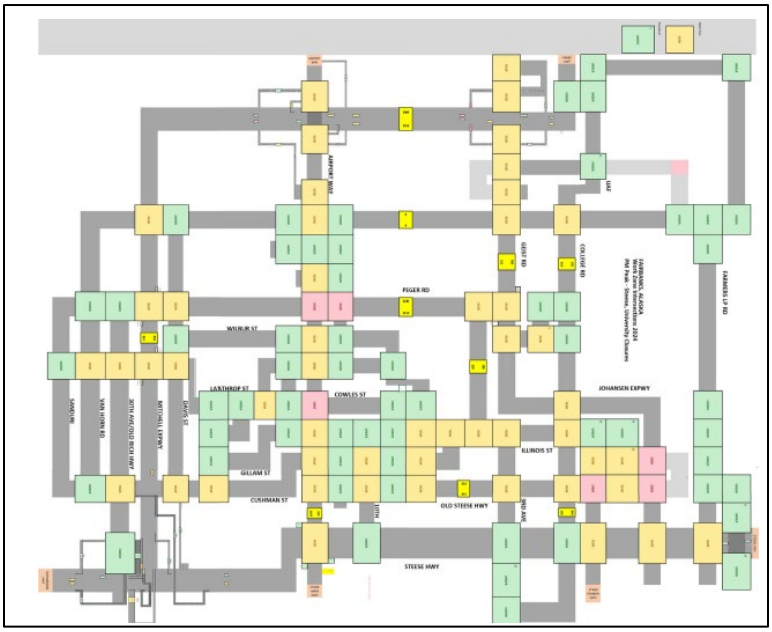
Research & Technology Transfer

Urban Work Zone User Impacts

FINAL REPORT – UrbanWZ 1-2-3 Analysis Tool Users Guide



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Each year, short-term and long-term work zones are put into place to allow for construction, maintenance and rehabilitation along highways and local roads. Work zones can have a significant impact on traffic flow through the construction site and the surrounding areas. Therefore, Federal Highway Administration (FHWA) and some states have created policies for work zone design pertaining to travel delays, queue length, construction time and cost, the quality of the construction, safety, impacts to businesses, communication with the public, and agency coordination.

Road closures during construction have a larger immediate impact on traffic (all traffic must detour) when compared to maintaining traffic through the work zone (some or all traffic can travel through the work zone); however, there may be an overall benefit to completely closing the road if the work zone activities take less time, are less costly, or are of higher quality. The purpose of this overall project is to research the policies and tools other states are using to make decisions regarding construction road closures, develop an Alaka-specific model for determining when the benefits of a road closure exceed any costs, create a tool to implement the model, and perform a trial run of the tool.

This document summarizes Kinney Engineering, LLC's (KE) research into what FHWA and other states have incorporated into their work zone design policies and tools they use in the work zone design process.

This report includes the User's Guide for the Excel-based traffic analysis tool developed through this project which assists in the evaluation of road closures and lane restrictions on urban projects that balances drivers, local access, work zone safety, and public construction schedules.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	mm	
ft	feet	0.3048	m	
yd	yards	0.914	m	
mi	Miles (statute)	1.61	km	
	AREA			
in^2	square inches	645.2	millimeters squared cm^2	
ft^2	square feet	0.0929	meters squared m^2	
yd^2	square yards	0.836	meters squared m^2	
mi^2	square miles	2.59	kilometers squared km^2	
ac	acres	0.4046	hectares ha	
	MASS (weight)			
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms kg	T
	Short tons (2000 lb)	0.907	megagrams	mg
	VOLUME			
fl oz	fluid ounces (US)	29.57	milliliters mL	gal
	Gallons (liq)	3.785	liters	liters
ft^3	cubic feet	0.0283	meters cubed m^3	
yd^3	cubic yards	0.765	meters cubed	

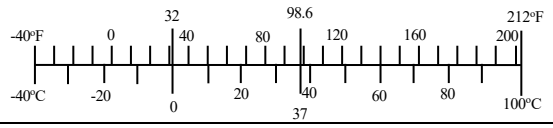
m^3 Note: Volumes greater than 1000 L shall be shown in m^3

	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (°F-32)	Celsius temperature	°C
	ILLUMINATION			
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m^2 cd/cm^2	
	FORCE and PRESSURE or STRESS			
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply	To Find Symbol	By
	LENGTH			
mm	millimeters in	0.039	inches	
m	meters ft	3.28	feet	
m	meters yd	1.09	yards	
km	kilometers mi	0.621	Miles (statute)	
	AREA			
mm^2	millimeters squared in^2	0.0016	square inches m^2	
	meters squared 10.764	square feet	ft^2	km^2
	kilometers squared 0.39	square miles	mi^2	ha
	hectares (10,000 m^2) 2.471	acres	ac	
	MASS (weight)			
g	grams oz	0.0353		
kg	kilograms lb	2.205	megagrams mg	
	(1000 kg) 1.103	short tons	T	
	VOLUME			
mL	milliliters fl oz	0.034	fluid ounces (US)	
liters	liters gal	0.264	Gallons (liq)	
m^3	meters cubed ft^3	35.315	cubic feet	
m^3	meters cubed yd^3	1.308	cubic yards	
	TEMPERATURE (exact)			
°C	Celsius temperature °F	9/5 °C+32	Fahrenheit temperature	
	ILLUMINATION			
lx	lux fc	0.0929	foot-candles	
cd/cm	candela/m^2 fl	0.2919	foot-lamberts	
2				
	FORCE and PRESSURE or STRESS			
N	newtons lbf	0.225	pound-force	
kPa	kilopascals	0.145	pound-force per psi square inch	



Urban Work Zone User Impacts

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Annotated Bibliography
for Urban Work Zone User Impacts

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Abbreviations

AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
CDOT	Colorado Department of Transportation
CO^3	Construction Congestion Cost tool
DOT	Department of Transportation
DOT&PF	Alaska Department of Transportation and Public Facilities
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
IHCP	Interstate Highway Congestion Policy
INDOT	Indiana Department of Transportation
KSU	Kansas State University
LCS	Lane Closure Strategy
MDOT SHA	Maryland Department of Transportation State Highway Administration
MIZZOU	University of Missouri
MnDOT	Minnesota Department of Transportation
MTI	Mineta Transportation Institute
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NJDOT	New Jersey Department of Transportation
NJTA	New Jersey Turnpike Authority
ODOT	Oregon Department of Transportation
RILCA	Rutgers Interactive Lane Closure Application
RITIS	Regional Integrated Transportation Information System
ROW	Right-of-way
RUC	Road user costs
SHRP2	Second Strategic Highway Research Program
TMP	Traffic Management Plan
UMich	University of Michigan
UWZUI	Urban Work Zone User Impacts
VOC	Vehicle Operating Costs
VDOT	Virginia Department of Transportation
VTrans	Vermont Agency of Transportation
WISE	Work Zone Impacts and Strategies Estimator
WZTA	Work Zone Traffic Analysis

Introduction

Each year, short-term and long-term work zones are put into place to allow for construction, maintenance and rehabilitation along highways and local roads. Work zones can have a significant impact on traffic flow through the construction site and the surrounding areas. Therefore, Federal Highway Administration (FHWA) and some states have created policies for work zone design pertaining to travel delays, queue length, construction time and cost, the quality of the construction, safety, impacts to businesses, communication with the public, and agency coordination.

Road closures during construction have a larger immediate impact on traffic (all traffic must detour) when compared to maintaining traffic through the work zone (some or all traffic can travel through the work zone); however, there may be an overall benefit to completely closing the road if the work zone activities take less time, are less costly, or are of higher quality. The purpose of this overall project is to research the policies and tools other states are using to make decisions regarding construction road closures, develop an Alaka-specific model for determining when the benefits of a road closure exceed any costs, create a tool to implement the model, and perform a trial run of the tool.

This document summarizes Kinney Engineering, LLC's (KE) research into what FHWA and other states have incorporated into their work zone design policies and tools they use in the work zone design process.

Overview of Findings

FHWA offers guidance in the Highway Capacity Manual (HCM) as well as a toolbox called QuickZone for states to use prior to construction to help minimize impacts due to traffic delays. These tools consider potential impacts that work zones might have such as capacity reduction, limited access to businesses, limited access and safety concerns for pedestrians and bicyclists, potential impacts to transit users, as well as motorist and worker safety. Other things that should be considered include increased travel time, increased emergency response time, and higher emissions.

Michigan, Maryland, Indiana, Oregon, Colorado, Minnesota, New Jersey, and Vermont all have manuals that offer guidance on work zone design, including maximum allowable queue lengths and traffic delays and suggestions for communicating with the public. Michigan, Indiana, and Oregon use spreadsheet-based tools for lane closure planning. Maryland has a computer program and New Jersey has a GIS-based tool. Kansas utilizes a Microsoft Access database chart that will tell the user when lane closures are allowed, based on input of the county, route, time of year and mile point.

The documents contained within in this annotated bibliography are grouped in five subtopics. The main findings for each topic include:

1. Criteria to Use in Evaluating Full Closure Decisions: A full road closure may provide faster project delivery, resulting in less inconvenience to motorists and increased safety. However, detour routes need to be analyzed to ensure the road can handle the increased traffic flow from diverted traffic. Impacts to local businesses and residents also need to be looked at. The calculation of the cost of a closure should include any upgrades to the detour route, traffic control devices needed for the detour route, and the cost of public outreach.
2. Criteria to Use in Evaluating Lane Closure Decisions: Evaluations for lane closure decisions tend to focus on motorist inconveniences (such as traffic queue length, traffic delay time and increased travel time through a construction zone). Construction cost and duration is generally not a consideration in determining when lanes can be closed and for how long. Many states publish tables showing how many lanes can be closed by day of the week and time of day for specific roadways or types of roadways.
3. Work Zone Impact Assessment: Documents in this section focus on evaluating the impacts of a work zone, including road user costs (like delay), as well as impacts to pedestrian and bicycle traffic, local businesses, and neighboring streets. Several specific software or spreadsheet tools are described:
    a) FHWA provides a toolbox that lists performance measures that could be considered when analyzing work zone traffic including existing travel time, delay caused by lane or road closure, queue length, speeds, capacity of the roadway, LOS, vehicle-miles traveled, or vehicle-hours traveled. Other factors that are not easy to monetize include business impacts, community impacts, and noise. Delay, queue length, speed, and volume are measures usually used during the design phase to determine if a lane closure or road closure is necessary. FHWA has been developing a tool to analyze the impacts on road users of multiple, concurrent work zones across a network or complex corridor. This tool is in the evaluation stages in several states.
    b) Michigan uses a macro-based spreadsheet tool to determine the user delay time and cost and the potential queue lengths.
    c) Indiana has a spreadsheet-based tool to determine the potential queue length and equations. The Indiana DOT design manual provides equations for calculating user costs along a detour route as well as tools to determine whether a full closure with a detour is a viable alternative for interstates and non-interstate highways.
    d) Maryland uses Synchro to analyze the impacts construction delays would have on the connected road network, including potential detour routes if a road closure is necessary. The state has established work zone related acceptable queue lengths and time delay limits that the analysis results are compared against.
    e) Oregon DOT has a spreadsheet-based tool that can be used to determine, based on existing traffic information, when traffic volumes are low enough that lane closure is a

viable option for a work zone rather than a complete road closure based on the output of estimated queue length and user delay costs.

4. Case Studies: Case studies from other states and countries provide examples of what type of data was collected, what software was used for the analysis, what the model outcome was, and how it affected the project decision making process.
5. Data Collection and Observations: Data regarding work zone impacts such as volume, speed, and delay can be collected using a variety of sources, including in-pavement detection, RITIS data, and traffic signal detection. Additional data of interest includes speed limits, number of lanes, lane width, shoulder width, hourly traffic volumes, and truck volume. The area to be studied depends on the size of the construction project, the planned construction dates, the length of the construction zone, the type of closure being modeled, and the surrounding road network.

The criteria presented in the sources described in the annotated bibliography are presented in table format in the last section of this report, organized by type. Links to the descriptions of the source documents are included in the tables.

Annotated Bibliography

Criteria to Use in Evaluating Full Closure Decisions

The documents in this section of the annotated bibliography describe procedures to evaluate whether a full road closure is appropriate for a specific construction project. Summarized below are documents written for Colorado, Virginia, Vermont, Minnesota and FHWA detailing the analysis process used during the planning phase to evaluate the road network affected by the proposed construction to determine if a full road closure is the best option.

Lund, Michael and Sarah Schacher. *Work Zone Impacts; Construction IM 21-01; NR Design Directive 21-01*. Alaska Department of Transportation and Public Facilities, 2021. https://dot.alaska.gov/nreg/precon/designdirectives/2021/NR_DD_21-01_Work_Zone_Impacts.pdf. Accessed December 10, 2021.

This memorandum describes procedures for coordinating work zone impact analysis and decisions across construction projects. For construction projects where road closures are anticipated, the memorandum presents a decision matrix that should be filled out as early as practicable in the design phase of the project to evaluate whether the project is a candidate for full road closure during construction. The evaluation criteria include impacts to various road user types, access impacts, and potential benefits in terms of construction time or cost. The memorandum also provides an outline for a traffic impacts analysis that should be completed for every project that will include road closures.

Work Zone Safety & Mobility Policy and Guidance. Vermont Agency of Transportation, 2021. https://vtrans.vermont.gov/highway/work-zone-safety. Accessed August 30, 2021.

Full road closures are considered if there are viable detour routes and the closure will accelerate the construction schedule; when the full road must be closed to accommodate the construction; and when emergency vehicle access can be accommodated and operations are not adversely impacted. Factors to account for when considering a full road closure include detour route capacity and safety; the need for any off-site improvements to the roadway or intersections to accommodate the additional detoured traffic, including truck traffic; truck traffic volumes and turning radii; non-motorized user access; residential and business access; and emergency vehicle access.

The guidance presents what information should be communicated to the public, such as safety messages and what users can expect traveling through the work zone or along the alternate route, for example, when the lanes or roads are closed; expected travel times, speeds, and delays; detour routes; and alternate modes of transportation or methods to reduce work zone traffic.

Strategies used to convey the information include printed brochures or mailers, press releases (radio, television, newspapers), social media, email lists, telephone hotlines, websites, public hearings, and community, business, and neighborhood group meetings.

Boodlal, L., D. Garimella, K. Chiang, S. D. Schrock, and E. J. Fitzsimmons. *NCHRP Research Report 945 Strategies for Work Zone Transportation Management Plans.* Transportation Research Board of the National Academies, Washington, D.C., 2020. http://www.trb.org/Main/Blurbs/181230.aspx. Accessed August 16, 2021.

A guidebook to aid state Departments of Transportation (DOTs) to develop and implement a work zone transportation management plan (TMP) that reduces crashes and other impacts of work zones. The guidebook presents a wide range of TMP strategies and provides information for identifying when a strategy is appropriate. One of the strategies included is a full road closure. The guidebook provides the following information pertinent to the UWZUI research goals:

- The benefits of a full road closure include:
    - faster project delivery
    - reduced inconvenience to motorists
    - larger working area and increased productivity
    - improved project quality due to a reduction in the number of joints and seams
    - reduced exposure for road users and construction personnel.
- The disadvantages of a full road closure include:
    - significant short-term travel effect on the public
    - increased traffic congestion on other routes
    - need to construct or improve detour route
    - adverse effects on businesses on the route of the full closure due to reduction in traffic volumes
    - adverse effects on businesses on the detour route due to too much traffic.

According to the FHWA study, *Full Road Closure for Work Zone Operations*, a full road closure reduces the average duration of a project by 76.5 percent, compared with part-width construction.

- Factors that should be considered in deciding whether to implement a full road closure include:
    - local agency agreement/coordination
    - the contractor's ability to complete the work on an accelerated schedule (working longer hours, obtaining adequate resources, etc.)
    - whether or not detour routes can handle oversize, over height, and overweight trucks
    - effects on businesses
    - impacts to local residents if work is scheduled on a 24-hour basis
    - ability to shift drivers to other modes.
- The cost of the closure depends on:
    - the need for upgrades to the detour route

- the necessary traffic control devices
- the necessary public outreach
- road user costs.

This guidebook includes the process Colorado DOT (CDOT) uses for analyzing requests for a full road closure and for ensuring that an approved closure is implemented successfully (described later in this section).

Chapter 8 - Temporary Traffic Control, 2020. In *Traffic Engineering Manual*. Minnesota Department of Transportation Office of Traffic, Safety, and Technology. https://www.dot.state.mn.us/trafficeng/publ/tem/index.html. Accessed August 25, 2021.

"Chapter 8 – Temporary Traffic Control" in the Minnesota DOT (MnDOT) *Traffic Engineering Manual* lists factors for when full road closure should be considered, such as the work zone cannot support traffic and construction at the same time, an accelerated schedule is desired, and the work zone cannot accommodate certain vehicles due to physical constraints (weight or size of vehicles).

The manual states that the maximum delay through the work zone should not exceed 15 minutes. Similarly, overall travel time on the detour route should not exceed 15 minutes. Demand management strategies should be considered if delays are anticipated to be longer than 15 minutes.

DeVries, L., S. Hersey, A. Tesfaye, and D. Reeves. *Full Closure Strategic Analysis.* CDOT-2014-7. Colorado Department of Transportation Applied Research and Innovation Branch, 2014. https://www.codot.gov/safety/traffic-safety/standard-and-specifications/work-zone-safety. Accessed August 18, 2021.

The strategic analysis was developed to provide a simple and consistent decision-making process to determine when to implement full closures in Colorado. A three-step process was developed as the decision tool, requiring information from an applicant (contractors, consultants, local agencies, or CDOT maintenance personnel) and a response from CDOT Traffic.

Step 1 requires the applicant to fill out a worksheet describing basic details of the closure, including location, estimated time of closure, highway characteristics, detour route, anticipated time and cost savings for a full closure versus phased construction scenario, and other potential benefits to a full closure. CDOT reviews the information and fills out an evaluation form qualitatively ranking the following criteria as favorable, fair, or unfavorable:

1) Impact to traffic (ADT x Number of days)
2) Functional equivalence of detour roadways
3) Use of state highways as detour routes
4) Impacts to businesses and local access
5) Travel distance added by detour

6) Local agency coordination
7) Advance public notice
8) Potential for diversion out of area (availability of alternative routes)
9) Construction time savings
10) Ability to do concurrent work

If a project is advanced to Step 2, CDOT may then request the applicant provide additional analyses and details such as including traffic impacts analyses, refined cost and time savings calculations, public information strategies, coordination with agencies and CDOT, further definitions of detour routes and diversions, and a check for any coinciding closures along the detour routes.

Step 3 involves the implementation of the full closure once it is approved. It requires having approved traffic control plans, coordinating with agencies and CDOT, having plans to monitor the effects of the closure and quickly make adjustments, and ensuring no conflicting closures exist.

Fontaine, M. D., B. H. Cottrell, and P. J. Chun. *Considerations for the Development of Work Zone Mobility Performance Measures and Thresholds for Virginia Freeways Final Report*. VCTIR 14-R6. Virginia Center for Transportation Innovation and Research, 2014. https://www.virginiadot.org/vtrc/main/online_reports/pdf/14-r6.pdf. Accessed August 25, 2021.

VDOT surveyed twelve state DOTs regarding performance measure thresholds and how they are used. They received six responses. After reviewing the actions taken by the various DOTs when the performance measure thresholds were exceeded, VDOT concluded that most DOTs use the thresholds to aid in decision making, but do not forbid the use of work zone alternatives that exceed the threshold. Five of the six DOTs that responded used private sector data sources such as INRIX or SpeedInfo and Regional Integrated Transportation Information System (RITIS) was used for querying the INRIX data.

Delay and queues are often the performance measures for work zone mobility. Delay measures include average delay per vehicle, average delay per person, total vehicle-hours of delay, and total person-hours of delay. Queuing measures include average queue duration, average queue length, number/percentage of time periods queuing occurs, maximum queue length, and percentage of time queue length exceeds a distance threshold.

VDOT conducted four case studies using private sector (INRIX) data to estimate delay and queue lengths. It was concluded that queue lengths were harder to determine using private sector data. The traffic data segment length plays a role on the precision of the queue length; shorter links (usually located in urban areas) generally estimated more precise queue lengths compared to longer links (usually located in rural areas). For delay measures, private sector data were found to be a viable source.

Work Zone Operations Best Practices Guidebook (Third Edition). FHWA-HOP-13-012. FHWA, U.S. Department of Transportation, 2013. https://ops.fhwa.dot.gov/wz/practices/best/documents/bpguidebook.pdf. Accessed August 25, 2021.

The guidebook presents best practices that state agencies use for work zone operations. Pertinent strategies for lane restrictions and road closures include:

- A1-1 Road Closure Program: Arizona DOT has a lane closure program that conducts a benefit/cost study for road closures to determine if a road can be closed for a project. The study considers traffic volumes, the duration of the project, and the length of the detour.
- A1-7 Lane Closure Policy/Map: Several state agencies (California, Colorado, Indiana, and Ohio) have policies and maps that present where and when lane closures are allowed. Factors used to determine allowable lane closures include hourly traffic counts, capacity, estimated queues, and estimated wait times.
- C1-2 Using Software to Predict Congestion and Associated User Costs: Some state DOTs use software to predict queue lengths and user costs due to lane closures, primarily for freeway projects. At the time the guidebook was published, Indiana DOT (INDOT) used QueWZ98 software, calibrated for the state, to estimate queues resulting from lane closures.
- C1-4 QuickZone Impact Analysis Spreadsheet: FHWA developed a work zone delay impact analysis spreadsheet tool called QuickZone. The tool is used to determine corridor delay, identify impacts of alternate construction phasing, and determine impacts of mitigation strategies. QuickZone 2.0 is currently available for purchase at https://store.mctrans.ce.ufl.edu/quickzone.
- D1-2 Corridor Planning to Minimize Delays and Enhance Safety in Work Zones: For freeways and high-volume arterials, INDOT collects data on the corridor to determine the existing roadway volumes and how much traffic can be served during reconstruction. The traffic that cannot be served is diverted to alternate routes and is analyzed to determine if improvements are needed on the alternate routes to accommodate the additional traffic.
- E2-2 Comparison of the Estimated Construction Time Required to Maintain Traffic Versus Diverting Traffic: INDOT requires an analysis to compare the benefits and costs of different traffic management options to determine the most appropriate to implement. Considerations include right-of-way costs, user-delay costs, and likelihood of accidents for on-site locations. For detours, considerations include additional travel time, the cost to travel the additional distance, costs of needed improvements along the detour route, and the effects the detour has on the community and businesses.
- E2-4 Evaluating Staging Approaches to Assess Tradeoffs between Traffic Flow and Construction Efficiency: Massachusetts DOT uses queue analysis and compares delay costs with potential savings (based on construction duration) for different alternate staging approaches to determine the effects to traffic flow.

A 2017 addendum provided additional best practice strategies. The additional strategies are not pertinent to this project.

Boodlal, L., and T. Abraham. *Training Course on Developing Transportation Management Plans for Work Zones Participant Workbook*. FHWA-HOP-12-037. FHWA, U.S. Department of Transportation, 2012. https://ops.fhwa.dot.gov/wz/resources/final_rule/tmp_examples/tmp_training/tmp_wrkbk_index.htm. Accessed August 18, 2021.

Module 4 of this workbook delineates impacts that should be considered as part of a work zone impacts assessment and outlines how to develop mitigation strategies to minimize impacts or keep them within agency thresholds. If impacts are acceptable, a TMP can be developed. If impacts are unacceptable, mitigation strategies should be identified and analyzed.

All potential impacts should be considered in the assessment including capacity reduction, access to business properties, access and safety of pedestrians and bicyclists, transit use and routes, motorist and worker safety, and impacts to the road. The module discusses examples of these impacts, how they may differ by area, why it is important to assess them, and the importance of doing an early impact assessment. An impacts assessment typically includes a traffic analysis for existing conditions as well as for proposed construction conditions/alternatives (for all affected roads) to determine where traffic delays or queueing may occur, with the extent determined by agency guidelines.

The work zone impact assessment process is also delineated. Step 1 is to compile project information including roadway characteristics, traffic characteristics, and construction alternative issues. The benefits of a full closure are also considered, such as enhanced worker or traveler safety, better quality of the product, and ability to accelerate the schedule. Step 2 of the process determines the work zone performance the agency is aiming for and describes measures of effectiveness to use, which should meet agency guidelines and policies. Step 3 is to assess the alternatives at a macro-level to select the best option. The analysis can range from qualitative to a detailed quantitative analysis depending on the size of the project. Step 4 is a micro-level analysis of the selected work zone option to compare existing conditions and work zone traffic conditions and determine impacts and any mitigations needed prior to construction, such as modifying signal timing. Impacts due to traffic delays and queues include increased travel time, increased emergency response time, and higher emissions.

Arizona DOT has a similar assessment process found in their *Implementation Guidelines for Work Zone Safety & Mobility* report.

Criteria to Use in Evaluating Lane Closure Decisions

The documents in this section of the annotated bibliography describe procedures to evaluate when and if lane closure is the best option for a construction project. Summarized below are documents written for Colorado, Virginia, Vermont, Minnesota and FHWA detailing the analysis

used to evaluate the road network affected by the proposed construction to determine if a lane closure is the best option. Some of the techniques and data sources described in these documents may be useful in the development of a decision tool for DOT&PF.

McGhghy, B, L. Rajasekar, L. DeVries, and R. Saline. *Lane Closure Strategy.* Colorado Department of Transportation, 2019. https://www.codot.gov/safety/traffic-safety/assets/work-zones/lane-closure-strategies/R1_Lane_Closure_Report.pdf. Accessed August 18, 2021.

The *Lane Closure Strategy* (LCS) for CDOT Region 1 was developed to balance travel time delays through work zones for the public with the cost of construction and maintenance. It is not intended to be a stand-alone document; it should be used with other available relevant information and in conjunction with Colorado statutes. The report is for lane closures only; full closures are addressed in the CDOT *Full Closure Strategic Analysis*.

The report establishes the LCS procedures used to identify and recommend when single-lane, multi-lane, and ramp closures are allowed. Roadways are grouped by type: freeways, multi-lane arterials, three-lane highways, two-lane highways, and freeway ramps. Work zone capacities and lane closure thresholds were reported for each roadway type. For example, lane closures are not allowed on freeways nor on two-lane highways if the traffic demand exceeds the reduced available capacity. Lane closures are generally not allowed on multi-lane arterials when the average delay exceeds 10 minutes; arrival and departure curves were used to calculate delays and queues using methodology presented in the 1990 *Fundamentals of Traffic Engineering* book. For freeway ramps, it was found that ramps with similar traffic volume levels tend to have similar hourly traffic flows, therefore, a ramp schedule was presented of allowable ramp closure hours based on traffic volumes and day of week (weekday or weekend).

The report appendices present pre-approved lane closure schedules for state highways in Region 1 based on roadway type, time of year, day of week, and length of lane closure.

Similar LCS reports are available for CDOT Regions 2 through 5 that establish their own capacity and delay thresholds for various roadway types and present pre-approved lane closure schedules.

Fitzsimmons, E. J., B. G. Nye, and S. Dissanayake. *Updating the Lane Closure Guide for Urban Highways in the Kansas City Metropolitan Area*. KSU-16-4R. Kansas State University Transportation Center, 2018. https://www.ksdot.org/Assets/wwwksdotorg/bureaus/KdotLib/2018/KSU-16-4_Summary.pdf. Accessed August 25, 2021.

The previous Kansas State Lane Closure Guidance Chart was updated using current data. The chart is an interactive spreadsheet in which the user selects specific segments of the interstates, US highways, and state highways in urban areas. The guide uses traffic volumes for each direction of highway by time of day, day of week, and month of year and compares the volumes for a given segment to general lane capacities for each segment, to determine the number of

lanes needed to accommodate the expected traffic. The interactive guide returns a graphic showing the number of lanes that should remain open by time of day for the selected day and month in order to accommodate the expected traffic volumes. The report also describes the data collection effort needed to update the guide to include all possible segments and to include accurate volume information.

Interstate Highway Congestion Policy. Indiana Department of Transportation, 2017. https://www.in.gov/indot/safety/work-zone-safety/interstate-highways-congestion-policy/. Accessed August 23, 2021.

The INDOT, Interstate Highway Congestion Policy (IHCP) describes the state policy for restricting lanes on interstates during construction to reduce traffic impacts and increase work zone safety. The appendices include exemptions to the policy.

Analysis guidelines are provided to support exceptions to the policy, which include methods to adjust traffic counts and methods to evaluate traffic impacts. Seasonally adjusted volumes are compared to the expected capacity of the lane-restricted work zone. INDOT provides expected capacities through work zones corresponding with the number of lanes closed (Table C-2), which are derived from the Highway Capacity Manual (HCM).

No additional analysis is needed if volumes are expected to be less than the work zone capacity. If volumes exceed the work zone capacity, analysis is required to estimate queues through the work zone. The INDOT Queuing Analysis Tool is the preferred software to evaluate the lane closure, though QuickZone 2.0 and other preapproved software can be used. The 2017 ICHP no longer permits the use of QueWZ98 for lane closure exceptions.

For interstate highway lane closures lasting more than ten days, queue and delay measurements are required during construction. Measurements should be taken between three to five days after and seven to ten days before significant traffic control changes, such as the initial traffic maintenance setup or a change in the maintenance setup or phase.

Road User Cost Manual. New Jersey Turnpike Authority, 2011. https://www.njta.com/doing-business/professional-services/publications/manuals/road-user-cost-manual-worksheets. Accessed December 10, 2021.

This manual focuses on methods for evaluating work zones with lane or shoulder closures on the New Jersey Turnpike. It includes measures for calculating vehicle operating costs due to speed changes as traffic enters a work zone, for stop-and-start operations in a work zone, and for idling while queued in a work zone. It also explains how to calculate delay costs for travel through a work zone at a reduced speed and for travel through a work zone when there are queues.

Ozbay, Kaan and Bartin, Bekir. *Development of Uniform Standards for Allowable Lane Closure FINAL REPORT*. FHWA-NJ-2008-014. Rutgers University; New Jersey Department of Transportation Bureau of Research; and FHWA, U.S. Department of Transportation, 2008. https://rosap.ntl.bts.gov/view/dot/17673. Accessed August 26, 2021.

The New Jersey DOT looked at the road closure guidelines of several states to help them develop a uniform process to evaluate freeway lane closure impacts. The report discusses the guidelines used, including microsimulation programs and acceptable queue lengths for various state agencies and the British Colombia Ministry of Transportation.

The New Jersey Turnpike Authority uses a GIS tool, Rutgers Interactive Lane Closure Application (RILCA), to calculate short-term lane closures on several interstates and New Jersey state routes. They use a Road User Cost Model, developed by a private firm, as a guide in their software to generate the delay and queue lengths. RILCA uses time, date, traffic volume and lane information, as well as how long the lane closure is expected to last, and number of lanes closed, to calculate the hourly queue and delay. They use QuickZone for long term lane closures with detour routes; the tool is described in detail in the report.

Work Zone Impact Assessment

This section summarizes documented evaluation procedures that can be used to determine the impacts a work zone will have on users.

Chapter 503 Maintenance of Traffic, 2021. In *Indiana Design Manual-2013*. Indiana Department of Transportation. http://www.in.gov/dot/div/contracts/design/Part%205/Current%20Version%20of%20Chapter%20503%20-%20Traffic%20Maintenance.pdf. Accessed August 18, 2021.

Chapter 503 “Traffic Maintenance” of the INDOT Design Manual (last revised in 2021), contains calculations to determine the queue lengths and the daily detour costs for motorists. INDOT has a spreadsheet-based Queuing Analysis Tool to estimate queue lengths and vehicle capacity through the work zone with lane restrictions. Queue length for a certain hour is calculated using the queue length of the previous hour, hourly volume (in passenger car equivalent per mile per lane), hourly capacity, jam density, and the number of available storage lanes upstream from the lane restriction. Existing speed limit and number of lanes, as well as number of work zone lanes and lane widths, are needed to determine existing and work zone capacities.

The Design Manual provides equations to determine detour user costs along the detour route. Variables include cost of lost time, cost of extra distance traveled, number of vehicles detoured, value of motorist time, vehicle operating expenses, length of detour and work zone, and average travel speed along the detour and through the work zone. The cost of any improvements needed on the detour route should also be considered.

Other factors listed that should be considered when comparing the cost of construction options include temporary and permanent right-of-way costs, construction costs, construction time savings, quality of work, environmental impacts, utility impacts, vehicle delay, daily and total project user costs, potential for crashes, worker safety, and travel time.

The Design Manual has links to spreadsheet-based tools to determine the viability of a full closure with a detour route for interstate and non-interstate highways. Capacities on the detour route are determined using Figure 503-2A in the manual, which presents capacity (per hour per lane) for different roadway types based on a minimum level of service (LOS) E operation.

Work Zone Traffic Analysis Manual. Oregon Department of Transportation Traffic-Roadway Section, 2020. https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/Work-Zone-Analysis-Manual.pdf. Accessed August 23, 2021.

The Work Zone Traffic Analysis Manual is a guidebook Oregon DOT (ODOT) uses with the Work Zone Traffic Analysis Tool (WZTA) tool to determine when traffic volumes are low enough that lanes can be safely closed, and it provides delay estimates to quantify the impacts of lane closures and other mobility restrictions. It uses ODOT 24 hour full vehicle classification counts, annual average daily traffic (AADT) volumes, annual growth rates, truck percentages and seasonal trend data to determine lane closure restriction charts and estimated travel delays. The WZTA tool is a spreadsheet that can be found on the ODOT website (available at https://www.oregon.gov/odot/Engineering/Docs_TrafficEng/WZTA-Tool.zip). The WZTA tool is used by inputting traffic count data, heavy vehicle adjustments, growth adjustment, AADT adjustments, seasonal adjustments and then selecting type of closure and estimated work zone capacity. This spreadsheet will then produce estimated queue length and user delay cost based on the input data.

Pulugurtha, S. S., P. Penmetsa, and V. R. Duddu. *Monetizing Reliability to Evaluate the Impact of Transportation Alternatives*. NCDOT Project 2015-07, FHWA/NC/2015-07. Infrastructure, Design, Environment, and Sustainability (IDEAS) Center, 2017. https://connect.ncdot.gov/projects/research/RNAProjDocs/2015-07_Final%20Report.pdf. Accessed August 25, 2021.

Researchers used a random general survey conducted in seven cities, towns and other areas across North Carolina and collected 417 responses. Nine focus group meetings of 93 participants total met and were given a presentation to explain the concept of travel time reliability and explaining the research project. This group was then asked about their tolerance towards lack of reliability, how long they would tolerate it and how many days each month would they be willing to tolerate it. The data collected from the general survey and the focus group were used to assess the value of buffer time and wage rate per minute of those who would choose the reliable route irrespective of possible travel time savings along the alternate route.

Using the calculated value of buffer time, NCDOT could calculate the benefit of reducing buffer time on a roadway and compare it to construction or other costs.

SHRP2 Solutions. *WISE: Work Zone Impacts and Strategies Estimator Software (R11): An innovative approach and traffic analysis tool for planning work zones earlier to better manage highway reliability and safety across corridors and networks*. FHWA, U.S. Department of Transportation, 2014. https://www.fhwa.dot.gov/goshrp2/Solutions/Reliability/R11/WISE_Work_Zone_Impacts_and_Strategies_Estimator_Software. Accessed September 16, 2021.

The Work Zone Impacts and Strategies Estimator Software or WISE (R11) is being developed through the second Strategic Highway Research Program (SHRP2) to analyze the impacts on road users of multiple, concurrent work zones across a network or complex corridor. The tool analyzes how a multitude of projects in a road network being constructed at the same time can affect traffic flow on a system-wide basis. The tool can recommend efficient staging strategies. When the software is used as a planning tool, WISE develops an optimized renewal programming schedule that minimizes the total cost of delays to the public and agency construction cost and when used at the operational level, it evaluates the impact of individual strategies at the project level and provides results that can then be used as part of an iterative procedure with the planning analysis.

Zhang, L., D. Morallos, K. Jeannotte, and J. Strasser. *Traffic Analysis Toolbox Volume XII: Work Zone Traffic Analysis – Applications and Decision Framework*. FHWA-HOP-12-009. FHWA, U.S. Department of Transportation, 2012. https://ops.fhwa.dot.gov/publications/fhwahop12009/fhwahop12009.pdf. Accessed August 25, 2021.

The toolbox lists performance measures that could be considered when analyzing work zone traffic: travel time, delay, queue length, speed, capacity, LOS, vehicle-miles traveled, or vehicle-hours traveled. Delay, queue length, speed, and volume are measures usually used on a sketch-planning level, while the other measures can sometimes be used depending on the analysis. QuickZone and the Highway Capacity Manual are examples of tools used on a sketch-planning level. For work zone capacity, the toolbox recommends collecting and using local data. However, default capacities are presented as a starting point that can later be adjusted to reflect local work zone conditions.

Emissions and fuel consumption are other performance measures that can be considered when assessing work zone traffic. The toolbox lists benefit/cost analysis models, which include unit cost estimates for emissions. The two tools listed are FHWA's HERS-ST and an estimate tool from California DOT.

This has been reviewed in California, Florida, Maryland, and Tennessee as proof-of-concept to be used as a dynamic traffic tool to optimize the regional freeway construction schedule in a way that minimizes delays to road users.

Mallela, J., and S. Sadasivam. *Work Zone Road User Costs – Concepts and Applications*. FHWA-HOP-12-005. FHWA, U.S. Department of Transportation, 2011. https://ops.fhwa.dot.gov/wz/resources/publications/fhwahop12005/. Accessed September 1, 2021.

Road user costs (RUC) are the summation of travel delay costs, vehicle operating costs (VOC), crash costs, emission costs, and impacts of nearby projects. The study gives examples on calculating most of the RUC components and suggests using methods from FHWA *Traffic Analysis Toolbox Volume IX*. Other factors that are not easy to monetize include business impacts, community impacts, and noise.

The study presented tools state agencies have used to assist in calculating RUC components such as QuickZone, QUE-98, and CA4PRS (Construction Analysis for Pavement Rehabilitation Strategies). Other states have developed spreadsheet tools. The tools generally have work zone configuration and capacity, traffic demand and composition, travel speeds, and unit costs as inputs. Tool outputs may include travel delay, queue lengths, crash costs, and/or estimated emissions. The tools mentioned in the study are based on HCM methodologies and are generally on a sketch-planning level.

The study listed performance measures generally used to analyze construction alternatives. Mobility performance measures included total road user cost, queue length, delay and travel time, incident clearance time, and buffer index. Safety mobility measures included estimated injury crashes and property damage only crashes.

The Kepner-Tregoe decision analysis method is recommended for selecting the construction alternative. The Kepner-Tregoe method breaks down measures by MUST and WANT objectives. Alternatives need to meet all the MUST objectives in order to move forward in the analysis. Examples of MUST objectives include maximum queue length, maximum delay time, and available detour capacity. The WANT objectives are the desired conditions that will be used to select the preferred alternative and can be weighted to prioritize the objectives. Examples of WANT objectives include minimize daily RUC, minimize detour length, and minimize queue length.

Maryland State Highway Administration Work Zone Analysis Guide. Maryland State Highway Administration, 2008. https://www.roads.maryland.gov/OOTS/WorkZoneAnalysisGuide_Sept08.pdf. Accessed August 24, 2021.

Maryland's Work Zone Analysis Guide breaks down the analysis process into work performed on arterial routes and on freeways. The existing level of service of the road, types of traffic signals in the area and the existing travel time through the area are compiled during the traffic analysis process. Maryland typically uses Synchro as a traffic analysis tool, analyzing a study network that includes the closest intersections, potentially affected side roads, the suggested detour routes and if there are traffic signals within the construction area, any other roads in the coordinated signal system. They will compare the results to set allowable mobility thresholds for time delay for arterial routes and length delay for freeways.

Maryland State Highway Administration Work Zone Lane Closure Analysis Guidelines. Maryland State Highway Administration, 2006. https://www.roads.maryland.gov/OOTS/13LaneClosureGuidelinesrev1.pdf. Accessed August 23, 2021.

The Maryland State Highway Administration created guidelines for all projects on state-maintained roads in order to help minimize the severity and length of delays in work zones. All roadwork projects, except emergencies or routine maintenance, are evaluated and analyzed to ensure any planned lane closures do not cause bottlenecks or long congestion delays. They offer standard acceptable queue lengths for freeway projects, time constraint for delays on arterial projects and signal control delay for intersections, depending on the level of service.

For projects where traffic impacts are expected to exceed allowable thresholds, traffic analyses are performed during the planning or early design stages of the project development process to compare work zone options, including staging/phasing options as well as temporary traffic control options, and the benefits and constraints of each option are documented.

Carr, Robert. *CO^3 User Manual.* University of Michigan Department of Civil and Environmental Engineering, September 18, 1997. https://www.michigan.gov/documents/mdot/CO3_User_Manual_464636_7.pdf. Accessed August 27, 2021.

The manual describes how to use the CO^3 (COnstruction COngestion COst) system to compare different work zone alternatives. The macro-enabled spreadsheet-based tool is used to calculate user delay times, user delay costs, and queue lengths of up to four different lane or road closure alternatives. Inputs to the tool include vehicle classification percentages (car or truck), user cost per hour, user cost per mile, reduced capacity, and historical hourly demand, as well as distances, speeds, speed delays, and any decrease to traffic demand of each alternative. Decrease to demand include drivers choosing other routes or cancelling trips due to construction. The tool is also used

for comparing alternate routes. The manual describes calculations used in the tool and provides an example project with examples on how CO^3 would be used.

Case Studies

This section provides documentation of completed studies that estimated the best work zone closure options for future construction or an event. Some of the studies also present the actual conditions when the work zone was in place.

Phillips, K., and T. Nguyen. *Long-term Urban Road Restrictions During Special Events. In Proceedings of the 2014 Conference of the Transport Association of Canada*. Montreal, Quebec, 2014. http://conf.tac-atc.ca/english/annualconference/tac2014/s-25/phillips.pdf. Accessed August 26, 2021.

Lane closures were planned on Yonge Street in Toronto, Canada as part of a pedestrian installation event that occurred in August and September 2012, reducing the number of lanes available for traffic flow from two lanes in each direction to one lane in each direction. To quantify the effect of the lane closures on multi-modal traffic volumes, turning movement counts were collected along the affected intersections on Yonge Street and along parallel arterials in July 2012 (pre-event) and again in September 2012 (during the event). Pedestrian and bicycle counts were included in these turning movement counts. Pedestrian counts were also collected using automated counters installed at three locations along Yonge Street. Traffic volumes were noted to move from Yonge Street to parallel arterial roadways; however, the report notes that Younge Street volumes are normally less than volumes on the parallel roadways, so the traffic volume changes were relatively small and did not significantly impact the other roadways.

Identifying the Optimal Road Closure with Simulation. In Proceedings of the 20th ITS World Congress. ITS Japan, Tokyo, Japan, 2013. https://ide-research.net/papers/2013_ITS_World_Congress_Osogami.pdf. Accessed August 26, 2021.

Researchers used a simulation of the Hiroshima city network and 24-hour origin-destination data for 220 traffic analysis zones within the city to determine the effect of two different closure schemes for construction work on a 6-lane highway. In both schemes, all lanes for one direction of traffic were closed. In one scheme, the opposite direction traffic lanes were used as normal (three lanes of traffic flowing in one direction). For the other scheme, the opposite direction traffic lanes were shared by both traffic flows (one lane of traffic in each direction). The time period of interest was midnight to 5 AM. The simulation showed that there was not a significant difference in the volume changes on roadways in the network between the two scenarios. The researchers concluded that the decision of which scheme to use could be based on other factors.

Full Road Closure for Work Zone Operations: A Cross-Cutting Study. FHWA, U.S. Department of Transportation, 2003. https://ops.fhwa.dot.gov/wz/resources/publications/fullclosure/crosscutting/its.htm. Accessed August 30, 2021.

Six interstate or state highway projects that utilized full closures (full road closure or full directional closure) are described. Overall, the projects chose the full closure approach to accelerate construction, increase safety, and because alternate routes were available to detour vehicles. The full closures reduced the construction duration between 63% to 95% compared to traditional construction methods.

Three projects reported using demand or equilibrium models to predict where traffic would go during the closures. Capacity improvements were made on alternate routes prior to the full closure. Two of the projects observed less demand on the alternate routes than the models predicted. This was attributed to either travel pattern changes, transportation mode changes, or drivers choosing routes other than the designated detour route. Traffic in the road network was found to reach equilibrium about two weeks after the full closure.

Public outreach was a key component of success; the public should be informed of what to expect during the closures, such as the planned detour routes and expected delays along the routes. The I-95 project in Wilmington, Delaware started the outreach campaign two years before the full closure and had public relations personnel as part of the team to keep the public well informed throughout the project. A radio station was purchased and was dedicated to relay traffic information 24 hours a day. Other outreach included newspaper ads, television commercials, project website, email lists, brochures, and telephone hotlines.

Data Collection and Observations

A variety of road and traffic data is available to be used to model current conditions and anticipated conditions during the construction to help make the best decision for cost, time and safety.

Kukkapalli, V. M., and S. S. Pulugurtha. *Modeling the Effect of a Road Construction Project on Transportation System Performance*. Project 1702B. Mineta Transportation Institute, 2019.

For a freeway road closure, researchers observed travel time on the freeway and parallel arterial roadways before and during the construction period, and calculated a variety of reliability metrics, such as average travel time, planning time, buffer time, and travel time index. The travel time and speed data for the roadway links of interest was downloaded from the RITIS website. The researchers also collected characteristics of the roadway links, such as speed limit, number and width of lanes, shoulder widths, and traffic volumes. Generalized linear models were used to compare the travel time parameters for the study links before construction with those parameters during construction. In general, travel time on the freeway was reduced during construction and travel time on the arterial routes was increased during construction.

Edara, P., Y. Chang, C. Sun, and H. Brown. *Data-Driven Traffic Impact Assessment Tool for Work Zones*. University of Missouri-Columbia, 2017. https://intrans.iastate.edu/research/completed/developing-a-data-driven-traffic-impact-assessment-tool-for-work-zones. Accessed on August 19, 2021.

Researchers gathered data for hundreds of work zones on two interstate highways and one arterial in the St Louis, Missouri area between January 2014 and September 2015. Data collected included: start and end date, length of work zone, the number and type of closed lanes (left, middle, right), and travel time. The travel time data was obtained from the RITIS website for the segment containing the work zone, the two segments immediately upstream from the work zone, and all of the available road segments within a two-mile radius of the work zone. Travel time data for the three weeks prior to the work zone activity was compared to the travel time during the work zone activity to compute travel time delay. A Random Forests statistical technique was used to model the travel time delay. A tool was then developed to estimate travel time delay for work zones on segments along the studied roadways. The tool is an interactive program that can be downloaded and run on a Windows computer.

Kwon, Eil and C. Park. *Development of a Guideline for Work Zone Diversion Rate and Capacity Reduction*. Minnesota Department of Transportation, 2016.

The researchers collected volume, travel time, average speed, 15-minute flow rate, and density for the freeway mainline and ramps before and during construction projects. The researchers also collected travel time and length for alternative routes. The freeway data was collected at sensors in the roadway. Arterial data was collected from traffic signal detectors. Diversion rates were calculated by comparing volumes before and during construction. A model for the diversion rate was developed by comparing the mainline traffic condition and the travel time for the alternate routes. A process for estimating the amount of traffic diversion for a specific work zone was developed, using the following steps:

1. Model freeway under normal conditions using micro-simulation model (Freeval).
2. Calibrate model with travel time data collected under normal conditions.
3. Adjust freeway model to represent proposed work zone conditions.
4. Estimate travel time for diversion route using speed limit data
5. If travel time for freeway under construction does not equal diversion route travel time, plug traffic conditions for the freeway work zone into diversion calculation.
6. Adjust volumes in freeway model based on diversion calculations. Repeat 5 and 6 until travel times converge.

Barnard, R. K. A Mix of Innovations Succeeds in Minnesota. In *FHWA Public Roads*. FHWA-HRT-09-004 Vol. 72, No. 6, 2009. https://www.fhwa.dot.gov/publications/publicroads/09june/02.cfm. Accessed August 23, 2021.

MnDOT retained a market research firm to conduct phone surveys and ask the public if they preferred an urban highway in St. Paul, Minnesota to be fully closed for 5 months or partially closed for 16 months. A total of 1,074 people responded to the survey and the results were split almost 50/50. As a result, MnDOT weighed the benefits and costs of the closure scenarios and selected the full closure for faster construction, lower costs, safer work zone, and higher quality of roadwork. A follow-up survey was conducted to the public after construction and revealed that nine out of ten people surveyed from each audience group (residents, businesses, and commuters) strongly agreed with MnDOT's decision to fully close the highway. At least two in five people surveyed from each group who opposed the full closure prior to construction changed their opinion afterwards, and fewer than one in ten surveyed from each group who were for the full closure had negative opinions after construction.

MnDOT held open houses at communities most affected by the construction to inform the public about the project timeline and to answer questions. Workshops were held for affected business owners to present the expected traffic patterns during the full closure. The workshop provided an opportunity for businesses to brainstorm marketing tactics to let the public know businesses were still open during construction.

Summary of Criteria to Consider for Full Closure Decisions

The Northern Region Design Directive 21-01 regarding work zone impacts provides a Road Closure Matrix form that examines 9 criteria that should be considered in deciding whether or not to allow a full road closure during construction. All of these criteria are also included in at least one of the other sources presented in the Annotated Bibliography section of this document. In addition to these 9 criteria, we have identified 37 other criteria that were described in the sources and could be used for evaluating either the appropriateness of a full road closure or the impacts of a proposed closure. All 46 criteria are presented in this section.

The criteria are separated by type, as follows:

Travel Time or Delay. Criteria that measure or describe impacts to road users in terms of changes in travel time or delay for a road closure as compared to maintaining traffic through the work zone.

Queues. Criteria that measure or describe queue lengths or durations for a road closure as compared to maintaining traffic through the work zone.

Construction Time, Cost, or Quality. Criteria that measure or describe changes to construction time, cost, or quality for a road closure as compared to maintaining traffic through the work zone.

Safety. Criteria that measure or describe changes in crash experience for either road users or construction workers for a road closure as compared to maintaining traffic through the work zone.

Business Impacts. Criteria that measure or describe impacts to businesses on the route under construction or the designated detour route.

Agency Coordination. Criteria that describe impacts to agencies other than the owner agency or the coordination needed with them.

Other. All other criteria.

Each criterion is also designated as descriptive or calculated:

Descriptive. Criteria that identify planning level considerations that either evaluate the appropriateness of a road closure or suggest coordination or more detailed analysis tasks that will be needed before a road closure can be approved.

Calculated. Criteria that can be calculated using available data and that result in a numerical value. These can be used to describe the expected benefits or costs of a road closure.

Travel Time or Delay Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Freight inventory delay	Evaluate the cost of goods being delayed in transit	Calculated	Value of average payload times the change in travel time for freight vehicles	2008 NJDOT
Road user delay	Evaluate the delay experienced by road users due to the road closure	Calculated	Calculate change in travel time for maintaining traffic through construction zone compared to travel along detour route	2014 VDOT
Road user costs	Evaluate the cost of road users being delayed by work zone	Calculated	Calculate change in time spent in queue or travel time for maintaining traffic through construction zone compared to travel along detour route	2021 INDOT, 2020 ODOT, 2012a FHWA, 2011 FHWA, 2011 NJTA, 2008 NJDOT, 1997 UMich
Vehicle operating costs	Evaluate the vehicle operating costs for changes due to detour	Calculated	Calculate incremental vehicle operating costs (equal to extra travel distance multiplied by the number of vehicles detoured and the IRS standard mileage rates) Calculate vehicle operating costs due to a speed change Calculate vehicle operating costs due to idling	2021 INDOT, 2011 FHWA, 2011 NJTA, 2008 NJDOT

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Average delay (travel time)	Evaluate difference in travel time with and without road closure	Calculated	Calculate change in travel time for maintaining traffic through construction zone compared to travel along detour route Could evaluate as percent of hours exceeding a threshold per day or something similar	2014 VDOT, 2012a FHWA, 2011 FHWA, 2008 NJDOT, 1997 UMich
Reliability	Evaluate difference in buffer index with and without road closure	Calculated	Calculate change in buffer index for maintaining traffic through construction zone compared to travel along detour route Buffer index is the difference between the 95th percentile travel time and the average travel time, divided by the average travel time	2011 FHWA
Average delay per vehicle	Evaluate delay experienced at key locations (signalized intersection on detour route, for example)	Calculated	Calculate delay at key locations Could sum along detour route Could compare to delay without construction Could compare to maximum acceptable value, could monitor during construction	2019 CDOT, 2014 VDOT
Intersection level of service	Evaluate change in Level of Service (LOS) for intersections with and without work zone operations	Calculated	Calculate the control delay and level of service at intersections (signalized and unsignalized) affected by the work zone Compare to control delay and level of service without work zone. Depending on without work zone level of service, different thresholds are applied	2012a FHWA, MDOT SHA 2008, MDOT SHA 2006

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Segment level of service	Evaluate change in Level of Service (LOS) for segments with and without work zone operations	Calculated	Calculate the level of service for segments affected by the work zone Compare to level of service without work zone. Depending on without work zone level of service, different thresholds are applied	2012a FHWA, MDOT SHA 2008, MDOT SHA 2006
Number of impacted vehicles	Compares the total number of vehicles impacted by a road closure to specific thresholds	Descriptive	AADT X # of days Favorable: <50,000 Fair: 50,000 to 100,000 Unfavorable: >100,000	2021 DOT&PF, 2014 CDOT
Functional classification	Evaluates whether or not detour routes have same or higher functional classification as compared to closed route	Descriptive	Favorable: Detour has same or higher functional classification Fair: Detour has lower functional classification, but can accommodate diverted traffic similar to closed road Unfavorable: Detour is of a lower functional classification	2021 DOT&PF, 2014 CDOT, 2012a FHWA
Added travel distance	Compares the travel distance for the detour routes as compared to the closed route	Descriptive	Favorable: 3 times travel distance or less Fair: 3 to 5 times travel distance Unfavorable: greater than 5 times travel distance	2021 DOT&PF, 2014 CDOT

Queue Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Queue length	Evaluate length of queues at key locations (signalized intersection on detour route, for example)	Calculated	Calculate queue lengths at key locations impacted by the road closure Could calculate average or maximum queue length over specific time Could compare to a maximum acceptable value, could monitor during construction, could compare as a percentage of road closure length	2021 INDOT, 2020 ODOT, 2019 CDOT, 2014 VDOT, 2012b FHWA, 2011 FHWA, 2008 NJDOT, 1997 UMich,
Queue duration	Evaluate duration of queues at key locations (signalized intersection on detour route, for example)	Calculated	Calculate queue duration at key locations impacted by the road closure Could calculate average or maximum queue duration over specific time Could compare to a maximum acceptable value, could monitor during construction, could compare as a percentage of road closure duration	2019 CDOT, 2014 VDOT, 2008 NJDOT
Percentage of time impacted	Evaluate the percentage of time a construction-related queue impacts traffic	Calculated	Calculate queue length or duration by time of day. What percentage of the time periods evaluated is queuing expected to occur or to exceed a predefined threshold value?	2014 VDOT

Construction Time, Cost, or Quality Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Construction cost savings	Evaluate construction cost change with and without road closure	Calculated	Calculate construction cost with traffic maintained through work zone and construction cost with road closure Include cost of detour route improvements	2014 CDOT, 2008 NJDOT
Accelerated construction benefits	Consider if there are circumstances that would make a shorter construction time beneficial	Descriptive	Is there a benefit to accelerating the construction schedule that would make it worth closing the road compared to a lane closure? (i.e. busy road, highly visible, upcoming event) Yes/No	2014 CDOT
Construction time savings	Evaluate construction time change with and without road closure	Calculated	Calculate construction time with traffic maintained through work zone and construction time with road closure Favorable: >30% reduction Fair: 0-30% reduction Unfavorable: 0% reduction	2014 CDOT
Accelerated construction constraints	Consider if there are circumstances that would increase construction time in spite of road closure	Descriptive	Does the contractor have the equipment, crew and materials to accelerate the schedule? Yes/No Will material availability limit construction acceleration? Yes/No Are there time of day constraints (such as houses nearby that would be affected by the noise and lights of construction) that will limit construction acceleration? Yes/No	2020 NCHRP, 2019 CDOT

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Quality of product	Consider if the quality of the final product will be improved if the road is closed during construction	Descriptive	Will the construction quality be better with complete road closure than with lane closure? Yes/No	2014 CDOT
Construction time or cost	Evaluates if a closure will reduce the construction time or cost	Descriptive	Yes/No	2021 DOT&PF, 2020 NCHRP, 2014 CDOT, 2008 NJDOT

Safety Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Traveler safety	Evaluate road user crash experience with and without a road closure	Calculated	Calculate crash likelihood for maintaining traffic through construction zone compared to travel along detour route	2014 CDOT, 2012a FHWA
Construction worker safety	Evaluate construction worker crash experience with and without a road closure	Calculated	Calculate crash likelihood for maintaining traffic through construction zone compared to travel along detour route	2014 CDOT, 2012a FHWA
Active transportation safety	Evaluate crash experience for people walking and biking with and without a road closure	Calculated	Calculate crash likelihood for maintaining traffic through construction zone compared to travel along detour route	2012a FHWA
Injury crash rate	Evaluate change in injury crash rate with and without a road closure	Calculated	Calculate the change in injury and fatal crash rate for maintaining traffic through construction zone compared to travel along detour route	2011 FHWA

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
PDO crash rate	Evaluate change in PDO crash rate with and without a road closure	Calculated	Calculate the change in PDO crash rate for maintaining traffic through construction zone compared to travel along detour route	2011 FHWA
Crash costs	Evaluate change in crash costs with and without a road closure	Calculated	Calculate the change in the crash costs for maintaining traffic through construction zone compared to travel along detour route	2011 FHWA
PDO incident clearance time	Evaluate time to clear work zone after a PDO crash	Calculated	Calculate average time to clear a work zone after a PDO crash or number of PDO crashes cleared within a threshold time	2011 FHWA

Business Impacts Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Adverse impact for businesses on closed route	Consider if reduced traffic volumes on the closed route will negatively impact businesses on that route	Descriptive	Will businesses on the closed route be negatively impacted? Yes/No Would an alternative construction traffic control reduce the negative impact? Yes/No	2020 NCHRP
Adverse impact for businesses on detour route	Consider if increased traffic volumes on the detour route will negatively impact businesses on that route	Descriptive	Will businesses on the detour route be negatively impacted? Yes/No Would an alternative construction traffic control reduce the negative impact? Yes/No	2020 NCHRP

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Economic cost	Evaluate economic impact of access or traffic volume changes during construction	Calculated	Collect data on economic cost of a closure as part of environmental impacts assessment	2008 NJDOT
Access impacts	Considers whether or not access can adequately be provided on the closed route	Descriptive	Favorable: Local land use does not directly access the closed route Fair: Equivalent alternate methods can provide access to land uses for the closed route Unfavorable: Access to local land uses will be impractical or circuitous	2021 DOT&PF, 2014 CDOT, 2012a FHWA

Agency Coordination Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Adjacent construction projects	Consider if effects of other construction projects need to be considered	Descriptive	Are there adjacent projects? Yes/No Will the delays or detours of one project impact the other project? Yes/No	2014 CDOT, 2008 NJDOT
Detour route ownership	Consider if detours will affect roads owned by other agencies	Descriptive	Are there other agencies whose roads will be impacted? Yes/No Favorable: Detour uses state highways Fair: Detour uses mix of state and non-state highways Unfavorable: Detour uses only non-state highways	2014 CDOT

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Ability to do concurrent work	Considers if a closure can facilitate other activities	Descriptive	Favorable: Other work can be done that would otherwise require a separate closure Fair: Other work can be done that would otherwise impact traffic separately Unfavorable: No additional activities can be accomplished	2021 DOT&PF, 2014 CDOT

Other Criteria

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Advanced public notice	Consider if there is adequate time to provide advance notice, which could be needed to build public support	Descriptive	How much advance notice can be given? Favorable: > 2 weeks Fair: 1 to 2 weeks Unfavorable: <1 week	2014 CDOT
Emissions	Consider if vehicle emissions under a road closure result in higher emissions that reduce quality of life?	Descriptive	Does increase in emissions during construction result in increased emissions above the community standard? Yes/No	2012a FHWA
Accommodation of oversize trucks	Consider if oversize trucks need to be accommodated on detour route	Descriptive	Do oversize trucks use typically use the closed route? Yes/No Can the detour route accommodate oversize trucks? Yes/No	2020 NCHRP, 2019 CDOT
Accommodation of active transportation modes	Consider if pedestrians can be accommodated if road is closed	Descriptive	Will road closure restrict pedestrian or bicyclist access? Is there an alternative route? Yes/No	2012a FHWA

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Emergency response	Consider if emergency response will be affected if road is closed	Descriptive	Will road closure affect emergency response vehicles? Yes/No Will the detour increase response time? Yes/No	2014 CDOT, 2012a FHWA
Availability of detour route	Consider if a feasible detour route is available	Descriptive	Is there a detour route available? Yes/No	2019 CDOT, 2008 NJDOT
Suitability of construction times or dates	Consider if special event or seasonal traffic impacts will need to be accommodated	Descriptive	Will the detour route be affected by special events traffic (state fair, concerts, sports events, etc.) during construction? Yes/No Will the detour route be affected by school traffic or seasonal recreational traffic during construction? Yes/No	2020 NCHRP, 2019 CDOT
Potential for diversion out of area	Consider if there are route alternatives that would allow drivers to avoid the construction area entirely	Descriptive	Favorable: There are well-known regional travel options Fair: There are limited travel options Unfavorable: There are very few travel options	2014 CDOT
Impacts to freight routes	Considers impacts to freight routes	Descriptive	Favorable: Not on primary freight route Fair: On primary freight route, but alternate routes are available and will not be under construction Unfavorable: On primary freight route and alternate routes have planned construction	2021 DOT&PF, 2012a FHWA

SUB-CRITERIA	EXPLANATION	DESCRIPTIVE/ CALCULATED	HOW IS IT MEASURED?	SOURCE(S)
Impacts to transit routes	Considers impacts to transit routes	Descriptive	Favorable: Not on transit route Fair: Transit stops can be accommodated with minimal impacts Unfavorable: Transit stops cannot be accommodated within a reasonable distance	2021 DOT&PF, 2012a FHWA
Impacts to schools/bussing routes	Considers impacts to school traffic or school bus routes	Descriptive	Favorable: All work can be done when school is not in session OR Not near a school nor on a school bus route Fair: School bus access can be maintained near existing stops Unfavorable: Work will close a primary bus stop or parent drop off during the school year	2021 DOT&PF, 2020 NCHRP, 2020 ODOT

Appendix A: UrbanWZ 1-2-3 Urban Work Zone Analysis Tool User's Guide

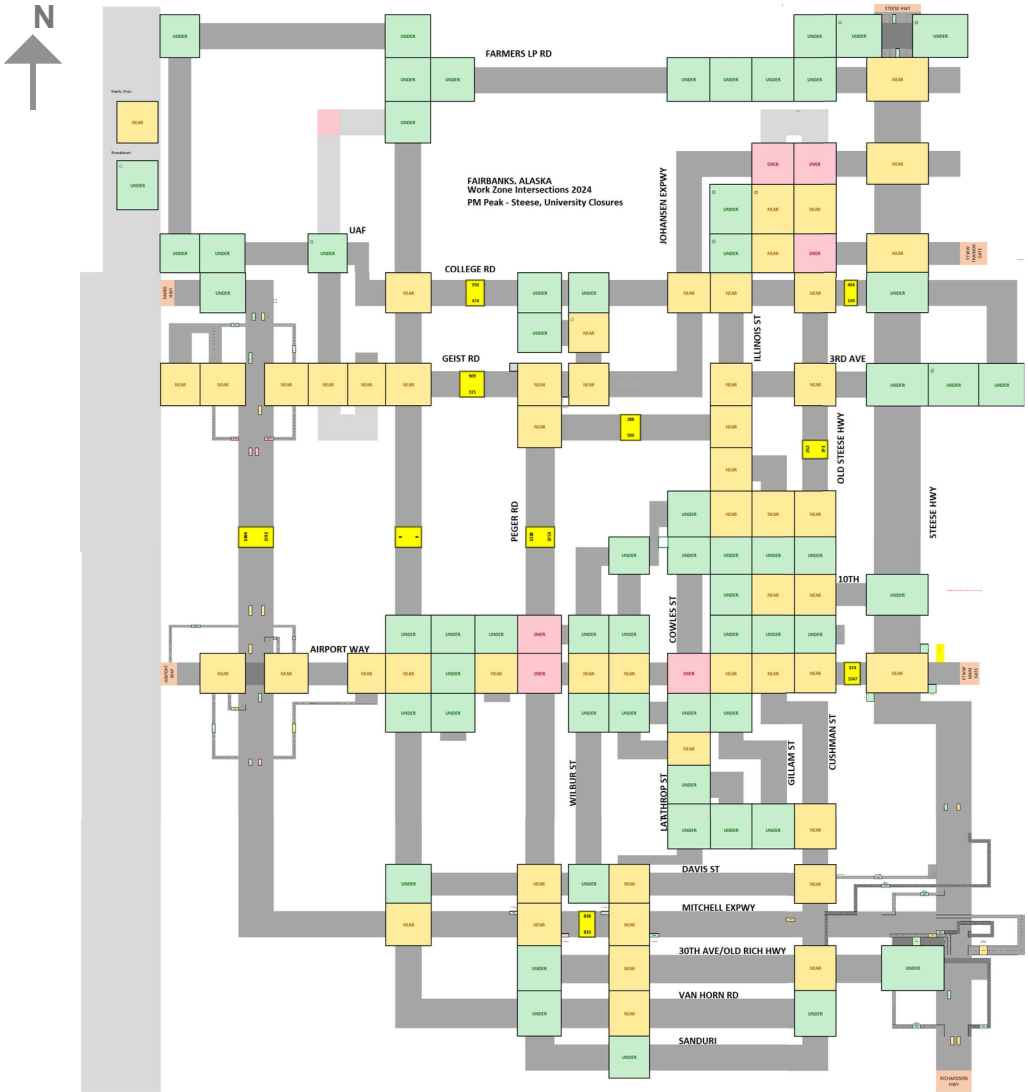
Urban Work Zone Analysis Tool
UrbanWZ 1-2-3
User's Guide, Revised

November 20, 2024

Prepared for
State of Alaska
Department of Transportation & Public Facilities (DOT&PF)
Research Project # HFHWY00226 / 000S948

by Kinney Engineering, LLC

Planning capacity analysis spreadsheet templates
for mapping and comparing Urban Work Zone Detour routing
to Existing Conditions capacity in any urban area.



Example: Fairbanks, Alaska

UrbanWZ 1-2-3
Urban Work Zone Analysis Tool

Quick Update Guide

November 20, 2024

Annual Updates using Excel Templates

Once an urban are or city Excel file has been created using the detailed User's Manual, it is possible to maintain annual updates to traffic data and work zone planning by updating the first three tabs only:

1 Tab 1 Change or keep User Thresholds for Existing and Work Zone conditions.
Edit any desired changes to turning movement percentage assumptions.
Input annual growth rate if desired for long range growth comparison.

2 Tab 2 Input changes to annual turning movement counts if known.
Input changes to intersection approach lanes or speed limits.
Changes to traffic control type can also be specified.

3 Tab 3 Input "X" for any planned lane closures.
Input "D" for any detour routes.
Input "E" for the end of a detour route if desired to stop traffic volume increases or decreases.
Input approach lane reductions at intersections.
Input work zone segment speed reductions on approaches to intersections.

Tabs 12 and 13 can be filtered and ranked for a printed for a Summary of existing versus work zone or long range conditions.

Tabs 9 and 10 can be printed to get a condensed map of exiting versus work zone or long range intersection capacity. Depending on the paper size and urban area size, this can require more than one sheet.

Urban Work Zone Analysis Tool WZAT
ALASKA REGIONS MODELED



FAIRBANKS, AK *(pop. 96,000 including the City and surrounding Borough)*
There are 116 urban intersections evaluated in the Fairbanks, AK spreadsheet model with custom interchange layouts. The area has about 75 traffic signals with at least two expressways around and through the city. Having a greater choice of alternative routes results in most detours having a low impact on overall urban area capacity However, when two major parallel corridors had to be closed simultaneously in 2022, modeling results reflect observed conditions where individual turning movements can be come overloaded and intersections over capacity will increase. Some intersection retrofits, and careful planning of multiple closures look like ways to minimize capacity concerns.

EAGLE RIVER, AK *(pop. 6500, unincorporated)*
There are 26 intersections evaluated in the Eagle River, AK model, consisting of primarily an original highway urbanized with signals next to a newer parallel freeway. Interchange templates were added with 3 interchanges parallel the city. The freeway carries high traffic volumes connecting a series of communities in the State, at well over 50,000 vehicles per day. The limited choice of alternative routes means when freeway closures occur due to incidents and emergencies such as a bridge strike or earthquake caused bridge closure as in 2018, the small downtown alternative routes are overwhelmed for capacity. Alternative detour strategies for the freeway are an evident need.

SITKA, AK *(pop. 8350, city within Borough)*
24 intersections were evaluated in the Sitka, AK model, for a community network on an island unaffected by roads to other community highways. A roundabout anchors the central road system with a high two lane volume over 10,000 vehicles per day on one route. When cruise ships bring thousands of pedestrians to the city, modeling shows closures of downtown to favor pedestrians, or closures of the central roundabout can push adjacent intersections into caution mode, “near” capacity. Some intersection retrofits may minimize concerns during closures.

Urban Work Zone Analysis Tool
UrbanWZ 1-2-3 Background

PLANNING LOS

Planning Level of Service (LOS) analysis is sometimes called a “napkin sketch” technique. It is a simple measure of critical volumes (vehicles per lane per hour) that enter into an intersection without conflict, without needing to input and model complex signal timing settings. This can also be critical volumes at a roundabout entrance versus upstream circulating volume, or at a freeway ramp entrance, where critical volumes merges into an outer lane at or near carrying capacity.

Planning analysis methods have been documented for decades as noted in sources below. With experience, engineers and planners can quickly recognize critical volumes (the highest combination of left turns against opposing through traffic), and add up east-west plus north-south conflicts to “size up” whether an intersection may be deficient or excess in terms of lanes available to meet demand.

WZAT

These WZAT spreadsheet templates are developed to allow a person to “build” a map and make quick assessments of any urban network for both Existing Conditions and Work Zone Detour routing during peak hours. These templates help spot the potential for lane needs or reductions at intersections or road segments. Changes to lanes, or even closures, can be evaluated, whether temporary or permanent.

This user’s guide was funded under Project # HFHWY00226 / 000S948. The example provided is for Fairbanks, Alaska, population 75,000, with about 75 traffic signals and roundabouts. Fairbanks provides a readily available source of mapping and traffic data to quickly demonstrate spreadsheet feasibility. Similar data can be applied to build other urban areas. This method was once tested for Anchorage, Alaska, population 300,000 with nearly 300 signals and was shown to evaluate the city’s intersection “sizes” in weeks. Prior planning using detailed signal timing settings had been taking more than a year to compile before planning analysis expedited review.

BASIS

Vehicles per lane, per hour are theoretically possible at over 2,000 vphpl under free flowing, ideal conditions. Empirically, motorist behavior and field conditions are not ideal. Distractions, motorist friction, road surface and roadside conditions, lighting, weather, and many factors combine to reduce free flowing capacity to 1500 vphpl or less. Capacity is not a comfortable or ideal operation, and can be on the brink of stop and go movement and intolerable delays for the public. Some studies show an upper range of 1100 to 1350 vphpl may be a better planning threshold for OVER capacity. At intersections where traffic must take turns, inefficiencies may lower these flow rates further to 900 vphpl or less.

A past capacity rule of thumb is that at or below 450 to 500 vphpl is a safe range for an UNDER capacity determination at an intersection. For free flowing lanes this may be .1000 vphpl. For left turning conflicts, 300 vphpl is often suggested as a need to consider dual left turn lanes, which implies that 100-150 vphpl is an indication of a single left turn lane that may be adequate and UNDER capacity. Planning LOS review can help confirm individual movements against conflicts.

Planning Capacity Levels

UNDER	Conflicting volumes at intersections or merges below minimum user defined thresholds of concern. TRB HCM suggests 450 vph is easily accommodated on a through lane approach.
NEAR	Conflicting volumes at intersections or merges are nearing capacity, between user defined thresholds of concern. Observations in Anchorage, AK in the 1990's suggest 900 vph as a peak hour maximum under heavy directional distribution.
OVER	Conflicting volumes at intersections or merges are at or over capacity, above user defined thresholds of concern. This is typically above 1100 to 1350 vphpl similar to observed work zone capacities. Above 1500 vphpl, stop and go queuing, breakdowns may be expected.
INPUTS	User defined traffic volume inputs, thresholds of concern in Tab 1. Acceptable capacity limits may be higher during work zone traffic control than during annual average conditions.

PLANNING versus DESIGN or OPERATIONS

Planning LOS capacity (or “napkin sketch” estimates) are generally best to categorize three basic levels: UNDER, NEAR, or OVER capacity. These are divided by empirical or user defined levels of conflicting volumes at an intersection or merge point. With experience the threshold between UNDER and NEAR may be about 500 to 750 vphpl. The threshold between NEAR and OVER may be 900 to 1350 vphpl. Thresholds depend on ideal versus actual conditions and the ability for traffic to flow under optimum traffic control.

Previous analysis citywide in Anchorage, Alaska has demonstrated OVER capacity is a conservative ranking, that can be slightly improved by 100-200 vphpl, or “one level” better when optimized with efficient signal timing and sequencing. Field operations show this signal timing improvement can realize a “one LOS” grade improvement such as an A-C.

An **ALTERNATIVE LOS** scale can be used for relative planning rankings of whole intersections or free flowing lanes with some roadside and in-lane interference (not for design or operations). Similar scales by others suggest up to 1200 vph maximum for LOS C.

LOS	vphpl
A	<500
B	500-750
C	750-900
D	900-1350
E	1350-1500
>=F	1500+

UNDER
NEAR
OVER

REFERENCES

TRB HCM Ch 6 Freeways, Empirical Capacity in work zones, 1997
TRB HCM Ch 9 Signalized Intersections, Planning Level of Service, 1997
Advantages of the Planning Method of Capacity Analysis for Signalized Intersections, Ruehr, Apr 1989 ITE Journal
NCHRP 187 Quick Response Urban Travel Estimation Techniques and Transferable Parameters, 1978, Updated by NCHRP 716, Travel Demand Forecasting, 2012
Intersection Capacity Measurements through Critical Movement Summations, A Planning Tool, McInerney & Peterson, Jan 1971 Traffic Engineering

UrbanWZ 1-2-3
Map Building

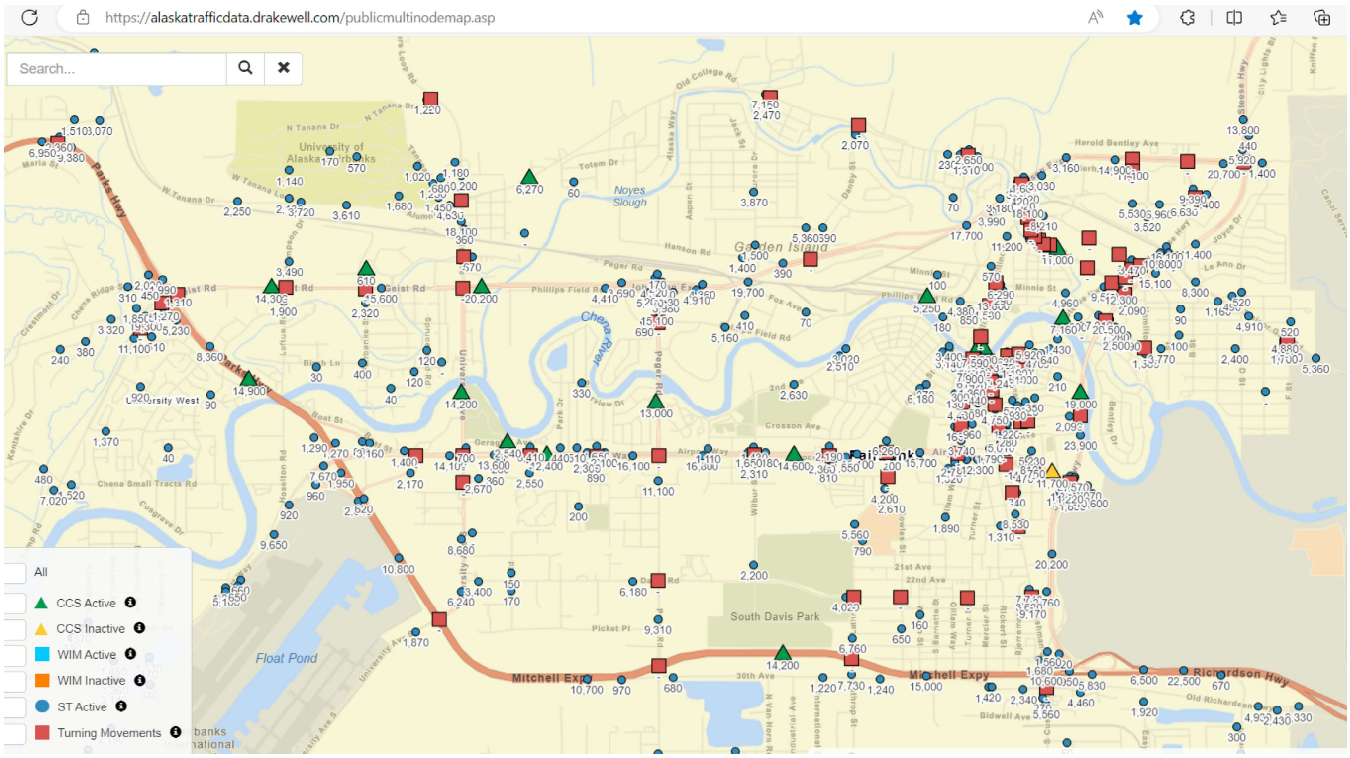
Templates are stored in Columns A-W. Build maps in columns X or AA to the right.

In general, copy 10x10 templates to intersections, creating a 90 degree grid that best represents the urban area layout desired.

The upper left cell in the 10x10 template is placed in the cell address identifying the intersection location. Much like a map, the cell address is a sort of “GPS” coordinate. Use care placing templates spatially such that you can connect intersections and the urban area grid as an area grows, or in case you forget an intersection in between and want to add it later.

Placing templates in 10x10 blocks is more efficient. Templates work best when side by side or stacked on top of each other, building a grid. Templates are set up to directly calculate adjacent traffic inputs and changes with detours. When templates are separated by a gap or a segment that does not have a 10x10 intersection, then you shad the center 8x8 cells grey to show a segment link between templates. Segments links will translate adjacent volumes in later Tabs when setting up detours and rerouting traffic.

Alaska Urban Area Traffic Data



https://alaskatrafficdata.drakewell.com/publicmultinodemap.asp

UrbanWZ 1-2-3
User's Guide

Spreadsheet Tabs and Templates Sequence

User Inputs are in Tabs 1-2-3 only. The rest of tabs auto-calculate.

1-USER	**User defined traffic thresholds**
2IN	**Local AADT, Turning Movements, Map**
3XWZ-DTIN	**User defined detour routes**
4EX	Existing conditions planning LOS results
5WZ+	Traffic increases along defined detours
6WZ-	Traffic decreases due to defined detours
7ADV-DT	Advance turns ahead of turn lane closures
8WZ	Work Zone conditions planning LO results
9EX-LIST	User filtered list of Existing Conditions LOS
9EX-MAP	Map of Existing Conditions LOS
10WZ-LIST	User filtered list of Work Zone LOS conditions
10WZ-MAP	Map of Work Zone LOS conditions
11MERGES	List of Merge concerns Existing & Work Zones
12LOS-EX	VMT, Delay, Costs for Existing Intersections, Segments
12EX-Summary	Summary List for Existing Urban Area
13LOS-WZ	VMT, Delay, Costs for Work Zone Intersections, Segments
13WZ-Summary	Summary List for Changed Urban Area
14DT-Incr_delays	Delay,Cost Increases for Detoured Traffic Only
15DT-Decr_delays	Delay, Cost Decreases for Detoured Traffic Only
HCMRef	Highway Capacity Manual LOS Basis
TimeCalc	Urban Area 20 Year Traffic Growth Calculation
Programming	Template programming for planning LOS
Formatting	Conditional formatting for lanes, LOS

Inputs are not locked cells. Rest of spreadsheets and tabs have locked and write protected cels to prevent errors.

Tabs 9,10, 12, and 13 Lists are not locked - these have user filterable lists for making reports.

Tabs 9 through 13 have printable results for comparing and summarizing changes between work zone conditions, long term 20 year growth assumptions, and existing conditions.

TAB 1 GLOBAL USER INPUTS

1	**TAB**	**1**	**USER defined Vehicular Capacity Thresholds, Planning Level E**									
2	**Urban Area:**	**Fairbanks, AK**										
3	**Analysis Period:**	**Baseline**										
4	**Date:**	**11/19/2024**										
5			**User Input (orange)**									
6	**EXISTING CONDITIONS Thresholds (Tab 3)**		**Intersection Approach Lanes**									
7		Planning Capacity Results	**LT**	**TH**	**RT**		Intent					
8	Intersections, Approach Lanes,	**Under**	50	500	75	<750 vph thru; <50 vph turning LT; <75 vph turning RT						
9	Thresholds of Concern (vphpl)	**Near**				750-1100 vph thru; 50-150 vph turning LT; 75-200 vph turning RT						
10		**OVER**	150	750	200	> 1100 vph thru; > 150 vph turning LT; > 200 vph turning RT						
11	Intersections, Roundabout Circulating Totals as a whole			1225		Free flowing threshold, between intersections, Freeways, Ramps						
12												
13			**User Input (orange)**									
14	**WORK ZONE Thresholds - Tolerances (Tab 8)**		**Intersection Approaches**			Can be modeled as Future Design Year tolerances as well						
15		Planning Capacity Results	**LT**	**TH**	**RT**		Intent					
16	Intersections, Approach Lanes,	**Under**	50	500	75	<750 vph thru; <50 vph turning LT; <75 vph turning RT						
17	Thresholds of Concern (vphpl)	**Near**				750-*1250* vph thru; 50-*200* vph turning LT; 75-*300* vph turning RT						
18		**OVER**	150	750	200	*> 1250 vph thru; > 200 vph turning LT; > 300 vph turning RT*						
19	Intersections, Roundabout Circulating Totals as a whole			1225		Free flowing threshold, between intersections, Freeways, Ramps						
20												
21	**AADT Adjustment Factor**		**120%**			*Adjust annual average daily traffic to reflect seasonal work zone ADT's or future forecast*						
22	**Existing Year Traffic Volumes**		**2022**			*Source from Traffic Counting agency, website*						
23	**Value of Travel Time**	(motorized basis)	**$ 30.00**									
24	**Hours per Day for this comparison**		**1**	*PM*		*Concurs with Time Period selected above?*						
25	**Duration of Year (in Days) for this comparison**		**90**			*Work Zone Closure Period of consideration*						
26	**Design Year Annual Growth Rate**		**0.00%**	*0.00%*		*For 20 Year Long Term Planning, grows Tab 8WZ, Total Growth*						

User inputs are areas in orange.
Input - Urban Area name, and peak hour time period if data is known and available.
Date of calculation is automated each time the file is opened.
Input Planning LOS thresholds of comfort or concern as desired, or accept defaults.
Segments volumes depend on Average Annual Daily Traffic Inputs.
For Work Zone Estimates, input seasonal traffic levels or use 100% for all year.
In Alaska, summer construction windows are limited, and seasonal factors are used to calculate typical turning movements unless actual counts are available.
A Design Year annual growth rate can be input to produce a 20 Year comparison to existing conditions.

Uncounted Intersections and Ramp hourly conversions

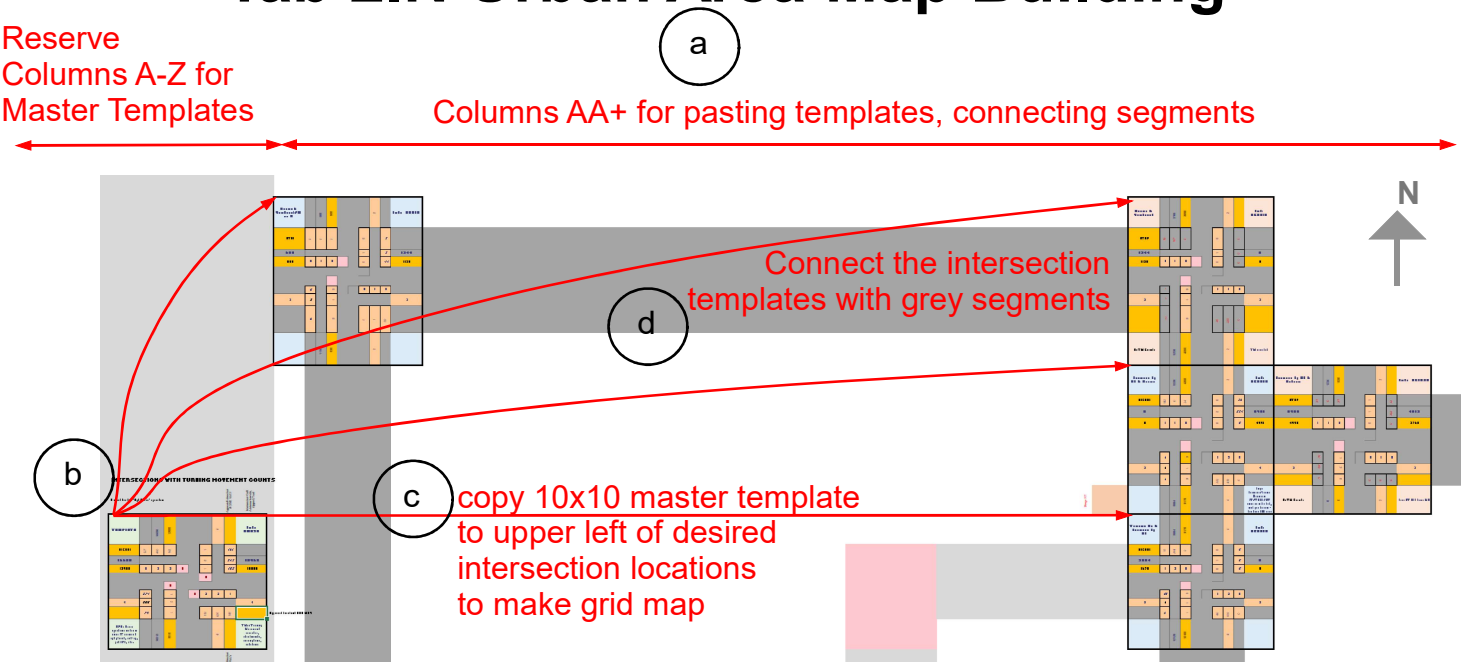
User Inputs (orange)		Default Values					
Time Period	PM	AM	MID	PM	OFF	NIGHT	
DHV	10%	6%	8%	10%	3%	3%	
DD	50%	50%	50%	50%	50%	50%	No DD use - using counts
LT	5%	5%	8%	5%	8%	8%	
THRU	90%	90%	84%	90%	84%	84%	
RT	5%	5%	8%	5%	8%	8%	

Uncounted Intersections and Ramp hourly conversions

User Inputs (orange)		Default Values					
Time Period	PM	AM	MID	PM	OFF	NIGHT	
DHV	10%	6%	8%	10%	3%	3%	
DD	50%	50%	50%	50%	50%	50%	No DD use - using counts
LT	5%	5%	8%	5%	8%	8%	
THRU	90%	90%	84%	90%	84%	84%	
RT	5%	5%	8%	5%	8%	8%	

Choose drop down for peak hour - AM, PM, Off Peak as desired.
Input hourly percentages for traffic input factors as desired, or use defaults.

Tab 2IN Urban Area Map Building



1 **MAP BUILDING Tab 2**

a. Save a copy of the Fairbanks, AK or Eagle RIver, AK spreadsheet to build from existing templates. Use Eagle River, AK if freeway interchange templates are desired. Unprotect worksheet Tab 2, password "UrbanWZ". Delete columns AA+ to create a blank map space to build a new urban area. DO NOT delete columns A-Z with master templates.

b. Copy upper left corner of the 10x10 master template in column M to an intersection "Intx" cell address in Excel, at a location spatially representing urban area grid-intersection location. Start in column AA or greater. Reserve columns A through Z to retain the templates already in the baseline spreadsheet file.

c. Copy additional templates to other desired intersections at their relative location in the Urban Area grid. Use care to align north/south or east west approaches to ease calculations between templates. Use the same 10x10 widths.

d. Connect the urban Area grid with a grey segment cells equal to the width of the approach/departure in order to build a simplified 90 degree grid map to represent the urban area layout. Ideally the grid map will resemble source data maps on file for the agency for daily and hourly traffic volumes.

e.In the Fairbanks, AK and Eagle River baseline examples, Alaska Traffic Data source maps are used to build a map. See: https://alaskatrafficdata.drakewell.com/publicmultinodemap.asp

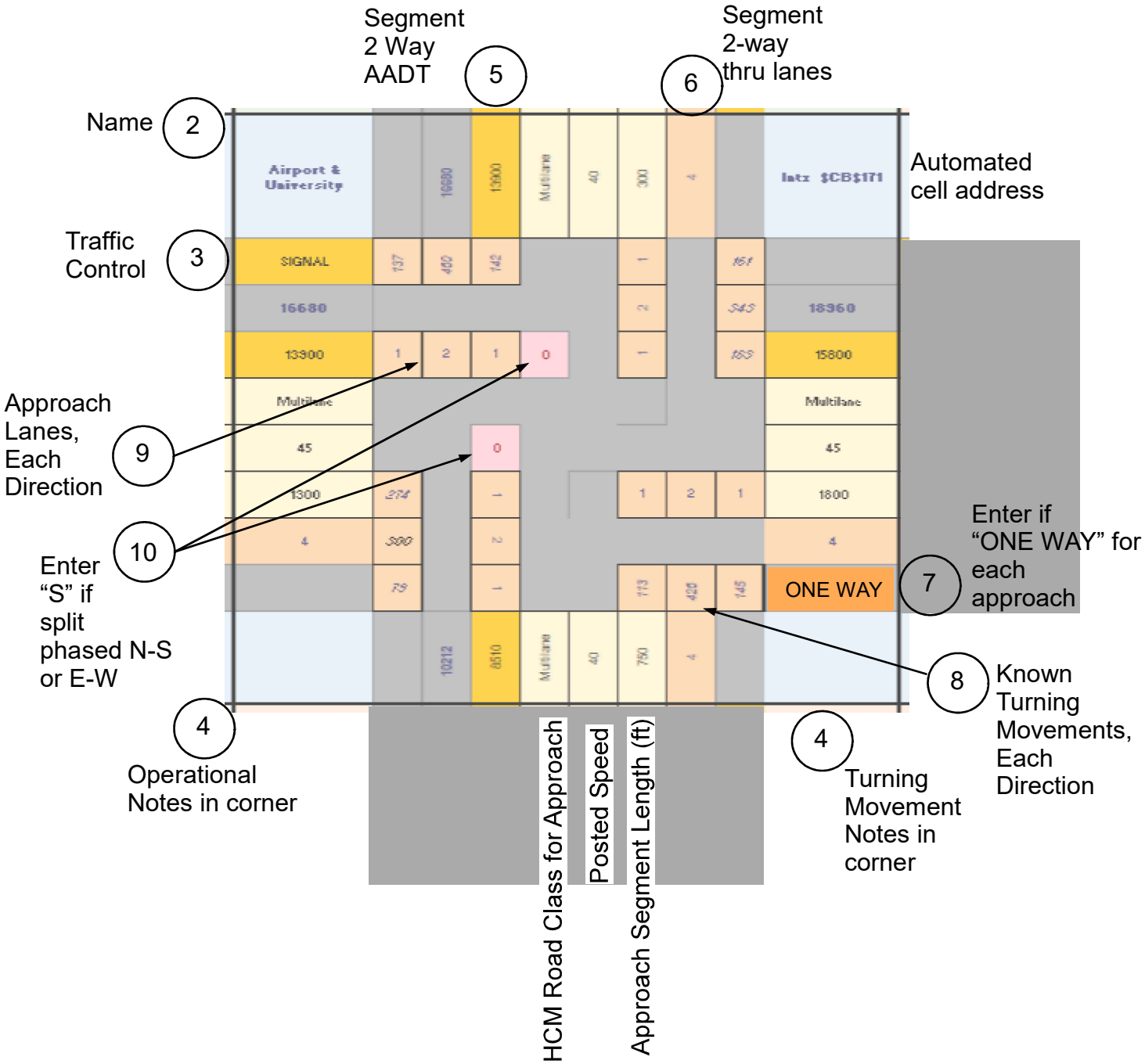
f. Once the map and all inputs are complete , write protect the sheet using password *Urban WZ. A*ll non-input cels inside templates will be locked, while orange cells remain usable.

g. Diamond and Parclo interchange templates are available in the Eagle River, AK spreadsheet. The Fairbanks, AK spreadsheet uses custom interchange layouts and standard urban area intersection templates.

Tab 2IN Traffic Volume Inputs

with known Turning Movements

(10 rows x 10 columns)



Tab 2IN Traffic Volume Input Template

with known Turning Movements

USER INPUT cels are shaded ORANGE:

1. Consider sketching the urban area map to conceptualize which intersections best fit in 90 degree rows or columns as if due east-west or due north-south as a simplified grid. in Excel, copy upper left corner of 10x10 template to each "Intx" cell address, spatially representing urban area grid-intersection location. Copy additional templates to other intersections in the Urban Area grid. Connect the urban Area grid with a grey segment cells equal to teh width of the approach/departure in order to build a simplified 90 degree grid map to represent the urban area layout. Ideally the grid map will resemble source data maps on file for the agency for daily and hourly traffic volumes. In this example, Alaska Traffic Data is used.

2. Input intersection name in upper left corner of pasted 10x10 template. "Intx" cell address is automated in upper right corner.

3. Input intersection traffic control type: FREE; STOP; SIGNAL; or ROUNDABOUT.

4. Input special notes in lower left and/or right corners - such as if it is split phased or has special operations, or if turning movements had errors, had to have corrections, assumed volumes, or are rotated, etc.

5 Input segment AADT known for each leg as annual average daily traffic volume. Seasonal adjustment factors for work zone will apply to adjacent grey cells.

6. Input segment thru lanes as if two-way (no auxiliary lanes; one-way equivalent is thru lanes times 2).

7. Adjacent to thru lanes, input "ONE WAY" if approach direction is one-way, even with two way equivalent lanes shown.

8. Input peak hour turning movement counts for peak hour being tested.

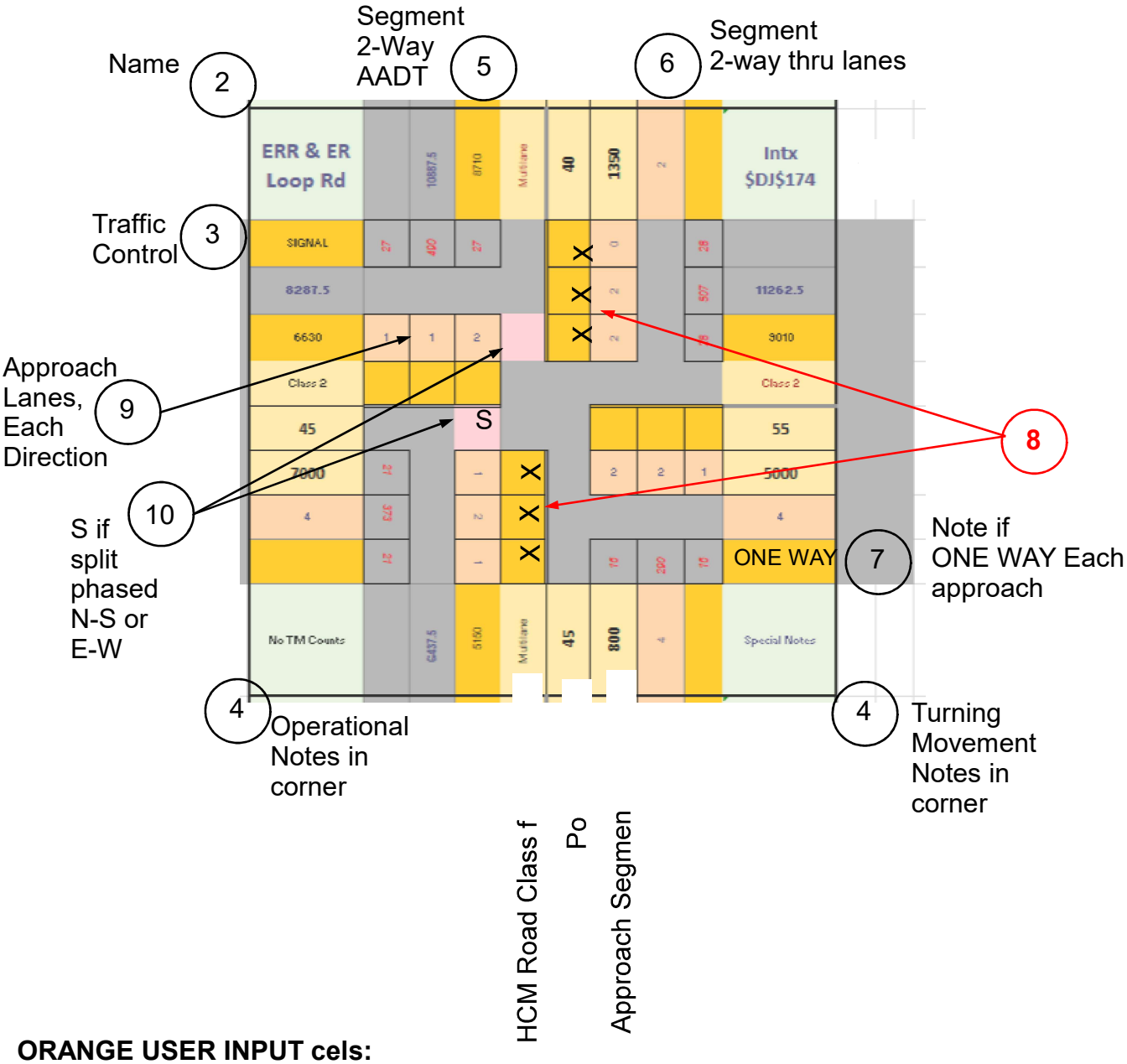
9. Input number of lanes at intersection approach. Always use at least 1 lane for Thru Traffic lanes, not 0. This is to prevent division by zero, even if lane is not there. For example a single approach lane is 0-1-0. A RT and LT lane with no Thru Lane would still be coded 1-1-1.

10. Enter "S" for Split Phase operation next to approach lanes in left cells Southbound SB, or Eastbound EB. Will show 2 way or 4 way split phase result in red. Split Phase operation generally occurs on a high volume mainline or sidestreet approach with shared left and thru lanes on a multilane, requiring protected movements.

For Alaska traffic data, see:
https://alaskatrafficdata.drakewell.com/publicmultinodemap.asp
Google Earth and Streetviews for quick lane views, speed limits, segment lengths

Tab 2IN Alternative Traffic Volume Template

if there are not Turning Movements available

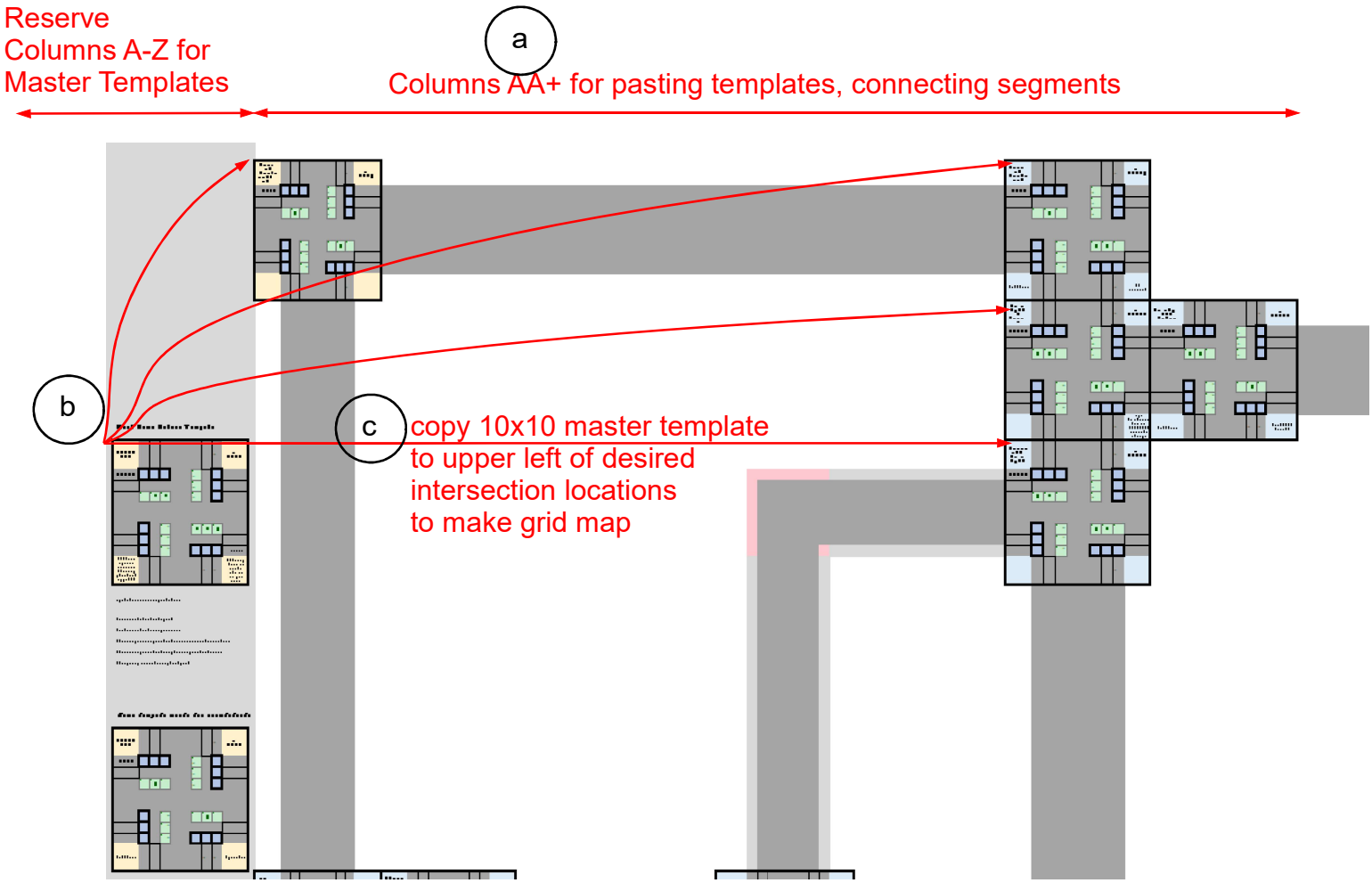


ORANGE USER INPUT cels:

Same steps as prior example, with one modification:

8. Input X-X-X in all three boxes ahead of sidestreet turn lanes restricted to right-in/right-out (RIRO) by raised median channelization. Peak hour turning movement counts will be calculated using typical percentages, adjusted for ONE WAY roads and median restrictions.

Tab 3WZ-DTIN Urban Area Map Copying



MAP COPYING Tab 3

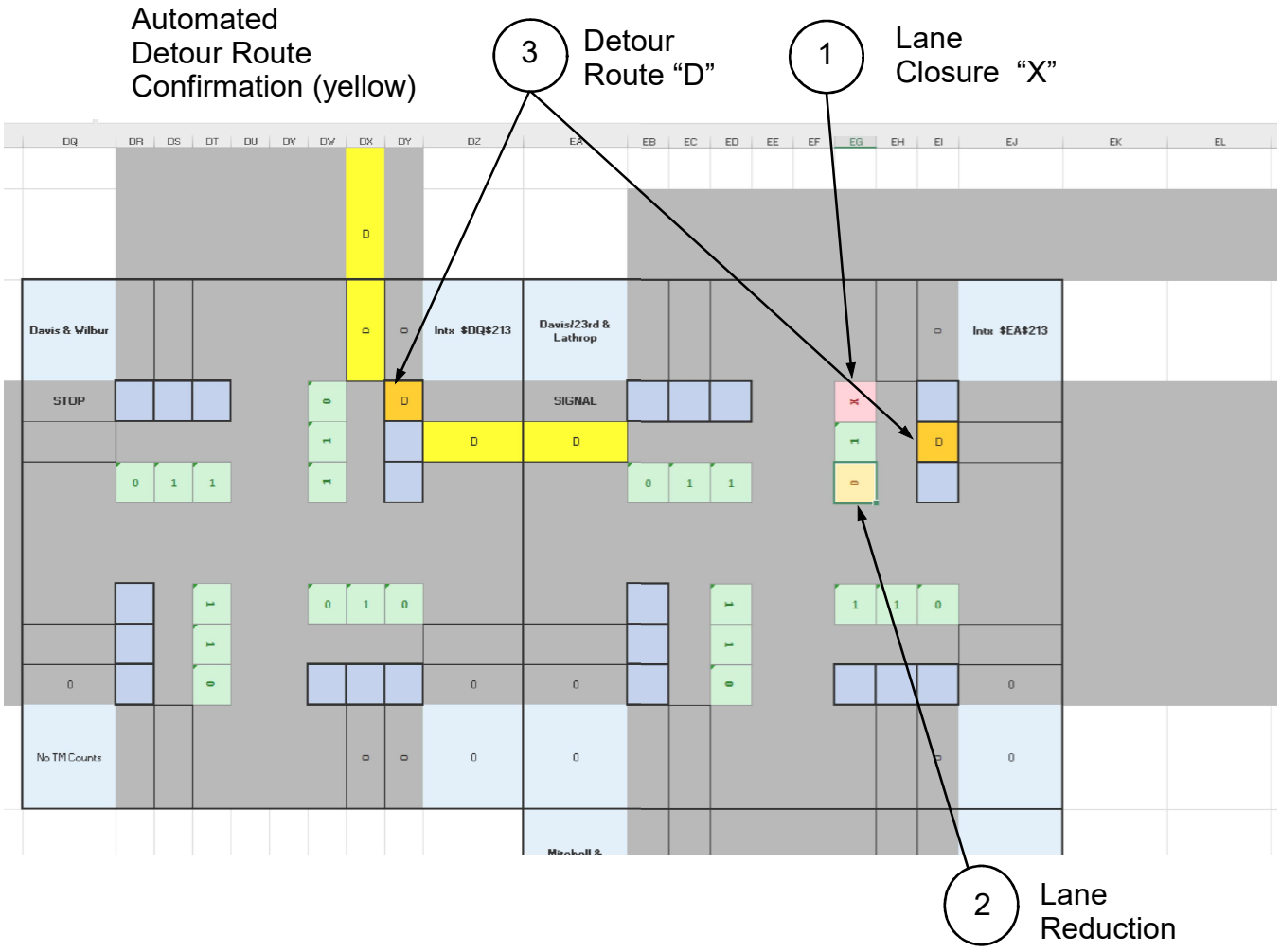
a. Using a copy of the Eagle River, AK baseline Tab 3, unprotect worksheet, password "UrbanWZ". Delete columns AA+ to create a blank map space. DO NOT delete columns A-Z with master templates.

b. Copy all columns from AA+from the User Input Map created in Tab 2. You will now have your new Urban Area ready for new templates. (Continue to reserve columns A through Z to retain the templates already in the baseline spreadsheet file.)

c. Copy the master template in Tab 3 to the upper left of all the intersections at their relative location in the Urban Area grid. Note the cell corner shading as a clue to when you update the templates . Templates will auto-populate with names, traffic control, and prior notes.

d. Once the map is complete and all inputs are in place, write protect the sheet using password Urban WZ and all non-input cels inside the templates will be locked, while orange cells remain usable.

Tab 3XWZ-DTIN Work Zone Detour Template



BLUE and GREEN USER INPUT cels only. Rest of cels are automated or locked.

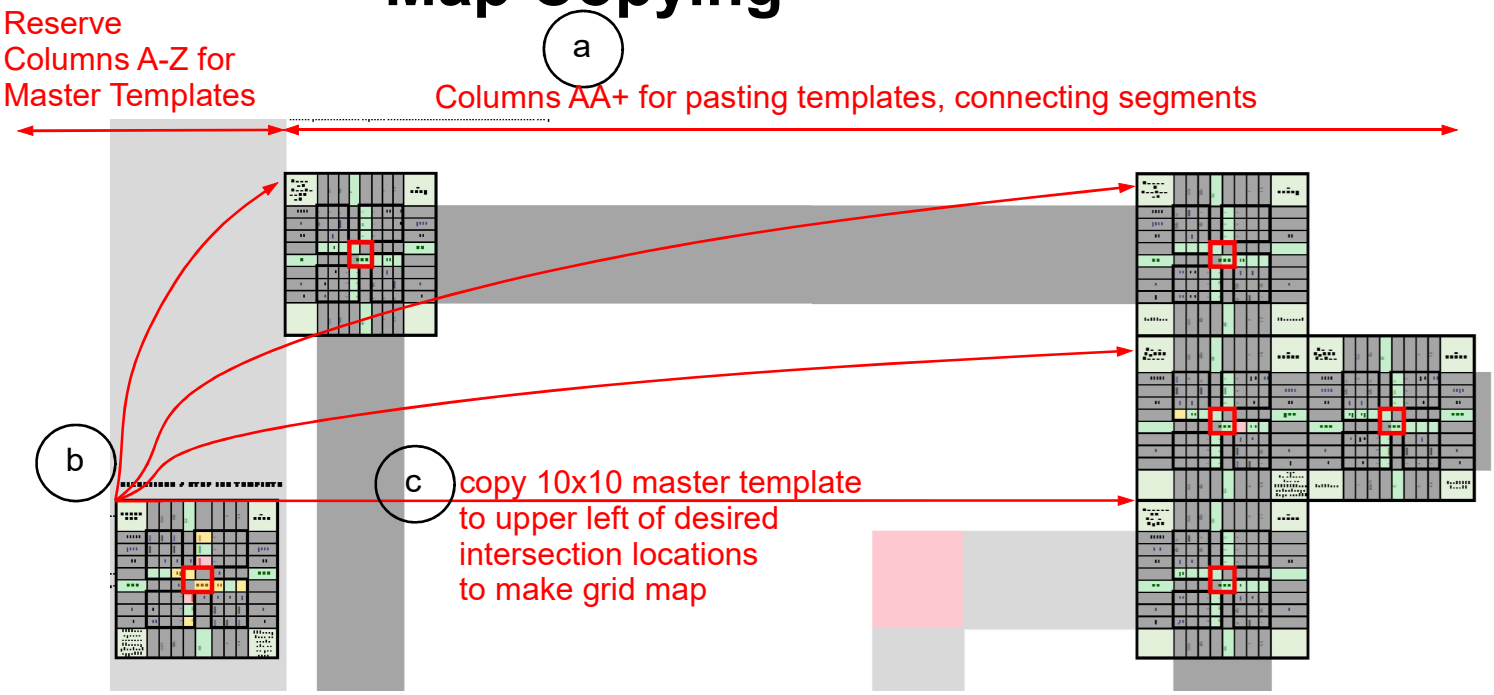
1. Input “X” in green cells for lanes to be closed at an intersection approach, starting at each end of the the point of closure. Cell will turn red. Input “X” at intersections downstream that fall within the closure.

2. Or input the number of lanes to remain open. If lanes are less than existing, cell will turn yellow. If number of lanes to remain open exceed existing, cell will turn red. If lanes to remain open match existing lanes, cell will turn green.

3. Input “D” for “Detour” in the blue cells to select and direct the route of detour from the approach point of closure. Trace or specify the detour route in each blue cell downstream to direct traffic back to the original route, around the closure until the detour is completed. “D” Detour routes are not required for non-closures, or in other words, for partial lane reductions in where lane cells turn yellow.

4. Input “E” to “End” a Detour and prevent carrying yellow routing further along segments than intended. This is more useful on freeways and before long segments than on turns.

Tab 4EX Existing Conditions Planning LOS Map Copying



MAP COPYING Tab 3

a. Using a copy of the Eagle River, AK baseline Tab 3, unprotect worksheet, password "UrbanWZ". Delete columns AA+ to create a blank map space. DO NOT delete columns A-Z with master templates. Other options are to use the Eagle River, AK spreadsheet in order to use interchange templates instead of custom layouts, or the Sitka, AK spreadsheet for a smaller, simpler city layout.

b. Copy all columns from AA+from the User Input Map created in Tab 2. You will now have your new Urban Area ready for new templates. (Continue to reserve columns A through Z to retain the templates already in the baseline spreadsheet file.)

c. Copy the upper master template for signals, STOP, and free flowing turning intersections in Tab 4 to the upper left of all the intersections at their relative location in the Urban Area grid. Note the cell corner shading as a clue to when you update the templates . Templates will auto-populate with names, traffic control, and prior notes. Planning LOS and capacity ratings will automatically be calculated and color coded for Existing Conditions. There are NO User Inputs in remaining Tabs.

d. Copy the lower master template for roundabouts in Tab 4 to the upper left corner of all roundabout intersections. This will result in capacity ratings for each "tee" approach that calculate and color code conflicting circulating volumes.

d. Once the map is complete and all inputs are in place, write protect the sheet using password Urban WZ and all non-input cels inside the templates will be locked, while orange cells remain usable.

Tab 4EX Existing Conditions LOS Templates

SIGNALS
STOPS
FREE FLOW

Corner data is
imported and automatic

Segment “2 Way”AADT is seasonally adjusted and computed in vphpl for color ranking against User Inputs OVER capacity is for free flowing movements, Tab 1.

Turning movements are calculated per approach lane in vphpl and color coded. OVER capacity is for individual turning movements.

Intersection total conflicting volume E/W + N/S is summed in upper left center, red box, color coded, and rated for overall capacity.

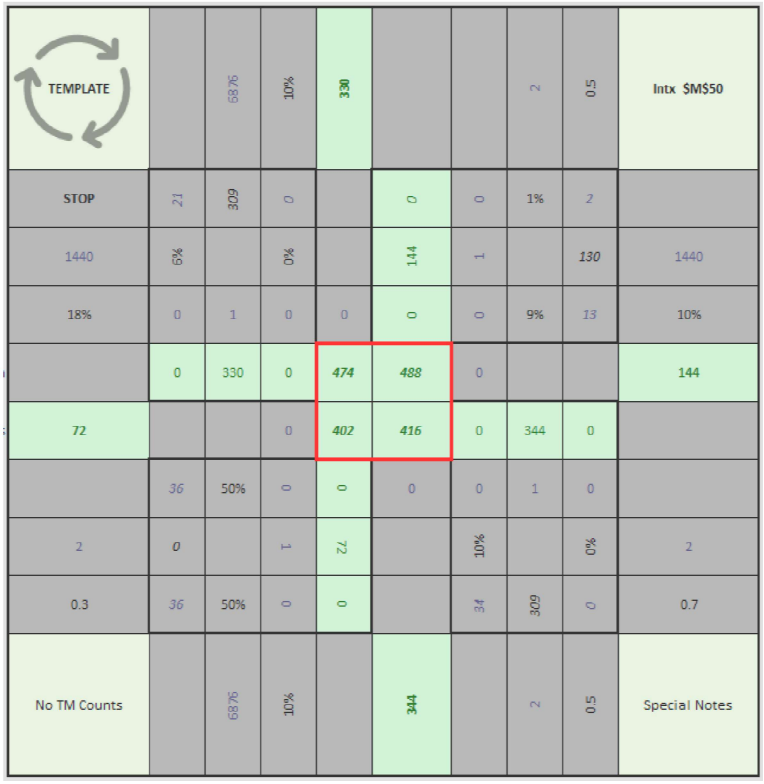


ROUNDABOUTS

All outer ratings are the same as for signals, stops, and free intersections.

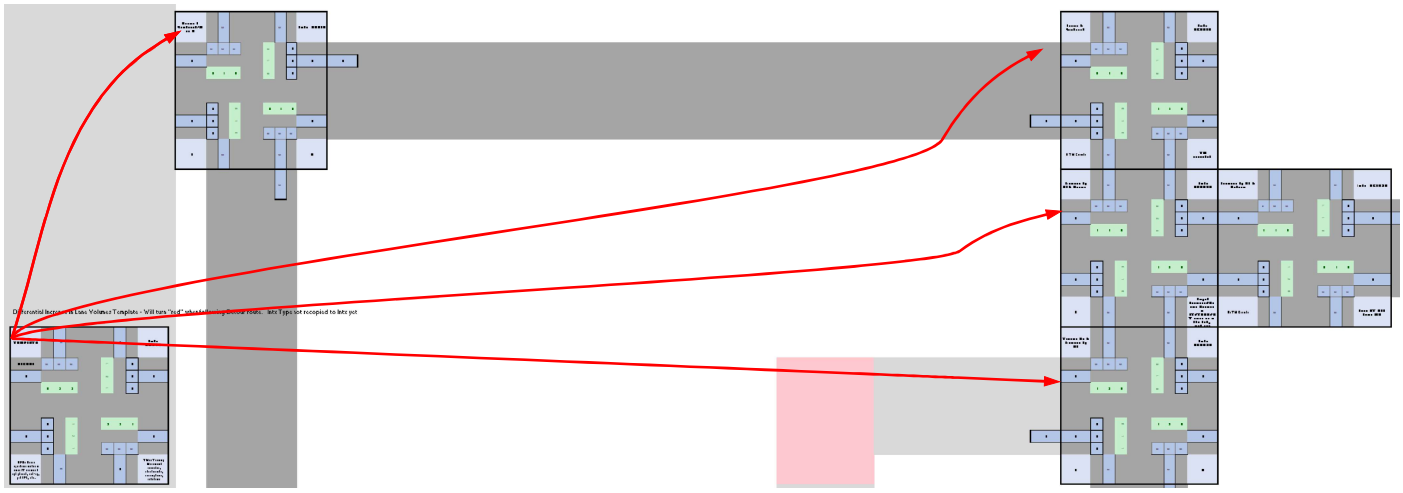
Central roundabout ratings are rated for each approach “tee” as circulating volumes (vphpl) versus entering volumes (vphpl) and color coded. OVER capacity at each tee is the same as for whole intersections.

All results for intersections and segments LOS or capacity are summarized in Tab 9, Existing Conditions List and Existing Conditions Map.



Tab 5WZ+ Work Zone Traffic Increases Map Building

Same copying method, copy User Input Map from Tab 3 to columns AA+, then copy Master Template in Tab 5 to each intersection.



Tab 5WZ+ Work Zone Traffic Increases

Calculated INCREASES in traffic, due to detours specified, are calculated in red.

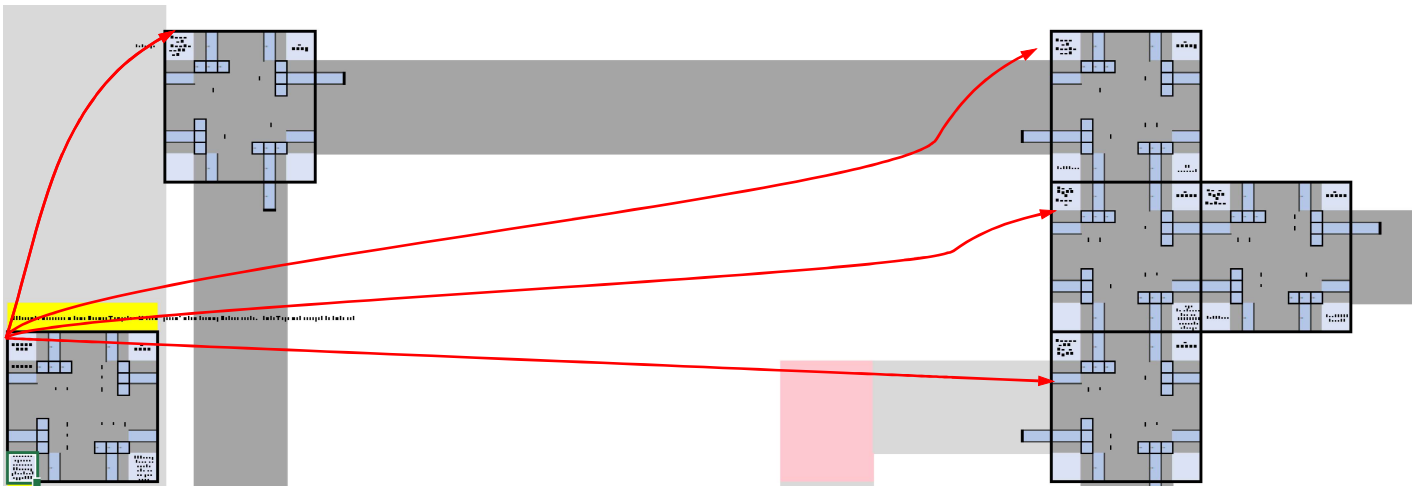


1. When building new maps, copy vertical segment formulas which look back from approach to departure between intersections. Copy this to each grey row leading to intersections. This will populate the approach volume changes from adjacent intersection departures.

2. Copy horizontal segment formulas the same way, leading to next intersections. Connect right angles carefully with appropriate formulas looking at adjacent cells.

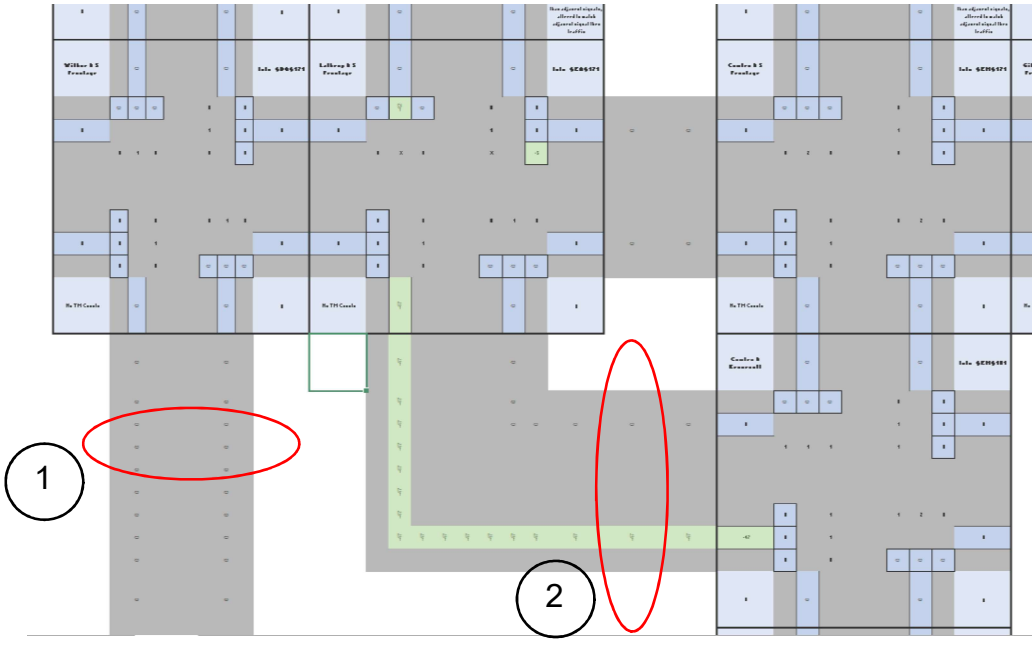
Tab 6WZ- Work Zone Traffic Decreases, Map Building

Same copying method, copy User Input Map from Tab 3 to columns X+, then copy Master Template in Tab 6 to each intersection.



Tab 6WZ Work Zone Traffic Decreases

Calculated DECREASES in traffic, due to detours specified, are calculated in red.

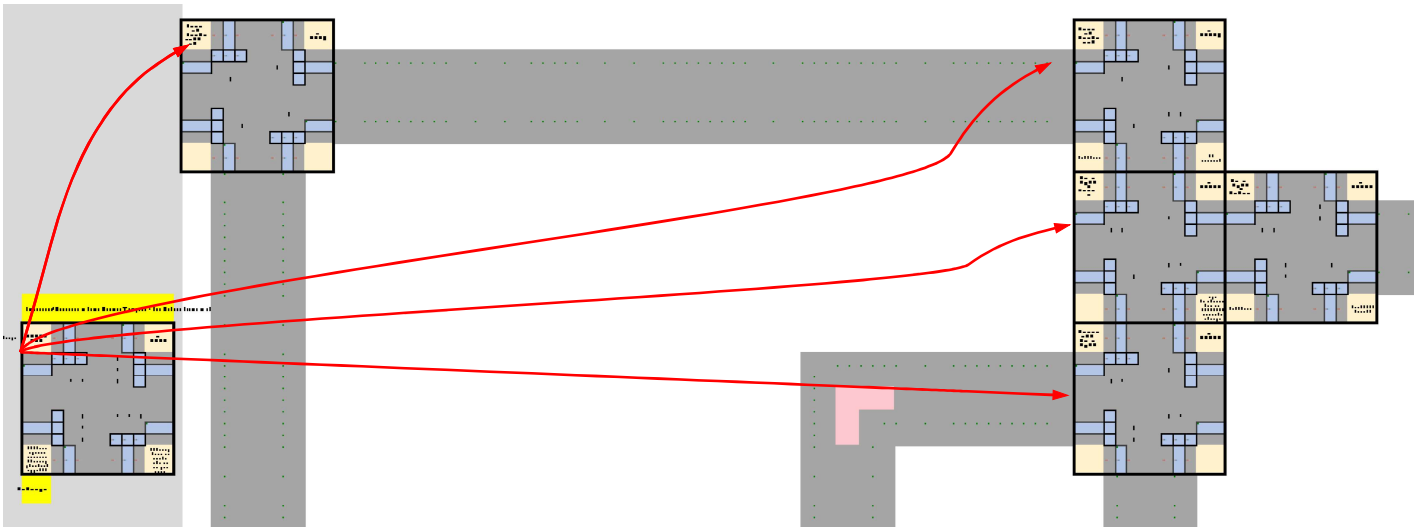


1. When building new maps, copy vertical segment formulas which look back from approach to departure between intersections. Copy this to each grey row leading to intersections. This will populate the approach volume changes from adjacent intersection departures.

2. Copy horizontal segment formulas the same way, leading to next intersections. Connect right angles carefully with appropriate formulas looking at adjacent cells.

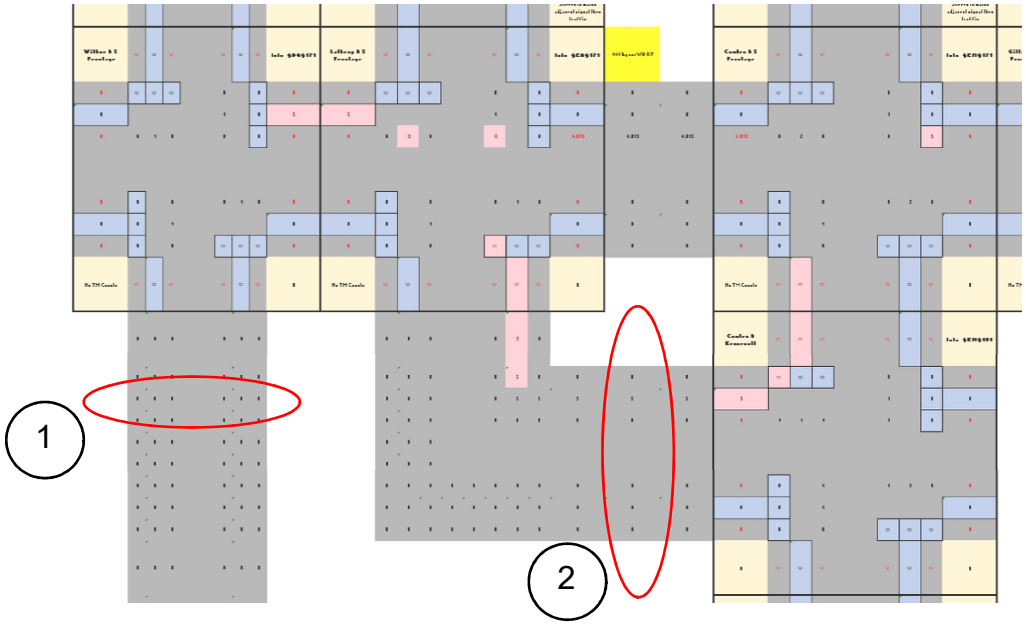
Tab 7ADV-DT Advance Detour Turns Map Building

Same copying method, copy User Input Map from Tab 3 to columns AA+, then copy Master Template in Tab 7 to each intersection.



Tab 7ADV-DT Advance Detour Turn Changes

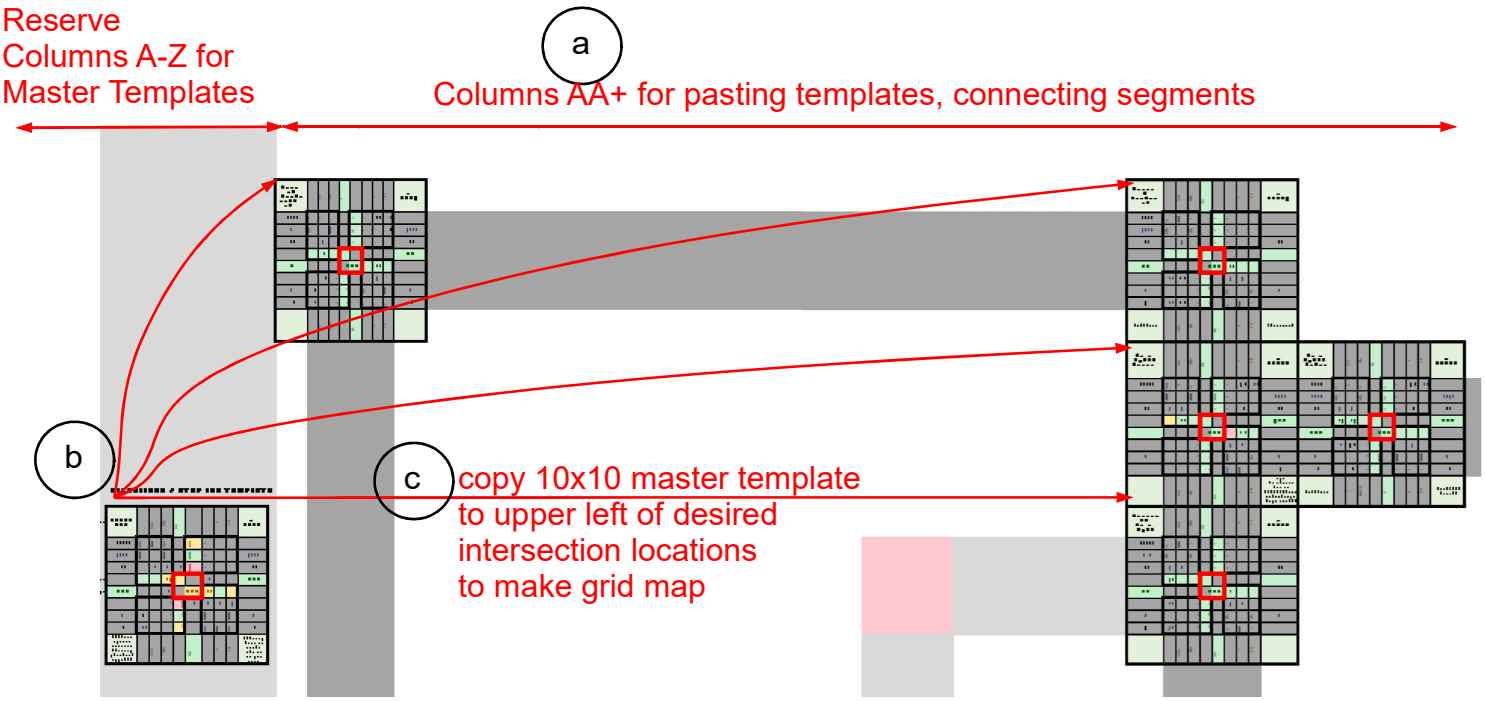
Calculated ADVANCE TURNS in traffic, due to detours specified, are calculated in red.



1. When building new maps, copy vertical segment formulas which look back from approach to departure between intersections. Copy this to each grey row leading to intersections. This will populate the approach volume changes from adjacent intersection departures.

2. Copy horizontal segment formulas the same way, leading to next intersections. Connect right angles carefully with appropriate formulas looking at adjacent cells.

Tab 8WZ Work Zone Conditions
Planning LOS Map Copying



MAP COPYING from Tab 3, 2 Inputs

a. Using a copy of the Eagle River, AK baseline Tab 3, unprotect worksheet, password "UrbanWZ". Delete columns AA+ to create a blank map space. DO NOT delete columns A-Z with master templates.

b. Copy all columns from AA+from the User Input Map created in Tab 2. You will now have your new Urban Area ready for new templates. (Continue to reserve columns A through Z to retain the templates already in the baseline spreadsheet file.)

c. Copy the upper master template for signals, STOP, and free flowing turning intersections in Tab 8 to the upper left of all the intersections at their relative location in the Urban Area grid. Note the cell corner shading as a clue to when you update the templates . Templates will auto-populate with names, traffic control, and prior notes. Planning LOS and capacity ratings will automatically be calculated and color coded for Existing Conditions. There are NO User Inputs in remaining Tabs.

d. Copy the lower master template for roundabouts in Tab 8 to the upper left corner of all roundabout intersections. This will result in capacity ratings for each "tee" approach that calculate and color code conflicting circulating volumes.

d. Once the map is complete and all inputs are in place, write protect the sheet using password Urban WZ and all non-input cels inside the templates will be locked, while orange cells remain usable.

These are the same steps and same calculations used for building Tab 4, Existing Conditions LOS, but are saved here for Tab 8WZ Work Zone Conditions LOS.

Tab 8WZ Work Zone Conditions LOS Templates

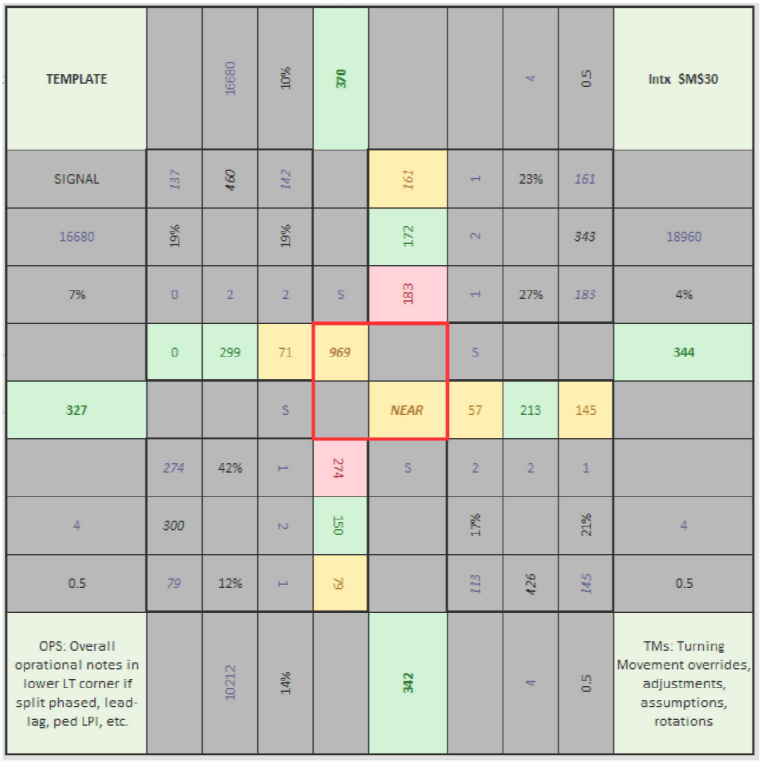
SIGNALS
STOPS
FREE FLOW

Corner data is
imported and automatic

Segment “2 Way”AADT is seasonally adjusted and computed in vphpl for color ranking against User Inputs OVER capacity is for free flowing movements, Tab 1.

Turning movements are calculated per approach lane in vphpl and color coded. OVER capacity is for individual turning movements.

Intersection total conflicting volume E/W + N/S is summed in upper left center, red box, color coded, and rated for overall capacity.



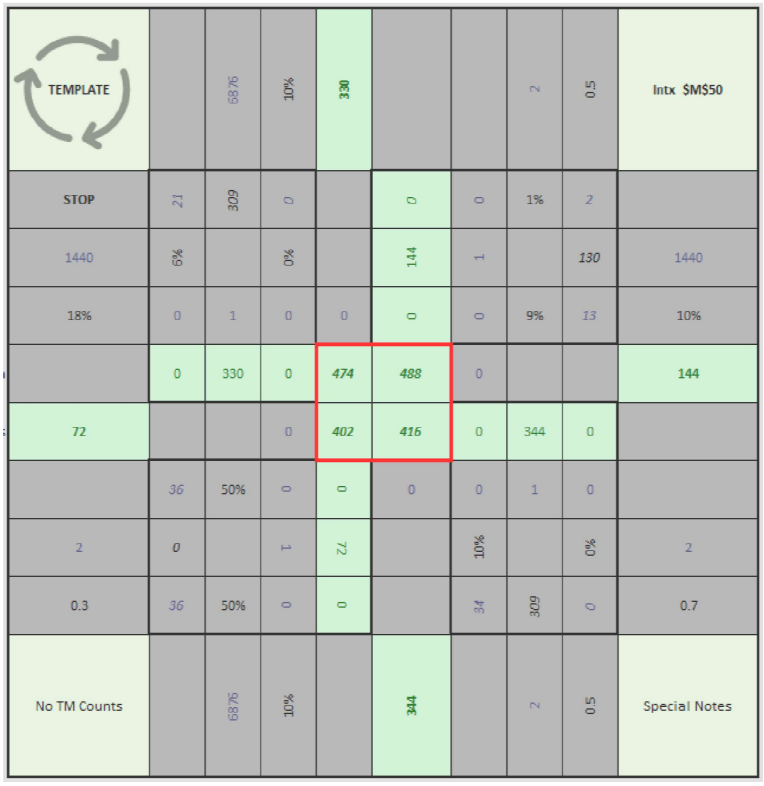
These are the same steps and same calculations used for building Tab 4, Existing Conditions LOS results, but are saved here for Tab 8WZ Work Zone Conditions LOS.

ROUNDABOUTS

All outer ratings are the same as for signals, stops, and free intersections.

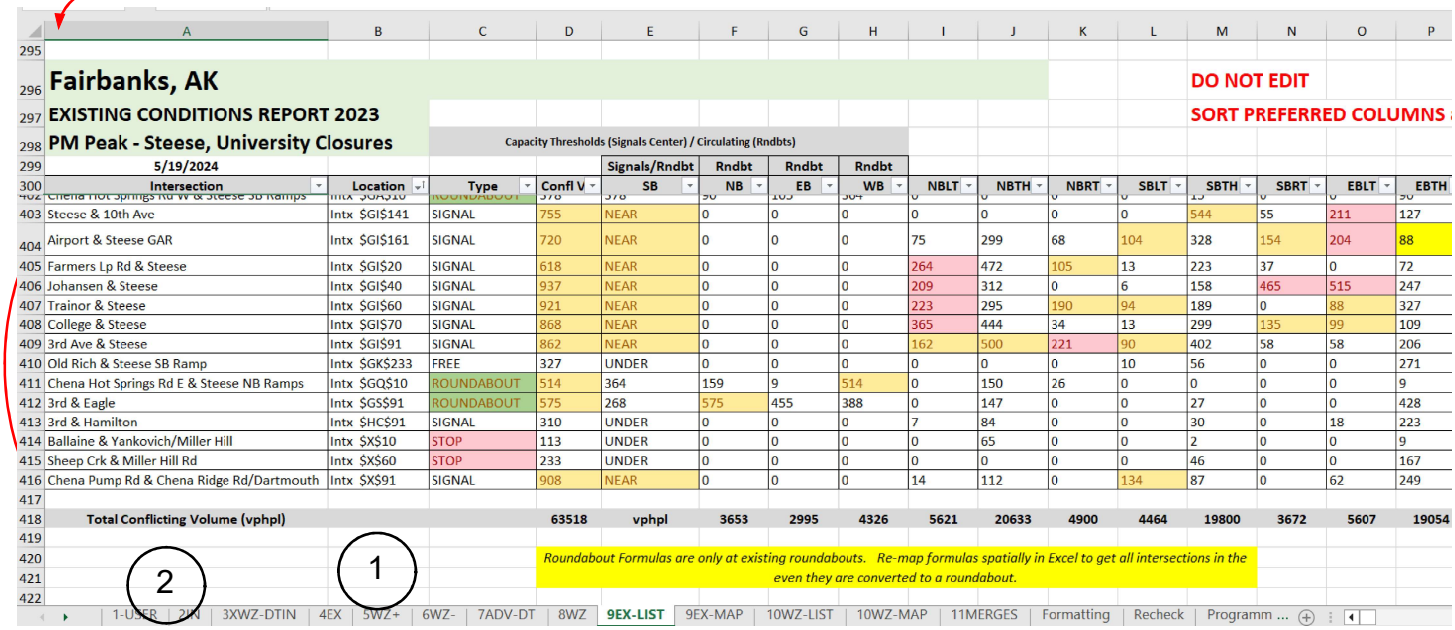
Central roundabout ratings are rated for each approach “tee” as circulating volumes (vphpl) versus entering volumes (vphpl) and color coded. OVER capacity at each tee is the same as for whole intersections.

All results for intersections and segments LOS or capacity are summarized in Tab 9, Existing Conditions List and Existing Conditions Map.



Tab 9EX-LIST Detailed Existing Conditions List

City Name, Report Conditions, Peak Hour, Date - are all automated from User Inputs in Tab 1



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
295																
296	**Fairbanks, AK**												DO NOT EDIT			
297	**EXISTING CONDITIONS REPORT 2023**												SORT PREFERRED COLUMNS			
298	**PM Peak - Steese, University Closures**			Capacity Thresholds (Signals Center) / Circulating (Rndbts)												
299	**5/19/2024**				Signals/Rndbt	Rndbt	Rndbt	Rndbt								
300	**Intersection**	**Location**	**Type**	**Confl V**	**SB**	**NB**	**EB**	**WB**	**NBLT**	**NBTH**	**NBRT**	**SBLT**	**SBTH**	**SBRT**	**EBLT**	**EBTH**
403	Steese & 10th Ave	Intx GI141	SIGNAL	755	NEAR	0	0	0	0	0	0	0	544	55	211	127
404	Airport & Steese GAR	Intx GI161	SIGNAL	720	NEAR	0	0	0	75	299	68	104	328	154	204	88
405	Farmers Lp Rd & Steese	Intx GI20	SIGNAL	618	NEAR	0	0	0	264	472	105	13	223	37	0	72
406	Johansen & Steese	Intx GI40	SIGNAL	937	NEAR	0	0	0	209	312	0	6	158	465	515	247
407	Trainor & Steese	Intx GI60	SIGNAL	921	NEAR	0	0	0	223	295	190	94	189	0	88	327
408	College & Steese	Intx GI70	SIGNAL	868	NEAR	0	0	0	365	444	34	13	299	135	99	109
409	3rd Ave & Steese	Intx GI91	SIGNAL	862	NEAR	0	0	0	162	500	221	90	402	58	58	206
410	Old Rich & Steese SB Ramp	Intx GK233	FREE	327	UNDER	0	0	0	0	0	0	10	56	0	0	271
411	Chena Hot Springs Rd E & Steese NB Ramps	Intx GQ10	ROUNDABOUT	514	364	159	9	514	0	150	26	0	0	0	0	9
412	3rd & Eagle	Intx GS91	ROUNDABOUT	575	268	575	455	388	0	147	0	0	27	0	0	428
413	3rd & Hamilton	Intx HC91	SIGNAL	310	UNDER	0	0	0	7	84	0	0	30	0	18	223
414	Ballaine & Yankovich/Miller Hill	Intx X10	STOP	113	UNDER	0	0	0	0	65	0	0	2	0	0	9
415	Sheep Crk & Miller Hill Rd	Intx X60	STOP	233	UNDER	0	0	0	0	0	0	0	46	0	0	167
416	Chena Pump Rd & Chena Ridge Rd/Dartmouth	Intx X91	SIGNAL	908	NEAR	0	0	0	14	112	0	134	87	0	62	249
417																
418	**Total Conflicting Volume (vphpl)**			63518	vphpl	3653	2995	4326	5621	20633	4900	4464	19800	3672	5607	19054
419																
420					*Roundabout Formulas are only at existing roundabouts. Re-map formulas spatially in Excel to get all intersections in the*											
421					*even they are converted to a roundabout.*											
422																

2 1

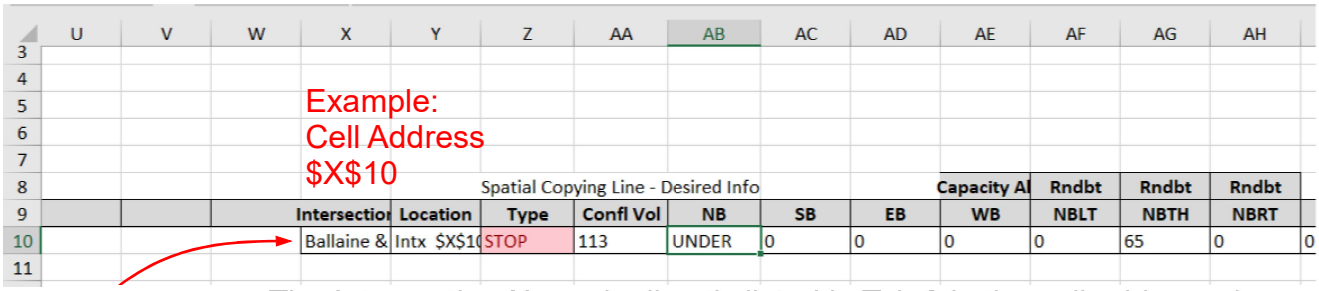
1-USER | 2IN | 3XWZ-DTIN | 4EX | 5WZ+ | 6WZ- | 7ADV-DT | 8WZ | **9EX-LIST** | 9EX-MAP | 10WZ-LIST | 10WZ-MAP | 11MERGES | Formatting | Recheck | Programm ...

1 The links to data in the summary LOS list are based on “Location”, or cell address, in Tab 3. The list is intentionally placed under a filtered set of headings in Row 300, Tab 9. When buildng a new city spreadsheet:

a) Unfreeze Panes (locked at Row 300
b) Sort intersections by Location (cell address)
b) CUT (**Ctrl-X**) intersection X10 *Ballaine & Yankovich* as an example with all the summarized links listed from *Column A to Column BI.*
c) PASTE (**Ctrl V**) the links to X10. This links the left most link in this row summary of Tab 9's list to the left most cell Naming the Intersection in Tab 3. Tab 9 will be directly linked to the location in Tab 4 and pull all the summary data for Existing Conditions LOS for that intersection name.

2 The Intersection Name is directly listed in Tab 3 in the cell address shown for Intersection Location (in this case *“Ballaine & Yankovich”*). Using the upper left corner for Name and Location makes it easier to COPY (**CTRL-C**) and PASTE (**CTRL-V**) this set of links to each cell address in Tab 9.

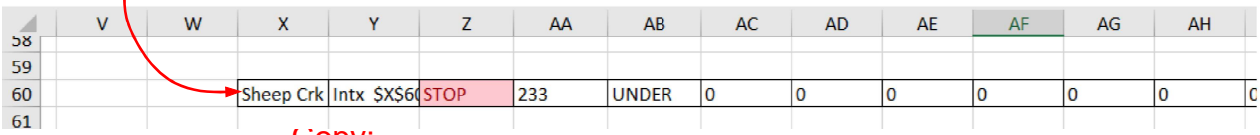
Tab 9EX-LIST Linking Each Row to Each Intersection - "Spatially" in Excel



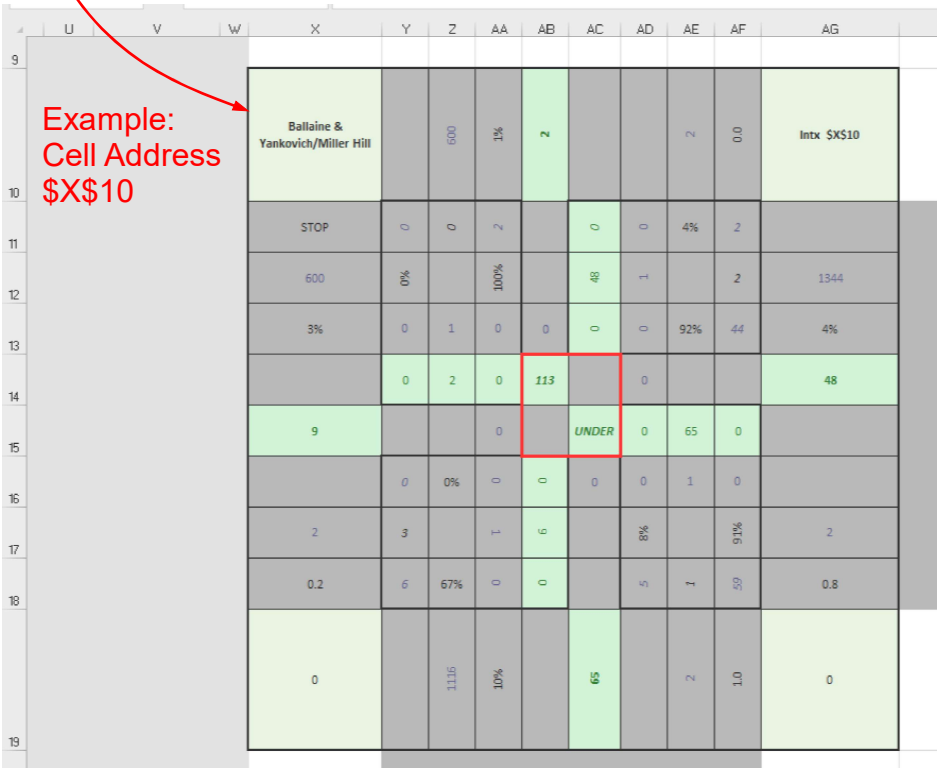
The Intersection Name is directly listed in Tab 3 in the cell address shown for Intersection Location (in this case *"Ballaine & Yankovich"*). Using the upper left corner for Name and Location makes it easier to COPY (**CTRL-C**) and PASTE (**CTRL-V**) this set of links to each cell address in Tab 9.

2

This same "row" of links can be copied (**CTRL-C**) to the upper left corner cell addresses of other intersections. Make this copy and paste it in Tab 9, cell X10 has these links pre-filled in Tab 9. The row links can be quickly pasted multiple times moving down every 10 cells or more to the next intersection "vertically" or north-south in your city grid. The next step is to move these results to populate a list in Tab 9.



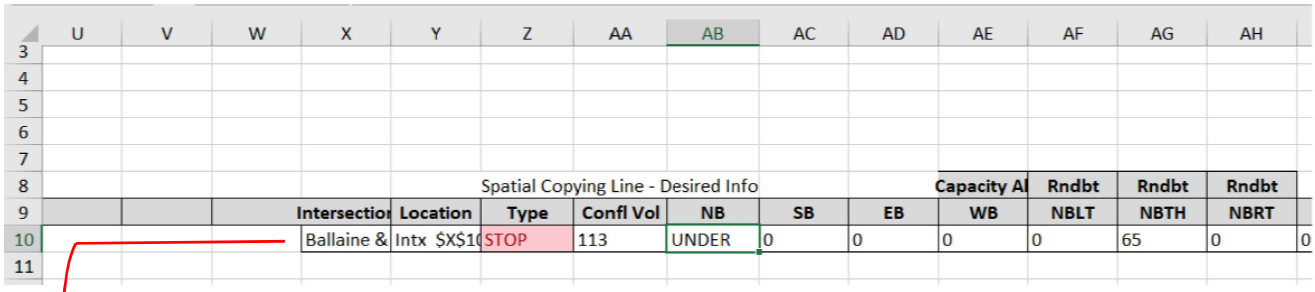
Copy:
Cell Address
X60



It is more efficient to complete one vertical column of city intersections at at a time. Once you cut all the data for north-south set of intersections, the columns X forward end up being clear. Then do the next vertical set of city intersections.

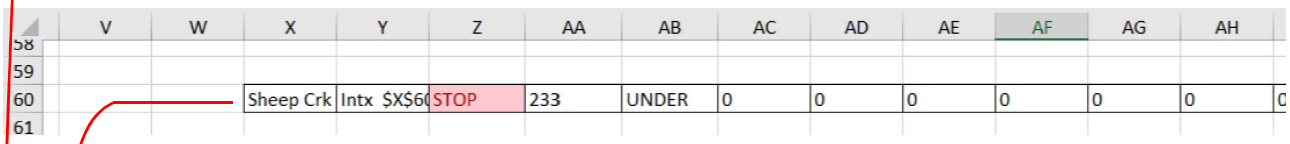
If you paste list links across a row to intersections horizontally in an east-west direction, there is a risk of overwriting the adjacent intersection links. This is why it is more efficient to work vertically one grid at a time.

Tab 9EX-LIST Cutting Each Row of Results and Pasting into Filterable Summary List



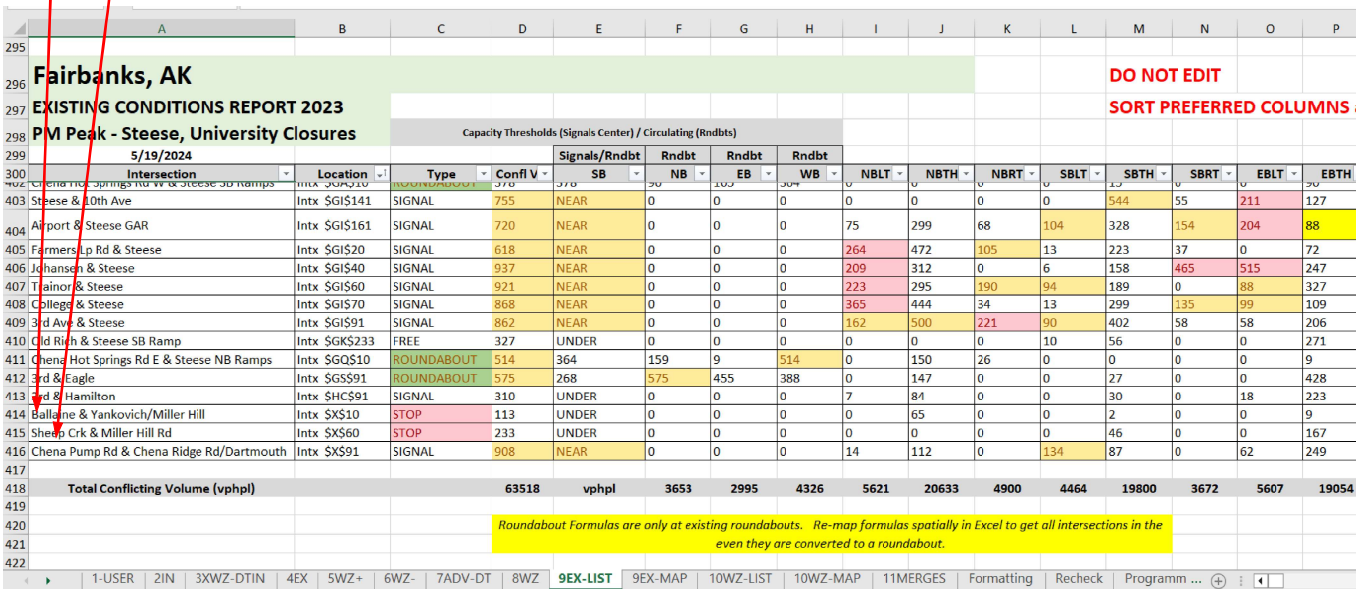
	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
3														
4														
5														
6														
7														
8						Spatial Copying Line - Desired Info					Capacity Al	Rndbt	Rndbt	Rndbt	
9				Intersectior	Location	Type	Confl Vol	NB	SB	EB	WB	NBLT	NBTH	NBRT	
10				Ballaine &	Intx X10	STOP	113	UNDER	0	0	0	0	65	0	0
11														

CUT (CTRL-X) resulting row data starting at first cell of data links, ending at last cell of data.



	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
58													
59													
60			Sheep Crk	Intx X60	STOP	233	UNDER	0	0	0	0	0	0
61													

PASTE (CTRL-V) data to Column A below list heading, adding rows as needed.



Fairbanks, AK

EXISTING CONDITIONS REPORT 2023

PM Peak - Steese, University Closures

5/19/2024

DO NOT EDIT

SORT PREFERRED COLUMNS

Capacity Thresholds (Signals Center) / Circulating (Rndbts)

Intersection	Location	Type	Confl V	Signals/Rndbt SB	Rndbt NB	Rndbt EB	Rndbt WB	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	EBLT	EBTH
Steese & 10th Ave	Intx GI141	SIGNAL	755	NEAR	0	0	0	0	0	0	0	544	55	211	127
Airport & Steese GAR	Intx GI161	SIGNAL	720	NEAR	0	0	0	75	299	68	104	328	154	204	88
Farmers Lp Rd & Steese	Intx GI20	SIGNAL	618	NEAR	0	0	0	264	472	105	13	223	37	0	72
Johansen & Steese	Intx GI40	SIGNAL	937	NEAR	0	0	0	209	312	0	6	158	465	515	247
Trainor & Steese	Intx GI60	SIGNAL	921	NEAR	0	0	0	223	295	190	94	189	0	88	327
College & Steese	Intx GI70	SIGNAL	868	NEAR	0	0	0	365	444	34	13	299	135	99	109
3rd Ave & Steese	Intx GI91	SIGNAL	862	NEAR	0	0	0	162	500	221	90	402	58	58	206
Old Rich & Steese SB Ramp	Intx GK233	FREE	327	UNDER	0	0	0	0	0	0	10	56	0	0	271
Chena Hot Springs Rd E & Steese NB Ramps	Intx GQ10	ROUNDABOUT	514	364	159	9	514	0	150	26	0	0	0	0	9
3rd & Eagle	Intx GS91	ROUNDABOUT	575	268	575	455	388	0	147	0	0	27	0	0	428
3rd & Hamilton	Intx HC91	SIGNAL	310	UNDER	0	0	0	7	84	0	0	30	0	18	223
Ballaine & Yankovich/Miller Hill	Intx X10	STOP	113	UNDER	0	0	0	0	65	0	0	2	0	0	9
Sheep Crk & Miller Hill Rd	Intx X60	STOP	233	UNDER	0	0	0	0	0	0	0	46	0	0	167
Chena Pump Rd & Chena Ridge Rd/Dartmouth	Intx X91	SIGNAL	908	NEAR	0	0	0	14	112	0	134	87	0	62	249
Total Conflicting Volume (vphpl)			63518	vphpl	3653	2995	4326	5621	20633	4900	4464	19800	3672	5607	19054

Roundabout Formulas are only at existing roundabouts. Re-map formulas spatially in Excel to get all intersections in the even they are converted to a roundabout.

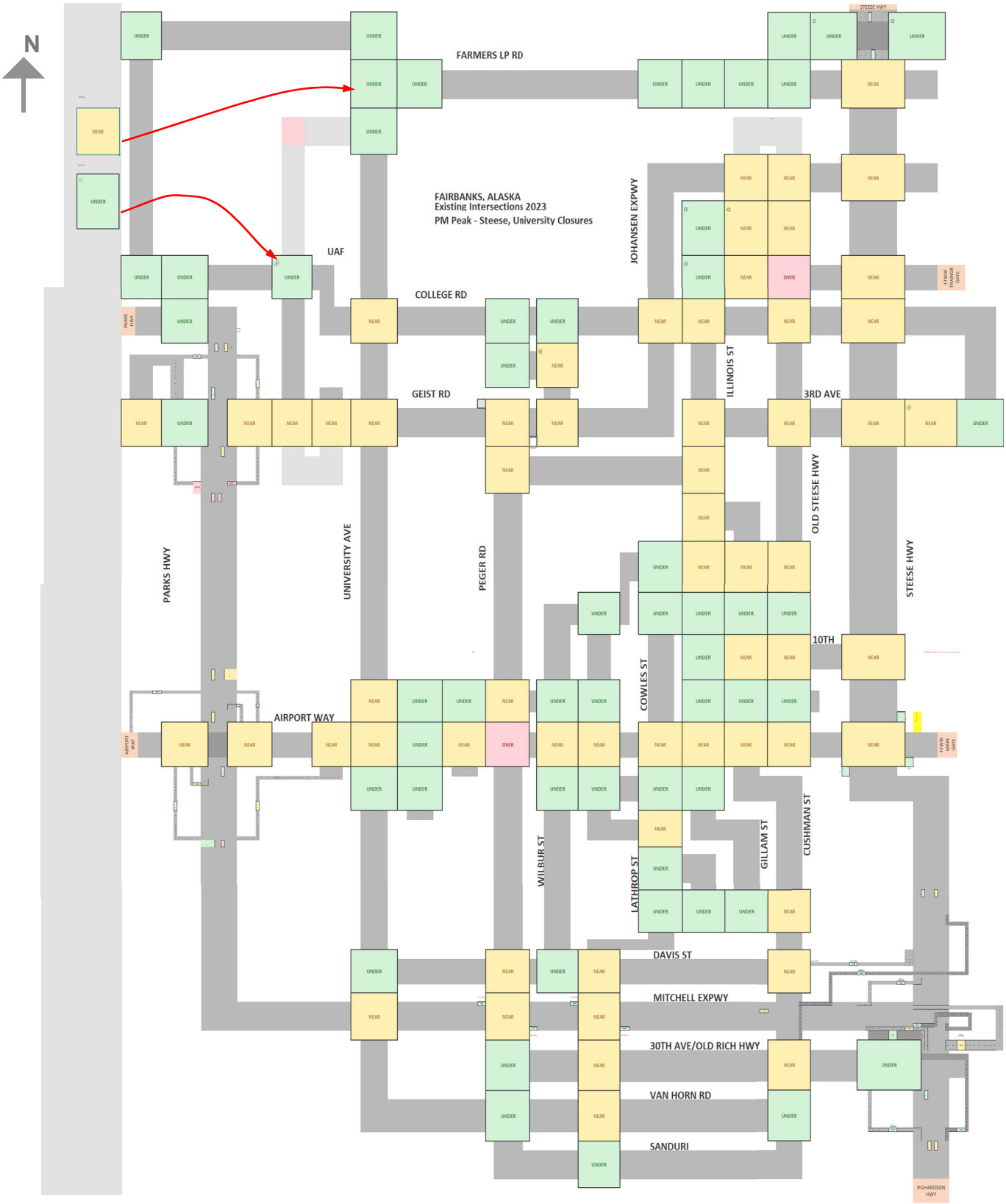
1-USER | 2IN | 3XWZ-DTIN | 4EX | 5WZ+ | 6WZ- | 7ADV-DT | 8WZ | 9EX-LIST | 9EX-MAP | 10WZ-LIST | 10WZ-MAP | 11MERGES | Formatting | Recheck | Programm ...

Repeat copying links of data to other intersection cell addresses in Tab 9, then cut and paste into list until list is complete for city.

List is now filterable for desired columns of data, such as overall capacity ranking for intersections (Planning LOS).

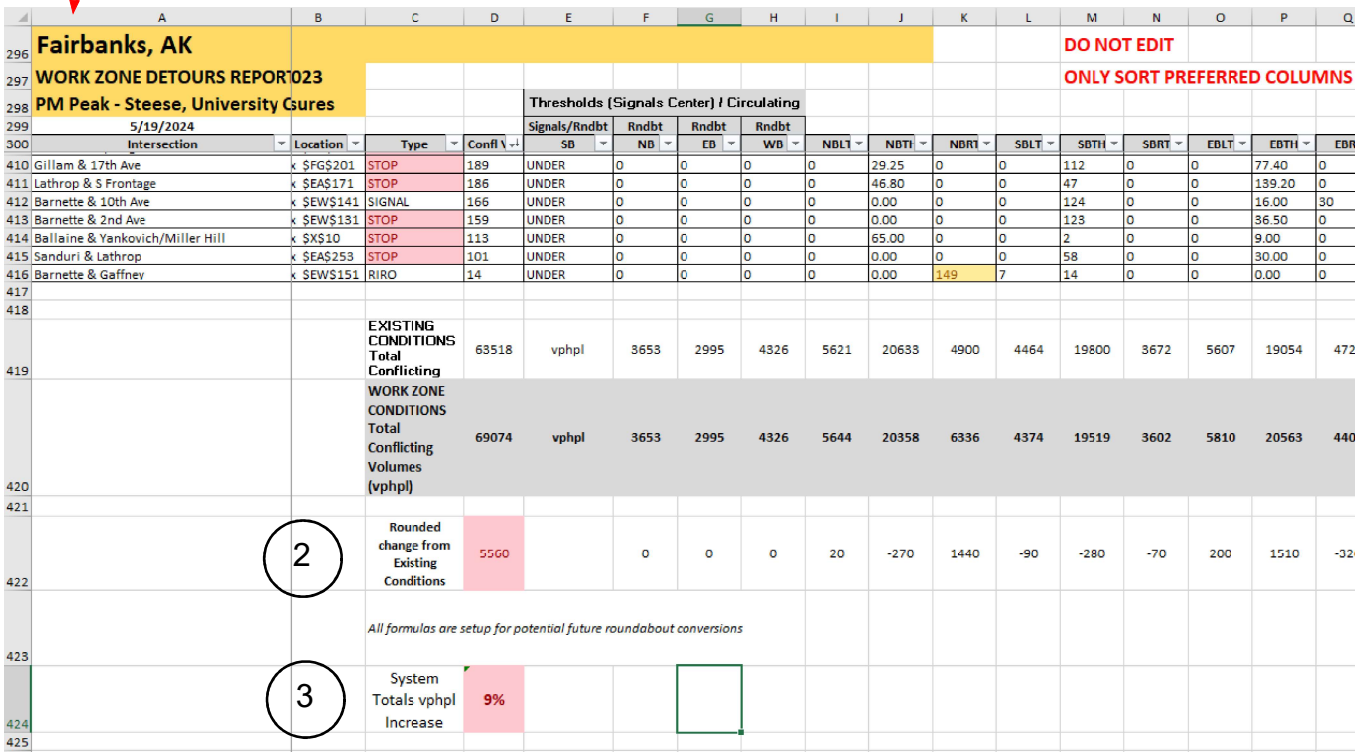
Tab 9EX-MAP Existing Conditions Map

Tab 9EX-MAP provides a full size 36x48 printable map corresponding to Tab 9 EX-LIST Planning LOS results. Copy the map from Tab 2IN into columns AA+. Then copy the merged cell templates for signals or roundabouts to each intersection for a simplified overall intersection Planning LOS capacity rating.



Tab 10WZ-LIST Detailed Work Zone Conditions

City Name, Report Conditions, Peak Hour, Date - are all automated from User Inputs in Tab 1



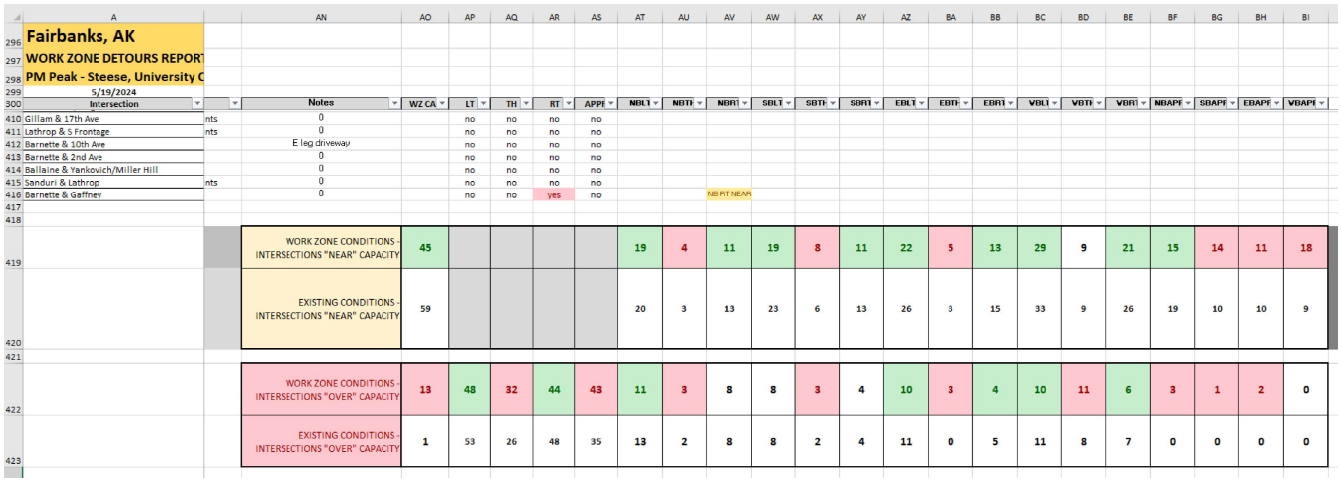
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
296	**Fairbanks, AK**												DO NOT EDIT				
297	**WORK ZONE DETOURS REPOR 023**												ONLY SORT PREFERRED COLUMNS				
298	**PM Peak - Steese, University Cures**				Thresholds (Signals Center) / Circulating												
299	5/19/2024				Signals/Rndbt	Rndbt	Rndbt	Rndbt									
300	Intersection	Location	Type	Confl	SB	NB	EB	WB	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	EBLT	EBTH	EBR
410	Gillam & 17th Ave	x	FG201	STOP	189	UNDER	0	0	0	0	29.25	0	0	112	0	0	77.40	0
411	Lathrop & S Frontage	x	EA171	STOP	186	UNDER	0	0	0	0	46.80	0	0	47	0	0	139.20	0
412	Barnette & 10th Ave	x	EW141	SIGNAL	166	UNDER	0	0	0	0	0.00	0	0	124	0	0	16.00	30
413	Barnette & 2nd Ave	x	EW131	STOP	159	UNDER	0	0	0	0	0.00	0	0	123	0	0	36.50	0
414	Ballaine & Yankovich/Miller Hill	x	X10	STOP	113	UNDER	0	0	0	0	65.00	0	0	2	0	0	9.00	0
415	Sanduri & Lathrop	x	EA253	STOP	101	UNDER	0	0	0	0	0.00	0	0	58	0	0	30.00	0
416	Barnette & Gaffney	x	EW151	RIRO	14	UNDER	0	0	0	0	0.00	149	7	14	0	0	0.00	0
417																		
418																		
419			EXISTING CONDITIONS Total Conflicting	63518	vphpl	3653	2995	4326	5621	20633	4900	4464	19800	3672	5607	19054	472
420			WORK ZONE CONDITIONS Total Conflicting Volumes (vphpl)	69074	vphpl	3653	2995	4326	5644	20358	6336	4374	19519	3602	5810	20563	440
421																	
422		2	Rounded change from Existing Conditions	5560		0	0	0	20	-270	1440	-90	-280	-70	200	1510	-32
423			*All formulas are setup for potential future roundabout conversions*														
424		3	System Totals vphpl Increase	9%													
425																	

1 Build the list “spatially” in the same way Tab 9EX-LIST was built by unfreezing panes, and pasting rows of formulas to link to 8WZ results. Then cut and paste rows under Row 300 to make a Work Zone list.

2 Tab 10WZ summarizes the total conflicting volume across all intersections in the urban area network. It then compares this to Existing Conditions totals. In some cases work zones increase overall conflict citywide, and in some cases, closures reduce intersections to zero conflict, affecting totals.`

3 When there are no detours, the base file should show that Work Zone Conditions are equal to Existing Conditions, or zero change in conflicting volumes. This indicates there are no detours mapped out in Tab 3. Due to decimal places in calculating, up to 100-200 vphpl systemwide differences can occur in the base file. Rather than get an exact “0”, the results summarized are rounded to nearest 100 vph overall, and are essentially zero without Work Zone detours in place.

Tab 10WZ-LIST Work Zone Conditions List Comparison and Filters



	A	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
296	**Fairbanks, AK**																						
297	**WORK ZONE DETOURS REPORT**																						
298	**PM Peak - Steese, University C**																						
299	5/19/2024																						
300	Intersection	Notes	WZ CA	LT	TH	RT	APPI	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBAPI	SBAPI	EBAPI	WBAPI
410	Gillam & 17th Ave	0		no	no	no	no																
411	Lathrop & S Frontage	0		no	no	no	no																
412	Barnette & 10th Ave	E leg driveway		no	no	no	no																
413	Barnette & 2nd Ave	0		no	no	no	no																
414	Ballaine & Yankovich/Miller Hill	0		no	no	no	no																
415	Sanduri & Lathrop	0		no	no	no	no																
416	Barnette & Gaffney	0		no	no	yes	no			NB PT NEAR													
417																							
418																							
419		WORK ZONE CONDITIONS - INTERSECTIONS "NEAR" CAPACITY	45					19	4	11	19	8	11	22	5	13	29	9	21	15	14	11	18
420		EXISTING CONDITIONS - INTERSECTIONS "NEAR" CAPACITY	59					20	3	13	23	6	13	26	3	15	33	9	26	19	10	10	9
421																							
422		WORK ZONE CONDITIONS - INTERSECTIONS "OVER" CAPACITY	13	48	32	44	43	11	3	8	8	3	4	10	3	4	10	11	6	3	1	2	0
423		EXISTING CONDITIONS - INTERSECTIONS "OVER" CAPACITY	1	53	26	48	35	13	2	8	8	2	4	11	0	5	11	8	7	0	0	0	0

Print columns are set for AN-BI. This provides a comparison of Work Zone Conditions to Existing Conditions.

The count of intersections NEAR or OVER capacity are provided. When the work zone counts are higher than existing conditions, cells turn red. When the work zone conditions are less than existing conditions, cells turn green.

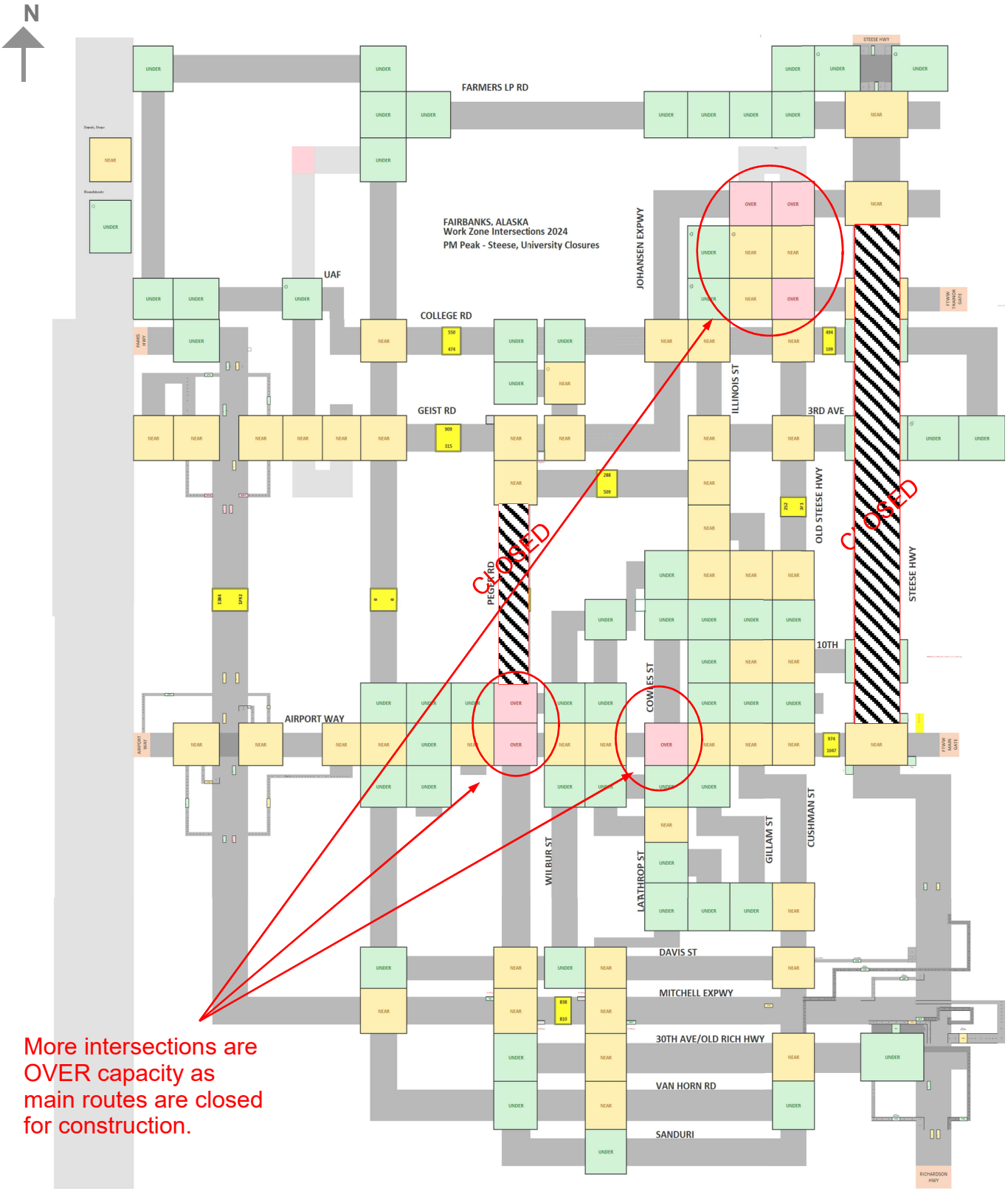
Different columns can be filtered to zero in on individual intersection approach movements that worsen. This can be Northbound, Southbound, Eastbound or Westbound. This can be left turns, thru movements, or right turns. It depends on which area the user wishes to focus in on. These movements are rated UNDER, NEAR, or OVER capacity based on Tab 1 User Input thresholds. A user can see not only which intersections change for overall capacity estimates, but also which movements may change.

Often, while whole intersection failures are not significant, individual turning movements or auxiliary lanes can be come much worse. While the whole intersection LOS may look not much different, individual turning movements can double or triple what is desirable in a single auxiliary lane, and may indicate intolerable queueing possible. For this concern, the User can drill down by looking at Tabs 4 and 8 for individual color coded movements, or filter this list for worst movements of concern by column selected.

Tab 10WZ-MAP Work Zone Conditions Map

This map is built and ranked the same way as Existing Conditions, but for work zones.

Tab 10WZ-MAP provides a full size 36x48 printable map corresponding to Tab 10WZ-LIST Planning LOS results. Copy the map from Tab 2IN into columns AA+. Then copy the merged cell templates for signals or roundabouts to each intersection for a simplified overall intersection Planning LOS capacity rating.



Tab 11 MERGE List

Freeway Merge Volume Checks - outside lane — 5/19/2024
Fairbanks, AK — PM Peak - Steese, University Closu

Name	Conditions	Merge Vol (vphpl)	Capacity
Farmers Lp SB & Steese Merge	Existing	540	NEAR
Mitchell to Steese NB Combined Merge	Existing	1003	NEAR
Mitchell to Steese SB Combined Merge	Existing	267	UNDER
Old Rich Hwy to Steese SB Merge	Existing	632	NEAR
Parks & Airport NB Combined Merge	Existing	785	NEAR
Parks & Airport SB Combined Merge	Existing	406	UNDER
Parks & Geist NB Combined Merge	Existing	589	NEAR
Parks & Geist SB Combined Merge	Existing	1551	OVER
Steeese & Old Rich NB Combined Merge	Existing	594	NEAR
Steese & Airport NB Combined Merge	Existing	833	NEAR
Steese & Airport SB Combined Merge	Existing	1165	OVER
Steese & Chena Hot Spring SB Combined Merge	Existing	864	NEAR
Steese & Chena Hot Springs NB Combined Merge	Existing	947	NEAR
Steese & Old Rich SB Combined Merge	Existing	935	NEAR
Steese to Mitchell WB Combined Merge	Existing	848	NEAR
Farmers Lp SB & Steese Merge	Work Zone	540	NEAR
Mitchell to Steese NB Combined Merge	Work Zone	1003	NEAR
Mitchell to Steese SB Combined Merge	Work Zone	267	UNDER
Old Rich Hwy to Steese SB Merge	Work Zone	632	NEAR
Parks & Airport NB Combined Merge	Work Zone	1211	OVER
Parks & Airport SB Combined Merge	Work Zone	406	UNDER
Parks & Geist NB Combined Merge	Work Zone	589	NEAR

Tab 11 provides a summary specific to mapped locations of merging traffic onto free flowing routes. Ramp volumes are typically one lane, merging with a calculated vphpl on the mainline. These totals are listed here for Existing Conditions and Work Zone Conditions, for comparison.

Besides capacity concerns at intersections, ramp merges are another intersection of concern and rated based on User Input thresholds the same as intersections as a whole.

Tab 12LOS-EX

Conflicting intersection volume per hour per lane from Tab 4EX.

VMT = Vehicle Miles of Travel for each approach segment length, volume per hour per lane, and number of lanes.

Average delay per vehicle from HCMRef for the intersection control type and the conflicting volume.

Total cost of intersection delay based on delay per vehicle and total entering volume.



HCM Ref Speed for Volume, Class

Total Delay Cost for Reduced Segment Speed Differential and entering volume

Road Segment Class

Posted Speed

Approach Segment Length

Equivalent 2-Way Through Lanes

Entering Volume vplph

Tab 12EX-Summary

Eagle River, Alaska

EXISTING CONDITIONS REPORT

Baseline

11/19/2024

Intersection	XLS "GPS" Location	Traffic Control Type	Interesection Conflicting Volume (vphpl)	Intersection Planning Capacity Rating	Intx Delay per User (sec/HR	Intx Total Delay Costs per Duration ($)	Approach Segment Delay Costs per Duration ($)	*Computations* Intx Vol-Delay: Delay/User (sec/veh) * Confl Vol (vphpl)	VMT Entering for Duratio	Intersecti on =1
Glenn SB & ER Lp	Intx AR215	STOP	276	UNDER	7.90	$ 3,389	$ 34	2182	77	1
Glenn NB & ER Lp	Intx BL215	STOP	261	UNDER	7.46	$ 4,866	$ -	1946	62	1
ER Loop & Driftwood	Intx DJ194	STOP	231	UNDER	6.59	$ 3,552	$ -	1520	143	1
ER Loop & Montague	Intx DJ184	SIGNAL	204	UNDER	8.14	$ 4,650	$ -	1658	60	1
Subtotals			21059	30,747	*18.36*	$ 704,908	$ 33,380	386695	*30,747*	*34*
			619	VMT	*avg intx delay sec/user*	Intersections	Segments	*seconds*	VMT	
			UNDER	veh-mi / HR	*at intersections*	Delay	Delay			
User Assumptions		avg at-grade intx conflict vphpl								
USER COST	$ 30.00	per HR Delay	UNDER	**30,747**	24610	$ 738,288				
HOURS of Impact per Day	1	Hour		**veh-mi travel per Hour**	**Total Delay HRS**	**Total User Delay Costs**		*18.36*		
TIME PERIOD: Days of Impact per Year	90	Days						*avg intx delay sec/user*		
PEAK: Hour Selected for Analysis:	PM	Hour						*at intersections*		

This Tab provides a one page wide summary list of intersections and ramp junction performance. The name, location, and traffic control for each location is followed by existing conflicting volumes and a planning level capacity rating calculated in Tab 4.

Existing intersection and approach segment delay costs are summarized from Tab 12. Total intersection delay, VMT and a count of intersections with traffic loading are in grey columns. These grey columns are not normally selected for final one page printouts. Intersections without traffic are not counted when calculating average intersection delay for the whole urban area.

Delays are for speed reduction and congestion levels over approach segments. Costs are applied to vehicle hours of delay on all entering volumes and segments.

Delays for the intersections are based on total entering vehicles at HCM Reference delay values per vehicle at flow rate Levels of Service.

Tab 13LOS-WZ

Conflicting intersection volume per hour per lane from Tab 4EX.

VMT = Vehicle Miles of Travel for each approach segment length, volume per hour per lane, and number of lanes.

1 *First delay*

Average delay per vehicle from HCMRef for the intersection control type and the conflicting volume.

Total cost of intersection delay based on delay per vehicle and total entering volume.



HCM Ref Speed for Volume, Class

Road Segment Class

Posted Speed

Approach Segment Length

Equivalent 2-Way Through Lanes

Entering Volume vplph

2 *Second delay*

Total Delay Cost for Reduced Segment Speed Differential and entering volume. If volumes are low, differential speed delay can be zero. Does not account for out of direction travel for detoured traffic. See Tab 14-15 for detour delay.

Tab 13WZ-Summary

Eagle River, Alaska

Work Zone Conditions Report

Baseline
11/19/2024

Intersection	Location	Type	Confl Vol	Intersection Planning Capacity Rating	Intx Delay per User (sec/HR)	Intx Total Delay Costs per Duration ($)	Approach Segment Delay Costs per Duration ($)
NER & Old Glenn	Intx CP60	SIGNAL	1301	OVER	49.82	$ 102,846	$ -
Old Glenn & ERR	Intx CF144	SIGNAL	1244	OVER	47.85	$ 90,029	$ 800
Old Glenn & ER Lp/Bus	Intx CP100	SIGNAL	1177	NEAR	45.52	$ 96,359	$ 4,810
E-W TEMPLATE I/C W LEG West Ramps	Intx CF252	UNDER	952.19	NEAR	0.00	$ 82	$ 132
E-W TEMPLATE I/C E LEG East Ramps	Intx CZ252	NEAR	952	UNDER	0.00	$ 165	$ 215
Glenn NB & Artillery	Intx BL144	STOP	872	NEAR	24.91	$ 38,942	$ 721
N EAGLE R I/C N LEG SB/NB Ramp JCTs	Intx BB50	UNDER	850	UNDER	0.00	$ 32	$ 101
ERR & ER Loop Rd	Intx DJ174	SIGNAL	786	NEAR	31.45	$ 43,486	$ 10,112
HILAND I/C S LEG SB/NB Ramp JCTs	Intx BB225	UNDER	766	UNDER	0.00	$ 18	$ 80
Old Glenn & Farm Ave	Intx CP90	STOP	741	UNDER	21.18	$ 37,069	$ -
Old Glenn &S Business	Intx CP120	SIGNAL	691	UNDER	27.64	$ 42,050	$ -
Old Glenn & Juniata	Intx CP70	STOP	660	UNDER	18.85	$ 33,485	$ -
N EAGLE R I/C S LEG SB/NB Ramp JCTs	Intx BB70	UNDER	657	UNDER	0.00	$ 34	$ 109
HILAND I/C N LEG SB/NB Ramp JCTs	Intx BB205	UNDER	650	UNDER	0.00	$ 19	$ 82
ERR & Firehouse	Intx CF164	STOP	645	UNDER	18.43	$ 16,465	$ 7,549
Old Glenn & Monte/ Brooks	Intx CP130	STOP	619	UNDER	17.69	$ 27,765	$ -
ERR & VFW	Intx CF154	STOP	617	UNDER	17.63	$ 15,375	$ 920
Old Glenn & Santa Maria	Intx CP80	STOP	600	UNDER	17.15	$ 29,346	$ -
ER Loop & Baranoff / Citation	Intx DJ164	STOP	590	UNDER	16.86	$ 14,721	$ 1,885
GlennSB & NER	Intx AR60	STOP	547	UNDER	15.63	$ 12,847	$ 834
Eklutna Park Dr & Terrace	Intx AH60	STOP	541	UNDER	15.46	$ 10,680	$ 1,347
Old Glenn & Coronado	Intx CP110	STOP	511	UNDER	14.61	$ 19,863	$ -
Glenn SB & Artillery	Intx AR144	STOP	507	UNDER	14.48	$ 12,071	$ 436
ER Loop & Yosemite / Hiland	Intx CP215	STOP	468	UNDER	13.38	$ 15,968	$ -
Old Glenn & Harry McDonald	Intx CP29	STOP	433	UNDER	12.38	$ 8,040	$ 3,054
ER Loop & VFW	Intx BV215	STOP	378	UNDER	10.81	$ 9,665	$ -
ARTILLERY I/C N LEG SB/NB Ramp JCTs	Intx BB134	UNDER	369	UNDER	0.00	$ 3	$ 78
Glenn NB & NER	Intx BL60	STOP	345	UNDER	9.85	$ 7,214	$ 20
Business & Carrs	Intx CF120	STOP	323	UNDER	9.21	$ 3,810	$ -
ARTILLERY I/C S LEG SB/NB Ramp JCTs	Intx BB154	UNDER	294	UNDER	0.00	$ 3	$ 60
Glenn SB & ER Lp	Intx AR215	STOP	276	UNDER	7.90	$ 3,389	$ 34
Glenn NB & ER Lp	Intx BL215	STOP	261	UNDER	7.46	$ 4,866	$ -
ER Loop & Driftwood	Intx DJ194	STOP	231	UNDER	6.59	$ 3,552	$ -
ER Loop & Montague	Intx DJ184	SIGNAL	204	UNDER	8.14	$ 4,650	$ -
Plus NET Travel Distance/Travel Time Costs applied to Detoured Traffic							$ -
Subtotals			21059	30,747	*18.36 avg sec delay / user at intersections*	$ 704,908 Intersections Delay	$ 33,380 Segments Delay
			619 UNDER	VMT veh mi / HR			

User Assumptions — avg at grade intx conflict vph pl

USER COST	$30.00	per HR Delay	UNDER	30,747 veh-mi travel for the Hour Modeled	24610 Total Delay HRS for Duration	$ 738,288 Total User Delay Costs
HOURS of Impact per Day	1	Hour				
TIME PERIOD: Days of Impact per Year	90	Days				
PEAK: Hour Selected for Analysis:	PM	Hour				
Long Term 20 Year Growth, if used	*0.00%*	*Annual*				

Comparison to Existing Conditions	2023	UNDER	30,747 veh-mi travel per Hour	24610 Total Delay HRS for Duration	$ 738,288 Total User Delay Costs
		No VMT Change	*100.0%*	1.00	No Added Delay

This Tab provides a one page wide summary list of intersections and ramp junction performance under changed conditions, similar to Tab 12 for existing conditions. The summary may be for work zone changes including detours, lane reductions, and/or speed reductions from Tab 3, or it may be for a 20 year long term growth factor from Tab 1 with or without any work zone changes.

Changed intersection and approach segment delay costs are summarized from Tab . Segment delay costs are increased when work zone speed limits are added. Tabs 14 and 15 combine to provide an additional delay at the end of the list for added detour distance.

Work Zone or Long Term total values for the urban area are summarized at the bottom, and then compared to total values for existing conditions in the last grey row. Total changes in VMT and delay from existing conditions are the last row.

Tab 14Incr-delays



Tab 14 computes approach volume segment delay and cost for differential traffic increases in Tabs 5 WZ+ and 7 Advance Detours. This increase in traffic due to “D” detour routing causes a delay and cost increase to those detoured users in the total network.

Tab 15Decr-delays



Tab 15 then computes approach volume segment delay and cost savings for differential traffic decreases in Tab 6 WZ-. This increase in traffic due to “D” detour routing causes a delay and cost increase to those detoured users in the total network.

<u>3 Sources of Delay</u>

Calculating delay and cost differentials for detour traffic only, and combining them provides a net result of the impact of detoured traffic, or moving traffic around on the network.

These tabs do not include 1) intersection delay for total traffic or 2) segment delay for speed reductions. Those delays due to changed conditions are already applied to detour traffic present in Tab 13 as part of total traffic. Those delays in Tab 13 are summarized in comparison to Tab 12 for existing traffic delays at their original intersections and segments.

3 *Third delay*

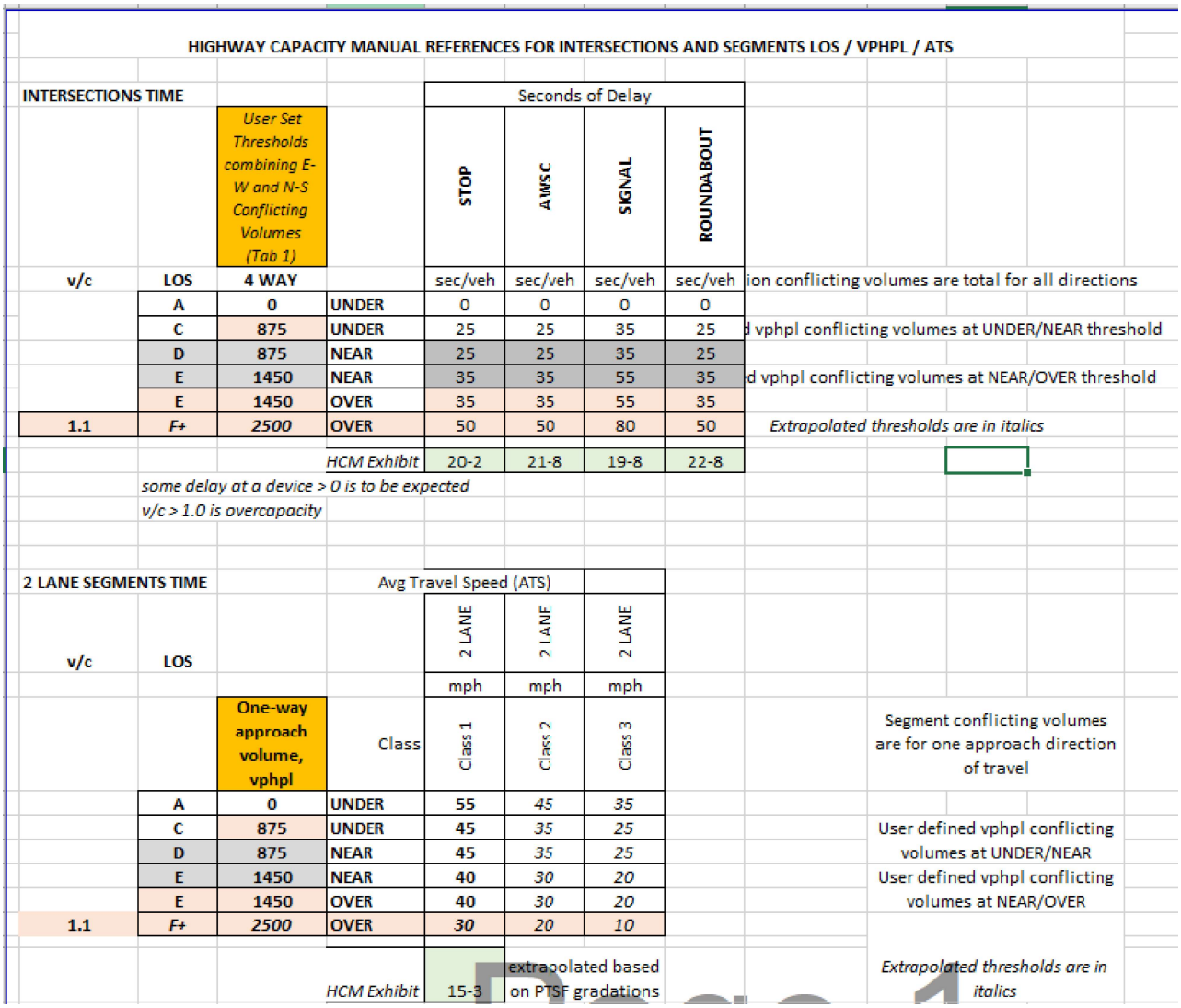
This third delay is additional based on travel time differentials for a selected group of rerouted traffic on a change in segment lengths based on original HCMRef calculated speeds for existing conditions.

This delay takes the segment link distance travel time costs for detour traffic only, and subtracts any link travel time and costs no longer incurred in closed or detoured segments.

HCMRef

The “HCMRef” Tab tabulates delay and flow rate Levels of Service per the TRB Highway Capacity Manual. Each HCM LOS Exhibit is cited and tabulated for intersection and segment types. These performance levels are then correlated to flow rates (veh/hr/lane) for intersection and segment capacity. Flow rates for each LOS threshold are either defined by the User Inputs in Tab 1 or come directly from the HCM for multilane highways and freeways.

Using the HCM values, UrbanWZ 1-2-3 assigns a delay value to each intersections conflicting volume. Using User calculated flow rates, roadway segments are assigned a corresponding HCM segment speed to compare with the existing or work zone posted speed. Speed reductions caused by congestion or by work zone speed limits are converted into user costs per segment by UrbanWZ 1-2-3.



HIGHWAY CAPACITY MANUAL REFERENCES FOR INTERSECTIONS AND SEGMENTS LOS / VPHPL / ATS

INTERSECTIONS TIME				Seconds of Delay				
		User Set Thresholds combining E-W and N-S Conflicting Volumes (Tab 1)		STOP	AWSC	SIGNAL	ROUNDABOUT	
v/c	LOS	4 WAY		sec/veh	sec/veh	sec/veh	sec/veh	ion conflicting volumes are total for all directions
	A	0	UNDER	0	0	0	0	
	C	875	UNDER	25	25	35	25	d vphpl conflicting volumes at UNDER/NEAR threshold
	D	875	NEAR	25	25	35	25	
	E	1450	NEAR	35	35	55	35	d vphpl conflicting volumes at NEAR/OVER threshold
	E	1450	OVER	35	35	55	35	
1.1	*F+*	*2500*	OVER	50	50	80	50	*Extrapolated thresholds are in italics*
			HCM Exhibit	20-2	21-8	19-8	22-8	

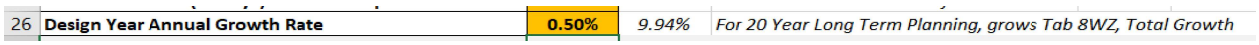
some delay at a device > 0 is to be expected
v/c > 1.0 is overcapacity

2 LANE SEGMENTS TIME				Avg Travel Speed (ATS)			
				2 LANE	2 LANE	2 LANE	
v/c	LOS			mph	mph	mph	
		One-way approach volume, vphpl	Class	Class 1	Class 2	Class 3	Segment conflicting volumes are for one approach direction of travel
	A	0	UNDER	55	*45*	*35*	
	C	875	UNDER	45	*35*	*25*	User defined vphpl conflicting volumes at UNDER/NEAR
	D	875	NEAR	45	*35*	*25*	
	E	1450	NEAR	40	*30*	*20*	User defined vphpl conflicting volumes at NEAR/OVER
	E	1450	OVER	40	*30*	*20*	
1.1	*F+*	*2500*	OVER	*30*	*20*	*10*	
			HCM Exhibit	15-3	extrapolated based on PTSF gradations		*Extrapolated thresholds are in italics*

Additional HCM tables are in the spreadsheet Tab “HCMRef”

TimeCalc

A spreadsheet user can input a long term, global annual growth rate for an urban area into Tab 1, User Inputs. This value is then referred to the "TimeCalc" tab to calculate a cumulative 20 year total growth factor over time. The example below from Tab 1 inputs shows 1/2% annual growth as 9.94% total growth over 20 years.



26	**Design Year Annual Growth Rate**	**0.50%**	*9.94%*	*For 20 Year Long Term Planning, grows Tab 8WZ, Total Growth*

Tab 8WZ then applies this growth factor to all turning movements. The Tab 1 Seasonal Adjustment Factor is also applied on top of this. The result is a capacity, delay, VMT, and cost evaluation for the urban area is performed the same as for work zones.

This annual growth factor input allows a user to consider long term growth. This can provide a rapid assessment of long term planning capacity concerns for an urban area network in comparison to existing conditions, without any other improvements.

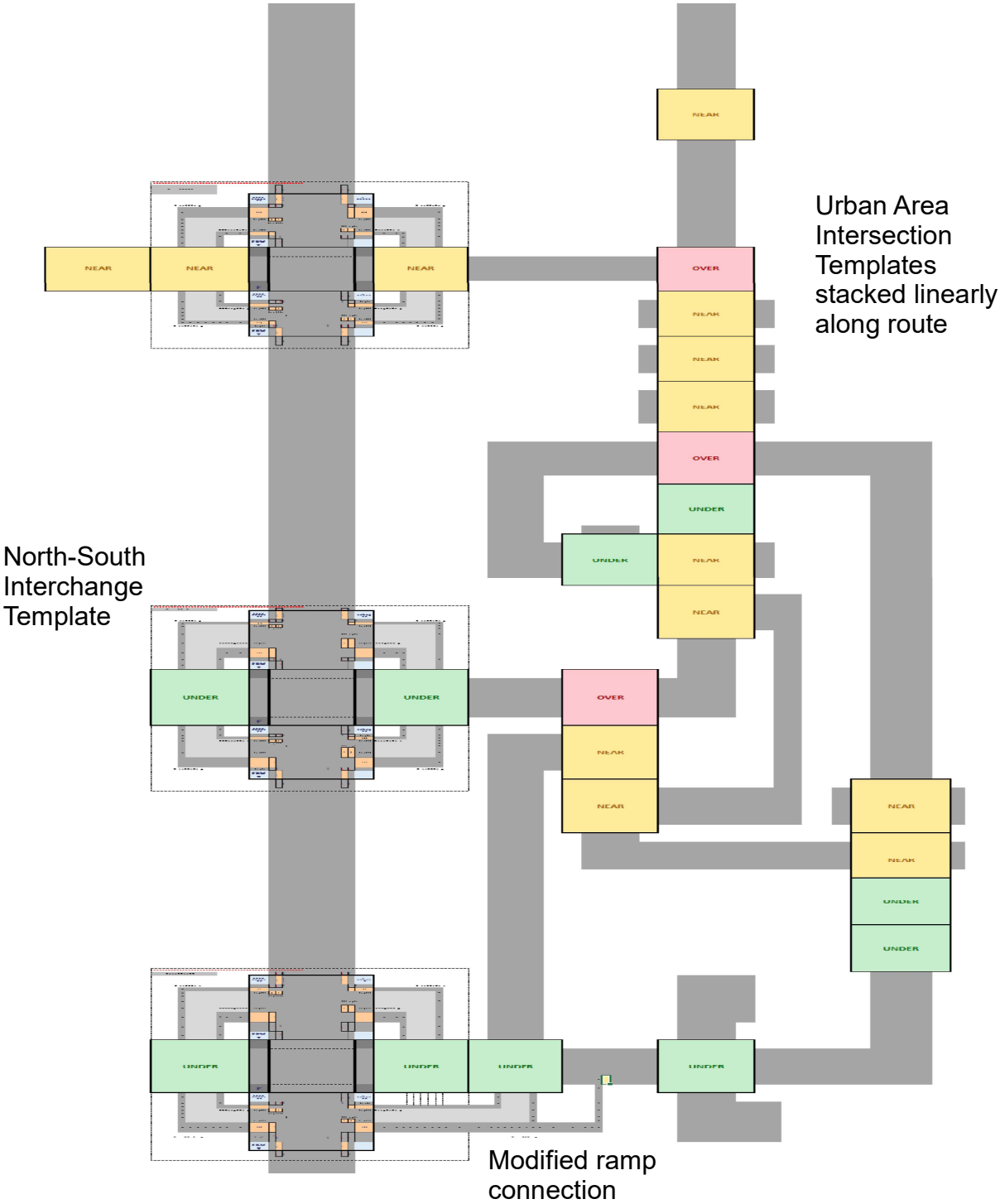
This table in "TimeCalc" tab shows how the annual growth rate accumlates over 20 years to become the total growth factor or percentage applied to turning movements.

.

		0.5%	Annual Growth Rate
Year	Value	Cumulative	
1	1000	100%	
2	1005	100.50%	
3	1010.0	101.00%	
4	1015.1	101.51%	
5	1020.2	102.02%	
6	1025.3	102.53%	
7	1030.4	103.04%	
8	1035.5	103.55%	
9	1040.7	104.07%	
10	1045.9	104.59%	
11	1051.1	105.11%	
12	1056.4	105.64%	
13	1061.7	106.17%	
14	1067.0	106.70%	
15	1072.3	107.23%	
16	1077.7	107.77%	
17	1083.1	108.31%	
18	1088.5	108.85%	
19	1093.9	109.39%	
20	1099.4	109.94%	
		9.94%	Design Year Total Growth

Tabs 2 and 3 Interchange Templates

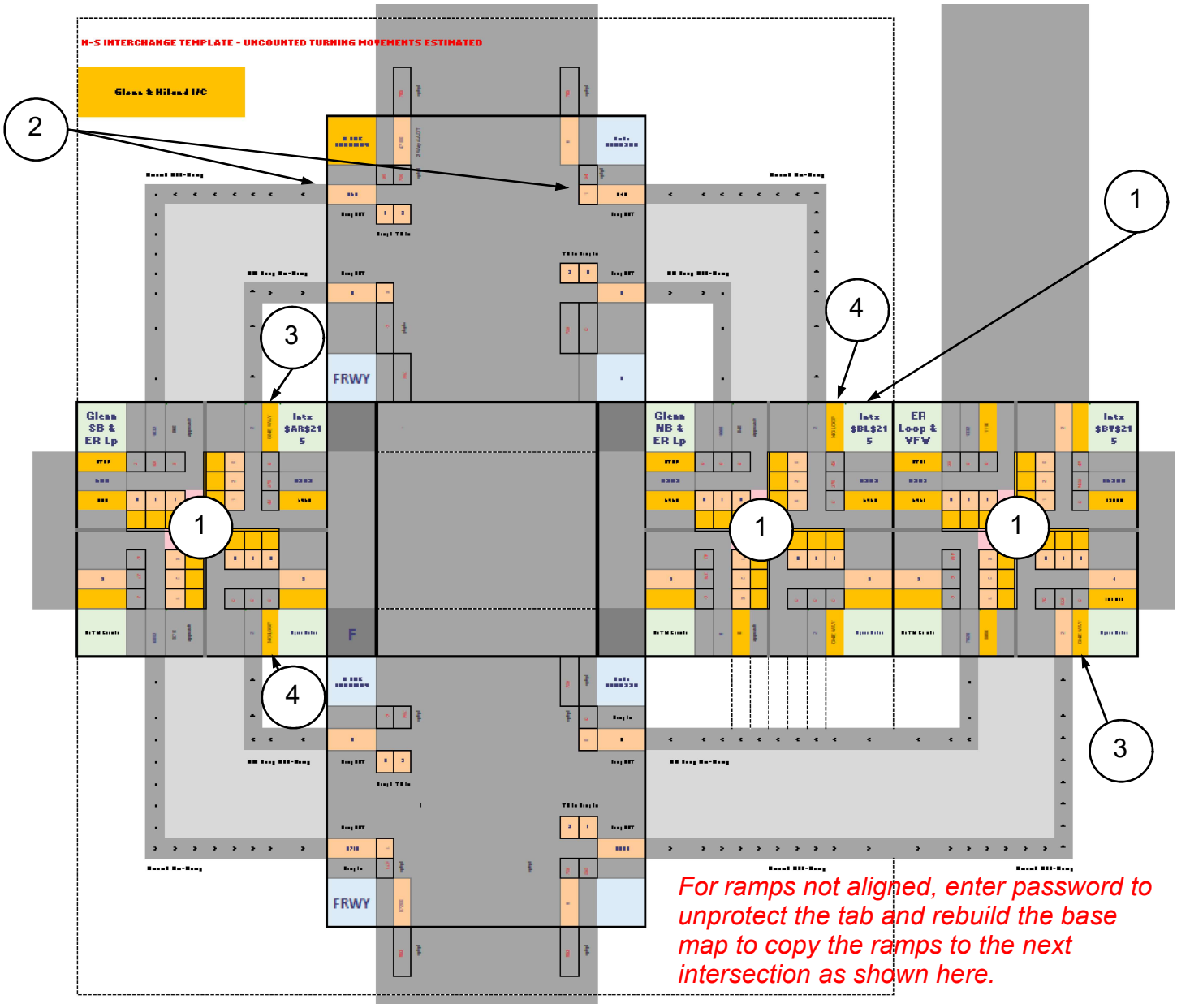
(30x34 - rows or columns)



Example:Eagle River, AK

North-South and East-West freeway templates can simplify interchange map building within an urban area. Templates allow for one-way diamond interchange ramps or par-clo loop ramps to be selected for each quadrant. Other types of interchanges are not built as templates. Standard Interchange templates are available in the EagleRiver, Alaska work zone spreadsheet and in Row 1000 in each Tab. These templates can be used to create a single point urban interchange (SPUI) or modified to include the centralized four LOS squares of a roundabout ranked diamond interchange.

Tab 2 Interchange Templates INPUT



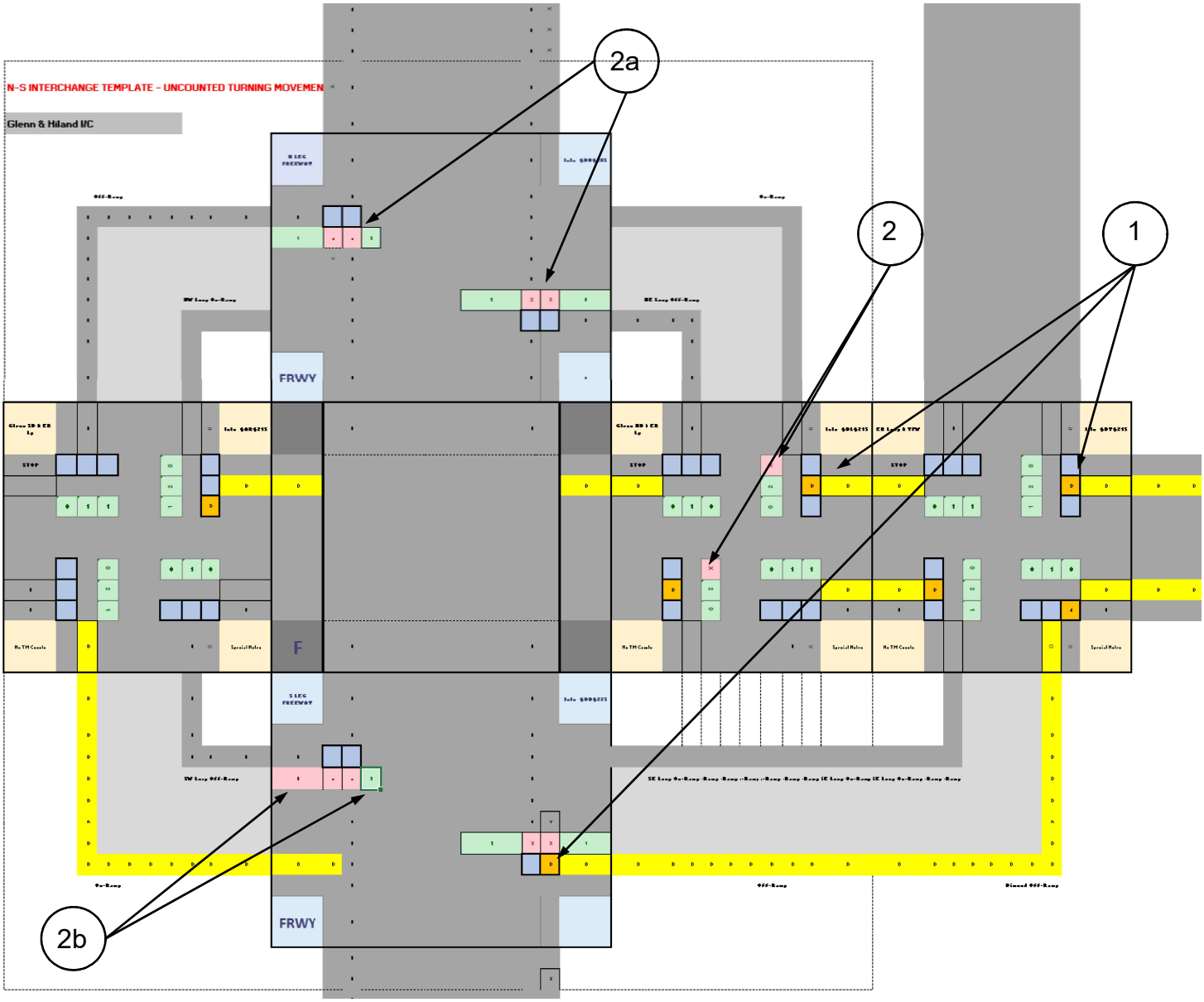
1. Input intersection names, segment leg AADT's, segment 2-way thru lanes, turning movements and lanes for Ramp Junctions the same as was done for individual intersections in Tab 2IN. (These 10x10 squares are shown in green for an east-west sidestreet above.)

2. Input AADTs for the 2-way mainline freeway, exit ramps, and entrance ramps and number of lanes. Vehicles per hour per lane will be calculated. (These 10x10 squares are shown in blue for a north-south freeway.)

3. Input ONE WAY if exit ramps are one-way on approach legs to individual intersections (shown in green above.) This also means there is no loop ramp in that quadrant.

4. Input NO LOOP IF entrance ramps have no loop ramp. No need to label these as one-way departures from sidestreet intersections.

Tab 3 Interchange Templates
DETOURS



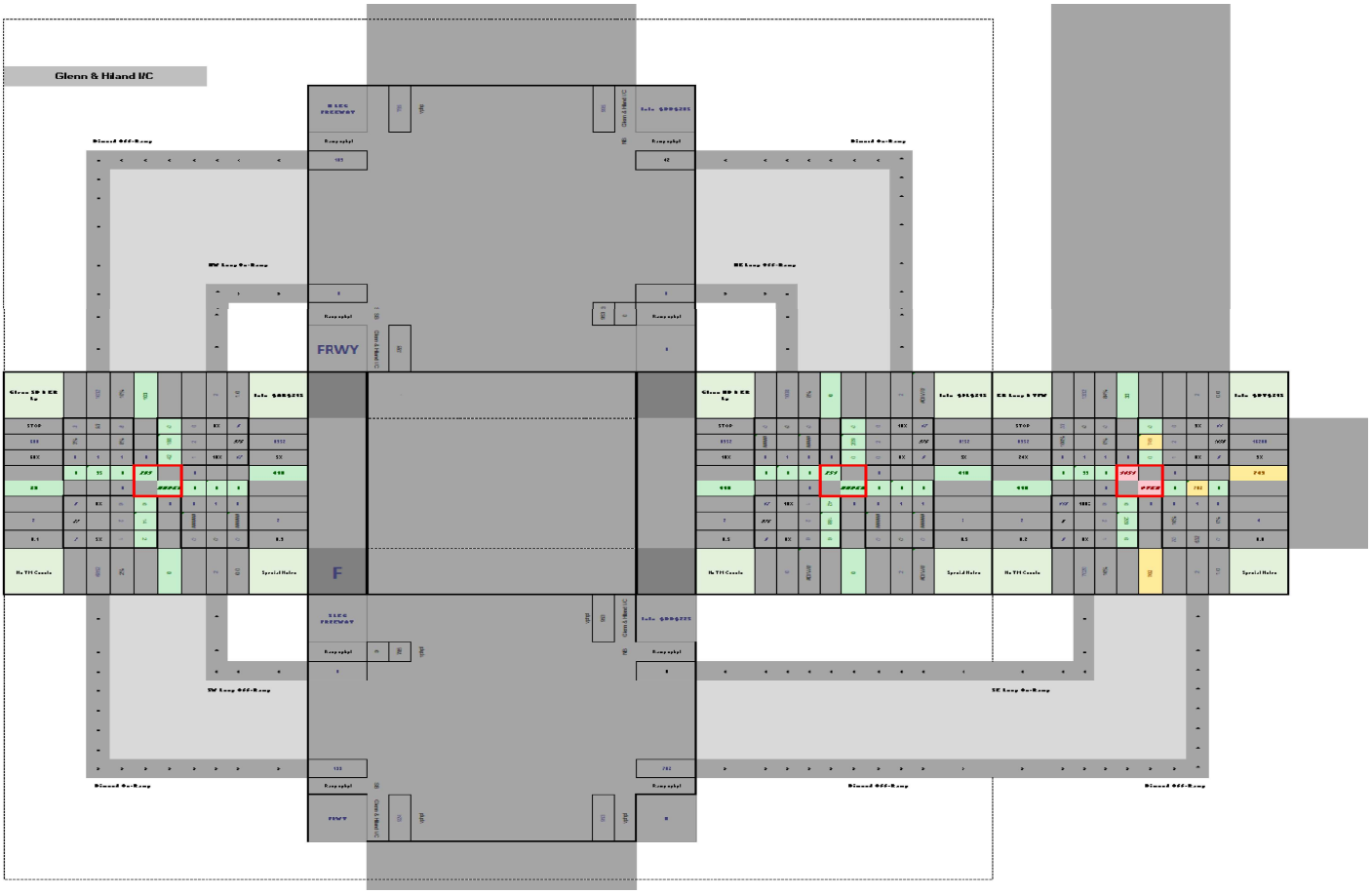
1. Input “D” to specify detour routes, the same as is shown for Tab 3XWZ-DTIN.

2. Input lanes closed to traffic with an “X”, cells will turn red. Or reduce lanes to less than existing.

   a. On freeway 10x10 ramp templates, input “X” in the center two squares if thru or ramp lanes are closed. The center two cells are used to inform adjacent interchange templates in the event advance detours are used at prior exits.

   b. Specify freeway ramp lanes or thru lanes on the outside two cells, not the center two cels.

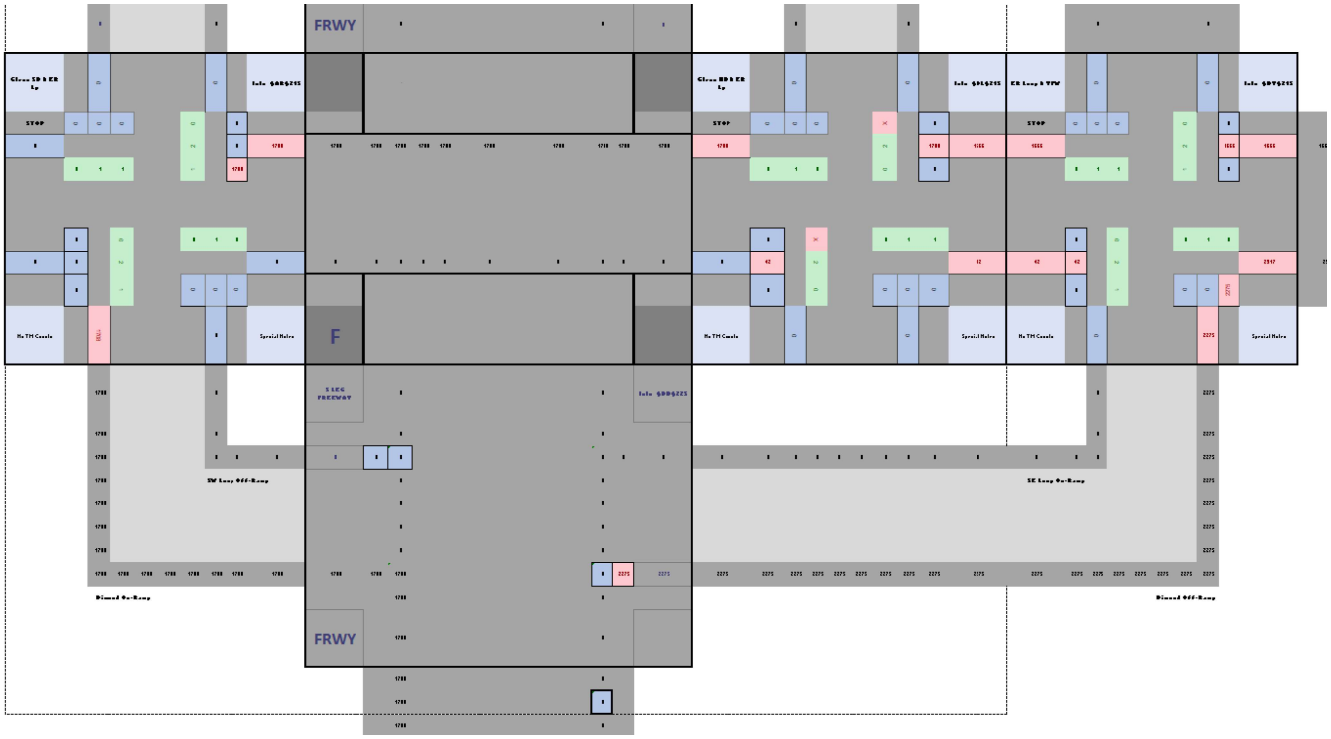
Tab 12INTERCHG Interchange Templates Planning LOS



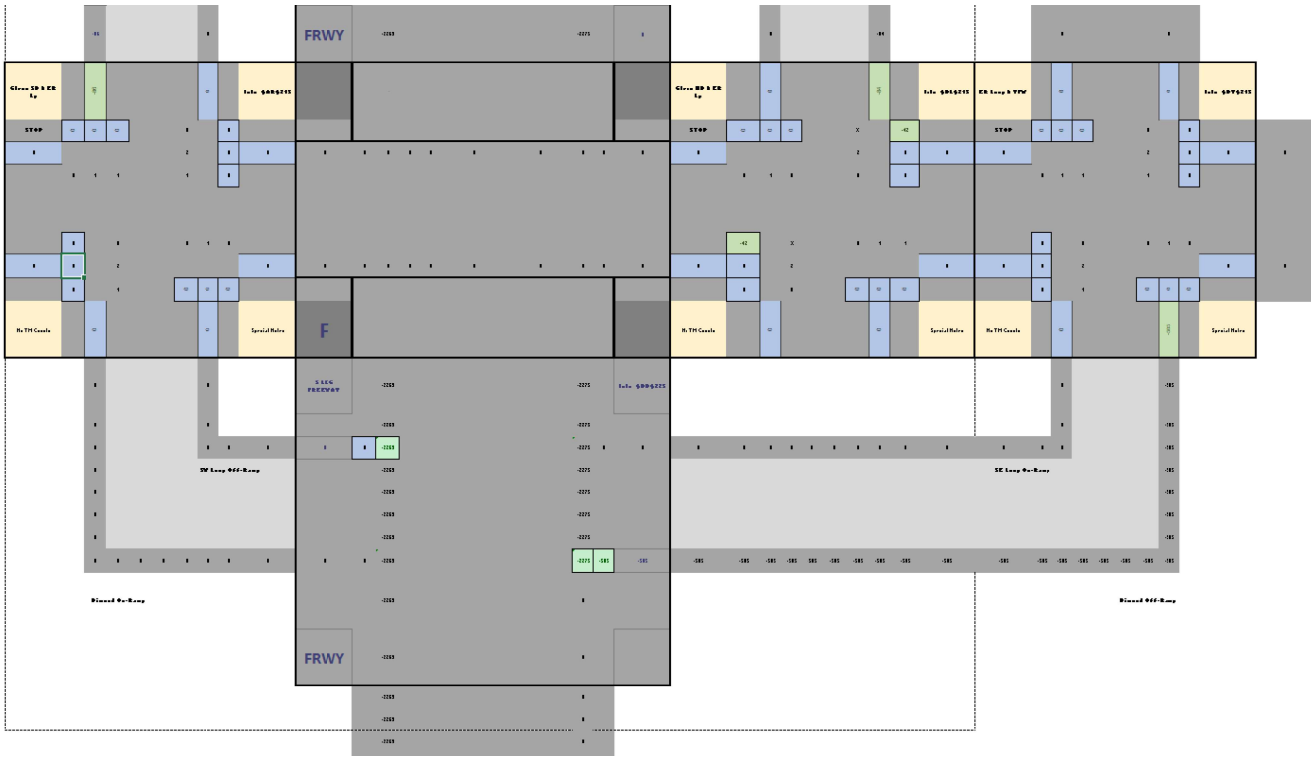
Planning LOS is computed in Tabs 4 for Existing Conditions and Tab 8 for Work Zone Conditions. The same method is used for intersections at ramp junctions as for other urban area intersections.

Use the same map built in Tab 2 for all Tabs, as instructed in Tabs 2 and 3 forward. Paste the interchange templates available in each tab to perform automated calculations in Tabs 4 forward. When exit and entrance ramps are offset to a different intersection, each Tab must be unprotected and edited by copying cells to a different intersection, as shown above.

Tab 5 Interchange Templates
Differential Traffic Increases

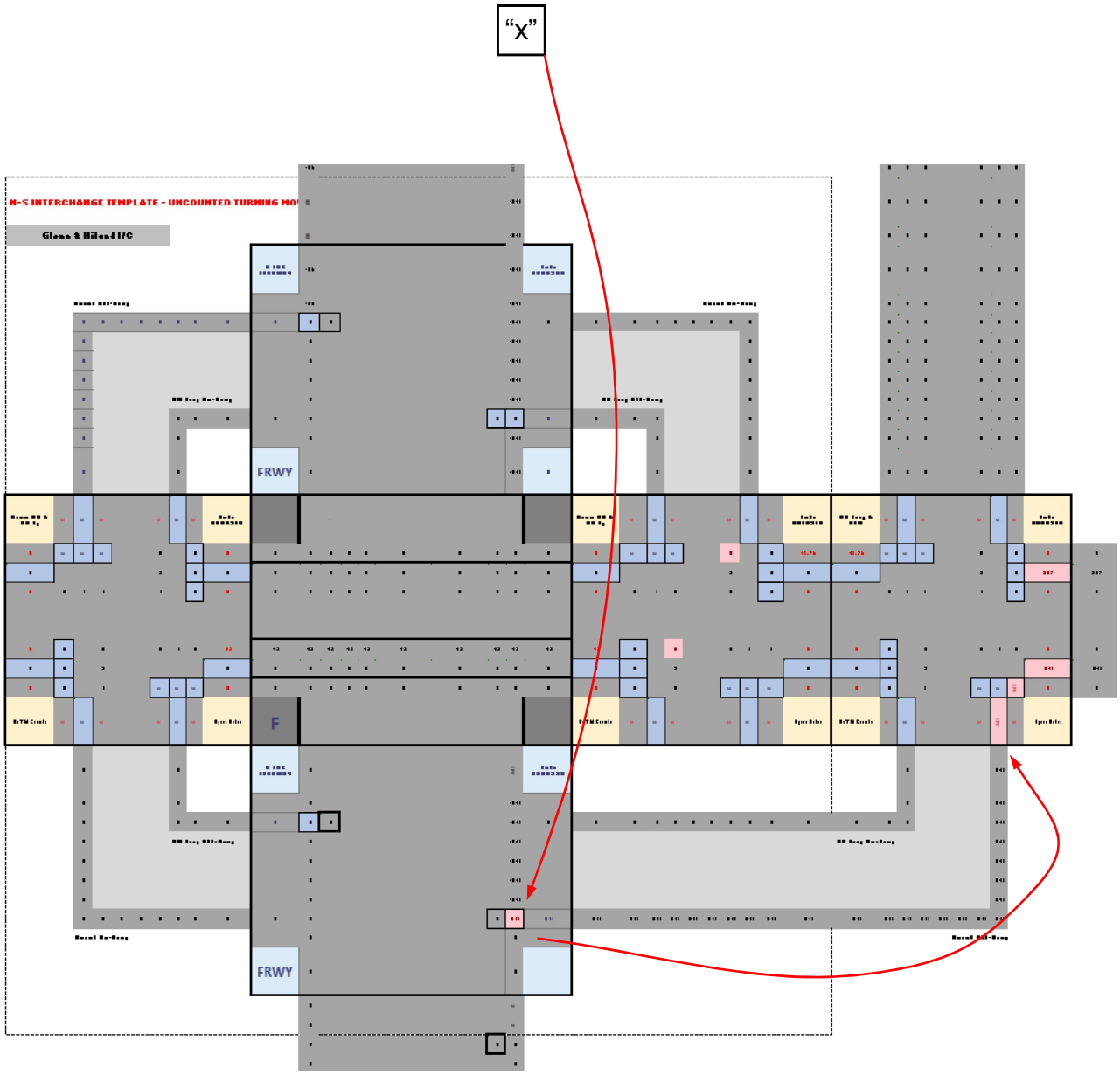


Tab 6 Interchange Templates
Differential Traffic Decreases



These tabs work automatically other than modifying custom interchange templates.

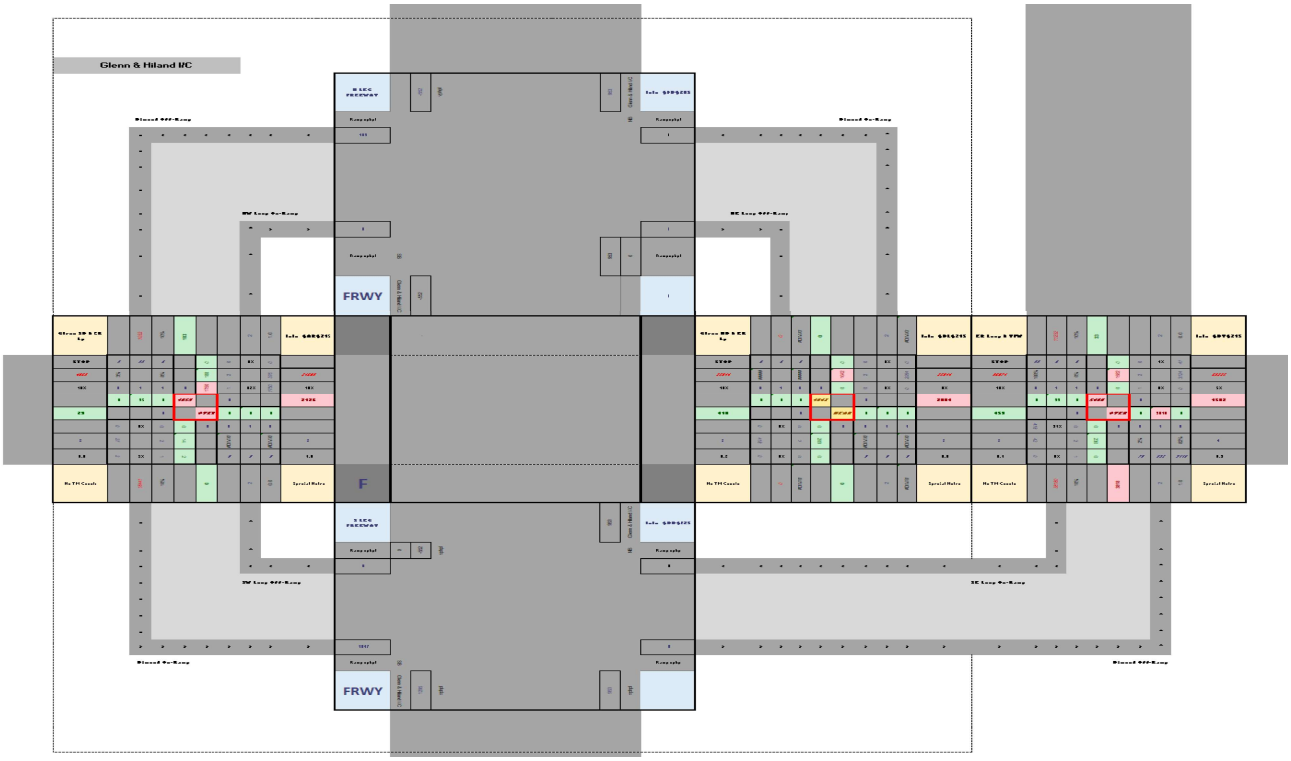
Tab 7 Interchange Templates
Advance Detour Traffic Routing



This tab works automatically other than modifying custom interchange templates. If the downstream interchange ramps or through lanes are closed with an "X", this carries forward to the upstream interchange.

If the upstream interchange has a "D" defined detour to use an exit, then downstream traffic volumes are differentially added to the ramp and specified detour route.

Tab 8 Interchange Templates
Work Zone Conditions Planning LOS



Tabs 9 and 10 Existing and Work Zone Conditions Capacity Lists

Eagle River, AK
WORK ZONE DETOURS REPORT 2023
PM Peak

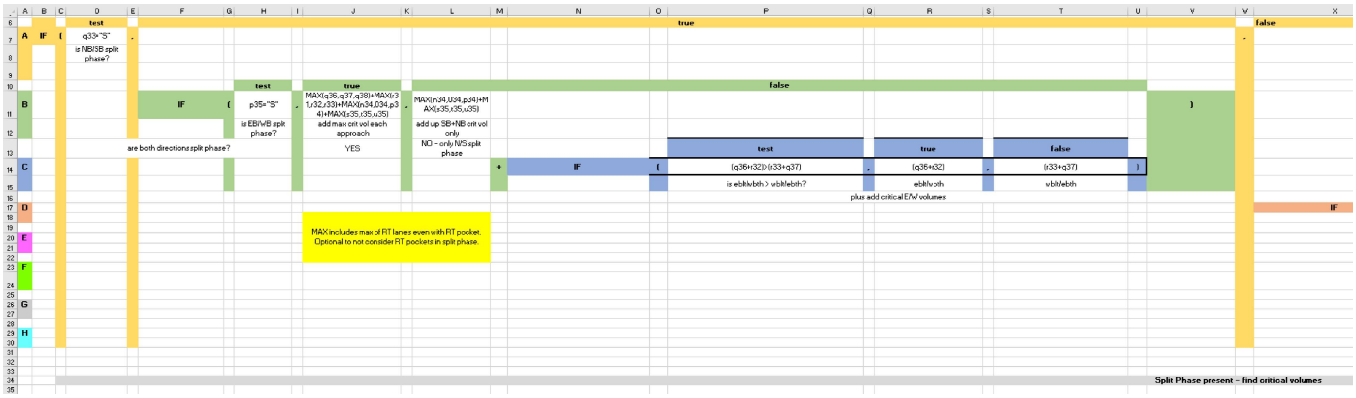
5/28/2024

Intersection	Location	Other Notes	WZ CAP	LT concern	TH concern	RT concern	APPR concern	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBAPPR	SBAPPR	EBAPPR	WBAPPR
Eklutna Park Dr & Terrace	Intx SAHS60	Special Notes	NEAR	no	no	no	no																
GlennSB & NER	Intx SARS60	Special Notes	OVER	yes	no	no	yes				SB LT OVER										SB APPR OVER		
Glenn NB & NER	Intx SBLS60	Special Notes	OVER	no	yes	no	yes								EB TH OVER			WB TH OVER				EBAPPR OVER	WB APPR OVER
Glenn SB & ER Lp	Intx SARS215	Special Notes	OVER	yes	no	no	yes										WB LT OVER						WB APPR OVER
Glenn SB & Artillery	Intx SARS144	Special Notes	NEAR	yes	no	no	yes				SB LT OVER												WB APPR NEAR
Glenn NB & ER Lp	Intx SBLS215	Special Notes	NEAR	no	yes	no	yes											WB TH OVER					WB APPR OVER
Glenn NB & Artillery	Intx SBLS144	Special Notes		no	no	yes	yes			NB RT OVER												EBAPPR NEAR	
ER Loop & VFW	Intx SBVS215	Special Notes	OVER	no	yes	no	yes		NB TH OVER									WB TH OVER		NB APPR OVER			WB APPR OVER
ER Loop & Yosemite / Hiland	Intx SCPS215	Special Notes	OVER	yes	yes	no	yes							EB LT OVER	EB TH OVER		WB LT NEAR	WB TH OVER				EBAPPR OVER	WB APPR OVER
ER Loop & Frontage	Intx SDJS194	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
ER Loop & Montague	Intx SDJS184	Special Notes	OVER	yes	yes	no	yes		NB TH OVER			SB TH OVER					WB LT NEAR			NB APPR OVER	SB APPR OVER		
ERR & ER Loop Rd	Intx SDJS174	Special Notes	OVER	no	no	yes	yes	NB LT OVER								EB RT OVER				NB APPR OVER	SB APPR NEAR	EBAPPR OVER	WB APPR NEAR
ER Loop & Baranoff / Citation	Intx SDJS164	Special Notes	NEAR	no	no	no	yes													NB APPR NEAR	SB APPR NEAR		
ERR & Firehouse	Intx SCPS164	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & ERR	Intx SCPS144	Special Notes	OVER	yes	yes	yes	yes	NB LT OVER		NB RT OVER						EB RT NEAR	WB LT OVER	WB TH OVER		NB APPR OVER			WB APPR OVER
ERR & VFW	Intx SCPS134	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
Business & Carrs	Intx SCPS120	Special Notes		no	no	no	no																
Old Glenn & Monte/ Brooks	Intx SCPS130	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
NER & Old Glenn	Intx SCPS60	Special Notes	OVER	no	yes	yes	yes	NB LT OVER	NB TH NEAR						EB TH NEAR	EB RT OVER				NB APPR OVER		EBAPPR OVER	
Old Glenn & Juniata	Intx SCPS70	Special Notes	OVER	yes	yes	no	yes	NB LT NEAR	NB TH OVER		SB LT NEAR	SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & Santa Maria	Intx SCPS80	Special Notes	OVER	yes	yes	no	yes	NB LT NEAR	NB TH OVER		SB LT NEAR	SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & Farm Ave	Intx SCPS90	Special Notes	OVER	no	yes	no	yes	NB LT NEAR	NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & ER Lp/Bus	Intx SCPS100	Special Notes	OVER	yes	yes	no	yes		NB TH OVER		SB LT NEAR	SB TH OVER						WB TH NEAR		NB APPR OVER	SB APPR OVER		WB APPR NEAR
Old Glenn & Coronado	Intx SCPS110	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & S Business	Intx SCPS120	Special Notes	OVER	no	yes	no	yes		NB TH OVER			SB TH OVER								NB APPR OVER	SB APPR OVER		
Old Glenn & Harry McDonald	Intx SCPS29	Special Notes	NEAR	no	no	no	no																

WORK ZONE CONDITIONS - INTERSECTIONS "NEAR" CAPACITY	5				3	1	0	3	0	0	0	1	1	2	1	0	1	2	1	3
EXISTING CONDITIONS - INTERSECTIONS "NEAR" CAPACITY	13				4	6	0	3	5	0	0	1	1	4	3	0	9	8	2	5
WORK ZONE CONDITIONS - INTERSECTIONS "OVER" CAPACITY	19	9	17	4	23	3	12	2	2	11	0	1	2	2	2	5	0	15	12	4	6
EXISTING CONDITIONS - INTERSECTIONS "OVER" CAPACITY	5	8	10	2	14	1	0	2	1	0	0	1	0	0	0	1	0	0	0	0	0

These tabs work the same a previous instructions other than modifying custom interchange templates.

PROGRAMMING

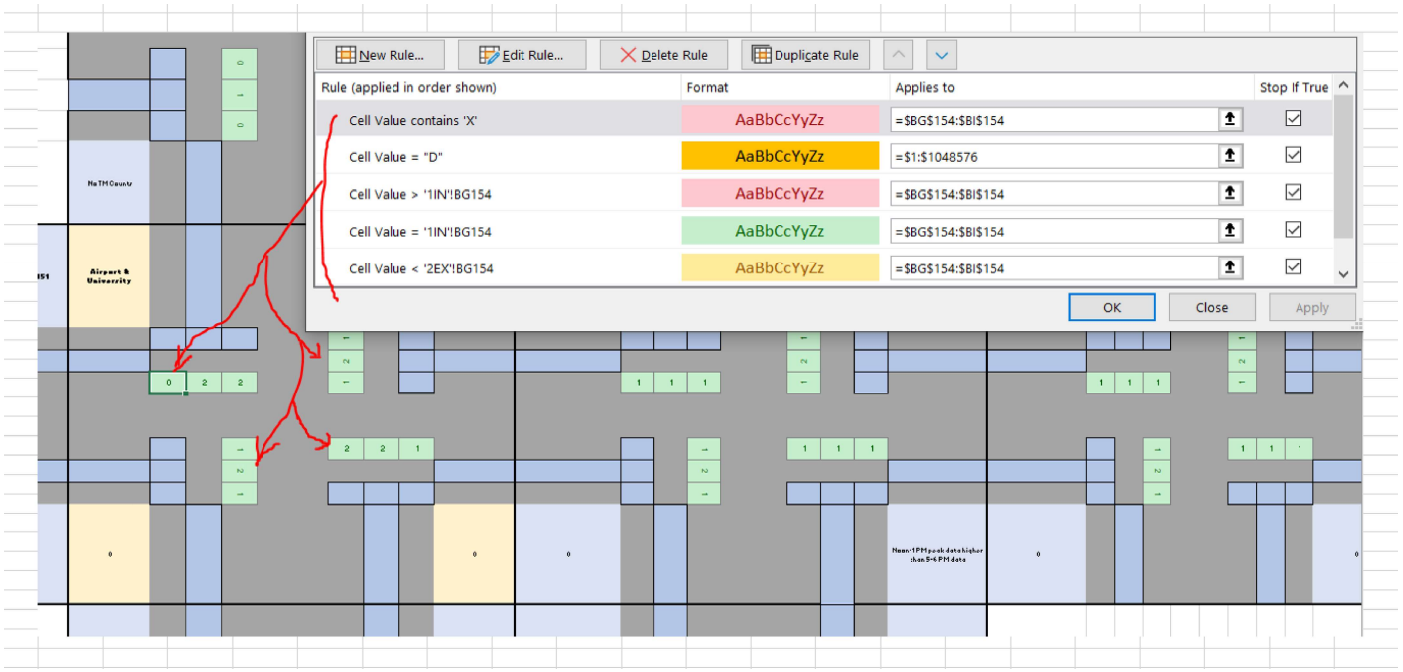


Long Loops →

The Programming Tab provides documentation of more detailed IF decisions when calculating critical volumes. Statements are designed by the decisions to be made, then are programmed to have cells compared to make those decisions depending on N-S or E-W travel directions. These are difficult formulas to write by eye, so the structure had to be written out to ensure parentheses, commas, and IF loops fit within each other and prevented errors in “(” or ”,“ syntax. Formulas are then edited based on a map of each cardinal direction replaced with translated equivalent cell addresses in each direction of the 10x10 intersection templates. Once the template it created, it is placed in each table for copying to intersection locations.

Other IF statements are listed on the Programming page, including where differential traffic numbers are sent when detours “D” are specified.

FORMATTING



The formatting tab in the spreadsheet shows how cells are colored for lanes.
“X” closed lanes in User Input Tab 3 for specifying detours turns cells red.
Orange cells are other user inputs in all tabs.
When lanes specified equal existing, cells turn green.
When lanes specified turn less than existing, but are not closed, cells turn yellow.