optimize the signal timing, either as an isolated case or a signal system. Mainline phase orientation, reference phase, offset style, and recall settings are set appropriately before optimizing.

Note: If at any time a change is made to intersection geometry, volumes, signal timing, etc., the system shall be re-optimized.

Existing field timing may or may not be fully optimized; it is often set to minimize motorist delay or queue lengths. For planning purposes or traffic impact studies, ODOT's practice is to optimize the timing for the best intersection v/c ratio. Movement v/c's should be relatively even on the intersection approaches. The cycle length and phase splits should be optimized for each analysis (existing, no-build and build alternatives) except during simulation calibration work, see Chapter 8. Generally, optimizing with longer cycle lengths and fewer vehicle phases will result in a lower v/c, however longer cycle lengths will increase queuing.

- **Intersection Cycle Length Optimization**– This algorithm optimizes the cycle length for a single intersection, based on delay.
- **Intersection Splits Optimization**– This algorithm optimizes the phase splits for a single intersection. This is a good place to start when optimizing the v/c for an intersection. Subsequent adjustments to movement green time may improve the v/c.

Make sure that Lead/Lag Optimize is set properly. This will allow Synchro to optimize the phase sequence (leading or lagging operation for left turns) when the signal functions as part of a coordinated system. Lagging operation may be inappropriate for high volumes, five-section “doghouse” heads or other concerns. Flashing yellow left turn heads can operate either in leading or lagging mode.

When optimizing for part (zone) or a whole network the system optimization should use the manual cycle length option so the best system cycle length can be found. An increment of 5 seconds should be used. System cycle lengths:

- Should not exceed ODOT's 60-90-120 second cycle limits for 2, 3 and 4 phase signals, respectively.
- Show promise for minimizing delay and stops and maximizing bandwidth
- Should have a low number of “dilemma vehicles”, i.e. a low number of vehicles expected to be caught near the intersection when a signal turns yellow.
- May change the phase splits at the intersections. Verify that the new split times are acceptable.

The optimized network should have good progression between signals in the system. The quality of the progression will generally be determined by noting the size of the bandwidth for the selected cycle length. The bandwidth should be maximized as much as possible. OAR Division 20 should be reviewed to ensure that the resulting bandwidth is acceptable. Link speeds can be dropped five mph in order to check minimum bandwidth requirements.

The Time-Space diagram will need to be reviewed as Synchro optimizes for delay, not progression bandwidth. The analyst will need to drag the intersection offsets on the time-space diagram with a mouse to improve the arterial bandwidths (the link bands are not used). Bandwidths should be visible for both directions in most cases. Experimentation is often necessary to determine which intersections are critical for increasing the bandwidth. Arterial bandwidths should be maximized for each direction unless it is desired to have a larger bandwidth in a given direction (i.e. outbound commuter flow). In addition, leading/lagging

settings in the Timing window should be reviewed for opportunities to improve the bandwidth. The analyst should also consider alternative system cycle lengths to maximize the bandwidth.

### Required Synchro Output Reports

The following reports should be retained for file documentation about the no-build conditions or an alternative.

- **Lanes, Volumes, Timings Report** - This report contains the information that is used as inputs into Synchro. When reviewing a Traffic Impact Study (TIS), it is essential to have this report in order to verify the analysis results. The Synchro default reports are adequate.
- **Queues Report** - This report contains information about estimated queue lengths and blocking. Synchro reports two queue lengths:
  - The 50th percentile queue is the largest queue length for a **typical** cycle;
  - The 95th percentile queue is the maximum back of queue with **95th percentile** traffic volumes. This is the queue length used by ODOT to determine recommended storage lengths.
  - **Note: Synchro calculates queue lengths as the maximum queue after only two cycles.** In conditions where the  $v/c > 0.70$ , Synchro queues may not accurately reflect queuing projections, especially if the intersection/node spacing is less than the estimated queuing. Watch for presence of “m” or “#” codes next to the queuing values. The “m” means that an upstream signal is metering the queue, so queues in this movement are actually shorter than they would be if there was not a constraint elsewhere. The “#” means that the 95th percentile volume is over capacity so queues shown are likely much longer, even up to twice shown. In these cases, the Synchro-based queues are not adequate and SimTraffic simulations are required for intersection queuing. In constrained analyses where the  $v/c \geq 0.90$ , arrival rates become unstable and the estimated queue lengths in Synchro are unreliable and SimTraffic simulation-based queues are required.
- **HCM Signals or Unsignalized Report** - Synchro will report out analysis of both signalized and stop controlled intersections. These follow the methodologies in Chapters 19-21 (Signalized, Two-Way Stop, and All-Way Stop) of the HCM 6<sup>th</sup> Edition.
  - HCM 2010/6<sup>th</sup> Edition Signalized - This report generally follows the same outputs as in the HCM and the Highway Capacity Software (HCS). Some items may be different such as actuated green times which in turn may affect some of the calculations. Note that the report will skip rows with unused or just default calculations. Note that the intersection  $v/c$  ratio is not calculated and will need to be done in a separate process.
  - HCM 2010/6<sup>th</sup> Edition TWSC & AWSC (Unsignalized) - Synchro will analyze two-way and all-way stop controlled intersections following HCM 2010 methodology. HCM 2010 Roundabout - Synchro will analyze single and multi-lane roundabouts using the current HCM 2010 methodology.
  - HCM 2000 Signalized – This report is needed for obtaining the intersection  $v/c$

ratio (not an output with HCM 2010 and later) if it is not calculated separately. Intersections with custom phasing, shared controllers, or certain shared lane configurations may also require that this report is used instead of the HCM 2010/6<sup>th</sup> edition report.

## **Vistro**

Vistro software analyzes and optimizes traffic operations for intersections, corridors, networks, or transportation impact analyses. This software uses Bing maps and intersection templates for network construction. Vistro is part of the PTV Group, which includes Visum and Vissim. Visum files from a windowed travel demand model can be imported into Vistro for detailing and can be kept in Vistro or exported back into Visum. Vistro files can be exported to Vissim for additional detail and microsimulation analysis. Networks with roundabouts, complex intersections/ interchanges or free-flow operations (i.e. freeways) should be started in Vistro and further analyzed in Vissim. Vistro can also accept imports and produce exports from Synchro 7 or newer using Synchro's Universal Traffic Data Format (UTDF) combined \*.csv files. For further guidance refer to [Appendix 8B](#).



*Vistro can also be used as a “front-end” to building Vissim networks (either from a Visum import or natively in Vistro) as its layout and inputs are similar to Synchro. However, this is not required as “from scratch” Vissim network construction is possible and is the preferred starting spot for many familiar or expert Vissim users.*

Vistro is the only software that reports out the HCM 2010 and later critical intersection v/c ratio used in HCM signalized intersection analyses. Vistro offers full signal timing with local (isolated) and network optimization. Vistro allows for creation and easy comparison of multiple alternatives and options at each location in a single file through its scenario management system. The user has the ability to create custom reports including volume diagrams, if desired. Vistro also has a quick built-in Vissim previewer which allows for easy visual checking of network operation.

This section shows ODOT Vistro settings organized by tab. The settings below only cover significant inputs. Parameters that are shown in Vistro in italic text are calculated values and cannot be changed and are also not shown below.

### **Global Settings**

Global settings should be changed when a new file is created. Tailoring the settings to the prevailing (majority) conditions will help reduce the number of changes needed when the scenario networks are constructed or modified. The individual intersection setup will change these values as necessary.

- **Speed (mph)** - Set to the prevailing condition in the network.

- **Pedestrian Crosswalk Width (ft)** – ODOT default width is 10 feet, however, this value is for half crosswalk width for Vissim analysis so the corresponding value should be 5 feet. . This value helps to set the correct detector distance from the stopbar.
- **Default Ideal Saturation Flow Rate, HCM (veh/h)** – Set to 1750 veh/h unless in an MPO area of greater than 200,000 population.
- **Default PHF** – Set to 0.95 (this value will be further modified by intersection).
- **Located in CBD** – Uncheck the box as this will apply additional reduction in the saturation flow rate unless the analysis is actually located in a central business district (downtown).
- **Major Flow Direction** – Set this to follow the orientation of the major facility in the analysis (or the primary/longest facility if there is more than one).
- **(Directional) Signal Group** – Set these to the major signal groups (phases) by direction (Phase 2 & 6 for major streets and Phases 4 & 8 for minor streets). See Figure 10.
- **Coordination Type** – Set to “Time of Day Pattern Isolated” as most signals are not coordinated. Leave the Vistro default as-is if in an adaptive or other coordinated system.
- **Actuation Type** – Change to “Fully Actuated” unless in a CBD.
- **Intersection Lost Time (s)** – Set to prevailing intersection type in the network based on 4 seconds/phase (i.e. 16 seconds for a 4-phase intersection)
- **Minimum Green (s)** – Set to 4 seconds (left turns in Figure 12). Other movements will be modified later on an intersection basis).
- **Amber & All Red (s)** – Set these to match prevailing speed following Figure 12.
- **Vehicle Extension (s)** – Set to 2.5 seconds (for left and side-streets) following Figure 12. Mainline through values will be modified later on an intersection basis.
- **Walk (s)** – ODOT default walk time is 7 seconds.
- **Proportion of CAVs (%)** – ODOT default is 0%. This value should only be modified for longer-range planning analyses. Appendix 6B includes guidance on scenarios where it may be appropriate to consider the potential future presence of CAVs. (Note: This input was added in Vistro 2022 and is not available in earlier versions).

### Intersection Setup Tab

The Intersection Setup tab is the first tab a user will use in setting up individual intersections after the intersections and connecting links have been placed. This initial data input should be entered into the Base Scenario as indicated in the Scenario window. Changes in the base scenario will affect all other scenarios. Changes to an individual scenario other than the base scenario will only affect that scenario.

- **Intersection Number** – The automatically created default is generally acceptable, however, more logical re-numbering may be needed to create in-order groupings along a roadway for ease of viewing the tabular and graphical reports.

- **Control Type**- Set intersection control for signalized, roundabout, all-way stop, or two-way stop control. Set to unknown for two-leg intersections, ramp/connection splits, or transitions from/to a single to multiple roadbeds. The rest of the inputs will change (especially with the roundabout setting) depending on the control type.
  - A large amount of different parameters are available with the roundabout control type that can be used to fully visually describe the overall geometry. These will be also used in Vissim to simulate operations. For HCM analyses, the important parameters are the bypass lane presence and control type and the number of circulating lanes. Most of the geometric parameters are self-explanatory but a few are described here:
    - Approach Half Width – Approach width without any turn bays
    - Flare Length – Half of the distance between the entry lane width at the yield point and the approach half width.
    - Grade Separation – Distance between the entry and exit lanes on the same leg. The default is 0 ft.
    - Splitter Island Length and Width – Both parameters are measured at the edge of the circulating roadway.
- **Lane Configuration**- Use or modify the pre-defined lane templates to match the actual lane configuration for each approach.
- **Number of Lanes in Pocket & Pocket Length** – Pocket (turn bay) lanes and length need to be set so the number of through lanes on a segment is accurate.
- **Crosswalk Width (ft)** – Set this to half of the actual crosswalk width.
- **Channelized checkbox, Control and Radius** – Select if the right turn lane is separated by an island. Indicate the right turn control type: signalized (SC), stop, yield, or free (target lane). Use the default if the actual radius is unknown, otherwise enter the measured (via aerial photo or plan).
- **Right Turn on Red** - (Signalized control type only) - Checking this box will allow right turn on red (RTOR) movement.

## Volumes Tab

Vistro allows for a complete accountability of base volumes as well as additional parameters for the optional TIA analysis. While Vistro has inputs for seasonal and future adjustments, these need to be calculated and documented separately as per Chapter 5 and 6. Complete existing 30HV and future design hour base volumes should be the only volumes entered into Vistro.

- **Base Volume Input (vph)** – enter the existing 30<sup>th</sup> highest hour or future design hour volumes. Volumes from travel demand models need to be post-processed first (important if Visum volumes are imported).
- **Heavy Vehicles Percentage (%)** – Enter the heavy vehicles (FHWA class 4 to 13) for each movement (if known or desired) or by approach.
- **Proportion of CAVs (%)** – ODOT default is 0%. This value should only be modified for longer-range planning analyses. Appendix 6B includes guidance on scenarios where it may be appropriate to consider the potential future presence of CAVs. (Note: This input was added in Vistro 2022 and is not available in earlier versions).
- **Right Turn on Red Volume (vph)** - This is a user-defined volume entry and will require an outside process or calculation to define for HCM analyses. See Section 13.3.2

- **Peak Hour Factor** – Refer to Section 5.8 for guidance on existing and future peak hour factors.
- **Presence of On-Street Parking & Parking Rate** – Check the box if parking is on the right (and/or left if the roadway is one-way) . Indicate approximately the parking turnover rate following the guidance in HCM 6<sup>th</sup> Edition Exhibit 19-16.
- **Local Bus Stopping Rate** – Enter the number of buses that stop and block the lane during the analysis period. Note that this can be conservatively defaulted to the total numbers of buses based on frequency and number of routes or a lesser number can be used based on actual stopping observations. Enter zero if the stop is in a pullout.
- **Pedestrian and Bicycle Volume** – Enter the number of pedestrians using the crosswalk or the number of bicycles crossing the selected approach leg. Note that this is different from the number of conflicting pedestrians.

The TIA Demand section on the Volumes tab has a number of additional volume inputs.

1. **In-Process Volume** – These are “pipeline” or in-process/approved development trips that are not occurring yet.
2. **Pass-By & Diverted trips** – These are trips already on the roadway system being diverted at the access location or from adjacent roadways. See Chapter 6 for more information.
3. **Existing Site Adjustment Volume** – These are trips are removed or added to account for changes in land use for assumed base volume trips.

### Traffic Control Tab

The detailed intersection traffic control information is entered in this tab. Settings will change depending on the control type selected on the setup tab. There are no specific settings for all-way stop control beyond the general settings.

All control types

1. **Analyze Intersection?** – This box must be checked to have the intersection included in the analysis and the reports.
2. **Analysis Period** – Use 15 min if peak hour factors are being used.

Two-Way Stop Control

1. **Priority Scheme** – Sets whether an approach is free or stop-controlled. Note that unusual configurations such as three-way stops cannot be coded in Vistro.
2. **Flared Lane & Storage Area** – Check the box if the stopped approach is flared for right-turning vehicles. Add the number of vehicles that can store in the flare (typically one or two). This option is only available for approaches without right-turn lanes.
3. **Two-stage Gap Acceptance & Storage** – Check this box if an intersection operates in two stages. For a four-way intersection, divided roadbeds are necessary. Add the number of vehicles that can safety store in the median. If there is a two-way left turn lane or a left turn acceleration lane instead, two-stage operation can only occur at a three-way “T” intersection. Only code one vehicle in this case.



## Roundabouts

1. **Number of Conflicting Circulating Lanes** – Set this to the number of circulating lanes at the approach entry (one or two for HCM-compatible analysis).
2. **Overwrite Critical Headway & Follow-up time** – if a specific calibrated HCM roundabout capacity equation is available (i.e. Bend single-lane roundabouts) then check the boxes and insert the appropriate parameters.

## Signalized

1. **Priority Scheme** – Set this to be consistent with the major and minor intersection approaches.
2. **Signal Coordination Group** – Coordinated signals are required to be part of a “signal coordination group.” Different roadways should have different coordination groups. These are setup under the “Signal Control” menu. Required for network optimization along with “coordinated” designation and setup of weighted routes.
3. **Cycle length (s)** – Set this using timing from signal timing sheets, the 90s default when using the “default signalization” setup (signal icon in top right corner), or 60s for two-phase, 90s for three-phase or 120s for four-phase signals.
4. **Coordination type** – Set this to “Coordinated” for signals requiring network optimization of coordinated systems or set to Isolated in other cases.
5. **Actuation type** – Most likely “Fully actuated” for most modern installations or “Fixed time” for CBD’s.
6. **Offset Reference** – Set to “LeadGreen” (leading start of green).
7. **Lost Time (s)** Set to  $4s * \text{number of signal groups (phases)}$
8. **Control type** – Set turn type (protected, permitted, etc) by right-clicking.
9. **Minimum Green (s)** – Use Figure 12 by movement type.
10. **Maximum Green (s)** – Maximum green times from signal timing sheets are entered here. This value can also be automatically generated with local optimizing of the default signalization.
11. **Amber & All red (s)** – Use Figure 11 by posted speed.
12. **Vehicle Extension (s)** – Use Figure 12 by movement type.
13. **Walk (s)** – Default is 7 seconds (should be setup already in the global settings); change if different on timing sheets.
14. **Pedestrian Clearance (s)** – Set to  $3.5 \text{ ft/s} * \text{curb-to-curb distance}$ .
15. **Recall Checkboxes** – Set following Synchro guidance. This setting is only used in Vissim.
16. **Detector Presence Checkbox, Location, and Length** – Set following Synchro guidance for Detector 1 (Figure 13). This setting is only used in Vissim.
17. **Sequence Editor** – Will be setup automatically if using default signalization process for normal two to four phase signals with dual rings. Pedestrian timing will also be shown if active. Edit phase sequence/barriers to match desired phasing as necessary.

Signals can also be locally optimized on this tab individually or all intersections at once or either splits only or splits and cycle length if the coordination type is not set to free running. Further optimization with the full network interaction requires coordinated signals and routes. The Synchro discussion on optimization also applies to Vistro.

1. **Splits only (Pie icon on top right)** – Choose (movement) v/c balancing for most applications.
2. **Cycle & Splits (Stopwatch icon on top right)** – Choose v/c balancing, cycle bounds between 60-and 130 seconds with a 5 second step.
3. All intersections in the network can be optimized locally by choosing Local Optimization under the Signal Control menu.

### **Trip Generation, Distribution, and Assignment Tabs**

Vistro has capabilities to do a (Traffic Impact Analysis) TIA-level cumulative analysis which may be necessary in some fast growing areas or where a few specific developments are being added in the future in a study area and it is wished to model them explicitly. However, these kind of analyses can become complex very quickly with large numbers of zones and paths.

Alternatively, the generation, distribution and assignment can be done in Excel and following APM Chapter 6 and be incorporated within the design hour volumes. Any location with a travel demand model shall use the model to determine trip distribution and ultimately assignment through post-processing techniques instead of a manual Excel or Vistro process. Regardless of methods and tools used, all assumptions and supporting calculations should be documented separately for the purpose of streamlining review.

Zones are placed where specific developments or sites are desired. Gates represent external locations where volumes flow to and from the zones. Paths are used to connect zones with gates. The Trip Generation tab is all user-defined data and requires external information such as the ITE Trip Generation manual to fill out land use descriptions, codes, rates, and in/out splits. Vistro will compute the total numbers of trips generated for each use. The Trip Distribution tab requires the user to manually indicate the percentage share to and from each zone-gate combination. The trip distribution needs to be based from existing count patterns if uses are similar, from similar developments, or from a travel demand model. The initial creation of shortest paths between zones and gates is best automatically generated using the Trip Assignment tab's "Add missing paths" function. Auto-generated paths may need to be edited if the network is complex. Computed site volumes are shown on the TIA Demand section of the Volume tab.

### **Network Optimization Tab**

A more detailed optimization can be performed in Vistro to fine-tune signal timing along a roadway. This will be necessary for maximizing bandwidths and progression and should be done if simulation is ultimately desired. A successful network optimization requires that:

1. Each signalized intersection needs to belong to a single signal coordination group. These groups (either one or more) can be created in linear fashion along a single route, or can be in parts of routes where closely spaced intersections exist, or can be part of a network grid.

2. The coordination type needs to be set to “Time of Day Pattern Coordinated.”
3. The coordination cycle length needs to be same or in multiples (i.e. 60 & 120 seconds) if half-cycles are permissible.
4. Network optimization routes for each signal coordination group need to be created and optional weighting (priority if there are multiple routes defined) applied. These routes need to go through at least two signalized intersections, can go around corners, and can be defined for one direction or both directions.

The Genetic method is the most robust method and is preferred. The default iteration settings for the Genetic method of network optimization are adequate as-is. Splits and cycles can also be optimized with the network if they were not done locally. Otherwise, select the offset optimization only with a one second precision level. The Lead/lag optimization checkbox should also be checked as sometimes optimization of the left turn sequence can lead to better outcomes.

The results of a successful network optimization are shown graphically in this tab with a time-space diagram. Either total flows or arterial bands can be shown. Both directions can be shown if the network optimization route is defined in both directions. The green splits can be dragged in either direction for manual adjustments of the offsets.

### **Mitigation Tab**

The Mitigation tab allows for the creation and testing of multiple scenarios for a particular intersection. It is best to create a “mitigated” scenario so the base or alternative scenario is not accidentally modified. The initial window will be the “unmitigated summary” which shows the basic intersection configuration, settings, capacity analysis, and analysis results. Adding a new mitigation scenario will create a copy which should be descriptively renamed (i.e. Option 1: AWS, Option 2: Roundabout, etc). The new mitigation scenario can then be changed as necessary including locally optimizing (if signalized).

### **Required Tabular & Optional Graphical Vistro Reports**

Vistro allows for the creation of fully customizable page layouts. Items such as employer name, logos, analyst name, project title, file names, etc. can be placed as desired. Map-based figures can be printed with or without the street network or names. Mitigation scenarios will need to be individually printed from the Mitigation tab. At a minimum, the following tabular reports are needed:

1. **Intersection Analysis Summary** – Summary of v/c, LOS, delay for each analyzed intersection.
2. **Intersection Level of Service** – Intersection-level reporting including inputs, capacity analysis calculations, v/c, LOS and queuing analysis results. Signal phasing sequence and splits are also shown.

Graphical reports are not required but these may be useful in memorandums and reports as they will save time versus creating separate graphical figures:

3. **Study Intersections** – Map showing location by intersection number. If there are many closely spaced intersections the index numbers may overlap, so in those cases, a separate figure needs to be created and the Vistro one not used.
4. **Lane Configuration and Traffic Control** – Indexed map showing intersection “bubbles” with lane configurations and traffic control.
5. **Base Volume** – Indexed map showing intersection “bubbles” with entered 30HV/design hour volumes.
6. **Traffic Conditions** – Indexed map showing intersection “bubbles” with overall signalized or worst movement unsignalized LOS, v/c and delay results.

## **SIDRA**

SIDRA analyzes intersections and networks of several types. Several analysis methodologies are available, including HCM 6 and HCM 2010. With SIDRA, vehicles can be restricted on roadways or by lane by vehicle type (e.g., bridge weight limit, truck lanes, etc.) and/or allow integration with most on-street modes. With its network and separate lane analysis/vehicle path capabilities (essentially a mesoscopic analysis), it can analyze urban facilities for the full capacity, delay and queuing impacts in the system without the need for micro-simulation. SIDRA fully accounts for queuing spillbacks on the system and will meter flow into adjacent intersections and reduce corresponding capacities. These capacity reductions are incorporated into all of the results including, v/c ratio, LOS, delay, queuing, etc.

SIDRA has been commonly used to just analyze roundabouts, but it is also able to analyze any non-standard intersection configurations that cannot be handled in standard HCM methodologies. The program uses a variety of HCM model extensions, producing HCM performance measures and analyzing intersection elements that standard HCM 6<sup>th</sup> Edition analysis cannot. These include intersections that are three-way stop-controlled, have more than four approaches or non-standard stop sign placement where the mainline turns onto another leg.

SIDRA analyzes stop, signal, or roundabout-controlled ramp terminals at diamond-style interchanges, as well as complex interchanges (single-point and diverging diamonds). SIDRA can also analyze signalized pedestrian crossings and ramp meters on roadway segments. SIDRA may also be used to supplement existing Synchro or Vistro analyses to cover non-HCM intersection types as mentioned previously, or conditions such as bus-only, light-rail or truck lanes that only could be previously analyzed in a Vissim micro-simulation.

### **SIDRA Overview**

In SIDRA most work will be done in the Site tab in the main menu, used for adding sites (i.e. intersections), adding specific input data, and obtaining site output reports. The Network tab enables the linking of sites to allow for coordinated signal timing, network optimization, analysis and results. The Route tab enables designation of routes within the network needed for optimized signal timing and performance measures. The Tools tab allows for comparisons between different networks or project files and creation of custom reports. Output reports, global settings, and displays can be customized under the Settings tab.

Analysis results are created once sites are processed (shown with a gear icon). The Layout icon shows the layout of the intersection created or where it currently is in creation. It is helpful to keep the site layout active while the intersection is being coded to see if the changes are what was wanted. It is important to work in window order (top to bottom) in the “Site Input” section as some windows determine what is shown in following ones. Within each input window, selecting “Apply” will record input on each pop-up window and also immediately update any layout window. Use of “Quick Input” allows for settings across legs, intersections, or all sites to speed up data entry.

## Processing

Processing is required in order to obtain analysis results and reports. Processing can be done on individual sites, across all sites, or on a network basis. Note that network and site processing are different. Site processing is necessary to produce individual isolated intersection analysis results and reports. Network processing is necessary to optimize signal systems, to obtain network site analysis results and performance measures. Input changes will trigger the need to re-process. It is not necessary to process all sites under a network if just network results are desired.

The Diagnostics report will contain any errors, warnings, and notices such as overcapacity conditions, unstable results, the need for more iterations etc., so it is important to review this after each time processing is done. Some of these warnings are addressable and could be minimized or eliminated (e.g. midblock lane changes or flows) and some may not be as they are just reflecting conditions (e.g. capacity constraints and adjustments). Ideally, the site or network model variability is as small as possible so that the changes in v/c or queue do not change any more than 1% in the last three iterations. The default 10 iterations may need to be increased for congested or unstable networks up to the maximum 30. Adjustments and corrections may be needed to bring the instability down to the threshold level.

## Workflow Outline

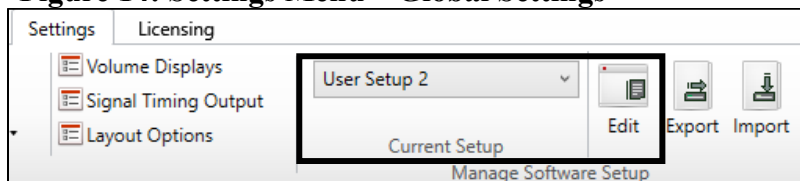
The overall workflow in SIDRA that should be followed to produce the best results is:

1. Adjust global settings
2. Choose the appropriate site template for each intersection
3. Enter site data
4. Configure network by linking up sites
5. Add routes across desired sites
6. Add network signal timing
7. Process network for initial results
8. Fix errors and minimize warnings, re-process as necessary
9. Calibrate settings to existing conditions (if applicable)
10. Set-up and produce output reports and compute intersection v/c ratios

## Global Settings

Global Settings in SIDRA are through the Settings Tab, by selecting “User Setup 2” in the drop-down box and selecting the Edit button in the Manage Software Setup as shown in Figure 14. This will set up basic US settings including English units, right hand drive and HCM models. Global settings should be changed when a new file is created. Customizing settings to match study area conditions will help reduce changes needed for each site. This custom setup can also allow for a closer calibration to field conditions. The individual site setup will change these values as necessary.

**Figure 14: Settings Menu – Global Settings**



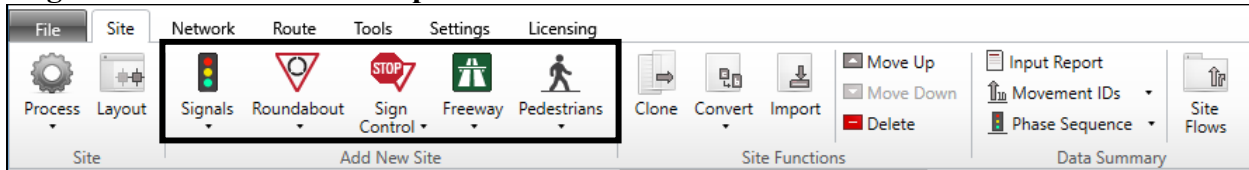
There are a number of tabs in the User Setup window and the values below should be changed at a minimum:

- **General Options Tab**
  - Site Level of Service Method: Delay & v/c (HCM 6)
  - Performance Measure: Degree of Saturation
  - Percentile Queue: 95%
- **Roundabout Models Tab**
  - Roundabout Capacity Model: US HCM 6
  - Roundabout LOS Method: same as Sign Control
- **Pedestrians Tab**
  - Walking Speed (Average): 3.5 ft/sec
- **Lanes Tab**
  - Basic Saturation Flow: 1750 pcphpl if outside of Portland, Eugene or Salem urbanized areas, otherwise 1900 pcphpl
- **Volumes Tab**
  - Vehicle/Pedestrians Volume Growth Rates: Change to match average study area growth rate (only used in Site Demand and Sensitivity analysis)
- **Network-1 Tab**
  - Network Level of Service Method: HCM 6 Speed Efficiency
  - Percentile Queue: 95%
  - Network Analysis Settings; Maximum Number of Iterations:30
- **Route Tab**
  - Route Level of Service Method: HCM 6 Speed Efficiency

## Site Input

The following sections are ordered by each pop-up window under the Site input in the left viewing pane. Each site will need a default lane configuration template chosen before data can be input. On the Site tab there is a section of icons in the Add New Site ribbon section. These icons have pull down menus to select a site template as shown on Figure 15.

**Figure 15: Site Menu & Template Selection**



Use the “Select Template” option to choose a template that is reasonably close to the actual site to minimize edits later. Rename the site (right-click for menu) to the actual intersection name. Sites can be duplicated (cloned) or converted to other types (e.g. two-way stop to all-way stop) as needed using the icons in the top ribbon or in the right-click site menu.

## Intersection Window

The Intersection Window will be first window that is used after all sites have been placed but before they are connected in a network.

- **Site Name & ID** – The site should be named to reflect intersection location. The Site ID may need to be revised to reflect a more logical numbering along a route for ease of viewing or reporting.
- **Approach Geometry** – Add/remove intersection legs, roadway names, and leg direction using the Approach Editor. One/two-way selection must be done before an intersection is placed in a network as changes are not allowed to the leg geometry of a site already in a network. If it is desired to change a street from two-way to one-way after a network is configured, the site must be deleted from the network, changed, then re-added. Volumes (due to a directional change) and other values may also need to be updated.



*For creation of 3-way stop controlled intersections, use the 2-way template instead of the 4-way. The 2-way template can be modified in the Priorities window to reflect the 3-way stop conditions, but the 4-way stop does not have a Priorities window available.*

- **Approach Distance**- This is the segment distance between intersections. This can be left as default for isolated intersections or as an entry distance into a network, but must be specified for internal network connections based on actual conditions or alternative drawings.



- **Extra Bunching** – This accounts for platoon effects from nearby signals. Set this percentage following Figure 16. The default program setting will follow values specified in global settings.

**Figure 16: Extra Bunching**

Distance to signal (ft)	0 - 350	350 - 700	700 - 1300	1300 - 2000	2000 - 2600	2600 +
Extra Bunching %	25%	20%	15%	10%	5%	0%

- **Approach Control (stop-controlled only)** – Set according to conditions: major road (not stopped) or stop/yield.
- **Area Type Factor (signalized only)** – Leave as default unless in a central business district, then set to 0.9.

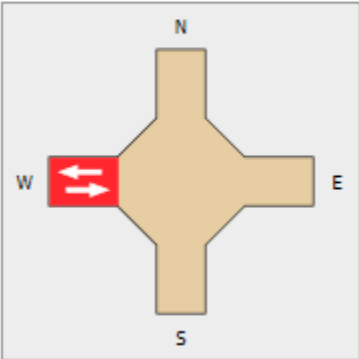
### Movement Definitions Window

- **Movement Classes Tab-** Vehicle classes to be used in the analysis are selected: Light (LV) and Heavy (HV) vehicles are defaulted and cannot be removed. At a minimum, the Large Trucks (TR) category should be added as the length of these is consistent with the WB-67 design truck length and with the values assumed in micro-simulation for tractor-trailer combinations. Each of these classes have different operational impacts for queue space, turning, gap acceptance, etc. If there are a significant amount of buses or bicycles in the network then these can also be added. SIDRA also has a user classification for streetcars or light-rail which can be added to accommodate this in-roadway use. Each added class will require lane disciplines, volumes, and other information in each following input window, otherwise processing errors will result. SIDRA vehicle classes align with the FHWA vehicle classes as:
  - Light Vehicles = Motorcycles, cars, SUV’s, light trucks; Classes 1-3
  - Buses= Buses; Class 4
  - Heavy Vehicles = Single unit and combination tractor/trailer trucks, buses; Classes 4-13 (Note overlap with buses and large truck categories, so adjustments to the vehicle percentages in the Volume Window are required to avoid over-estimation of impacts.)
  - Large Trucks = Combination tractor/trailers; Classes 7-13
- **Movements Tab** – This tab is used to remove (i.e. only a right turn allowed) or add turn movements (i.e. U-turns) on approaches for the initial intersection layout as shown in Figure 17. Note that removed turns will not be selectable in following windows and will not be applied to any movement classes. If in later steps errors occur regarding vehicle classes or movements or if the intersection is still not configuring properly, make sure to review this tab to check if the appropriate movements are allowed (or not).

**Figure 17: Example Approach Movement Restriction on West Approach**





Movement Classes
Origin - Destination Movements

**Approach Selector**



Pine St

**Origin - Destination Movements**

From West to Exit:	W	N	E	S
	 U	 L2	 T1	 R2
<b>Movement Exists</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>OD Movement ID</b>				12

### Lane Geometry Window




- **Lane Configuration Tab:**

- **Lane Configuration Data** - This allows for creation or elimination of approach lanes, exit lanes, and islands in a pictorial way so that changes are visualized. Click on each lane or island to select changes. Lane configuration is specified as full length or turn lanes (short lanes) and lane type as normal or bypass. Lane control is specified as yield, stop, signal or continuous/free-flow depending on site template selection. A strip island is a barrier for intersections, but becomes a splitter island for roundabouts. Corner islands can be configured using high angle (typically stop/yield/signal control) or low-angle slip lanes (typically a free-flow/add-lane style). Other lane data includes width and approach grade. Lane lengths for approach or exit lanes (intersection spacing) need to match up with actual conditions as much as possible and also be consistent with the approach distance specified in the Intersection Window.
- **Short Lane Data** – Specify storage length from stop bar to entry point from field measurements (this will include some of the taper) and lane that queue will overflow into if the storage length is insufficient.

- **Lane Disciplines Tab:**

- **Lane Disciplines** - For each applicable movement class, indicate which approach lanes and turn movements are used or not. For example, this will allow creation of bus or truck-only lanes or a U-turn that is only used by light vehicles as shown in Figure 18. This will control input availability in following windows. Make sure to code for all approaches especially if multiple movement classes are used and to re-check this after lane geometry changes are done to avoid processing errors.

**Figure 18: Lane Discipline Example – Bus Right Turn Only**

Lane Disciplines			
Full-Length Lane			
From South to Exit:	W	N	E
	 L2 ▼	 T1 ▼	 R2 ▼
Light Vehicles (LV) >	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Heavy Vehicles (HV) >	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Buses (B) >	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

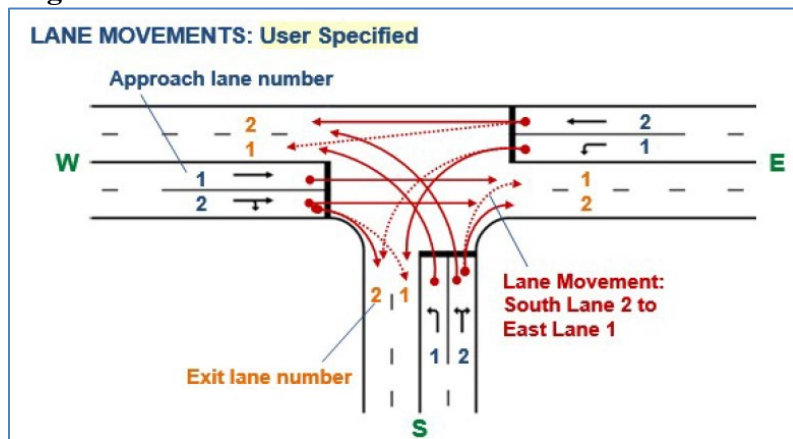
- **Free Queue Distance** - For shared lanes (most likely through-right lanes) at signalized intersections only, code the available storage length that turning vehicles have before blocking the through movement and the available storage length that through vehicles have before blocking the turn movement. This is the distance in a channelized turn lane or in a right-turn flare. Note that the distance can be different between the two values. For example, a right turn flare could store two turning vehicles but the access to the flare could be blocked by just one through vehicle.
- **Lane Data Tab:**
  - **Basic Saturation Flow** – Enter saturation flow rate if different from global settings. See Appendix 6B for saturation flow rates when CAVs are being considered.
  - **Lane Utilization Ratio** – The value is automatically calculated but can be overridden. This is an important setting for a proper calibration. Lane utilization should always be checked for dual turn lanes or if a through lane is dropped just beyond an intersection. Lane utilization must be balanced out on all lanes and approaches if overriding the default. Entering 40 percent for one lane does not automatically cause the adjacent lane to have a lane utilization of 60 percent. All lanes should add up to 100 percent.
  - **Saturation Speed** - Speed of the through movements under saturation flow conditions. Leave as default, unless field speed values are known. While this factor is available for all intersection types, it is generally only applied to signalized intersections. Exit negotiation speed is used for unsignalized intersections and roundabouts as the saturation speed.
  - **Capacity Adjustment (%)** – Input capacity change beyond program. Leave as default unless calibration requires it.
  - **Buses Stopping (signalized only)** – if downstream or upstream bus stops exist on an approach within 250’ of the intersection, enter the total number of buses per hour that use that stop.
  - **Parking Maneuvers (signalized only)** – If parking exists on an approach within 250’ of the intersection, enter the total amount of parking maneuvers (either entering or leaving the spot) that occur per hour. Leave as default “Program” if no parking exists.

- **Dominant Lane (roundabout only)** – This is for multiple lane approaches only. Leave as default unless a dominant lane (i.e. highest lane utilization) is noted in existing field operations.

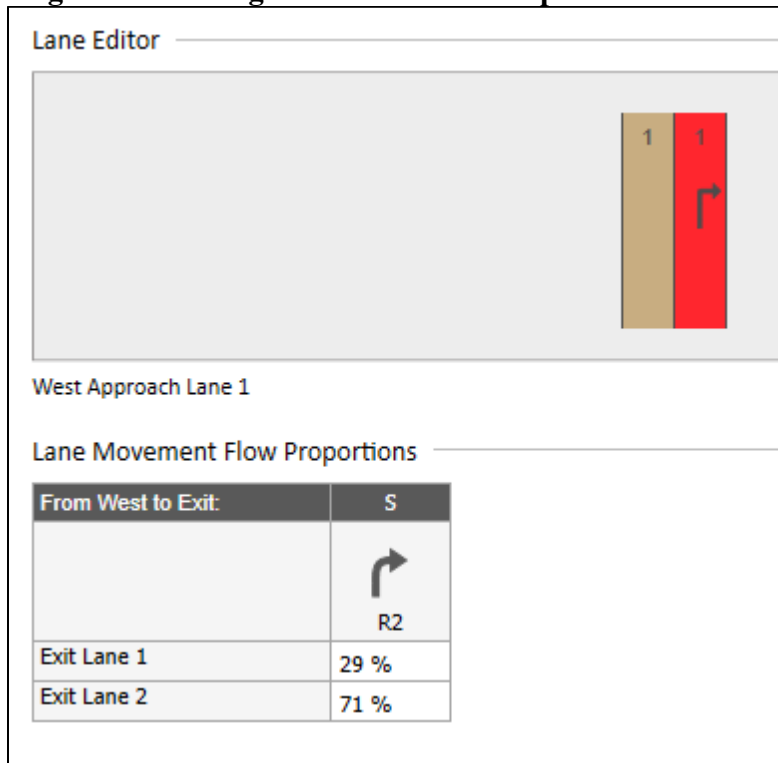
## Lane Movements Window

- **Flow Proportions Tab**
  - **Flow proportions** (by applicable movement class) - This is used for network analysis. This allows the assignment of lane movements from the origin (approach) lane(s) on one leg to the destination (exit) lane(s) on another leg. Movements can be forced to stay in a single exit lane or go into multiple exit lanes depending on lane configuration or actual operating conditions as seen in Figure 19. Figure 20 shows modified lane allocations (default was 100% into Exit Lane 2) from a single right lane turning into two exit lanes. Specific movement classes can be assigned to specific paths. Movements may need to be adjusted as needed to minimize lane change volumes shown in the processing diagnostic warnings.

**Figure 19: Lane Movements**



**Figure 20: Setting Exit Lane Flow Proportions**



- **Blockage Calibration Tab**

- Lane blockage Calibration Factor - Used to adjust the effect of the downstream lane blockage (queue spillback) on the upstream lane capacity. The parameter is specified for each lane movement. The values below 1.0 will decrease the effect of lane blockage and over 1.0 will increase the effect of lane blockage.

**Roundabouts Window (only visible if roundabout site selected)**

- **Options Tab**

- No changes are needed unless it is desired to override the global roundabout model settings. ODOT requires the HCM 6<sup>th</sup> edition analysis for a roundabout and may request additional analysis, such as SIDRA standard or HCM 6<sup>th</sup> Edition w/ SIDRA (unbalanced flow).

- **Roundabout Data Tab**

- Only data entry necessary is the number of circulating lanes (1 or 2 with HCM).
- Roadway width, island diameters, and entry angle/radius leave as default unless using the SIDRA standard model.
- **Raindrop design checkbox** – This is a layout picture parameter used for interchanges. Any prohibited turning movements also need to be removed under

the Movement Definitions window when this option is toggled on and added back when toggled off as SIDRA will not give errors or automatically change.

- **Circulating transition line** – A spiral “painted” line originates from the island and pushes traffic into the outer circulatory lane (turbo roundabout). This is only for layout picture purposes.
- **Number of downstream circulating lanes** – Leave as default, unless layout picture does not show proper number of lanes.

- **HCM 6 Data Tab**

- **Approach Parameter A & B** – Leave as default unless an engineering study has been done specifying new values. For City of Bend, single lane roundabouts only – change Parameter A (intercept) to 1333 and Parameter B (coefficient) to 0.0008. See Appendix 6B for the  $f_A$  and  $f_B$  CAV adjustment factors. These can be multiplied by the A & B parameters to properly reflect the CAV effects.
- **Roundabout Model Calibration Factor** – This will change the roundabout headway and critical gap values. Leave as the 1.0 default unless required for calibration. Changes can have significant effects, so any adjustments should be only be as required for calibration. Increasing the value greater than the 1.0 default will increase required critical gap times which will cause capacity to decrease.
- **Entry to Circulating Flow Ratio (Two-lane roundabouts only)** – This is a calibration parameter that allows for the adjustment of follow-up headways in order to avoid underestimating capacities flow rates at low circulating flows (~ 600 pcph) for low circulating flow rates by choosing a desired level (High, Medium, Low, None) based on observed conditions with “High” giving the highest capacity.

## Pedestrians Window

This window applies to coding pedestrian movements at intersections as well as signalized and unsignalized pedestrian mid-block crossings using the Pedestrian site templates.

- **Pedestrian Movements Tab**
  - **Main Crossing** – None, full or staged. Strip/slip/splitter islands must be coded to use staged option.
  - **Volume Data settings** – Leave as default. Peak flow factor (PHF) can be changed if in a high pedestrian volume location.
  - **Volume Data** – Total two-way number of pedestrians crossing approach. Leave other factors as default values.
- **Pedestrian Movement Data Tab**
  - **Crossing Distance** – Leave as default unless desired to change. Default distance includes lane widths, island width, plus 3’ distance to curb edge (6’ total) for non-staged crossings. Staged crossings use lane width plus 3’ distance to curb for each stage.
  - **Opposing Pedestrian Factor** – Leave as default (can increase to multiply effective flow rate for vehicles yielding to pedestrians)
  - **Walking Speed** – 3.5 ft/s
- **Pedestrian Timing Tab (Signals only)** –
  - **Minimum walk time** – 7 s (or by timing sheet)
  - **Crossing Speed** - Change crossing speed to 3.5 ft/s.

**Minimum Clearance time** – From timing sheet or calculate time as total curb-to-curb width / 3.5 ft/s.



*SIDRA allows the user to use optional vehicle classes alongside light and heavy vehicles. SIDRA’s heavy vehicle class assumes fixed percentages from all truck classifications, which can lead to an over-estimation of impacts for optional vehicle classes. The vehicle volumes for those optional classes will need to be reduced to account for this. Example 12-13A-1 illustrates the adjustment process.*

## Volumes Window

Volumes, volume data settings, and volume factors can be imported from other sites in the same or different project files if desired.

- **Vehicle Volumes Tab**
  - **Volume Data Settings for Site** – Leave unit time for volumes (60 min) and peak flow period (15 min) as default. The volume data method is best changed to “Total & %” where total vehicles and heavy/large truck percentages are added. If the analysis is in a high truck area and explicit truck volumes are known, then select the “Total & Veh” method. Note that “light volumes are computed

automatically for both cases unless the “Separate” method is chosen which requires explicit volumes for all movement classes.

- **Movement Volumes per Approach** – Enter balanced hourly volumes (30th HV, average weekday, etc.) with vehicles classes in volumes or percent. The availability of vehicle class entry is based on lane disciplines chosen in the Lane Geometry Window. Light vehicle (FHWA Classes 1-3) and heavy vehicle (FHWA classes 4-13) classes are always included in the same window. It is recommended that optional classes only be used as needed. Two common optional classes that can be used are buses (FHWA class 4) and large trucks (FHWA classes 7-13). It should be noted that both optional classes overlap slightly with the standard heavy vehicle class that is provided by SIDRA, as such the heavy vehicles input will only represent a portion of the volumes or percentages if either of the optional classes is used. As SIDRA’s heavy vehicle class assumes fixed percentages from all truck classes, the inclusion of optional vehicle classes can lead to the over-estimation of their impacts. An adjustment must be made to account for this:
  - If the bus optional class is used, then the volume or percentage used for the bus values needs to be reduced by 15%.
  - If the large truck optional class is used, then the volume or percentage used for the large truck values needs to be reduced by 19%.

---

#### **Example 12-13A-1: Large Truck Optional Class Adjustment**

---

For a project, a full 13-class vehicle classification count was obtained. The count showed that large trucks (Classes 7-13) accounted for 5% of the count while heavy vehicles (Classes 4-6) accounted for 10% of the count.

The large truck percentage needs to be adjusted when using it with the default heavy vehicle percentage as large trucks make up 19% of the heavy vehicle classification in SIDRA.

**Total large truck percentage from counts** = 19% large truck assumption as a fraction of the heavy vehicle percentage + reduced large truck percentage

In this case, 19% of 10% is roughly 2% as SIDRA only accepts integer percentage values. That means that the reduced large truck percentage = 5% - 2% = 3% .

While using the optional heavy truck classification the adjusted large truck percentage would be entered into SIDRA as 3%.

- 
- **Peak Flow Factor** – Equals the PHF with default 60 minute analysis period. Enter appropriate intersection PHF following APM Chapter 5 guidance. Use the “Quick Input” Site setting to add the PHF to all movements on all legs.

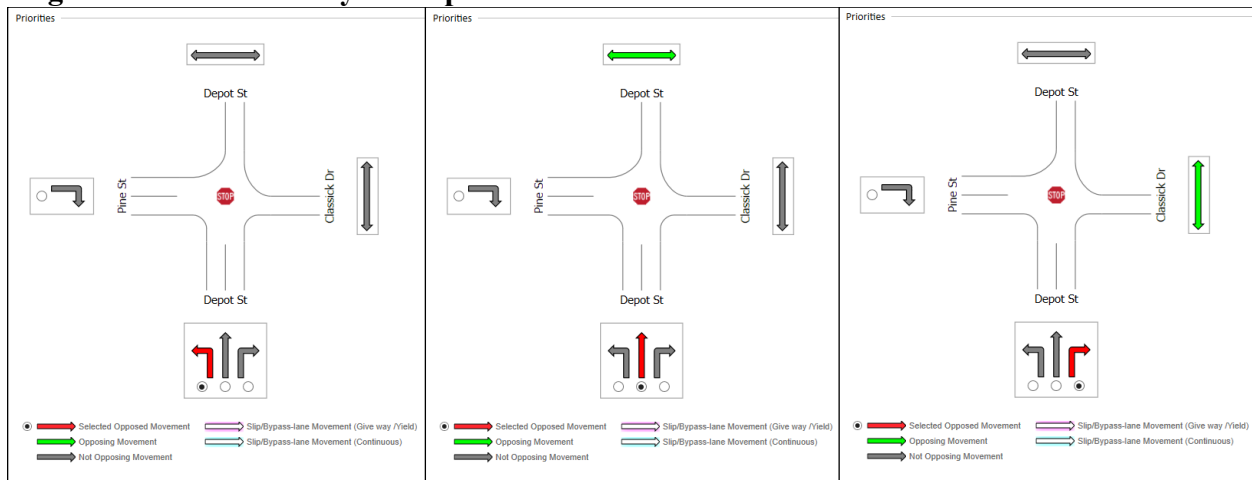


- **Flow scale** – Used as a factor to increase volumes for sensitivity testing only
- **Growth rate** – Used for sensitivity testing only, should be consistent with assumed growth rate in the analysis.

**Priorities Window (Unsignalized & signalized intersections only)**

SIDRA identifies opposed turns automatically for signals and sign-controlled intersections by the data in the Priorities window. The Priorities window is used when pedestrians at a signal or two-way stop intersection are to be opposing movements for vehicle movements. If approach control is changed in the Intersection or Lane Geometry window, then each opposing movement should be checked in turn in the Priorities window to ensure the correct opposing movements are identified. Figure 21 shows the priorities being stepped through on the south approach of this non-standard intersection. The left turn has no opposing vehicular or pedestrian movements (this is a free movement and there are no crosswalks on the west and south approaches), the through movement is opposed by the north crosswalk, and the right turn is opposed by the east crosswalk.

**Figure 21: Turn Priority Example**



Priorities should also be checked for non-standard intersections (i.e. right turn permitted without stopping, free movements, etc.) or custom timing schemes. Priorities do not always need to be changed, but each movement should be checked and any changes documented.

## Gap Acceptance Window

Parameters in this window control yielding behavior to the major unopposed movements. Default values in this window may be acceptable. Modifications, if necessary, only need to be done for calibration.

## Gap Acceptance Tab

- **Critical gap** – The minimum time between successive vehicles in opposing (major) traffic acceptable for entry by opposed (minor) vehicles.
- **Follow-up headway** – The average headway between successive opposed (minor) stream vehicles entering a gap available in the opposing (major) traffic stream
- **Minimum departures (unsignalized only)** - Rate per minute representing minimum capacity for opposed turns
- **End Departures (signalized only)** – Maximum number of “sneakers” that can depart during the yellow phase.
- **Exiting flow effect** – This occurs when drivers on the minor approach are not able to determine whether a vehicle will exit the major roadway or continue in front of the minor road approach. The percentage of exiting traffic flow to be added to the opposing flow rate for an entry movement at a roundabout or minor road movement at a two-way stopped controlled intersection
- **Percent opposed by nearest lane only** - The percentage of the minor movement flow rate yielding to the nearest lane. This parameter is required for turbo (spiral) roundabouts.
- **Opposing pedestrians** – See Pedestrian Window.

**Two-Way Sign Control Tab** – Leave as default unless need to change for calibration.

## Vehicle Movement Data Window

- **Path Data Tab**
  - **Exit & Approach Cruise Speeds** – Set to posted speed limit or 85<sup>th</sup> percentile speed (if available)
  - **Negotiation Speeds** – Set to 9 mph for right turns, 15 mph for left turns, and 20 mph for roundabout entry. Skewed higher-speed approaches should use higher speeds depending on alignment or use default (program calculation). Can set slower speeds for large trucks/heavy vehicles if desired/known.
  - **Negotiation Distance/Radius** – Use default (program calculation)
  - **Downstream Distance** - Use default (program calculation)

- **Calibration Tab (Specific Movement Classes only)**
  - **Queue Space** - This parameter underlies most of the capacity, saturation flow, queuing, and performance calculations. This is the distance between the front ends of two successive vehicles in the queue and is specified by movement class and turn movement and is a function of vehicle length (vehicle length + gap between vehicles). If vehicle length defaults change then the queue space variable should also change. The defaults given are generally sufficient but adjustment may be needed based on the local project area vehicle fleet and overall driver behavior.
  - **Vehicle Length** – Use defaults for each movement class. Changes should be consistent with SimTraffic assumed vehicle lengths. Queue space (above) needs to be updated with any length changes.
  - **Turning vehicle factor** – Used to calculate the saturation flow for turning movement at signalized intersections. Leave as default (fixed factors).
  - **Gap acceptance factor** – Adjusts critical gap and follow-up headway parameters of a movement. Use for calibration adjustments if direct critical gap and follow-up times are not known.
  - **Opposing vehicle factor** – Represents the passenger car equivalent of a movement class in the opposing traffic stream. May need to adjust this if there are large numbers of large vehicles.
  
- **Signals Tab**
  - **Signal Coordination** – This will set coordination for site analysis or a lesser – detailed specification for networks. The default setting (Program) is for actuated-isolated or fixed time controllers or if it is planned to use network program or user-specified coordinated signal offset calculations for progression such as from a timing sheet. Select the Arrival type option for actuated-coordinated signals. Use arrival types (4-6) for coordinated movements, (3) for random arrivals and (1-2) for poor/unfavorable timing conditions. These are equivalent to the HCM definitions (See HCM 6 Exhibit 18-8).
  - **Turn on Red** – Use to indicate if right-turn-on red is present (RTOR volumes are calculated internally).
  - **Non-Actuated** – Used to indicate intersection legs that are not detected for semi-actuated operation.
  - **Start Loss & End Gain (lost time)** – Use default values unless analyzing large or complex intersections or interchanges, then use 3 seconds for each.
  - **Minimum & Maximum Green** – Use values from signal timing sheet. Alternatively, use default ODOT settings from Figure 12 for minimum green and leave default program settings for the maximum green. If Maximum green times are explicitly input, then these must be consistent with maximum green times used in the Phasing and Timing Window (the program does not flag errors).
  - **Phase Actuation (only for program-calculated cycle lengths and timing)** – Includes effect of phase skipping for actuated signals.

- **Early Cut-off & Late Start** – Either terminates a phase early for clearing out traffic between closely spaced intersections such as in a common-control group (shared controller) at an interchange or delays a phase start to emulate a leading pedestrian phase.

## Phasing & Timing Window

- **Sequences Tab**

- **Signal Analysis Method** – Select either fixed time or actuated depending on the actual signal timing. The intersection is assumed to be isolated unless coordination is set under the Vehicle Movement Window above. If not known, assume actuated.
- **Sequences** – Pick the phase sequence that most closely matches the subject intersection: Two-phase (permitted left turns), variable phasing (potential concurrent left-through movements depending on volumes), split phasing, or leading left turns (best starting point for new signals) as shown in Figure 22. The freeway interchange template has its own sequence different from these.

**Figure 22: Sequences**

Sequences | Sequence Editor | Phase & Sequence Data | Timing Options | Advanced

Analysis Method \_\_\_\_\_

Signal Analysis Method Actuated

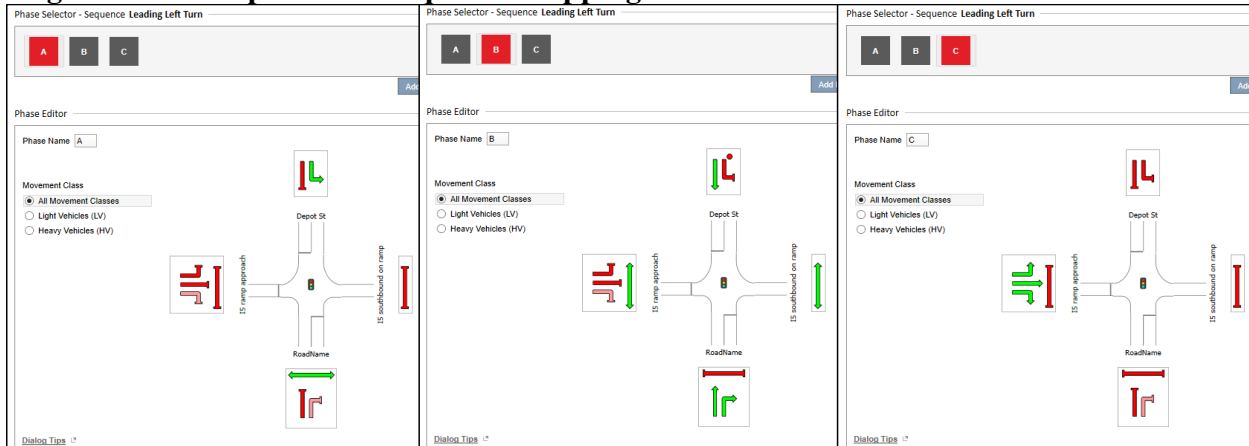
Sequences \_\_\_\_\_

Select	Sequence Name	Phases
<input type="radio"/>	Two-Phase	A, B
<input type="radio"/>	Variable Phasing	A, B1*, B2*, C, D, E1*, E2*, F
<input type="radio"/>	Split Phasing	A, B, C, D
<input checked="" type="radio"/>	Leading Left Turn	A, B, C

- **Sequence Editor Tab**

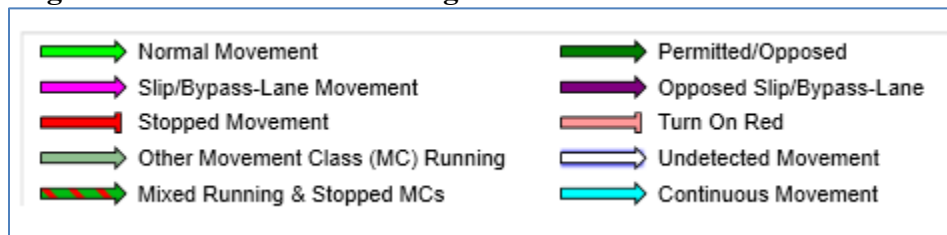
- **Phase Selector** - Edit vehicle and pedestrian phases by approach direction in Sequence Editor following typical phase rotations or from timing sheets, if available, or from noted field conditions. Custom sequences can also be created if desired. Sequences can be added, cloned (copied), moved, or deleted as necessary. The maximum number of sequences is ten. Phase names will need to be changed if the order is changed. The sequence can be stepped through by phases to see how the operation would occur as shown in Figure 23 for a three-phase intersection at a ramp terminal where the major street left turns are first, then followed by the through movements, and then the third phase has the minor movements.

**Figure 23: Example Phase Sequence Stepping**



Vehicular by classification and pedestrian movements can be toggled on/off for each phase by clicking on them. Depending on the sequence type and lane geometry there may be a variety of color choices beyond the normal (green) and stopped (red) choices as shown in Figure 24.

**Figure 24: Movement Color Legend**



- **Phase & Sequence Data Tab**
  - **Reference Phase** – One phase needs to be selected as a reference phase for calculation of offsets. A leading left or through phase is the most common.
  - **Phase Time** – Enter phase splits (green +yellow/all-red) from timing sheets if available. These must satisfy minimum green and pedestrian timing requirements. However, user phase times are not checked against any maximum cycle length value so the analyst will need to make sure that the times are consistent. Otherwise, let the program calculate the phase times for best results. The Phase Time selections have no effect unless “User-Given Phase Times” are also selected in the Timing Options Tab for the site cycle length.
  - **Phase Frequency**- Leave as default (assumed 100% and phase will come up every cycle) unless actual field operation is known.
  - **Yellow/All-Red Time** – SIDRA does not allow decimal yellow/all-red times, so rounded values are shown in Figure 24.
  - **Effective Detection Zone Length** – Use 6’ for the major road representing a single loop detector. Use 16’ for the minor road representing a rectangle or pair of loops. If detector configuration and size is different – use the field values instead.

If video detection is in place then this is variable and likely longer (check with jurisdiction controlling timing).

- **Actuated Signal Data** – If user phase times are not known or used then appropriate (realistic maximum green times should be selected) for the major and minor movements. Start with the defaults and iterate until a desired cycle length is achieved. Values too high or low may create unrealistically long or short practical (program) cycle lengths. Gap Setting (vehicle extension) should use the same times as in Figure 25.

**Figure 25: Recommended SIDRA Yellow & All-Red Times**

Posted Speed (mph)	Yellow (s)	All Red (s)
25	4	0
30	4	0
35	4	1
40	4	1
45	5	1
50	5	1
55	5	1

- **Timing Options Tab**

- **Practical Cycle Time** – This is the default program cycle method (equivalent to the “Natural” cycle time in Synchro) based on volumes and resulting movement practical degree of saturation. This method is good for initial runs of new signals, but can give times too long or short. Maximum cycle times should be based on the 60/90/120 s guidance for 2/3/4-phase signals. Cycle rounding should be to the nearest 5 seconds.
- **Optimum Cycle Time** – This is the preferred cycle method. For coordinated signals, the Optimum Cycle Time option should be selected. The lower limit cycle time can be left the default Program setting or can be set by the user if SIDRA gives cycle lengths that are too low. Upper limit cycle time should be 120-150 seconds and the cycle increment should be 5 seconds. This setting is just for optimization of individual sites. Specific optimization settings needs to be setup for the entire network
- **User-Given Cycle Time** – Use when entering timing sheet data for existing signals or when a fixed cycle length is desired (especially if generated practical timing is too low). This timing must be able to accommodate minimum green and pedestrian timing if not specific phase times.
- **User-Given Phase Times** – Use when specific phase times have been entered under the Phase & Sequence Data tab.
- **Phase Time Options** – Lane blockage effects should be included (box checked) and green split priority should be indicated for coordinated movements as a general rule.

- **Advanced Tab**
  - **Undetected** – Some slip (typically channelized right turn) lanes at intersections will not be detected. Select and check the “undetected” box for any of these.

### **Site/Network Demand and Sensitivity Window**

Like with most of the other windows in SIDRA, the analyst needs to be careful regarding use of the sensitivity analysis of site or network analysis as results can be substantially different between the two. The volume growth settings for pedestrian and vehicles needs to be non-zero in the global assumptions or the Volume Window if it is desired to use the design life or flow scale analyses.

The analyses in this window also can be used as a model calibration tool by identifying lanes, lane utilization ratios, saturation flows, and other parameters operating at capacity conditions.

- **Design Life** – Design life analysis for future year conditions (e.g., level of service or capacity target) based on linear or geometric growth assumptions. This enables testing of different demand volume growth scenarios.
- **Flow scale** – Demand analysis for testing capacity and level of service. This option allows for testing scenarios that are either less and/or greater than the current year.
- **Sensitivity** - Analysis of general parameters such as queuing and saturation flow scenarios that are either less and/or greater than the current year.

All of the sensitivity analyses above can have results reported for movements, lanes, approaches, an intersection and the entire network. Testing ranges where applicable should be at least 25% with 5% increments. Results are shown in a similarly named section in the Detailed Output.

### **Parameter Settings Window**

Most of the information in this window is covered by the global settings (in the General Options, Model Parameters, Movement Classes and Cost Parameter tabs), but the parameters can be adjusted per site if desired for calibration purposes (i.e. short lanes).

- **Options Tab**
  - **General Options** – Same as global settings.
  - **Calibration Notes** - A text box is provided for recording any calibration notes made for any site. Adjustments are very likely will be required for matching to actual conditions, so it is very important to document all calibration settings and iterations.

- **Model Parameters Tab**
  - **Passenger Car Equivalents** – The defaults are generally ok, but may need to change for intersection calibration especially if the number of trucks are large and or approach grades are present.
  - **All Other Settings** – Leave as shown unless needing to change for calibration.
- **Cost Tab** – Same as in global settings. This tab is optional as the results will only show if operating/user cost by movement or graphic displays are chosen.
- **Fuel & Emissions Tab** - This tab is optional as the results will only show if fuel and emissions by movement or graphic displays are chosen. Specific emission parameters for CO<sub>2</sub>, CO, HC, and NO<sub>x</sub> can be modified along with basic mass and power vehicle parameters by movement class.

## Network Inputs

### Network vs Site Analysis

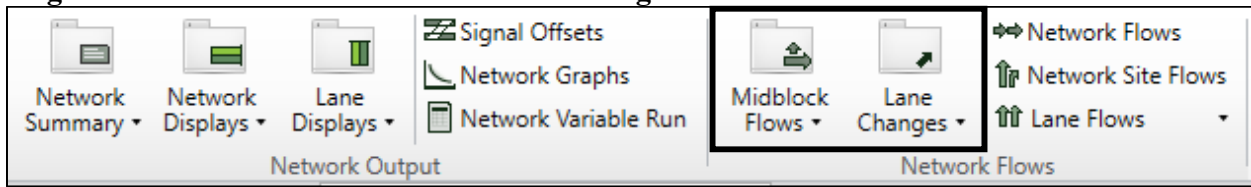
SIDRA Intersection analyzes up to 50 intersections individually in a single file or connected together as a network. This allows for small city networks, arterial facilities, isolated intersections, groups of related intersections that, for example, might be found in complex at-grade intersections, or interchange areas. Network analysis allows excess queues to be transferred across multiple upstream or downstream intersections. Transferred queues may also restrict intersection capacities, so network queuing and v/c ratio analysis may have substantially different values than individual site analysis. Unless only one intersection is under study, SIDRA analysis and reported results should be network-based for addressing impacts of signal systems, closely spaced intersections, and congestion. Also, because of the extensive network analysis, SIDRA v/c and LOS results may not compare well with previous or subsequent analyses done in other deterministic analysis programs.

### Need for Calibration

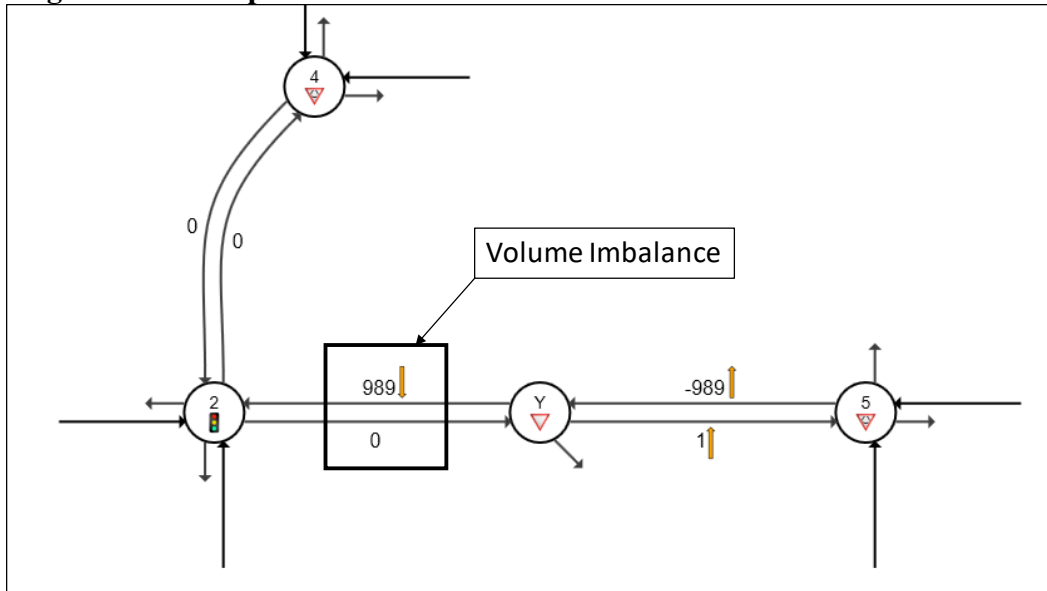
Calibration will be generally needed for most networks to varying degrees to provide for a reasonable estimate of field conditions. As with micro-simulation models, work on obtaining final existing or future year performance measures should not be started until existing SIDRA operations agree with actual observed field conditions. All information should be checked for correctness (i.e. volumes, PHF's, movement class percentages, signal timing/phasing, priorities, etc.) before calibrating. It is important to check the network reports and at a minimum, the mid-block flows (link volume balance) and the lane change graphical reports as shown in Figure 26 through Figure 28. Flow imbalances and excessive lane changes may make it difficult to calibrate and have a stable solution convergence. If the mid-block differences are legitimate, it may be best to code a driveway intersection to capture the changes instead of leaving them implicit in order to have a more stable network.



**Figure 26: Network Mid-Block & Lane Changes**

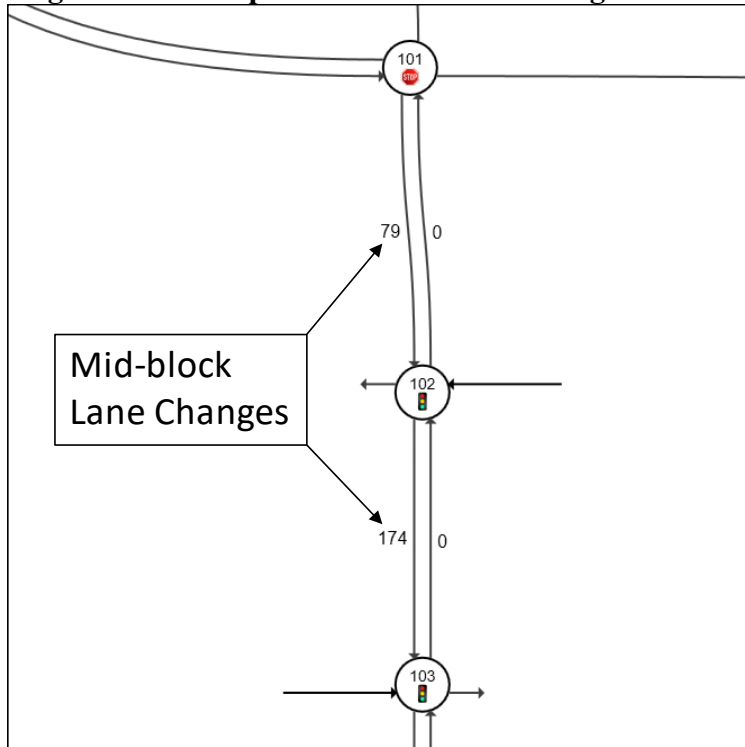


**Figure 27: Example Mid-Block Flow Imbalance**



Minimizing mid-block lane changes will require review of the Flow Proportions Tab under the Lane Window to see if volume percentages are properly assigned from the subject lane to the different exit lanes.

**Figure 28: Example Midblock Lane Changes**



Calibration should start with the major SIDRA parameters and their key calibration parameters shown below in Figure 29. There are a number of settings that can be additionally adjusted for the observed conditions to help with the calibration of the key parameters; some of these are specific calibration tabs which are indicated throughout the site input window sections. Focusing on data elements that either improve or impede flow will make the largest changes (e.g. lane data, vehicle movement data, signal timing, etc.). At the end of calibration, the queues reported (or other desired measure of effectiveness) by SIDRA should generally agree with the field conditions.

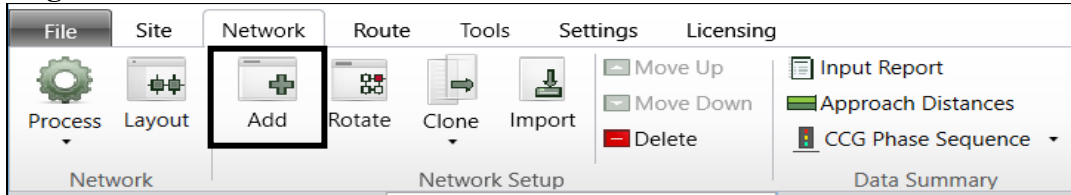
**Figure 29: Key SIDRA Calibration Parameters**

Site Type	Parameter	Key Calibration Parameter	Location
Signal	Saturation Flow Rate	Area Type Factor & Basic Saturation Flow	Intersection & Lane Geometry
Roundabout	Follow-up Headway & Critical Gap	Model Calibration Factor	Roundabouts
Two-Way Control	Follow-up Headway & Critical Gap	Base Follow-up Headway & Critical Gap	Gap Acceptance

## Network Configuration Window

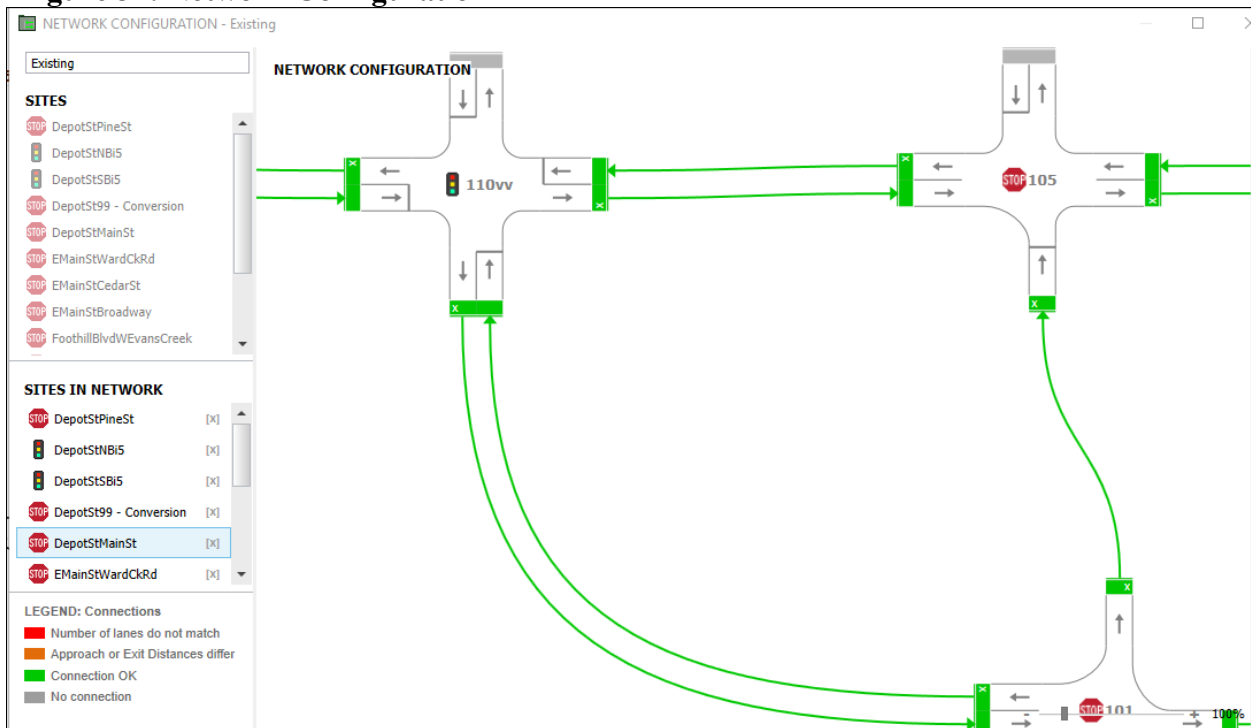
This window needs to be set up first before adding any network data, routes or analysis. Setting up a network simply involves clicking on the tab and then the Add icon in the top ribbon as shown in Figure 30.

**Figure 30: Network Menu**



Drag the sites into the appropriate relative location with each other and connect them (drag the end of the intersection to the next intersection) as seen in Figure 31. Update any mismatch with lanes or exit distances as flagged. Intersection geometry cannot be changed once a site is in a network (must remove, update, and then re-add if changes are desired like converting to a one-way street).

**Figure 31: Network Configuration**



## Network Data Window

- **Network Data Tab**

- **Network data** - Enter in desired network name (e.g. existing, future no-build), ID number (default ok) and descriptive title. All other data can be left as is.
- **Network Parameters that Override Site Data** – Same as global settings but can be changed if desired.
- **Network Analysis Settings** – The number of iterations may need to change this up to the maximum 30 iterations if network is not meeting the 1.0% network model variability flag. Processed networks with changes exceeding the 1% flag will be more unstable and have a less robust solution than ones that meet the threshold. More iterations will equal more processing time.

## Common Control Groups (CCG) Windows

Common Control Groups (CCG) are only needed when a group of intersections share a signal controller such as for interchanges and other complex or closely-spaced locations. A CCG can have up to six sites (most common is two) and up to 10 CCG's in a single network. All sites in a CCG will have the same phase sequence and times.

- **Define CCGs Window** - Use the “Add CCG” button and name it, then allocate the sites to each CCG.
- **CCG Phasing & Timing Window** – This uses the same settings as for individual sites. Note in the sequence editor, all sites in the CCG will be shown on screen, so make sure that the signal phasing makes sense across the intersections.

## Network Timing Window

Network timing will be required for properly setting up coordinated timing and signal progression including network cycle time, phase time, signal offsets, and optimization.

- **Coordination Tab**

- **Signal Coordination**- Choose which sites and/or CCG's are coordinated. If a mixture of coordinated and uncoordinated sites are in a network, then any uncoordinated sites will use site timing and phasing values. Select the reference site (for signal offset calculations; offset = 0 s) and if user offsets are being used (such as from a timing sheet) enter in the offsets.

- **Signal Offsets Tab**

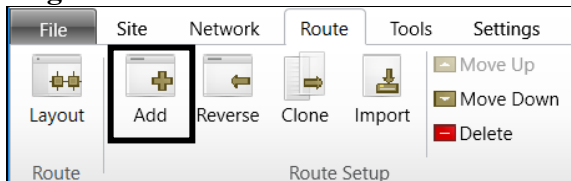
- **Signal Offsets (method selection)** – Select “User” if using site arrival types. Selection of Arrival types under the Vehicle Movement Data will override any signal offset calculations, so those should not be set if the more-detailed offsets will be used. Select “Program” if arrival types are not specified. Program-calculated offsets require defined network routes which contain more than one signalized site and/or CCG. The availability of signal offsets is dependent on network geometry where the mainline does not stop between signalized intersections.

- **Routes for Offset Calculation** - Select and prioritize the offset routes (if there are more than one) for facility, preferred direction, or movement class. Offset method should be set to “Start of Green (Leading).”
- **Signal Offset Definition** – Set to Green Start for 2070-type or newer signal controllers. Set to Phase Change (beginning of yellow) if system is using older 170-type controllers.
- **Timing Options Tab** – These are the same options as shown in the site timing. Optimum cycle time method is preferred or user-given cycle time can be specified if working from timing sheets with specified phase times (phase times must equal user-specified cycle length). User-given cycle length with program phase times can also be used if a known cycle length is desired (this could be an optimum time from an earlier iteration and it is desired to fix/lock the timing to a single value).

### Network Routes

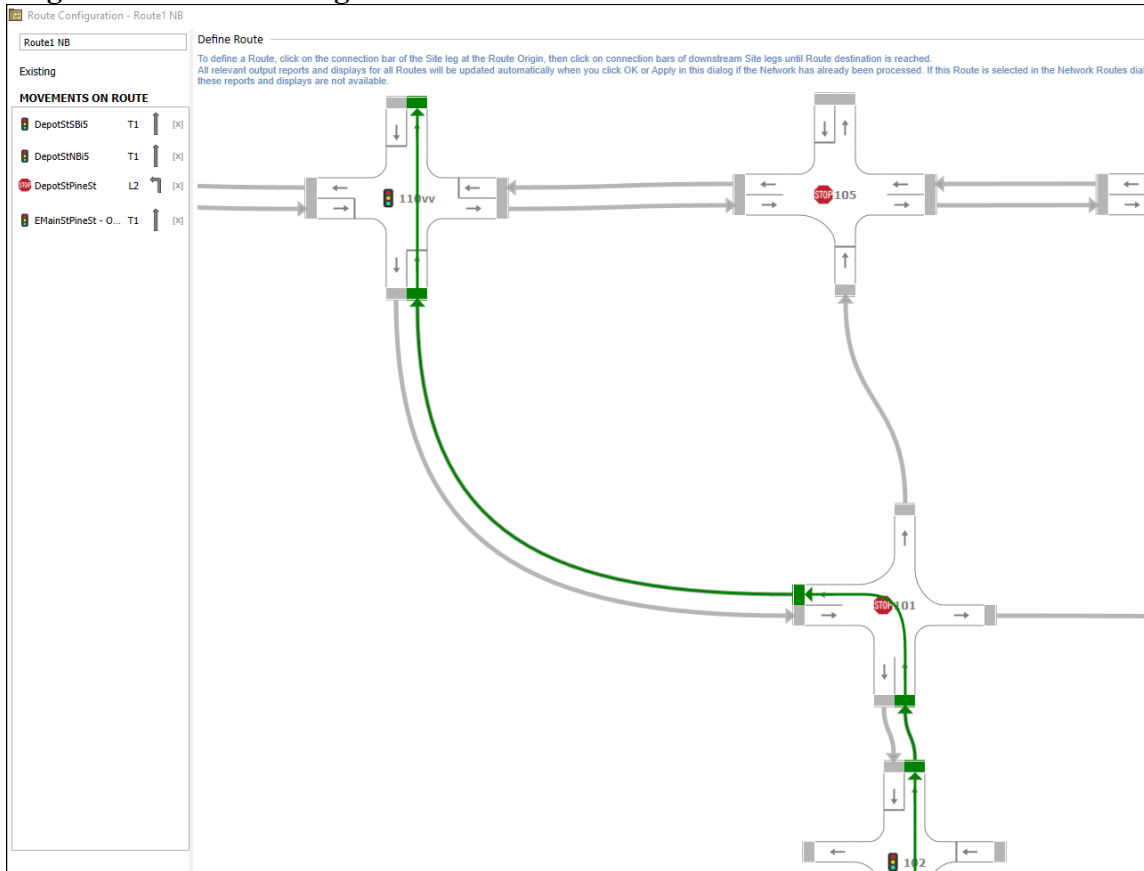
Routes may be needed for performance reports, displays, route-based signal coordination or signal offset calculations. They are also necessary for obtaining network measures of effectiveness (MOE’s) such as travel time/distance, average speed/delay, travel time index, or stop rate. If routes are needed, click on the “Add” icon under the Route tab as shown in Figure 32.

**Figure 32: Route Menu**



Like what was done to connect up sites to make a network, click on connection bar of intersections till destination is reached as shown in Figure 33. Use the reverse icon to quickly define a route in the opposite direction.

**Figure 33: Route Configuration**

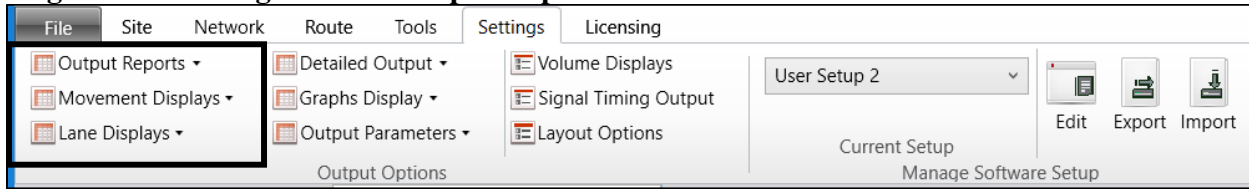


- **Route Data Tab** – Name and title (description) each route for ease of use. Route Summary/Displays typically set to Sites unless a finer level of detail is desired down to the movement or approach level. Note that the route summary values are different but it easy to toggle between the three levels.
- **Route Configuration Tab** – Same window as in the “Add Route”, but the existing movements can be edited or revised.

## Reporting

In SIDRA, there is no shortage of the possible types of reports and graphics, but it is almost too much without limiting the number of viewable reports. Site output reports and displays can be customized under the Settings Tab on the top ribbon as shown in Figure 34. These settings will limit the reports that show up in the Site Output window and when using the print commands. Note that the site output will reflect the site type (e.g. Phasing Summary will only show for signalized intersections).

**Figure 34: Settings Menu –Output Report Selection**



### Recommended Report Settings

- **Output Reports** - Detailed Output, Lane Summary, Lane Changes, Phasing Summary, Timing Analysis, Movement Timing, Critical Movements, Saturation Flows, Roundabout Analysis
- **Movement Displays** – Delay (Control), Level of Service, Degree of Saturation, Queue Distance (both average & %ile), Signal Coordination, Travel Speed
- **Lane Displays** – Lane Level of Service, Degree of Saturation, Queue Distance (both average & %ile), Lane Blockage Probability, Capacity Reduction, Signal Coordination
- **All others** – Leave as default

If the project file is just an isolated unconnected intersection then use the site reports. However, most analyses will have networks set up, so it is important to use the network site reports instead as the results can be substantially different especially if there are any capacity limitations or issues. Calculation of intersection v/c ratios and reporting of other MOE's such as delay and queuing accurately will require use of the correct report.

### Output Reports

Select isolated or network sites from the “Sites” or “Sites in Network” lists in the left viewing pane. Right-click on the desired site and select the “Print All (Site)” or “Print All (Network Site)”. This will bring up a selection window with four sets of checkboxes which has the reports that were filtered down from the Settings Tab. At a minimum, the following should be printed to a pdf format for each site:

- **Output Reports**
  - **Lane Summary** – Contains demand & arrival volumes, highest lane group v/c ratio, average delay, LOS, 95<sup>th</sup> percentile queuing, approach/storage lengths and blocking probability.
  - **Phasing Summary** – Contains controller type, cycle length, phase sequences and phase times
  - **Movement Timing** – Shows the green/red phase splits for each movement
- **Site Layout and Volume Displays** – Site Layout (lane geometry graphic), Input Volumes
- **Movement Displays** – all optional
- **Lane Displays** – all optional

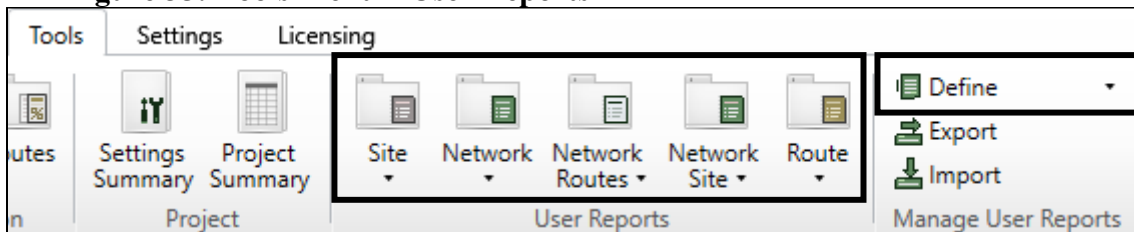
In addition, for all network analyses, choose the “Print All (Network)” setting from the “Selected Network” window and print the Network Summary (summary statistics) and Network Layout (configuration graphic) reports. Note that all of the reports under this setting are all network-wide which are different from the “Network Site” choice.

If routes are enabled, then choose the “Print All (Route)” setting for each desired route in the route list and print the Route Summary (summary statistics), Route Travel Performance (route MOE’s such as travel time, speed, etc.), Time-Distance (space-time diagram for signal progression), and the Route Layout (configuration graphic) reports.

If desired, it may be necessary to capture the “Detailed Output” report. The required intersection v/c ratio calculations for signalized intersections use the critical movements under the Signal Timing section and arrival flows and saturation flow rates for calculating critical flow ratios are under the Lane Capacity section. This report is not available under the “Print All” settings. Bring up the detailed report for the desired isolated or network site and do a right-click followed by “Print.”

The Tools tab allows the creation of comparison reports for sites and networks in the same file or in different project files and the creation of custom user report templates. The use of custom user reports are optional, but they will simplify the reporting process by consolidating the number of individual reports. Use the “Define” setting under the Tools tab to choose the individual reports to be included for the isolated/network sites, networks, and routes. Once defined, the individual folders shown in Figure 35 can be chosen to show the custom report for each desired element. Reports can either have one report type per project file or one for every intersection depending on the project. Once the specific report is shown on the screen, go to “File” then “Print” option to obtain (save to pdf format preferred).

**Figure 35: Tools Menu – User Reports**



Custom site and network site reports should include, at a minimum in the following order:

- Site Layout
- Input Volumes
- Lane Summary
- Phase Timing Summary
- Movement Timing (Displayed Signal Timing)



Custom-user-defined network reports should contain at a minimum:

- Network Layout
- Network Summary (Hourly Values)
- Signal Offsets (Route)

Custom-user-defined route reports should contain at a minimum:

- Route Layout
- Route Summary (Hourly Values)
- Route Travel Movement Performance Report
- Time-Distance Diagram (if route is primarily for signal timing)