AWZA Arizona Work Zone Analysis Tool

A tool for Work Zone Queue and Delay Estimation

Tool Demonstration & Training

Date: December 3, 2020
Time: 9:00 am

Tool Information

Tool Development and Course Presenters

Wood Environment & Infrastructure Solutions, Inc.

- Anita Johari, PE, PTOE
- William Gil, EIT

ADOT Contact

Adam D Carreon, PE

Operations & Safety Engineer – Special Projects

Acarreon@azdot.gov, 602.712.2212

Tool Location: Planning/Transportation Studies/Smart Work Zone (SWZ) Technical Concept Study

Smart Work Zone (SWZ) Technical Concept Study | ADOT (azdot.gov)

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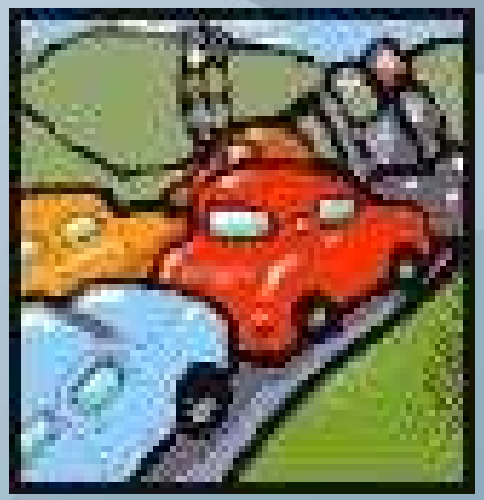
Course Objective

- Simple tool to estimate work zone queue and delay
- Tool also estimates user cost due to the projected queue and delay
- Work Zone Impact Analytical Tools
  - ✓ Simple Method Volume Distribution
  - ✓ FHWA approved queue and delay estimation methodology (modification to MoDOT Spreadsheet)



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Work Zone Safety & Mobility Rule

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Goals of Work Zone Safety and Mobility Rule

Rule: FHWA 23 CFR 630 Sub Part J

Goal: Reduce and eliminate crashes and fatalities & to mitigate congestion due to work zones.

Significant Route: Those state routes where a lane closure on the roadway is expected to cause sustained work zone impacts that are not considered tolerable based on the goals and objectives of this policy or public opinion.

Non-significant Project: Traffic volumes low, public interest low, duration is short to moderate. No impact analyses may be required; go straight to Traffic Control Plans (TCP).

Significant Project – Intermediate or Short Term: Significant Route, project duration three days or less. No impact analyses may be required; go straight to TCP.

Significant Project - Long Term: Significant Route, project duration longer than three days. Complete full Traffic Management Plan(TMP) with impact analysis.

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Goals of Work Zone Safety and Mobility Rule

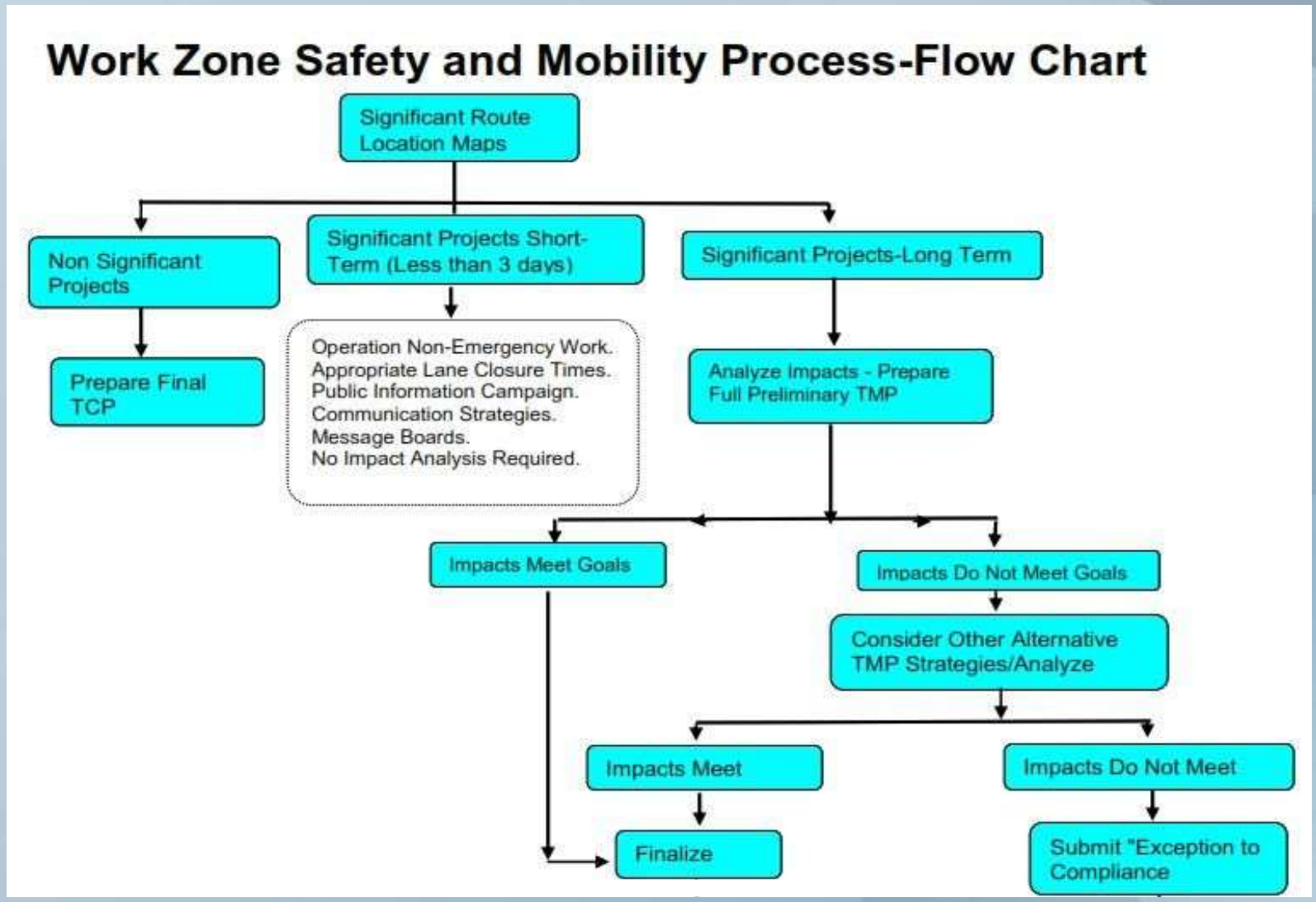
Rule: FHWA 23 CFR 630 Sub Part J

Goal: Reduce and eliminate crashes and fatalities & to mitigate congestion due to work zones.

Freeway Construction in Central & South-Central District: Nighttime and weekend closures only.
Weekday Closure Duration: 9:00 pm – 6:00 am
Weekend Closure Duration: Friday evening: 8:00 pm to Monday Morning 6:00 am

In freeways with four or more lanes per direction, minimum 2-full lanes should be open to traffic.

Goals of Work Zone Safety and Mobility Rule



Temporary Traffic Control Work Zone

Key Components of a Work Zone

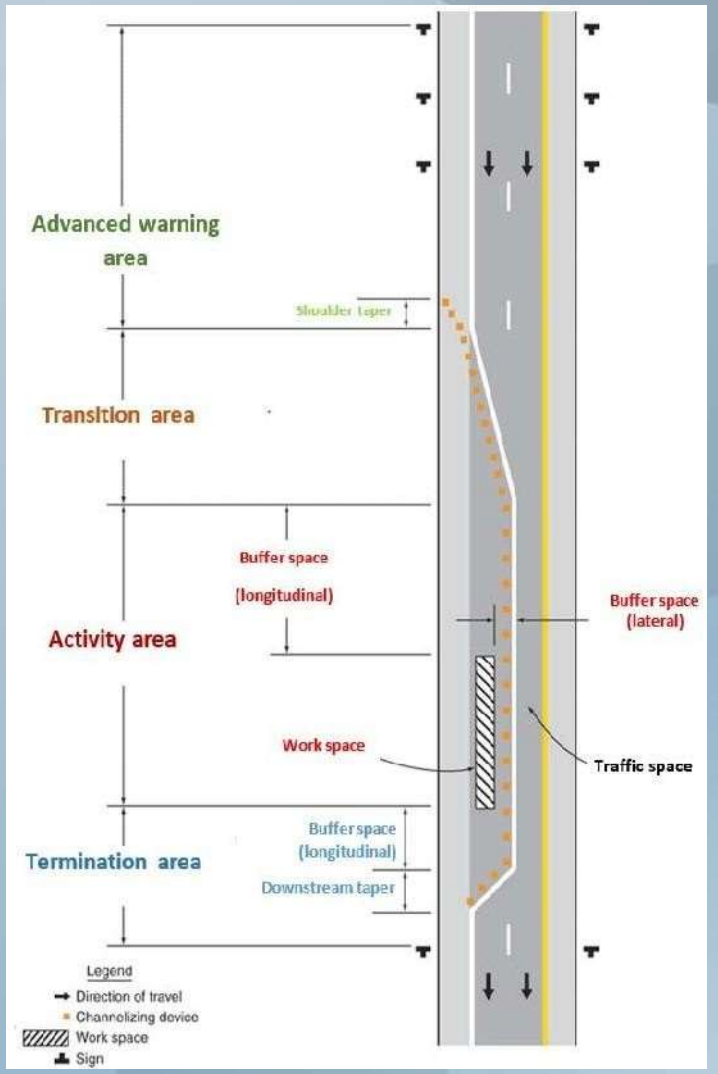
Components of Temporary Traffic Control zones

1) **Advanced warning area**
   Drivers are informed about upcoming TTC zone

2) **Transition area**
   Drivers may be asked to change their normal path

3) **Activity area**
   It is comprised of the work space, the traffic space, and the buffer space.

4) **Termination area**
   Drivers return to the normal path



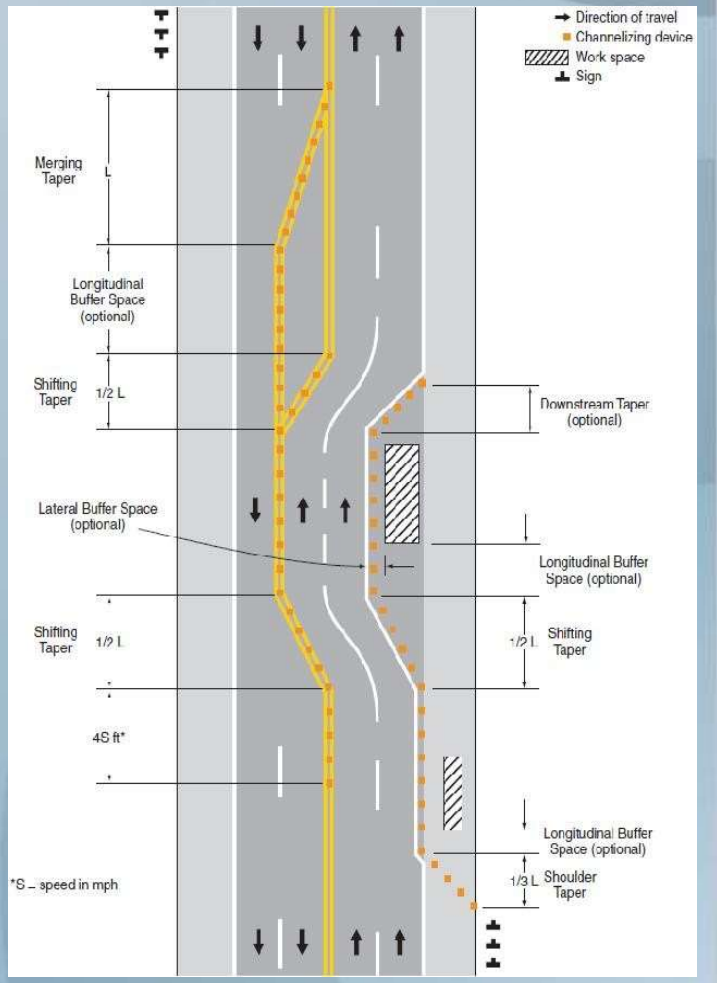
Source: MUTCD Figure 6C-1, Page 553

What Causes Queue and Delay in a Work Zone

- WZ Geometry – Number of Lanes, lane width,
- Traffic Volume demand
- Lateral clearance,
- Layout and length of work zone,
- Presence of intersections/ramps,
- Work zone speed,
  Concrete barriers vs. drums

Human Factors

- Work intensity
- Work Zone duration (long-term or short-term)
- Time (daytime or nighttime)
- Day (weekday or weekend)
- Presence of Police
- Advance Warning Signs and DMS



Source: MUTCD Figure 6C-2, Page 556

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Work Zone Analysis & Tools

- For the development of the Work zone analysis - we need to analyze Queue (in miles) and Delay (minutes/vehicle) in the Work Zone & compare it to baseline conditions
- FHWA has developed several spreadsheet tools, while modeling tools are used for complex work zones.
- The New AZWZ Analyses Tool we are presenting calculates queue/delay using simple math method, using the same calculation methodology prescribed by FHWA.

AZWZ Analyses Tool

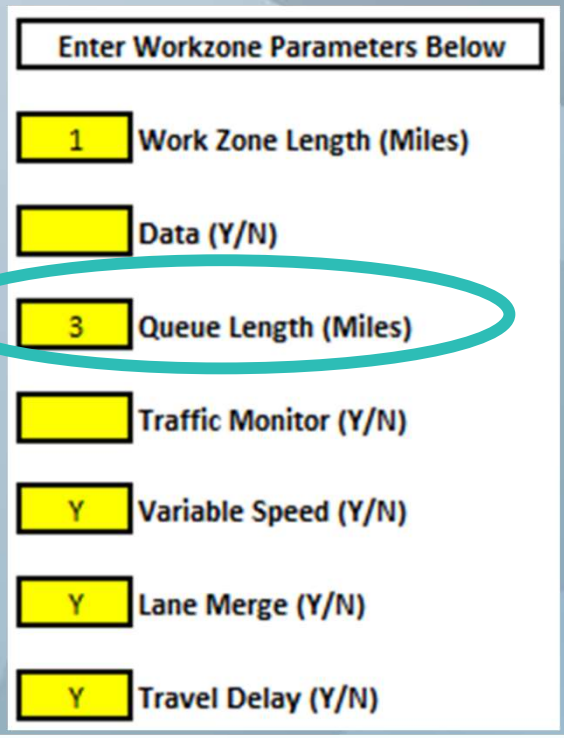
1. Base Conditions Analysis – Assess the base condition without work zone. This will identify if any delay and queue is present in existing conditions.
2. Work Zone Queue Analysis – This assesses the queue and delay conditions in a work zone. The results include expected maximum queue & delay in the work zone, in a 24-hour period.
3. User Cost – Calculates delay cost.

AZWZ Analyses Tool cannot analyze flagger situation, WZ Q-Pro, developed by the University of Illinois should be used.

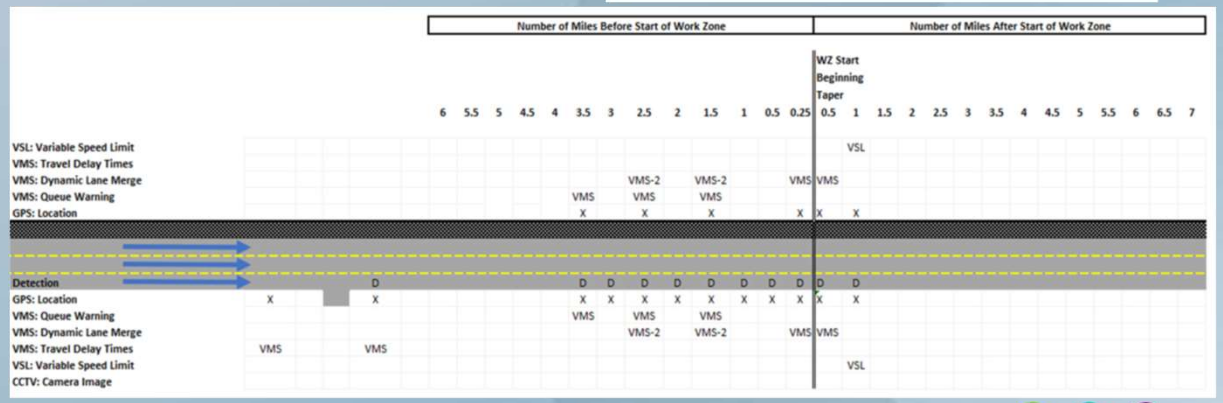
AWZA Tool Application in Smart Work Zones

ADOT SWZ Analyses Tool in Context

- The ADOT SWZ selection is based on a Design Tool where the designer will enter the parameters into the tool that will then "design" an appropriate SWZ system
- This AZWZ Analyses Tool was developed to determine the ***queueing*** expected from the work zone



- ADOT will use this tool in-house or provide the tool to Contractors/ designers

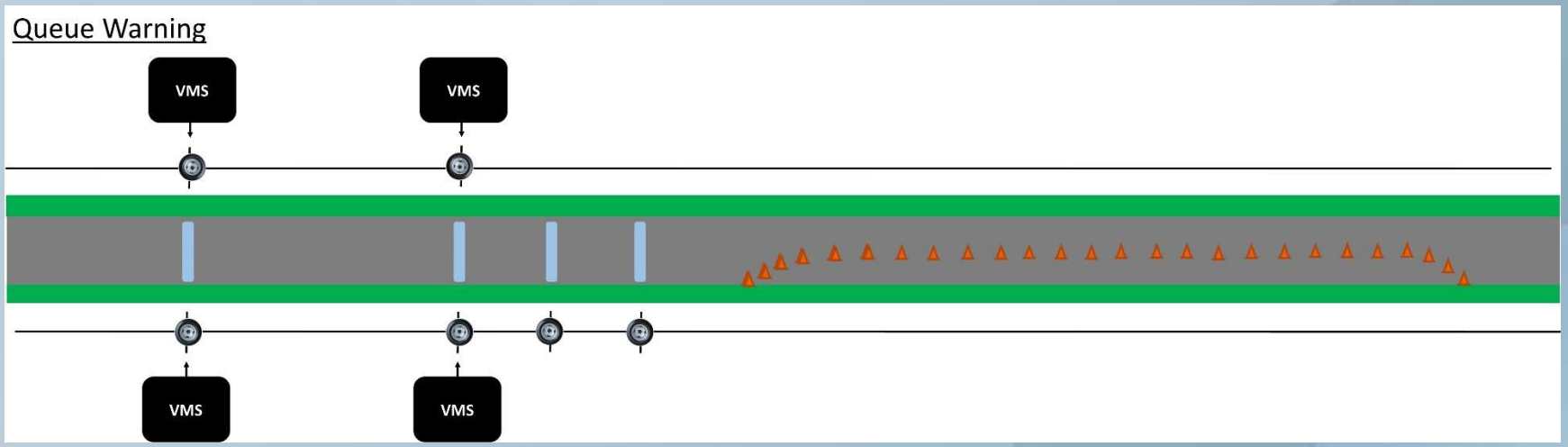


ADOT Questions to Determine SWZ Subsystems to Use in Corridor

- **Congestion** – Is the work zone going to cause congestion or a case where the volume to capacity ratio will exceed 1.0? If yes, utilize a ***Queue Warning*** system.
- **Lane Restriction** – Is the work zone going to be restricting or closing lanes of traffic? If yes, utilize a ***Dynamic Merge*** system.
- **Delay information –** Is there an alternate route option within 5 miles in advance of the work zone and/or to alleviate drive frustration? If yes, utilize a ***Travel Delay*** system.
- **Surveillance Capability** – Is there no permanent camera or surveillance capability existing to be able to monitor the work zone? If yes, utilize a ***Traffic Monitoring (Camera)*** system.
- **Length of Work Zone and Need for Changing Speeds when Workers are Present** – Is the length of the work zone exceeding 2 miles and there is a desire to be able to change speeds when workers are present? If yes, utilize a ***Variable Speed Limit*** system.

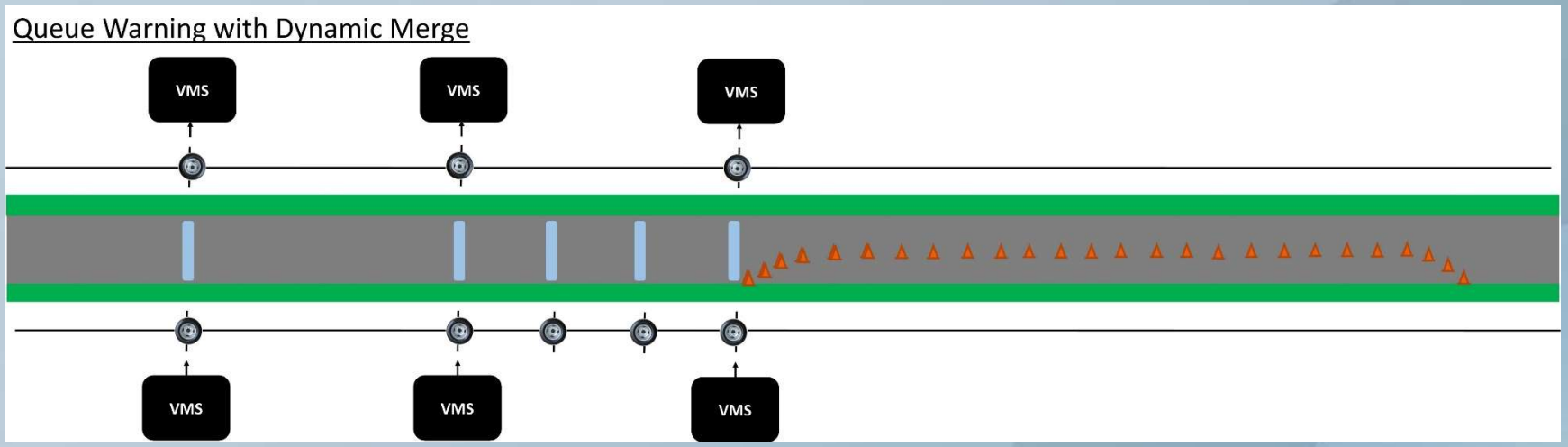
ADOT SWZ Queue Warning System

- Queue Warning



ADOT SWZ Dynamic Merge System

- Queue Warning with Dynamic Merge



Terms and Definitions

Tool Inputs – Base Conditions

1. Project Location
   - ADOT District
   - Area Type
2. Facility Type:
   - Pick freeway for Interstate and Freeway
   - Pick Major Arterial: for Principal and Major Arterials
   - Pick Minor Arterial: for Minor Arterial & Major/Minor Collector Roads
3. Number of lanes/direction
4. Posted speed limit
5. Average Daily Traffic (from ADOT TDMS webpage) If you have hourly volume distribution, use that
6. Grade %
7. Frequency of signal spacing (minor/major arterials only)

Baseline Analysis – existing condition without work zone

If hourly volume is available, populate volume in respective column

Possible Q - in existing condition

Results

Baseline Capacity Analysis Using Simple Math Method

Roadway Information

Route Name	I-10
No. of Lane/direction (normal)	4
ADT of Roadway	225,000
Posted Speed	65
District	Central
Area Type	CBD
Roadway Classification	Freeway
HV %	5%
If Arterial - are signals < 1 mile apart	Yes
Grade	<2%
Lane Width	>11.5

Fill In information

Choose from Pull Down Menu

Auto fill - don't change value

Base Capacity	1,650

Directional Hourly Volume *112,500*

Daily Distribution of Traffic Volumes							Base Capacity	
ADT Distribution	Major Arterial		Minor Arterial		Freeway & Expressway		V/C Ratio	Queue In Existing Conditions ?
Hours	%	Vol	%	Vol	%	Vol		
0:00	0.7%	0	0.3%	0	0.9%	1061	0.16	-
1:00	0.5%	0	0.2%	0	0.8%	885	0.13	-
2:00	0.4%	0	0.2%	0	0.8%	906	0.14	-
3:00	0.6%	0	0.3%	0	1.3%	1407	0.21	-
4:00	1.5%	0	0.6%	0	2.3%	2598	0.39	-
5:00	3.0%	0	1.8%	0	4.1%	4597	0.7	-
		0	3.7%	0	5.3%	5952	0.9	-
							1.01	Q*
8:00	5.8%	0	6.2%	0	5.7%	6360	0.96	
9:00	5.8%	0	4.8%	0	5.4%	6040	0.92	-
10:00	5.5%	0	5.1%	0	5.4%	6094	0.92	-

ADOT – Regional Classifications

For Planning Purposes ADOT MPD has the following classification by area type:

1- CBD (Central Business District)

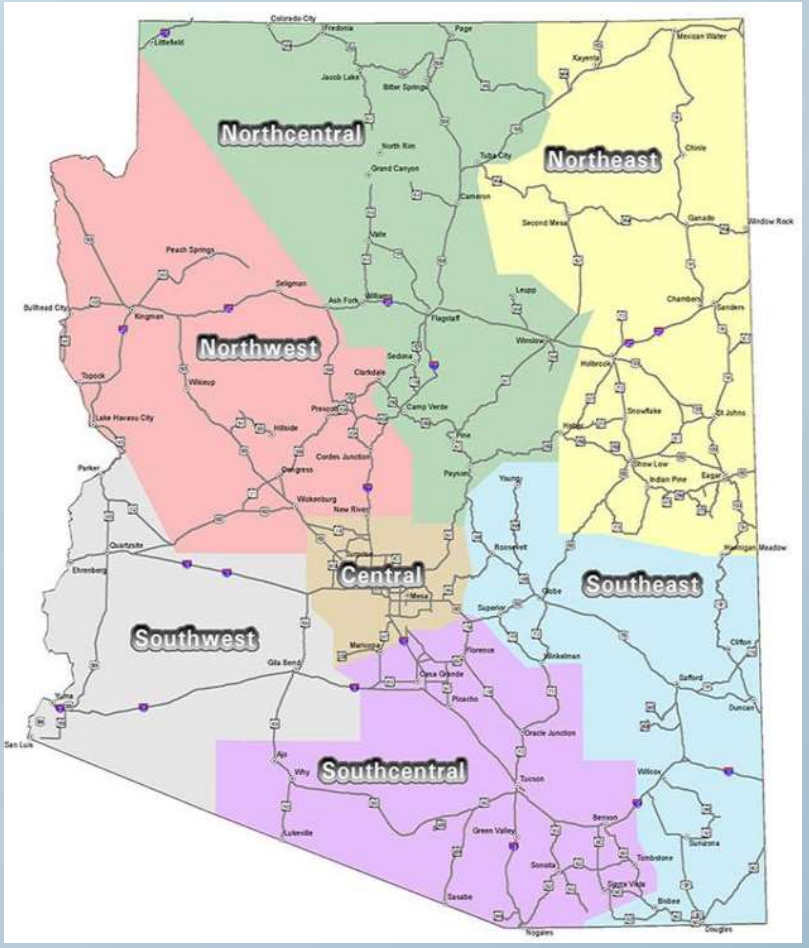
2 – Urban

3 – Sub-Urban

4.- Rural

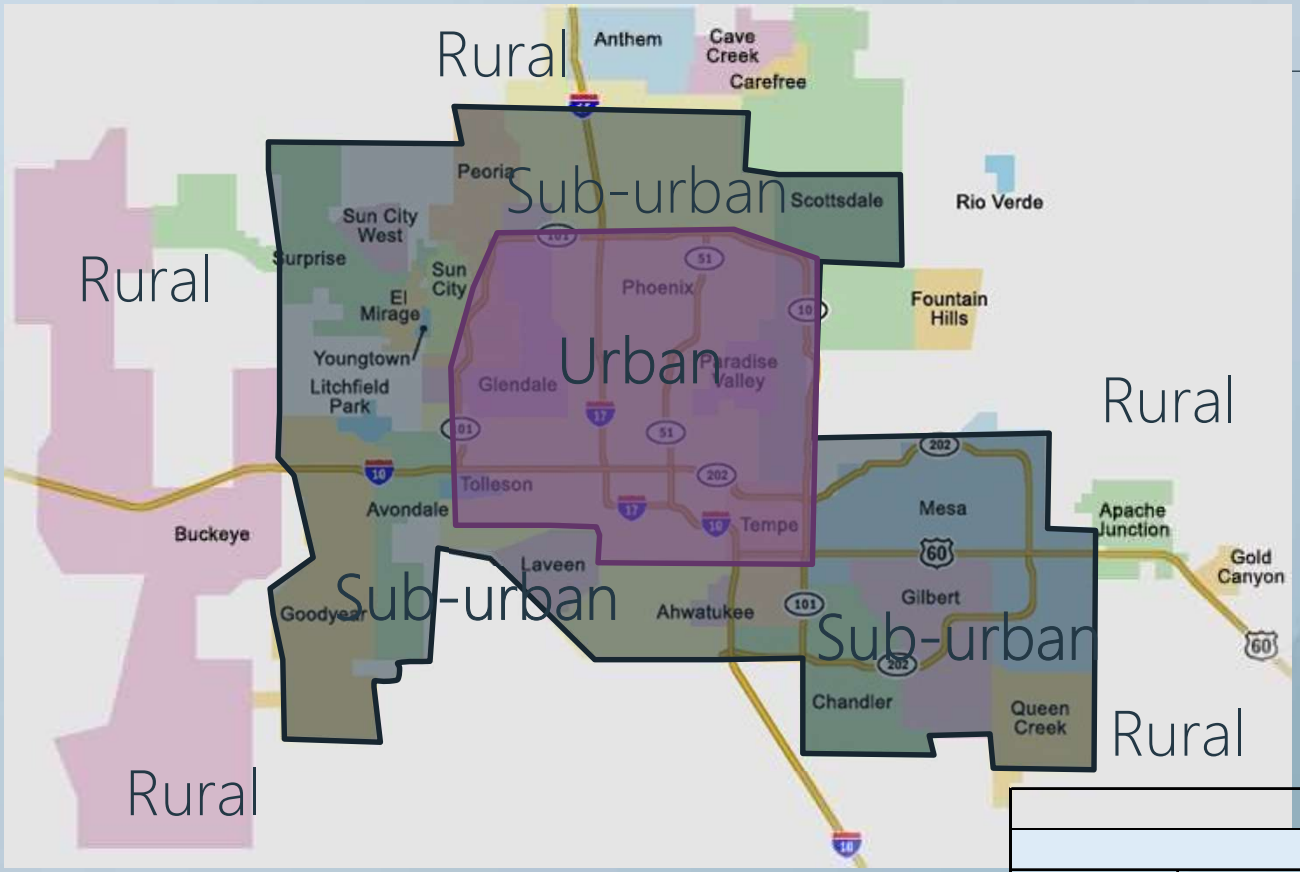
5 – Small Town (< 10,000 population)

ADOT Districts – Classification



District	Major/Popular Areas	Classification
Northeast	< 5000 pupulation	Rural
North Central	Flagstaff	Sub-urban
	Sedeona	Small town
	Page	Small town
	Payson	Small town
	rest	Rural
Northwest	Lake Havasu	Sub-urban
	Bull head City	Sub-urban
	Kingman	Small town
	Prescott	Small town
Southwest	Yuma	Sub-urban
	rest	Rural
Southeast	< 5000 pupulation	Rural
South Central	Casa Grande	Sub-urban
	Tucson	urban
	Green Valley	Sub-urban
	Nogales	Small town
	Sierra Vista	Small town
	Benson	Rural

Central Districts – Classification



Central				
Urban				
Phoenix	Mesa	Tempe	Scottsdale	Glendale
Sub-Urban				
Peoria	Surprise	Buckeye	Goodyear	Avondale
Chandler	Gilbert	QueenCreek		
Small Town				
Maricopa	Fountain Hills			
Rest of the Area				
Rural				

ADOT – Roadway Classifications

For Planning Purposes ADOT MPD has the following roadway classifications:

1 – Interstate

2 – Freeway

3 – Principal Arterials

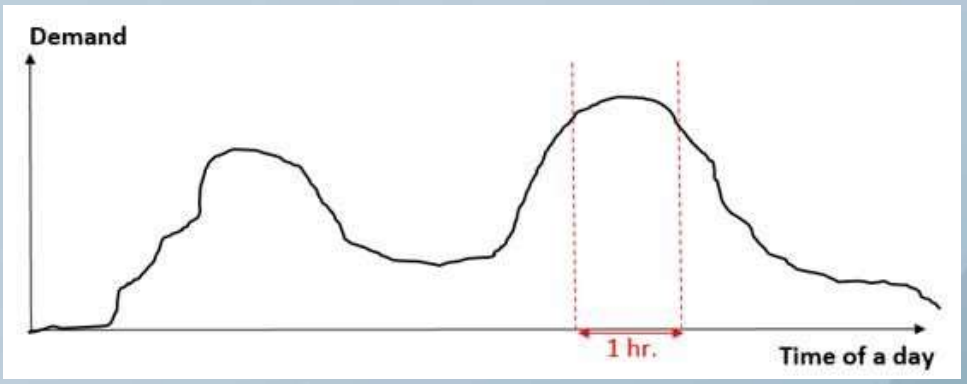
4 – Minor Arterials

5 – Major Collectors

6 – Minor Collector

Different Definitions of Traffic Volumes

- **Flow (or volume):** number of vehicles passing a point during a given time interval
- **Peak hour volume:** highest hourly volume (*veh/hr*)



Obtain from ADOT TDMS website or other valid source

- **Average Daily Traffic (ADT):** volume estimation based on volume count data for less than a year *(veh/day)*
- **Average Annual Daily Traffic (AADT):** volume estimation based on volume count data for less than a year *(veh/day)*

Traffic Volumes

If hourly volume from field is available, please use the field data

Daily Distribution of Traffic Volumes							Base Capacity	
ADT Distribution	Major Arterial		Minor Arterial		Freeway & Expressway		V/C Ratio	Queue In Existing Conditions ?
Hours	%	Vol	%	Vol	%	Vol		
0:00	0.7%	0	0.3%	0	0.9%	1061	0.16	-
1:00	0.5%	0	0.2%	0	0.8%	885	0.13	-
2:00	0.4%	0	0.2%	0	0.8%	906	0.14	-
3:00	0.6%	0	0.3%	0	1.3%	1407	0.21	-
4:00	1.5%	0	0.6%	0	2.3%	2598	0.39	-
5:00	3.0%	0	1.8%	0	4.1%	4597	0.7	-
6:00	4.3%	0	3.7%	0	5.3%	5952	0.9	-
[illegible]	5.5%	0	6.6%	0	5.9%	6650	1.01	Q*
8:00	5.8%	0	6.2%	0	5.7%	6360	0.96	-
9:00	[illegible]	0	4.8%	0	5.4%	6040	0.92	-
10:00	5.5%	0	5.1%	0	5.4%	6094	0.92	-
11:00	5.5%	0	5.4%	0	5.4%	6105	0.93	-
12:00	5.5%	0	5.7%	0	5.7%	6382	0.97	-
13:00	5.4%	0	5.8%	0	5.9%	6663	1.01	Q*
14:00	6.2%	0	6.3%	0	6.1%	6901	1.05	Q*
15:00	7.1%	0	7.5%	0	6.5%	7347	1.11	Q*
16:00	7.4%	0	8.0%	0	6.7%	7548	1.14	Q*
17:00	7.7%	0	8.3%	0	6.7%	7492	1.14	Q*
18:00	6.9%	0	6.1%	0	5.3%	6019	0.91	-
19:00	5.2%	0	4.5%	0	4.2%	4685	0.71	-
20:00	3.8%	0	3.1%	0	3.3%	3720	0.56	-
21:00	2.7%	0	2.3%	0	2.8%	3206	0.49	-
22:00	1.9%	0	1.2%	0	2.1%	2388	0.36	-
23:00	1.2%	0	0.7%	0	1.3%	1507	0.23	-

Q* if V/C > 1, or Q dissipating from previous hour

Work zone Analysis

Roadway projects may need either one or a combination of work zones such as: shoulder work, Lane work, median work, roadway and intersection closures and detours.

Assess the different types of Work Zones needed for each phase of construction of the entire duration of the project.

Separate queue and delay analysis is needed for each type of work zone.

Work zone Analysis

There are two modules – Module 1 and Module 2

Module 1 - is to analyze the following work zones:

- Shoulder Closure
- Lane Closure - Number of Lanes closed
- Median Crossover
- Temp Bypass

For this analysis:

- Input baseline information in Tab: Step 2
- Input work zone information in Tab: Step 3.
- View work zone queue and delay results in Tab: Step 4.

Work zone Analysis

Module 2 - to assess if the planned route for detour will have adequate capacity to accommodate the detour traffic

For this analysis use – use Tab: Detour_Capacity_Assessment. If the Roadway Capacity results in Q, compare and review the increase in V/C ratios with baseline condition.

Tool Inputs – Work zone Conditions

1. Type of Work Zone
   - Shoulder Closure
   - Lane Closure - Number of Lanes closed
   - Median Crossover
   - Temp Bypass
2. Number of lane in Work zone
4. Lane Width
5. Work zone Intensity – high, medium, low
6. Work zone protection – VPs, TCB
7. Lateral offset from barrier - <2ft, >2ft
8. Lateral offset from Work zone - <4ft, >4ft
9. Time of work – 24-hour, day, night
10. Availability of detour
11. User cost – for trucks and for cars

Type of Work zone Definitions

Shoulder Closure – typically only shoulder is closed.

- All existing travel lanes are open for travel
- Number of lanes in work zone are same as the existing number of lanes
- Travel lane widths may be reduced to accommodate TCB or VPs.

Lane Closure

- Reduced number of lanes are open for travel
- Travel lane widths may be reduced to accommodate TCB or VPs.

Median Crossover & Temp Bypass

- Reduced number of lanes are open for travel
- Travel lane widths may be reduced to accommodate TCB or VPs.

Tool Inputs – Work zone Conditions

Lane Width:

- >11.5 ft
- 10-11.5 ft

Work zone Intensity:

- High: large number of construction equipment and workers in the work zone
- Medium: some construction equipment and workers in the work zone
- Low: smaller equipment and few workers in the work zone

Work zone protection

- VPs,
- TCB

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Tool Inputs – Work zone Conditions

Lateral offset from barrier is the distance between the travel lane and TCB or VPs: <2ft, >2ft

Lateral offset from Work zone: Distance between the actual work zone and travel lane (this includes the width of the TCB or VPs) - <4ft, >4ft

Availability of detour: Assess if there are any alternative routes traffic can take and choose one of the following options:

1. Alternative routes informed to road user
2. Adequately available routes – but not informed to road users
3. Some available and informed to road users
4. Some available, but not informed to road users
5. None - Not available

Tool Inputs – Work zone Conditions

Time of work – 24-hour, day, night

User cost: if you want to calculate the cost: Use the Arizona or National costs:

- for trucks
- for cars

Work Zone Inputs

Baseline Conditions Self Populated (no input needed here)

Input Information about the planned work zone

Workzone Capacity Analysis Using Simple Math Method

Roadway Information

Route Name	I-10
Lanes/direction (normal)	4
Posted Speed	65
ADT of Roadway	225000
District	Central
Area Type	CBD
Roadway Classification	Freeway
HV %	5%
Signals < 1 mile apart	Yes
Existing Lane Width	>11.5
Base Condition Capacity	1,650

Work Zone Information

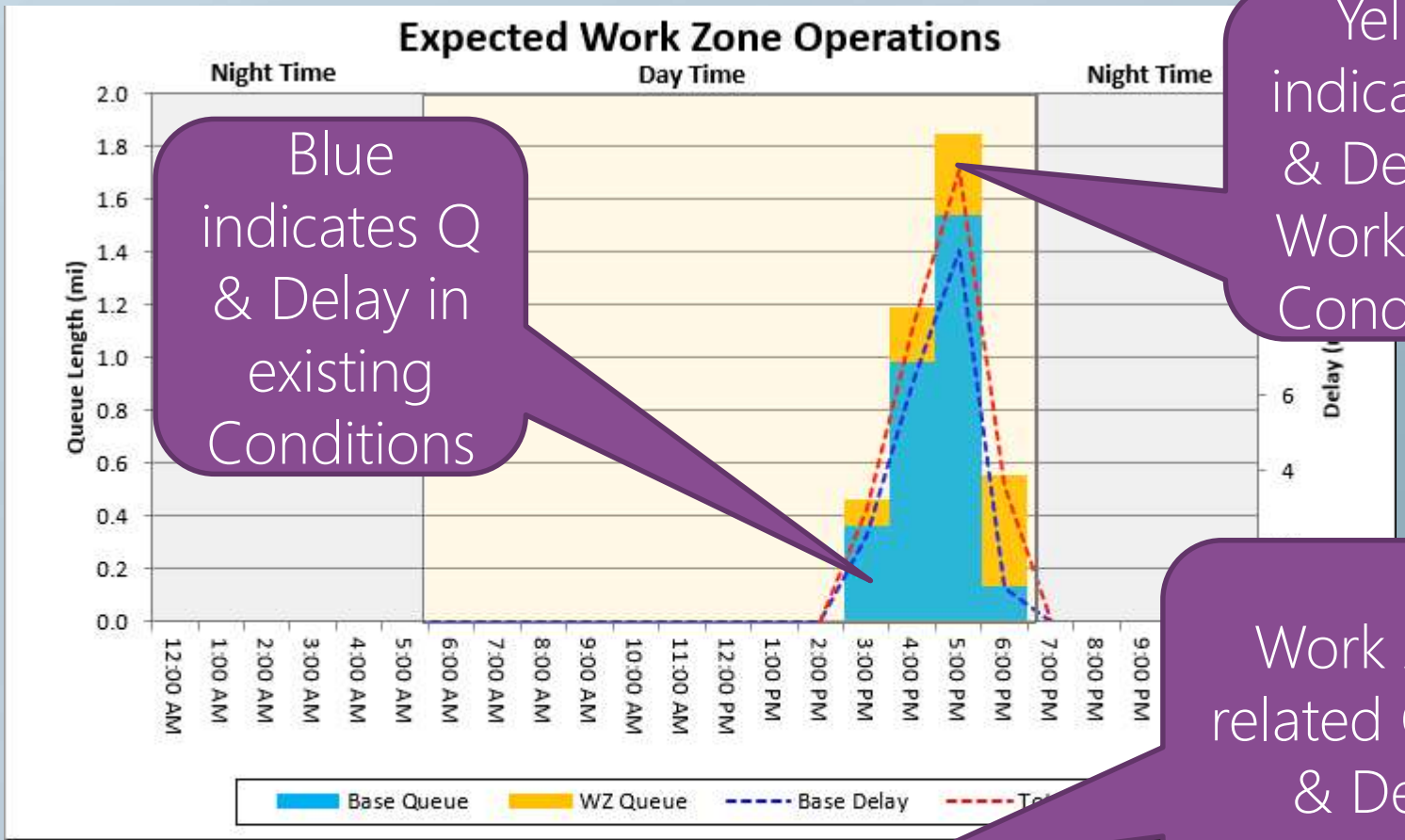
Type of Work Zone	Lane Closure
lanes/direction (Work Zone)	2
Work Zone Check	OK
WZ Lane Width Adjustment	> 11.5
Work zone Intensity	High
Work Zone Protection	TCB
Lateral Off Set from Barrier or VP from	< 2 ft
Lateral offset of work zone from Travel Lane	< 4 ft
Time of Work	Night
Start Time	8:00:00 PM
End Time	6:00:00 AM
Duration (# of Hours)	10
Detour Availability	Alternate Routes Informed to Road users
Diversion %*	25%
User Cost / Hour (Trucks)	$ 22.70
User Cost / Hour (Cars)	$ 10.30
Workzone Capacity	1346
WorkZone ADT	168,750

Directional Hourly Volume 84,375

ribution of Traffic Volumes

ADT Distribution	Major Arterial		Minor Arterial		Freeway & Expressway		Roadway Capacity V/C Ratio	Queue Anticipated in Work Zone ?
Hours	%	Vol	%	Vol	%	Vol		
0:00	0.7%	0	0.3%	0	0.9%	796	0.30	-
1:00	0.5%	0	0.2%	0	0.8%	664	0.25	-

Work Zone Analysis – Tool Results – Freeway



Blue indicates Q & Delay in existing Conditions

Yellow indicates Q & Delay in Work zone Conditions

Work zone related Queue & Delay

RESULTS

Measure of Effectiveness	Base Conditions	Work Zone	Total
Max Queue Length (mi) Day Time:	1.5	0.4	2.0
Max Queue Length (mi): Night Time		0.0	
Max Delay (minutes): Day Time	9.8	2.7	12.5
Max Delay (minutes): Night Time		0.0	

Freeway Work Zone not typically Allowed

- Flagger Situation in any freeway
- For Central and South-Central Districts
  - No Lane Closure during daytime,
  - Shoulder Closure is allowed at all times
  - Lane reduction - Nighttime only activity
  - For lane reductions - maintain minimum 2-lanes of traffic
- Weekday Nighttime activity: 9:00 pm – 6:00 am
- Weekend Nighttime activity: Friday 9:00 pm – Monday 6:00 am

Lane reduction not allowed for the following conditions:

Existing # of GP lanes/direction	Lane closures not allowed	Notes
6 or 7	More than 3 lanes	Maintain minimum 3 lanes of traffic
4 or 5	More than 2 lanes	Maintain minimum 2 lanes of traffic

Detour Route Capacity Assessment

- Some work zones will require closure of a road and detouring traffic to an alternative route.
- It is critical to evaluate the capacity of the alternative route to ensure that the roadway has the adequate capacity for the additional detoured volume.

Detour Route Capacity Assessment

For this analysis use –
Tab 2- Step-2 – Facility Data – to enter the information about the planned detour route

Tab: Detour_Capacity_Assessment – enter the increase in % of the traffic because of detour

If the Roadway Capacity results in Q:
review the V/C ratio where (Q) is present Tab-Detour Capa….., with Tab 2 and identify the increase in V/C ratios.

If the change in V/C ratio > 20% and V/C > 1.2, then excessive queue and delay may be experienced in the planned detour road.

Detour Route Capacity Assessment

Information self populates from Tab: Step-2 Facility Data

V/C > 1 with result in queue

Compare this V/C ratio with the baseline condition of the roadway

If the increase is within the tolerance, then use this road as detour, else use a different work zone strategy or work time

Anticipated increase in volume of the existing facility because of detour

Enter the increase as a percentage of the existing facility's volume

Detour Capacity Analysis Using Simple Math Method

Roadway Information

Route Name	I-10
No. of Lane/direction (normal)	4
ADT of Roadway	225000
Posted Speed	65
District	Central
Area Type	CBD
Roadway Classification	Freeway
HV %	5%
If Arterial - are signals < 1 mile apart	Yes
Grade	<2%
Lane Width	>11.5
Base Capacity	1,650

Fill In information

Choose from Pull Down Menu

Auto fill - don't change value

Detour Volume Estimation

Detour Volume is added to existing roadway, anticipated increase in volume	25%

Directional Hourly Volume *140,625*

Daily Distribution of Traffic Volumes							Base Capacity	
ADT Distribution	Major Arterial		Minor Arterial		Freeway & Expressway		V/C Ratio	Queue In Existing Conditions ?
Hours	%	Vol	%	Vol	%	Vol		
0:00	0.7%	0	0.3%	0	0.9%	1326	0.2	-
1:00	0.5%	0	0.2%	0	0.8%	1106	0.17	-
2:00	0.4%	0	0.2%	0	0.8%	1132	0.17	-
	0.6%	0	0.3%	0	1.3%	1758	0.27	-
		0	0.6%	0	2.3%	3247	0.49	-
			1.8%	0	4.1%	5746	0.87	-
				0	5.3%	7439	1.13	Q*
						8312	1.26	Q*
8:00	5.8%	0	6.2%	0			1.2	Q*
9:00	5.8%	0	4.8%	0	5.4%	7549	1.14	Q*
10:00	5.5%	0	5.1%	0	5.4%	7617	1.15	Q*

Detour Route Capacity Assessment – Example

Road A is planned as the detour route for US 17, when US 17 will be closed for construction.

Road A is a four-lane roadway with 37,700 ADT

US 17 carries approximately 17,500 ADT

Calculate the resultant increase in percent of traffic on Road A because of US 17 closure

$$\frac{17,500}{37,700} = 46.41\ \%$$

Detour Capacity Analysis Using Simple Math Method

Roadway Information

Route Name	Road A
No. of Lane/direction (normal)	2
ADT of Roadway	37700
Posted Speed	45
District	Northwestern
Area Type	Sub-Urban
Roadway Classification	Minor Arterial
HV %	15%
If Arterial - are signals < 1 mile apart	No
Grade	<2%
Lane Width	>11.5

Fill In information

Choose from Pull Down Menu

Auto fill - don't change value

Detour Volume Estimation

Detour Volume is added to existing roadway, anticipated increase in volume: 46%

Base Capacity	1,940
Directional Hourly Volume	*27,598*

Examples