ARIZONA DEPARTMENT OF TRANSPORTATION

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ARIZONA STATEWIDE ALTERNATE ROUTE PLAN

Final Report

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Federal Highway Administration

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16. Abstract

Increasing traffic volumes on Arizona's State Highway System are contributing to the increased frequency and duration of incident-caused rural highway closures, amplifying the need to effectively divert traffic around these situations. Through this research project, the Arizona Department of Transportation (ADOT), in collaboration with other state agencies, is addressing the need for a statewide, seamless and homogenous set of current alternate routes to supplement the existing detours developed by ADOT District offices. To accomplish this goal, this project developed an alternate route database in close cooperation with the ADOT Districts and Arizona Department of Public Safety (AZ DPS). The alternate route electronic database and workbook will be distributed both internally within ADOT and to DPS as a controlled document. Both agencies will use the detour workbook for incident management, with designated ADOT staff continuing to update the workbook as needed. In the future, ADOT can use rural Variable Message Signs (VMS) and other systems to implement detours from the workbook and include detour information in Highway Closure and Restriction System (HCRS) bulletins.

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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	2.54	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	6.452	centimeters 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	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0328	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 (after subtracting 32)	Celsius temperature	°C

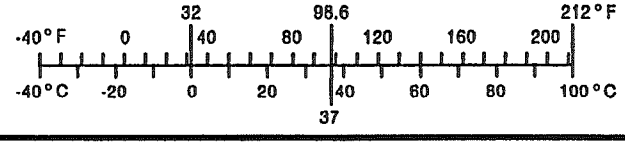
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
yd	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
yd^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	millimeters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3

		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

These factors conform to the requirement of FHWA Order 5190.1A

*SI is the symbol for the International System of Measurements



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1.0 INTRODUCTION AND BACKGROUND

Traffic volumes have increased greatly across Arizona in recent years. As rural highway closures due to incidents become more frequent and longer in duration, the need has grown to effectively divert traffic around these situations.

The Arizona Department of Transportation (ADOT), in collaboration with other state agencies, recognized the need for a state-wide, seamless and homogenous set of current alternate routes to supplement the existing detours developed by ADOT District offices. To accomplish this goal, ADOT's Arizona Transportation Research Center (ATRC) selected the services of Kimley-Horn and Associates to develop an alternate route database in close cooperation with the ADOT Districts and Arizona Department of Public Safety (AZ DPS).

Excerpts from the research problem statement developed by ATRC, as listed below, provide additional background information and help to illustrate the significance and the urgency of this problem.

1.1 EXCERPTS - RESEARCH PROJECT PROBLEM STATEMENT

There have been several recent, highly publicized accident-related closures on rural highways around Arizona during 1998. ADOT and other state incident managers have been tasked by the Governor's Office to explore ways to avoid such multi-hour delays in the future.

A basic step would be to develop a consistently accurate and valid detour plan for Arizona's major rural highways. This will involve the review and integration of existing District detour plans, of varying quality and depth, into one consistent document as a planning tool for ADOT and its incident management partners. Further, it would be necessary to analyze all of the major federal, state and Indian highway segments to develop alternate route options.

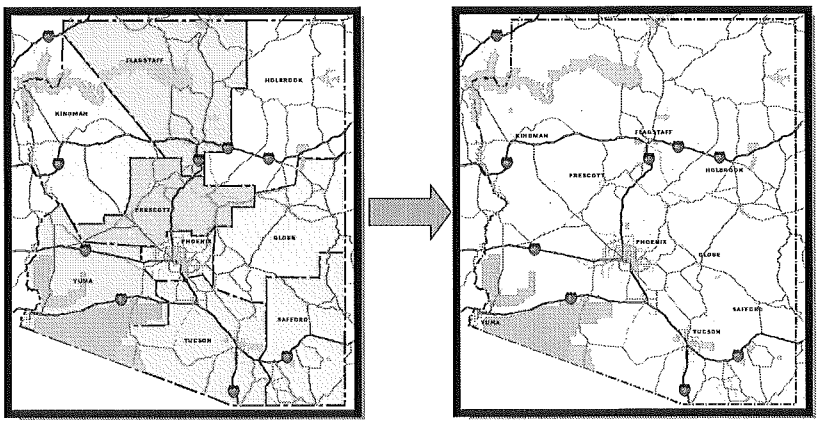


Figure 1 – From Divided by Districts to Seamless Detours

Whereas ADOT District detour plans do exist today, they are not all current. These individual District plans are not particularly consistent in format, in level of detail, or in distribution to emergency service providers and other partners. Additionally, these plans often do not address routes as they cross District boundaries or state borders.

There is a strong need for a clear and comprehensive plan that addresses these shortcomings and that can be clearly formatted for the District personnel and any other potential users.

RESEARCH OBJECTIVE

To develop a Statewide Alternate Route Plan that provides accurate, clear and consistent route alternatives for all major rural highway segments across the state of Arizona. At least three detour or non-detour options will be developed for each route segment.

EXPECTED IMPLEMENTATION AND PROCESS OWNER

The project will enable all of the ADOT Districts to deal with incident-caused highway closures throughout the state in a more consistent and more efficient way. It will benefit the traveling public and will optimize the use of the limited resources of ADOT, DPS, and the affected rural communities. The ADOT process owners would be the State Engineer's and the Director's offices.

1.2 PROJECT DIRECTION

The tabular workbook format for alternate routes was conceived primarily as a working tool for the Phoenix TOC operators, who had difficulty interpreting the wide variety of district detour plan formats. The TOC staff coordinates statewide incident management activities for ADOT's districts at night and on weekends.

The project's Technical Advisory Committee (TAC) provided guidance and support throughout the project. Key agencies represented in the TAC were:

- Arizona Department of Transportation
  - Construction and Maintenance Districts
  - Transportation Technology Group
  - Transportation Planning Division
  - Community Relations Office
  - Freeway Management System/Traffic Operations Center (Phoenix)
- Arizona Department of Public Safety (DPS)
- Federal Highway Administration (FHWA)

The following individuals served as TAC members:

Ron Casper	-	ADOT, District Engineer, Safford District
Tom Foster	-	ADOT, District Engineer, Prescott District
Maj. Bob Halliday	-	Arizona Department of Public Safety
Jennifer Brown	-	Federal Highway Administration

Matt Burdick	-	ADOT Community Relations Office
David Hunt	-	ADOT Transportation Technology Group (Commercial Vehicle Operations)
Steve Owen	-	ADOT Arizona Transportation Research Center
Wayne Rich	-	ADOT Transportation Planning Division – Geographic Information Systems
Jim Shea	-	ADOT Freeway Management System - Traffic Operations Center
Dottie Shoup	-	ADOT Freeway Management System – Traffic Operations Center
Tim Wolfe	-	ADOT Transportation Technology Group

This project was presented at the 1999 Rural Advanced Technology & Transportation Systems conference in Flagstaff, Arizona, where it met with great interest from transportation stakeholders from Arizona and other states.

2.0 METHODOLOGY

The methodology employed in this project heavily depended on using a Geographic Information System (GIS) to derive alternative routes using algorithms specially coded for this purpose. The study area for this project was defined as the state of Arizona with the exclusion of the incorporated areas of the state, which was later amended to only exclude the Phoenix and Tucson metropolitan areas. The primary objectives of this project were:

- Record existing ADOT detour plans consistently
- Address closures on all Interstate, U.S. and State Routes
- Develop three seamless detours for every blocked segment
- Calculate travel times to support detour selection
- Present detours in a way easily understood

2.1 INITIAL WORKPLAN

Specific tasks to be performed in carrying out the original workplan are discussed below. During the course of the project, significant changes to this plan became necessary. These refinements are noted in the items below, and further summarized in Section 2.3.

Task 1 – Identify Routes and Links for Detours

a) Kimley-Horn was to identify the specific routes for which detours would be developed. Detours would be developed for closures on all interstate, U.S., and state routes in Arizona. Only the non-urban extent of these routes was considered for the development of the detour plans.

b) Kimley-Horn was to identify the specific links on each of the routes identified in Task 1(a) for which detours would be developed. This effort was coordinated with ADOT Districts to allow the plan to address the detour information needs of each ADOT District. This coordination effort was accomplished by having each ADOT District Engineer review and approve the link selection for his/her district. Kimley-Horn provided each District with a paper map visually depicting the links for which detours would be developed. Each District was asked to provide additional links or to note which of the suggested links were not to be considered. Links within incorporated areas of the state would not be considered. ADOT Districts were given two weeks to provide input. It was originally estimated that detours would be developed for a total of approximately 560 links.

Note: Ultimately 750 distinct closures were defined in this project.

Task 2 – Prepare Base Map

Developing detour information on a statewide scale is a very labor-intensive task. To minimize manual work and, consequently, the cost of developing the detours, the majority of the detour planning tasks were to be conducted using GIS-based routing algorithms. To perform this task, a GIS base map was to be prepared of all the routes in the state for which detours were developed and those which could provide the detours. The preparation of the base map was to consist of:

a) Obtaining a current, statewide highway network data from a reputable GIS resource vendor. If, upon evaluation, the quality of the vendor data was not significantly superior to other, already available route coverages, or was deficient in any way, other data sources deemed appropriate could be used.

b) Augmenting the network (a) with other routes, which may not be available from the vendor, such as the Indian Tribal roadways in Arizona;

c) Verifying and updating the segmentation of the complete state-wide highway network into links for which the detours were to be developed;

d) Inputting link attributes such as posted or average speed, link direction and truck route information (ADOT District Offices would provide truck route information, to be used in detour records pertaining to their respective Districts). Posted speed limits for all routes statewide would be provided by ADOT, in GIS format, indexed by milepost, if available; otherwise, a printed format would be acceptable. For route segments where speed data could not be provided by ADOT, Kimley-Horn would assume speeds typically observed on similar routes; and

e) Verifying other network attributes as needed (exit and route names, topology, completeness, etc.).

Note: No commercial GIS dataset could be obtained that would meet all project needs and eventually the roadway network data were developed using the resources of ADOT Transportation Planning Division. See also Section 3.0 of this report for details.

Task 3 – Develop Detours

Kimley-Horn was to develop detours for the highway links identified in Task 1(b) consisting of a total of three (3) detours for each link. The three detours would be based on shortest travel time for the entire detour. The travel time for each link would be calculated by dividing each link's length by its assigned speed and was to be expressed in minutes. Each consecutive detour for a closed link would represent the next shortest travel time that could be achieved, based on link speed input in Task 2(d). The non-detour travel options were to be developed by ADOT and input into the detour database outside of this project. Detours that would take the re-routed traffic outside of the Arizona borders were deemed acceptable (see **Figure 2**). The detour information would be compiled in the format shown in **Figure 4**. The "from" and "to" detour link designators would be based on local exit name. The ADOT staff would provide the exit name information in GIS format. Some data management could be required of ADOT staff before making this data available to Kimley-Horn. The "from" and "to" fields would also include milepost information.

The detour data would be stored in a Microsoft Access™ database. In addition to the data tables contained in the database, one standard report would be designed and developed to be used to printout the data records in a structured, binder-ready format. All deliverables for this dataset would be based on this report format. The ADOT Project Manager would review and approve the report format. It was anticipated that two weeks would be provided for this review.

Note: See Section 4.0 of this report for details of this work.

Task 4 – Review Detours with ADOT

Kimley-Horn was to coordinate a review of the proposed detours developed in Task 3 with ADOT. Each participating ADOT District Office and the ADOT Project Manager would be provided with a printed copy of the draft detour dataset for ADOT's review. ADOT District Engineers would be asked to review this dataset with any District staff they deem necessary before conducting the review of the detours in Kimley-Horn's Phoenix office, where the project team would be on-hand to answer any questions or make needed revisions. ADOT Districts would be given two weeks to review the draft detour dataset in their offices, after which time a representative from each District was to spend a single three- to five-hour session with Kimley-Horn's staff in Phoenix within an agreed time window, based on the project schedule. In case this review approach proved not feasible, Kimley-Horn staff would travel to ADOT district offices involved in this project and review the dataset there, as described in Task 7. This effort would represent the only opportunity to provide comments by the ADOT Districts during this project. Additional revisions by ADOT would be possible through the MS Access™ database after completion of this project.

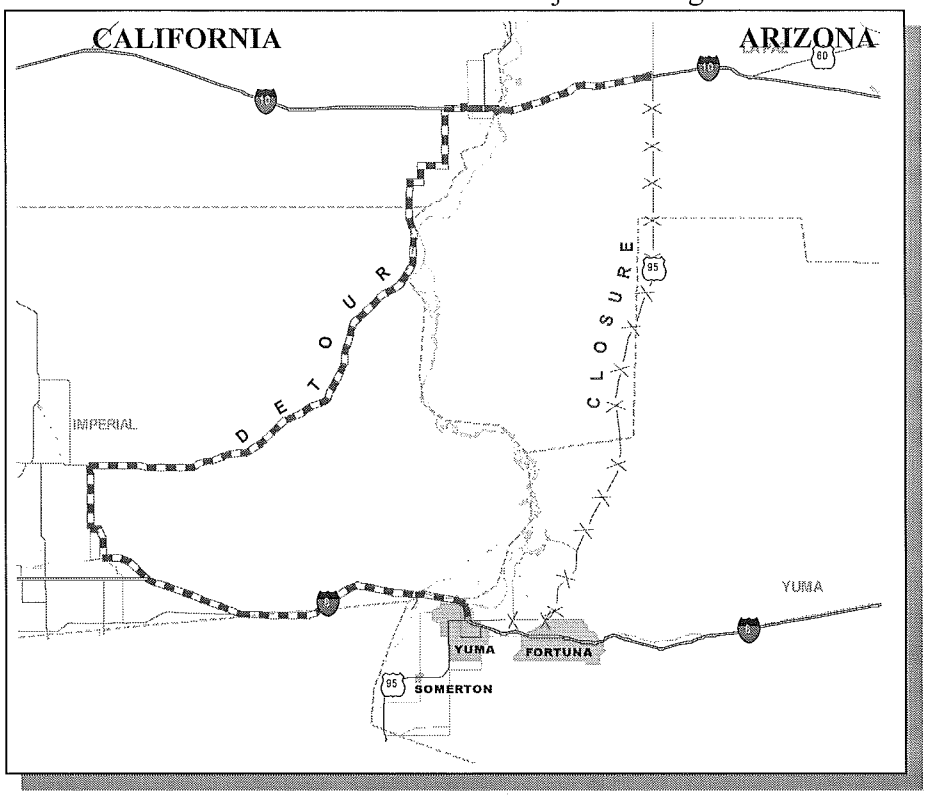


Figure 2 - Example Detour Candidate

Note: This Task effort was extensively modified because of the necessary number of reviewers at the ADOT District level and also in light of the expanded involvement of the Arizona Department of Public Safety. The TAC determined that four regional workshop sessions would allow the best input from the process stakeholders. See Section 5.0 for details of this work.

Task 5 – Develop Final Detour Dataset

Kimley-Horn would revise the draft detour dataset based on ADOT's comments and deliver ten printed, bound reports of the dataset and one electronic master copy of the dataset to ADOT. In addition to the detour information, each bound copy of the report would include a map of the highway links for which the detours were developed.

Note: See Section 6.0 for details of this work.

Task 6 – Project Management and Meetings

Kimley-Horn would provide ADOT with up to four monthly progress reports and one report summarizing the project activities upon completion of the project.

Kimley-Horn would attend up to eleven meetings with the STATE as follows:

a) The project kick-off meeting, to be held in Phoenix;

b) Up to nine ADOT District staff review meetings for Task 4, budgeted to be held in Kimley-Horn's Phoenix office; and

c) One project coordination meeting.

Note: As described previously, the project workplan was modified significantly by the TAC to enhance the review process.

Task 7 (Provisional) – Review of Detour Dataset in ADOT District Offices

Based on the direction of the ADOT Project Manager, if necessary, Kimley-Horn staff would travel to one or more of the ADOT District Offices in order to provide the District Engineers and their staff with an opportunity to review the detour dataset, as described in Task 4. This additional effort would only be considered if the ADOT Project Manager and Kimley-Horn decided that the review approach presented in Task 4 was not effective. This provisional task was budgeted separately from the originally contracted project as described in the Scope of Services.

Note: As mentioned above, the work plan was in fact modified to include travel to three regional workshops outside of Phoenix. See Section 5.0 for details of this work.

2.2 PROJECT ASSUMPTIONS

The following assumptions were agreed upon at the initiation of the project:

- ADOT would provide all available route data to Kimley-Horn in GIS format. All GIS data provided by ADOT would be in ARC/INFO coverage or Arc View shape file format.
- The ADOT Transportation Planning Division (TPD) was expected to facilitate the acquisition of the Indian Route data from the Navajo Indian Tribe government. Route data for the remaining Indian Reservations would be obtained from the 1997 TIGER/Line dataset, supported - as needed - by other sources.
- ADOT TPD and TOC staff responsible for GIS would also be available to clarify the existing network attribute coding of the state's route coverage and would also be expected to perform basic data management functions such as re-projecting an ADOT coverage or extracting a portion of an ADOT GIS database for use on the project.
- There would be one review cycle of the draft detour dataset by the ADOT District Engineers.
- Kimley-Horn's staff would meet one time with the ADOT Project Manager or persons designated by the ADOT Project Manager in order to discuss review comments. This

meeting could be outside of the in-office review sessions that would be conducted with ADOT District staff.

- The final deliverables would consist of printed, bound copies of the detour dataset in quantities specified in Task 5 and one electronic copy of the same dataset. The electronic delivery medium would be a CD-ROM disk.
- The electronic copy of the final deliverable would include a copy of a Microsoft Access™ database, containing the detour data tables and one functional report module to be used in printing out the dataset. The Microsoft Access™ database would also include a basic user interface, consisting of a form or forms that could be used to view and update the dataset.
- ADOT would provide Kimley-Horn with local exit names and mileposts for the interstate, U.S., and state highway system, as noted in Task 2.
- Average travel speeds of approximately 85% of the posted speed limits would be used to estimate travel times on roadway links, unless actual observed or modeled average speeds were made available. ADOT would provide the posted speed limits for all links.
- The only maps required in the deliverables are those listed in Task 5.
- All meetings would be held in Phoenix, unless Task 7 was to be executed.
- No queuing analysis was to be performed.
- Since this project was to focus on the development of detours for routes outside of incorporated areas, if ADOT desired a record of a detour which uses a city's or a town's roads, a complete description of the detour would be provided by ADOT staff (i.e. the District Engineer or their staff), in the format immediately transferable into the standard format shown in **Figure 4** (see Section 3.0 of this report); alternatively, this additional detour information would be added to the dataset by ADOT staff after the completion of this project.
- Non-detour options would be developed by ADOT outside of this Scope of Services;
- Designated ADOT staff would conduct the final detailed review of the detours in Kimley-Horn's Phoenix office.

The project tasks enumerated above were to be performed within 150 calendar days. **Figure 3** presents a summary task flowchart.

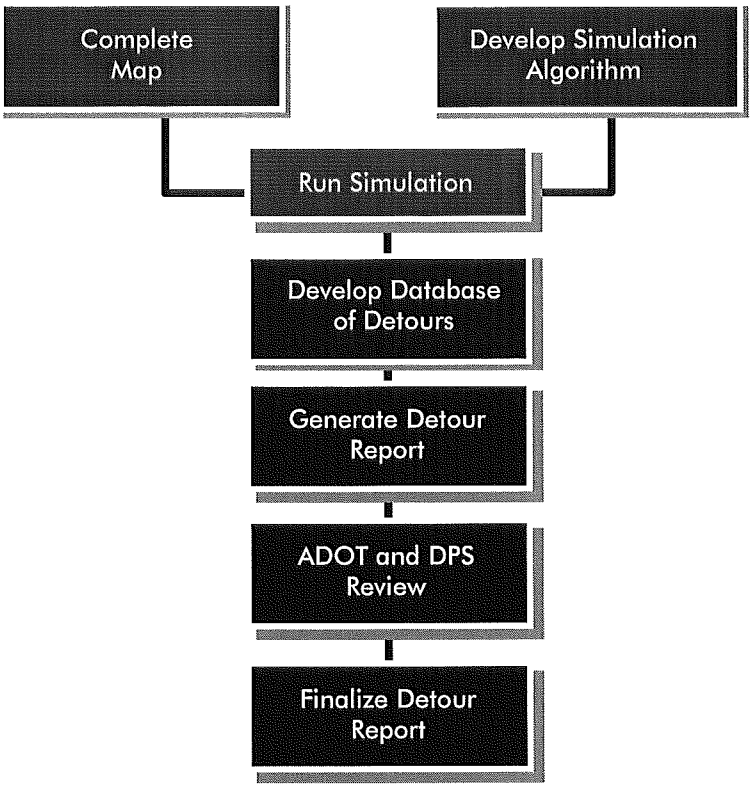


Figure 3 – Task Flowchart

2.3 FINAL WORKPLAN

As noted above, many elements of the original project plan were modified in the course of the work. The following sections of this report provide details of the process that evolved through TAC and stakeholder involvement.

Critical factors leading to these changes in the project workplan could not have been reliably predicted in advance. These factors include the following:

- The inability to obtain a commercial map dataset that would meet all key needs of the process and of the Department.

- The need to improve product quality by expanding the active roles of ADOT District staff and of the Department of Public Safety to ensure that all local agency needs and working relationships were recognized and addressed.

3.0 BASE DATA PREPARATION

3.1 DATA NEEDS

The project data needs were identified to satisfy the information requirements of the detour records and for the detour development process. **Figure 4** presents conceptually the kind of information that was required for each closure and detour description, which included:

Incident (closure) Information:

- Closure's route designation and number, e.g. Interstate 40 or I-40
- Descriptive closure location:
  - "From" location, e.g. Exit 257 (SR 87/Second Mesa)
  - "To" location, e.g. Exit 285 (West Holbrook/B-40)
- Closure's "from" and "to" milepost (MP) information
- Length of closure in miles
- Average speed along the closed segment under normal conditions
- Normal travel time (calculated from segment length and normal speed) in minutes
- Direction of travel that is closed, e.g. EB

Alternate Route Information:

- Detour number (1-3)
- For each detour segment:
  - Route designation and number (if on the state highway system, otherwise road name)
  - Travel direction along that detour segment
  - Beginning and ending or "from" and "to" information for the detour segment
    - Name of the intersecting road
    - Milepost along the detour segment
  - Known truck restrictions
  - Segment length in miles ("link length" on the **Figure 4**)
  - Average speed along the segment under normal conditions
  - Travel time along the segment in minutes
- Total detour length in miles
- Total travel time along the detour
- Net increase in travel time, calculated as the difference in travel time along the closed segment under normal conditions versus travel time along the detour

The tabular workbook format for alternate routes was conceived primarily as a working tool for the Phoenix TOC operators, who had difficulty interpreting the wide variety of district detour plan formats. The TOC staff coordinates statewide incident management activities for ADOT's districts at night and on weekends.

While the majority of the required information consisted of link or node attributes, correct road network topology was critical to the development of computer-generated routing options. For the purposes of this project, it was necessary to acquire a roadway network dataset offering some basic connectivity.

Incident Information									Alternate Route Information											
Closed Route	Descriptive Location		MP		Link Length (miles)	Average Speed (mph)	Normal Travel Time (min)	Direction Closed	Detour	Route	Travel Direction	From		To		Truck	Link Length (miles)	Average Speed (mph)	Alternative Travel Time (min)	Net Increase in Travel Time (min)
	From	To	From	To								Name	MP	Name	MP					
I-40	Exit 257 (SR 87/Second Mesa)	Exit 285 (West Holbrook/B-40)	257	285	28	60	28	EB	1	SR 87	NB	I-40 Exit 257		Jct. IR 15		Y	28	45	37	90
										IR 15	WB	SR 87		Jct. IR 6 (SR 77)		Y	23	45	30	
										IR 6 (SR 77)	SB	Jct. IR 15		I-40 Exit 292		Y	32	45	42	
										I-40	WB	I-40 Exit 292		I-40 Exit 285		Y	7	45	9	
										TOTAL:							**90**		**1hr 36min**	
									2	Detour alternative No. 2 (alternative travel time greater than in Detour 1). Formatting similar to Detour No. 1										
									3	Detour alternative No. 3 (alternative travel time greater than in Detour 2). Formatting similar to Detour No. 1										

Figure 4 - Detour Record Concept

3.2 GIS MAP DATA OPTIONS

To accommodate the need for a topologically correct road network GIS dataset, several prominent commercial vendors of GIS data were contacted, all of whom advertise their road network spatial databases as highly topologically correct and complete. Two vendors provided trial data for Arizona. An exhaustive evaluation of the datasets was conducted to determine which one would best serve the needs of this project. The evaluation consisted primarily of comparing the spatial accuracy of the road network data against samples of ADOT's recently collected road centerline data (using real-time differential GPS), testing selected topology features of the network, and spot-checking for missing roads with the most current Arizona road atlas in hand. In addition, link and node attributes of both datasets were evaluated in terms of their suitability for routing. One vendor's data was selected as more suitable, due primarily to the fact that the vendor was at the time updating their Arizona road network for the purposes of another local project and was expected to provide a more complete, up-to-date network.

The cost of the selected road network data set for the state of Arizona was significant and so additional justification of that purchase was required by ADOT. It was determined that the most desirable method of acquiring the dataset would be to have it licensed directly to ADOT. ADOT would then have continuous use of the data, as opposed to using the data only once, on this project. With ADOT's direction, Kimley-Horn initiated a discussion with the vendor aimed at acquiring the data for ADOT. Unfortunately, after lengthy negotiations, it became clear that the licensing restrictions imposed on the data by the vendor would effectively prevent ADOT from using the data for any worthwhile purposes outside of this project. For this reason, the dataset was not purchased from that vendor. Similar restrictions on data use were identified to exist for data from other vendors. As a result, no commercial dataset was acquired for the purposes of this project.

3.3 GIS DATA SOURCES

The only remaining sources of road network topology and attribute data were the ADOT ATIS Roads CD, ADOT Highway Performance Monitoring System (HPMS) dataset and TIGER/Line 98 road network for Arizona. TIGER/Line 98 network was provided by Caliper Corporation, as TIGER data had not yet been released to the general public at the time. (TIGER/Line files are extracts, from the U.S. Census Topologically Integrated Geographic Encoding and Referencing database, of selected geographic and cartographic information, such as roadway networks). The data quality of these available sets varied widely. The primary problem with the ATIS Roads data was its general lack of connectivity as well as – to a lesser degree - missing or misnamed road links. The TIGER/Line '98 data, while fairly exhaustive, would have required a great deal of post-processing before it could be used for routing, as it was the least topologically "clean" set. Finally, the HPMS data, while still suffering to a large degree from the same problems as the other two sources, presented a very attractive alternative due to the vast amount of roadway information contained in their attribute tables. It was decided that the HPMS dataset would be used as a basis for the routable road network for the entire state, with corrections to its topology and completeness to be incorporated before the actual routing would be performed.

The HPMS dataset was translated into the TransCAD native file format and most of the improvements to it were done within the TransCAD GIS software. TransCAD was selected as the primary GIS platform for this project due to its built-in routing functionality and custom programming capability.

Based on the TAC's guidance, the derived detours were to be based on a shortest path algorithm set to minimize travel time. The detours were to utilize not only the state highway system but were to include other major roads such as county roads, Indian Routes and others, as needed (see Task 2 description above). As a result, the HPMS dataset had to be updated to include roads not originally contained in it, along with their respective attributes, i.e. road name, length, speed, etc.

The base network data preparation process included the following primary activities:

- Adding missing road links (county roads, Indian Routes, etc.)
- Connecting road links where they intersect
- Removing unnecessary nodes
- Correcting and standardizing road link names
- Adding missing attribute data (e.g. known truck restrictions). The Motor Vehicle Division's current map of oversize and overweight restrictions was used. The map presents a variety of restrictions information using color and shape codes as well as mileposts of the restrictions. Example restrictions include low overpasses or length restricted routes. Those restrictions were coded as the GIS roadway network's link attributes that would ultimately appear in the final detour workbook if a restricted link were selected as part of a detour.

Figure 5 exemplifies typical network cleanup issues that were encountered.

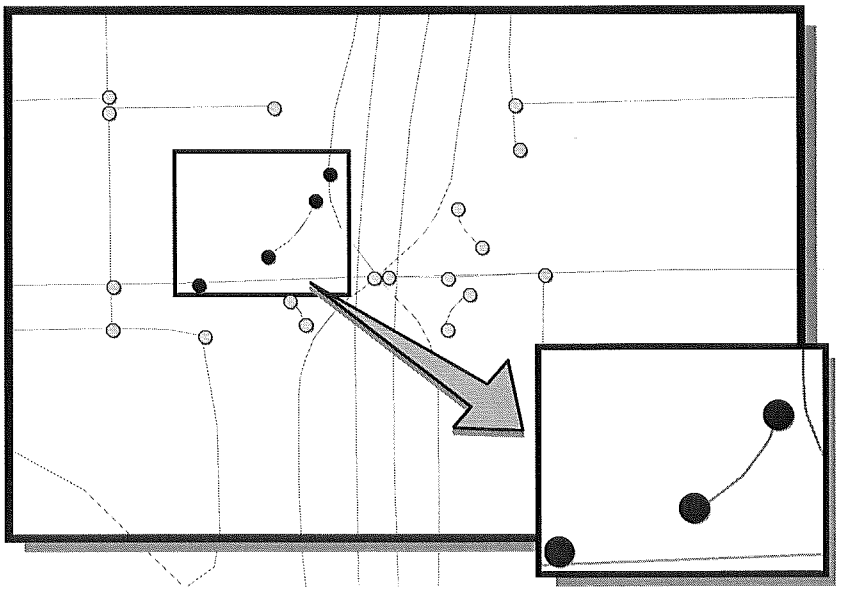


Figure 5 – Network Topology Cleanup

The effort associated with preparing the base routable road network proved more extensive than anticipated, primarily due to the amount of time it took to resolve topology problems both existing in the original HPMS network and introduced through "dropping" non-State Highway System road links into the base network from other sources, such as the TIGER/Line '98 network.

Midway through this effort, ADOT GIS staff offered their State Highway System Arc/Info routes to be used as an alternative base data source for the statewide road network. The HPMS cleanup effort was abandoned and the new, route-based network prepared for routing. The advantages associated with using the new data source had to do with it being more topologically correct and complete than the HPMS network. Still, significant cleanup and augmentation was needed to prepare that network for subsequent runs of the routing algorithms developed for this project.

4.0 DEVELOPMENT OF ROUTING ALTERNATIVES

The primary objective of this project was to develop alternative routes for closures on the State Highway System without introducing route discontinuities that would arise from taking into account jurisdictional boundaries such as ADOT or DPS District boundaries, county lines, or even the state borders. As a means to ensure that detours were being developed for the correct routes, each ADOT District was asked to identify those routes on a road map. Their input was considered during the detour development phase of the project.

Kimley-Horn worked with the Boston, Massachusetts - based Caliper Corporation, the makers of TransCAD GIS software, to develop and implement the routing algorithm suitable for the purposes of this project. The routing module of TransCAD that was developed for this project is based on a well-documented shortest path algorithm and allows two modes of operation – interactive and batch mode. The routing module is an "add-in" to the TransCAD program and utilizes built-in TransCAD routing functions. It was important to be able to operate the routing module in a batch mode as the project had to develop alternate routes for the entire statewide highway system, which precluded the possibility of doing so on a one-closure-at-a-time, link-by-link basis. The interactive mode was, however, provided in the routing module to allow for spot-checking of detour options and adjustments to particular detours based on local data. It also proved very helpful in the subsequent detour review process with ADOT and DPS, described later in this report. **Figure 7** depicts the user interface of the routing module in interactive (toolbox) mode.

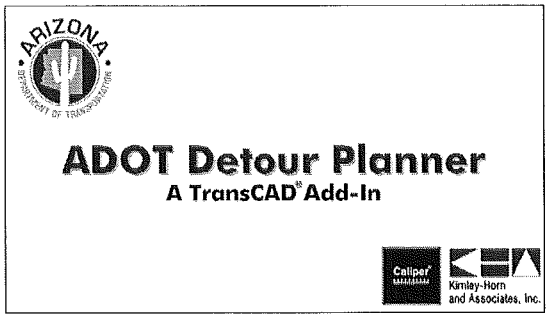


Figure 6 – Detour Software Title Page

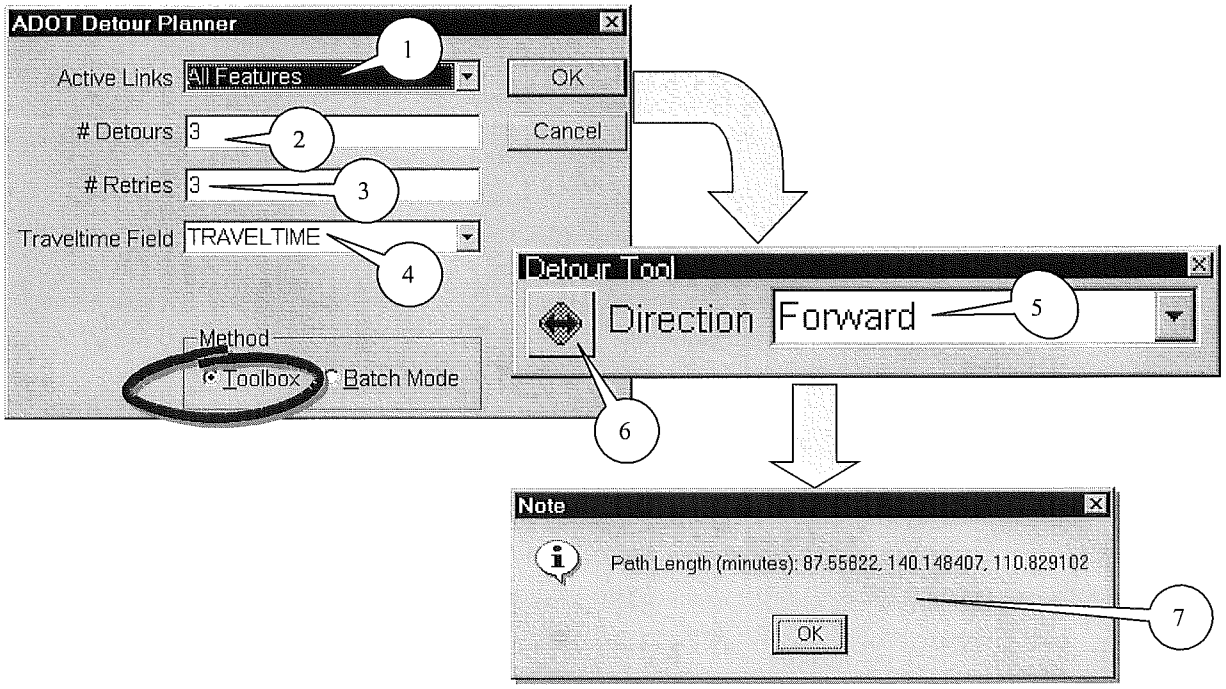


Figure 7 – TransCAD Routing Module (Interactive)

The operation of the detour module in the interactive mode is quite simple:

(1) With the road network loaded in TransCAD, the user selects which part of the network is to be considered as a potential valid source of detour links (a selection of the subset of the entire road network can be made prior to using the module);
(2) The user then selects how many different detours for closure the software is to attempt to derive;
(3) The user specifies how many times the software should "back away" from the end nodes of the closure in order to identify a valid detour (this has to do with having enough links connected to the end of the closed link to be able to find a detour and may result in part of the detour traversing a link or two along the route which has the closure);
(4) In this field, the user selects which road link attribute field is being minimized (travel time, in this project);
(5) In this dialog box the, user selects whether to process the closure in the forward or reverse topological direction of the link;
(6) The user then activates the algorithm by clicking on the routing "button" and then on the link that is closed; and, finally
(7) The program runs and displays the travel time in minutes for each of the identified detours as well as the proposed detour routes. An example map display of the thus derived detours is shown in **Figure 8**.

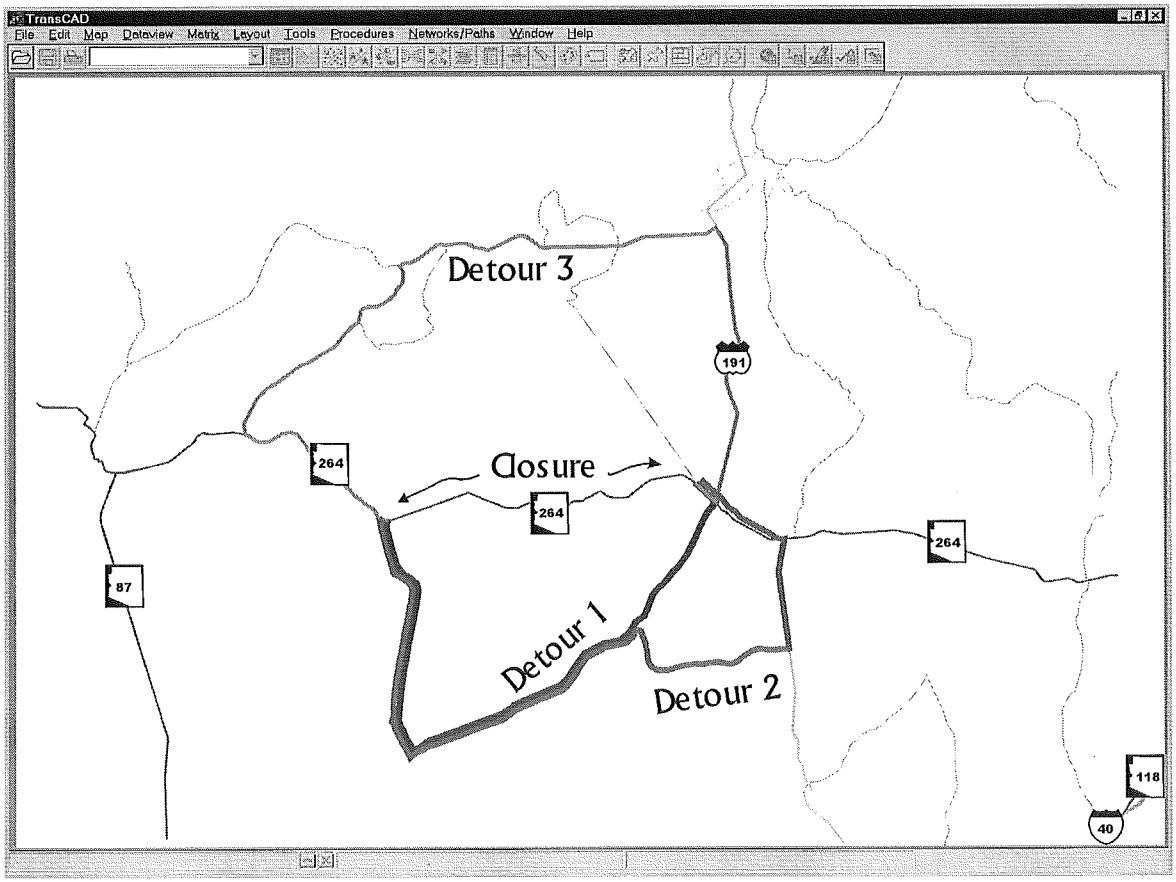


Figure 8 – Example Graphical Output From the Interactive Detour Module

The batch mode of the routing module uses the same algorithm and operates using the same input (see **Figure 9**) as the interactive mode, with the additional requirement to specify the "links to process" portion of the network. Here the user must specify the set of road links where a closure may occur and the set of links, which may become parts of detours. Obviously, these sets can be coincidental, but in the case of this project, they were not. The set of links on which closures could occur was restricted to the State Highway System while the road links which could provide detours for those closures included the entire State Highway System and a variety of other major roads. The batch mode of the detour module took many hours to process the entire state's road network (excluding Phoenix and Tucson metropolitan areas) with the settings of three detours per closure. An example of the raw output of the batch mode is presented in **Figure 10**.

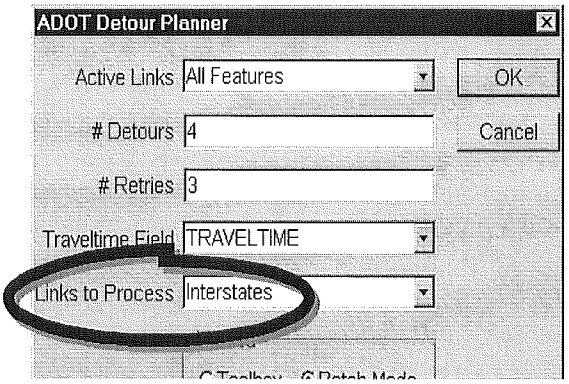


Figure 9 – Batch Mode

Dataview1 - 080999_2130

ID	DIR	FROM	TO	DETOUR	SEQUENCE	LINK	LINK_DIR	LINK_FROM	LINK_TO
103348	F	103059	103067	0	0	–		–	–
103348	R	103067	103059	0	0	–		–	–
103634	F	103067	103099	1	1	106838	F	103067	106417
103634	F	103067	103099	1	2	150778	F	106417	158014
103634	F	103067	103099	1	3	637039	R	158014	635793
103634	F	103067	103099	1	4	636229	R	635793	635785
103634	F	103067	103099	1	5	636213	R	635785	635777
103634	F	103067	103099	1	6	636150	F	635777	635745
103634	F	103067	103099	1	7	636061	R	635745	635697
103634	F	103067	103099	1	8	635968	R	635697	634916
103634	F	103067	103099	1	9	635594	R	634916	634860
103634	F	103067	103099	1	10	635406	R	634860	634820

Figure 10 – Batch Mode Output

The snapshot of the output database shown in **Figure 10** includes some of the data fields that were used in the subsequent detour record processing and formatting. In particular, the "DIR" field, with text data reading "F" or "R", indicates the forward and reverse topological direction for the roadway link and was used as one of the means of ensuring that the software indeed attempted to derive detours for that link in both directions. A topological direction in this context simply means the direction in which a link was drawn inside the GIS software and is an inherent attribute of vector data. The "link_from" and "link_to" fields hold the starting and ending node numbers of the roadway link, as determined by its topology.

The database table generated by the batch mode was combined, using the link ID field (see the left-most column in **Figure 10**) with the link and intersection (node) attribute tables extracted from the GIS-based road network inside an MS Access 97 database where it forms a cohesive

closure and detour information system. A set of hierarchical queries was used to arrange the closure and detour data into a logical layout that would lend itself to report formatting. **Figure 11** depicts an example report based on this database.

The report format shown in **Figure 11** was used to produce a printout of all alternate route sets derived by the TransCAD GIS software for closures on the State Highway System. This printout ("draft detour workbook") was then mailed out, along with a statewide road network map and a route index, to all ADOT District offices and to DPS for review. Each reviewer was asked to identify viable detours for inclusion in the final detour workbook. ADOT and DPS scheduled four stakeholder review meetings to discuss the review comments and to provide a forum for additional input.

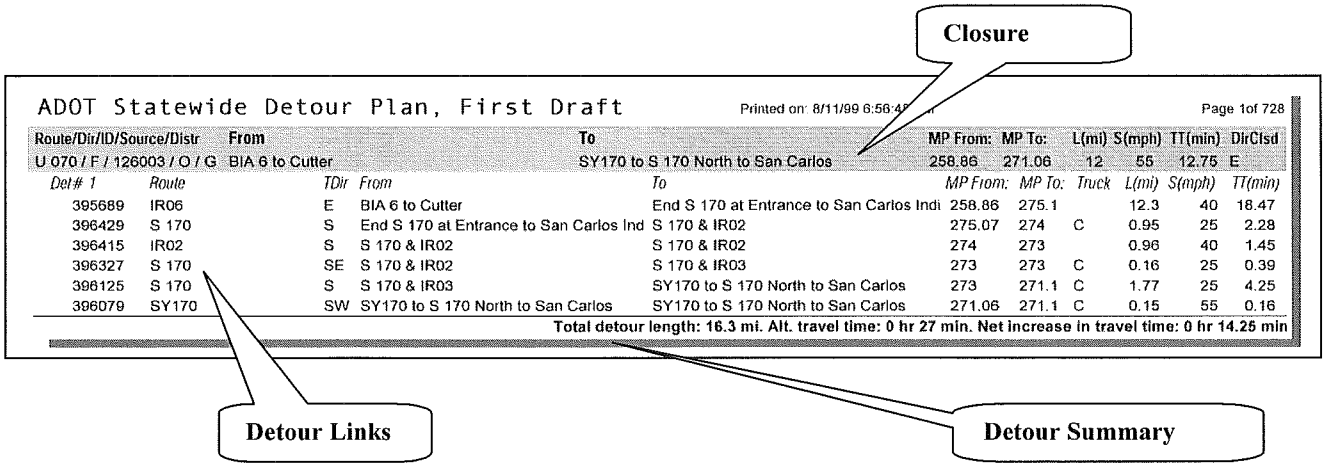


Figure 11 – Draft Detour Report Example

5.0 STAKEHOLDER REVIEW PROCESS

Originally this critical review process called for each ADOT District Engineer to conduct an internal review of the draft plan with their staff, and then to visit the Kimley-Horn office in Phoenix to provide comments and revisions. As the project developed, it soon became clear that this would not provide the critical interactions needed to generate seamless detour routing across District boundaries.

The review process was extensively modified to involve the necessary number of maintenance and traffic staff reviewers at the ADOT District level and also in light of the expanded involvement of the Arizona Department of Public Safety. Numerous DPS district commanders and field post sergeants took an active and involved role in the preliminary review and in the workshop meetings. The TAC determined that four regional workshop sessions would allow the best input from the process stakeholders. These meetings were conducted as follows:

- September 2, 1999 – Phoenix, Kimley-Horn office
- September 7, 1999 – Flagstaff, ADOT District Office
- September 14, 1999 – Prescott, DPS Office
- September 16, 1999 – Tucson, ADOT District Office

ADOT and DPS staff from all Districts was invited to participate. Each review workshop began early in the morning and followed a similar pattern, which included a brief project overview presentation followed by an all-day detour development session. Working aids included commercial and public maps of various portions of the state, a laptop copy of the TransCAD detour software module and GIS maps, as well as a detour addition/change form, shown in **Figure 12,** which was used to facilitate the workshop activities. During the working portion of the detour review session, the reviewers were first asked to provide their comments to the draft detour workbook, which was mailed to them two weeks in advance. The reviewers were also asked to describe additional detour options not covered in the draft detour workbook and to make changes or adjustments to those draft detours or to the existing ADOT detours. **Figure 13** shows the September 2 workshop in Phoenix.

Approximately 300 data sheets (detour forms and GIS screen captures) were recorded; about 20 detours were recorded electronically during the review workshops using the TransCAD software and a working copy of the MS Access database (see **Figure 14**); approximately 40 detours from the draft detour workbooks were validated, and approximately 60 existing ADOT detours were commented on by reviewers, for a total of approximately 420 entries. Since the majority of the detours provided had comments to use a reverse of the detour for a closure in the opposite direction, approximately 800 separate closure/detour entries needed to be made in the database.

Name: _____

Tel.: _____

Page _____ of _____

Arizona Statewide Detour Plan

Detour Addition / Change Form
(one closure per page maximum)

Closure Information:

CLOSED ROUTE: _____ *DIRECTION CLOSED:* EB WB SB NB

FROM MILEPOST: _____ *FROM LOCATION:* _____

TO MILEPOST: _____ *TO LOCATION:* _____

CLOSURE LENGTH (MILES): _____ *NORMAL SPEED (MPH):* _____

Closure Notes:

Detour Information:

DETOUR ROUTE NAME	*DIRECTION OF TRAVEL*				*DETOUR SEGMENT "FROM" INFORMATION*		*DETOUR SEGMENT "TO" INFORMATION*		*SPEED (MPH)*	*TRUCK RESTR.*
	E	*W*	*N*	*S*	*LOCATION (INTERSECTION, TOWN, ETC.)*	*MP*	*LOCATION (INTERSECTION, TOWN, ETC.)*	*MP*		

Detour Notes:

Fax to: 602.944.7423, Attention: Andrew Kolcz

Figure 12 - Detour Addition/Change Form

Figure 13 - Detour Review Workshop (Phoenix)

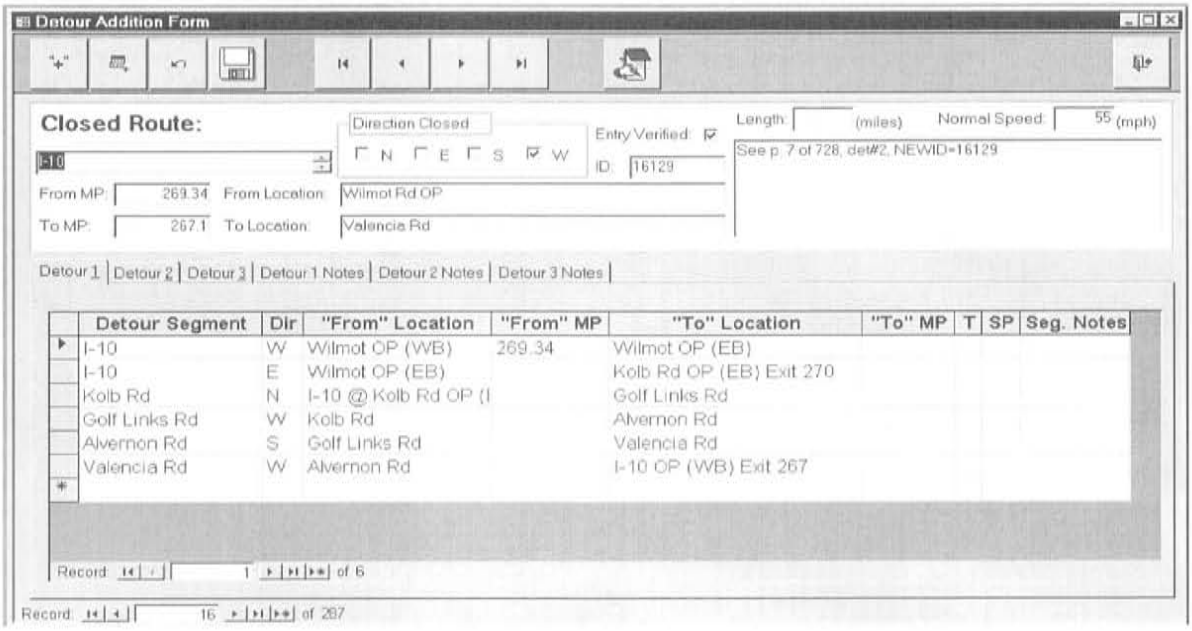


Figure 14 – Detour Database for Review Workshops

6.0 FINAL PRODUCT

The final product of this project as originally defined in the project scope consists of a detour workbook binder and a corresponding MS Access database. The workbook will become a controlled document, with additions, deletions, and modifications being administered by the workbook owner, State Engineer's and the Director's offices. Only detours that were validated through the review workshops were included in the final workbook.

Based on the TAC's guidance, the final format of the detour workbook evolved from the example shown in **Figure 11** as follows:

- Workbook pages to be 8.5"x11" in landscape orientation.
- One closure and associated detours per page with as large a font as feasible.
- Closure description and each detour description to be clearly separated, preferably using frames or boxes.
- Field headings for closure description should be aligned with the corresponding field headings within each detour description.
- Detour route segments should be in bold typeface.
- The speed and travel time entries should be clarified.
- The closure/detour listing should not contain any software/database ID numbers.
- "From" and "To" information should be as descriptive as available.
- A state milepost map should be included at the beginning of the detour book. This map would be provided by ADOT TPD – GIS Section.
- Tabs should be provided for the Introduction section and for the sections of the workbook showing detours for Interstate, State Routes, and U.S. Routes.
- The existing ADOT detour, if available, would always be listed as the primary detour for any given closure except where the reviewers have provided a better detour alternative. In such cases, the primary detour would be the one indicated by the reviewers and the corresponding ADOT detour would be listed in second place.
- The report's pages should be numbered and an index page should be provided.

As a result of those guidelines, the page layout shown in **Figure 15** (see page 23) was approved for the final detour workbook. Additional typical sample pages from the detour workbook are included in the **Appendix**.

The user interface to the detour database is shown in **Figure 16**.

CLOSURE DESCRIPTION

CLOSED ROUTE	DIR	BEG. MP	END. MP	BEGIN CLOSURE AT: (DESCRIPTIVE)	END CLOSURE AT: (DESCRIPTIVE)	LENGTH:	SPEED	TRAV. TIME:
I-08	EB	115	151	GILA BEND	SR 084	36.0 mi	75 mph	29 min

PRIMARY DETOUR

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
BUS 08	EB	115	120.2	I-08	SR 085	5.2 mi	35 mph	9 min
SR 085	NB	120.2	120.5	BUS08	SR 238	0.3 mi	35 mph	1 min
SR 238	EB	0	45	SR 085	SR 347	45.0 mi	45 mph	60 min
SR 238 MAY BE DIRT AT MP25, CONSULT LOCAL AUTHORITIES								
SR 347	SB	175	161	SR 238	SR 084	14.0 mi	55 mph	15 min
SR 084	WB	161	151	SR 347	I-08	10.0 mi	55 mph	11 min
						74.50 mi		96 min

Total detour length: 74.50 mi. Estimated travel time*: 1 hr 36 min. Estimated increase in travel time: 1 hr 7 min.

DETOUR OPTION 2

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
BUS 08	EB	115	120.2	I-08	SR 085	5.2 mi	35 mph	9 min
SR 085	NB	120.2	154.5	BUS08	I-10	34.3 mi	55 mph	37 min
SR 085 - from MP 141.6 to MP 80.7: Escorts required for 12-feet wide and over								
I-10	EB	113	199	SR 085	I-08	86.0 mi	65 mph	79 min
I-10 - at MP 177.7: Low Over Pass-or Legal Weight Only Bridge-or-Fee for over weight vehicles-See MVD map								
I-08	WB	178	151	I-10	SR 084	27.0 mi	75 mph	22 min
						152.50 mi		147 min

Total detour length: 152.50 mi. Estimated travel time*: 2 hr 27 min. Estimated increase in travel time: 1 hr 58 min.

DETOUR OPTION 3

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
BUS 08	EB	115	120.2	I-08	SR 085	5.2 mi	35 mph	9 min
SR 085	NB	120.2	154.5	BUS08	I-10	34.3 mi	55 mph	37 min
SR 085 - from MP 141.6 to MP 80.7: Escorts required for 12-feet wide and over								
I-10	EB	113	164	SR 085	SR 347	51.0 mi	65 mph	47 min
I-10 - at MP 139.6: Low Over Pass-or Legal Weight Only Bridge-or-Fee for over weight vehicles-See MVD map								
SR 347	SB	189.2	161	I-10	SR 084	28.2 mi	55 mph	31 min
SR 084	WB	161	151	SR 347	I-08	10.0 mi	55 mph	11 min
						128.70 mi		135 min

Total detour length: 128.70 mi. Estimated travel time*: 2 hr 15 min. Estimated increase in travel time: 1 hr 46 min.

* Travel times based on posted speed limits.

Figure 15 - Detour Binder Page Format

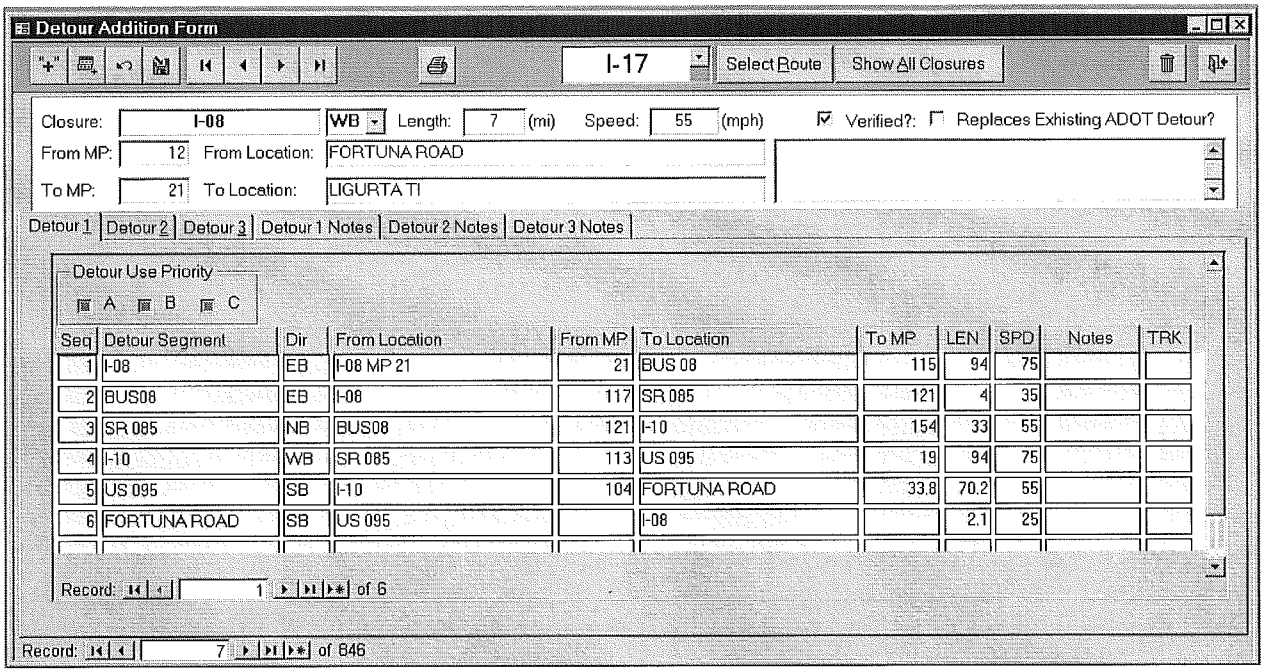


Figure 16 - MS Access User Interface to the Detour Database

Both electronic and printed copies of the detour database and workbook were submitted to ATRC upon completion of the project.

7.0 PROJECT BENEFITS, IMPLEMENTATION PLANS, AND LESSONS LEARNED

The **benefits** of this project can be summarized as follows:

- Pre-determined detours with known travel times and distances will facilitate traffic management decisions about most effective re-routing during incidents on the State Highway System;
- The detour workbook provides seamless detours across ADOT and DPS District boundaries;
- Once implemented by the ADOT Phoenix TOC, it can increase effectiveness of rural VMS, which can display alternate route directions to drivers;
- This project has created the foundation for an "online" detour generating program using graphical, map-based presentation format of the detours;
- The project has demonstrated the ability to test various detour scenarios by simulating link closures; and
- The project facilitated interagency collaboration on detours and incident management as well as intra-agency cooperation, within both ADOT and DPS.

The immediate **implementation plans** for the detour database and workbook developed through this study consist of:

- An electronic copy of the detour database as well as printed copies of the detour workbook were delivered to ADOT to be distributed both internally within ADOT and to DPS as a controlled distribution document.
- ADOT and DPS will use the detour workbook for incident management.
- Designated ADOT staff will continue to update the workbook as needed.
- ADOT can use rural VMS to implement detours from the workbook.
- In the future, ADOT could include detour information in HCRS bulletins.
- In the future, ADOT could include map-based detour information.
- In the future, ADOT could include an online detour-generating facility.

The statewide detour plan study was the first project of its type in Arizona and, as a result, there were many **lessons learned** from this experience by all process stakeholders. Some of the more important lessons are:

- Obtaining or preparing a complete, topologically correct and properly attributed GIS-based "routable" road network is not only difficult but costly as well.
- Initial concepts and desires of how this type of program works tend to grow as development progresses and stakeholders learn more about their needs, the process, and the solutions that are available to them.
- There is strong interest in detours at all agency levels, from top management to on-the-road supervisors and officers.
- Detours using route segments located outside of the State Highway System are now being considered from the perspective of adding flexibility to the alternate route system. The

advantages and disadvantages of doing so are being reviewed by the Districts on a case-by-case basis.

- A text-only detour workbook, without site-specific detour maps, is considered more difficult to use than one with detours depicted graphically as maps.
- Cost of commercial data licensing cost was excessive.
- Use of commercial data would have been significantly limited, due to licensing restrictions.
- Datasets that are set up for purposes other than routing are not suitable for routing projects without significant revisions.

8.0 RECOMMENDATIONS – THE NEXT STEP

8.1 ROUTING TOOLS

The project team's interaction with the Technical Advisory Committee as well as the four regional detour review meetings have revealed that there exists a desire among those ADOT and DPS personnel most reliant on alternate route information to take the ADOT detour database to the next level – an **interactive system** with timely, manually- and system-generated updates and corrections.

The stakeholders over time lost enthusiasm for the tabular workbooks not only because of their size and link detail, but more notably due to the effectiveness of the interactive displays using the laptop for optional route consideration and selection during workshops. The excellent graphics and utility of this tool led many to express their **desire for this map-based approach** in the field (offices or vehicles) in the future. As discussed below, this is an implementation step that was ranked highly in the ATRC's ITS project development workshop and which will be nominated to the ADOT Research Council for possible funding in the near future.

Numerous stakeholders involved in this project expressed a need for a detour / routing system with the following desired characteristics:

- Dynamic
- Flexible
- Easy to update
- User-friendly
- GIS-based
- Integrated with HCRS/RCRS and RWIS
- Scalable
- Open-ended
- Accounts for current roadway, weather, and traffic conditions
- All routing options can be explored
- Allows application of custom constraints
- Provides quick, clear output w/maps
- Considers typical traffic volumes along detour routes
- Includes signing options along closure and detour segments.

Such a routing system would provide more efficient routing options, improve responsiveness to incident-caused re-routing needs, provide potential reduction in delays, capture local routing knowledge, provide a common platform for better information sharing and presentation, improve service to the motorists, and provide the ability to develop "what-if" routing scenarios before they are needed.

The concept of a future, interactive routing system was presented at the 1999 ADOT Emphasis Area Workshop for Intelligent Transportation Systems. The concept found significant support among the workshop participants and the project idea was voted-in as a candidate for future

research funding. As noted above, the proposed project will be reviewed and prioritized for possible near-term initiation by ADOT's Research Council and upper management.

8.2 TRAVELER ADVISORIES

The TAC also discussed the benefits of a motorist communication system that would be conducive to the earliest possible notification to those motorists being detoured for whatever reason. This system could be implemented through local radio stations or through a dedicated station that would provide information only on the closure, i.e., estimated duration of closure, alternate detour routes etc.

Field-based radio devices - Highway Advisory Radio (HAR) transmitters - can be deployed at locations prior to and within the detour route that would provide important information to motorists.

Highway Advisory Radio is a means of providing traffic information, via AM or FM radio, to travelers in their vehicles. Upstream of the HAR signal, users are instructed by roadside signs to tune their vehicle radios to a specific frequency. Information may be relayed to the users by a pre-recorded message or through live messages. HAR is useful in providing a more detailed message than what can be displayed on VMS; provides more timely information on short-term closures than commercial radio; and has a wider range than a variable message sign because it can be accessed from the AM/FM radio in the vehicle.

Messages that are broadcast on HAR should typically be less than one minute long, but may be as long as three minutes as necessary, and broadcast in a continuous loop. Ideally, the motorist will hear two complete cycles before passing through the broadcast zone.

This concept, used in other states, is being considered for field tests in rural Arizona.

APPENDICES

APPENDIX A
SAMPLE TABLE OF CONTENTS OF THE STATEWIDE DETOUR PLAN WORKBOOK

APPENDIX B
SAMPLE ALTERNATE ROUTE PAGES (3) FROM THE STATEWIDE DETOUR PLAN WORKBOOK

APPENDIX C
MAPS FROM THE STATEWIDE DETOUR PLAN WORKBOOK

APPENDIX D
WORKSHOP HANDOUTS AND MATERIALS FROM THE DEVELOPMENT OF THE STATEWIDE DETOUR PLAN WORKBOOK

APPENDIX A

SAMPLE TABLE OF CONTENTS OF THE STATEWIDE DETOUR PLAN WORKBOOK

Note: More information on the Statewide Detour Plan workbook can be obtained by contacting:

Stephen R. Owen, P.E., Project Manager
Arizona Transportation Research Center
1130 North 22nd Avenue, Mail Drop 075R
Phoenix, Arizona 85009
Tel.: 602.712.6910
Fax: 602.256.6367
e-mail: stowen@dot.state.az.us

SAMPLE

Table of Contents

APPENDIX B

SAMPLE ALTERNATE ROUTE PAGES (3) FROM THE STATEWIDE DETOUR PLAN WORKBOOK

CLOSURE DESCRIPTION

CLOSED ROUTE	DIR	BEG. MP	END. MP	BEGIN CLOSURE AT: (DESCRIPTIVE)	END CLOSURE AT: (DESCRIPTIVE)	LENGTH:	SPEED	TRAV. TIME:
I-08	WB	115	151	GILA BEND	SR 084	36.0 mi	75 mph	29 min

PRIMARY DETOUR

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 084	EB	151	161	I-08	JCT SR 347/SR 084	10.0 mi	55 mph	11 min
SR 347	NB	161	175	SR 084	SR 238	14.0 mi	55 mph	15 min
SR 238	WB	45	0	SR 347	SR 085	45.0 mi	45 mph	60 min
SR 238 MAY BE DIRT BEYOND MP25, CHECK WITH LOCAL AUTHORITIES								
SR 085	SB	120.5	120.2	SR 238	BUS08	0.3 mi	35 mph	1 min
BUS 08	WB	120.2	115	SR 085	I-08	5.2 mi	35 mph	9 min
						74.50 mi		96 min

Total detour length: 74.50 mi. Estimated travel time*: 1 hr 36 min. Estimated increase in travel time: 1 hr 7 min.

DETOUR OPTION 2

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 084	EB	151	161	I-08	SR 347	10.0 mi	55 mph	11 min
SR 347	NB	161	189.2	SR 084	I-10	28.2 mi	55 mph	31 min
I-10	WB	164	113	SR 347	SR 085	51.0 mi	65 mph	47 min
SR 085	SB	154.5	120.2	I-10	BUS08	34.3 mi	55 mph	37 min
BUS 08	WB	120.2	115	SR 085	I-08	5.2 mi	35 mph	9 min
						128.70 mi		135 min

Total detour length: 128.70 mi. Estimated travel time*: 2 hr 15 min. Estimated increase in travel time: 1 hr 46 min.

DETOUR OPTION 3

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
I-08	EB	151	178	JCT I-08/SR 084	JCT I-08/I-10	27.0 mi	75 mph	22 min
I-08 - at MP 174.5: Low Over Pass-or Legal Weight Only Bridge-or-Fee for over weight vehicles-See MVD map								
I-10	WB	199	113	I-08	SR 085	86.0 mi	65 mph	79 min
SR 085	SB	154.5	120.2	I-10	BUS08	34.3 mi	55 mph	37 min
BUS 08	WB	120.2	115	SR 085	I-08	5.2 mi	35 mph	9 min
						152.50 mi		147 min

Total detour length: 152.50 mi. Estimated travel time*: 2 hr 27 min. Estimated increase in travel time: 1 hr 58 min.

* Travel times ed on posted speed limits

CLOSURE DESCRIPTION

CLOSED ROUTE	DIR	BEG. MP	END. MP	BEGIN CLOSURE AT: (DESCRIPTIVE)	END CLOSURE AT: (DESCRIPTIVE)	LENGTH:	SPEED	TRAV. TIME:
SR 260	EB	252	305.7	PAYSON	HEBER	50.7 mi	55 mph	55 min
				SGT. R. Miller 744, 520-535-5313				

PRIMARY DETOUR

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 087	SB	252.5	172.25	SR 260	US 060	80.3 mi	65 mph	74 min
US 060	EB	178.4	339.9	SR 087	SR 260	161.5 mi	65 mph	149 min
US 060 - at MP 228.1: Low Over Pass-or-Legal Weight Only Bridge -or-Fee for over weight vehicles-See MVD map								
SR 260	WB	340.1	305.7	US 060	SR 260	34.4 mi	55 mph	38 min
						276.15 mi		261 min

Total detour length: 276.15 mi. Estimated travel time*: 4 hr 21 min. Estimated increase in travel time: 3 hr 26 min.

DETOUR OPTION 2

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 087	NB	252	345	SR 87 (PAYSON)	I-40 (WINSLOW)	93.0 mi	65 mph	86 min
SR 087 - from MP 178.1 to MP 342.2: Escorts required for 12-feet wide and over								
I-40	EB	253.8	286	I-40 (WINSLOW)	I-40 (HOLBROOK)	32.2 mi	75 mph	26 min
I-40 - at MP 283.6: Low Over Pass-or-Legal Weight Only Bridge -or-Fee for over weight vehicles-See MVD map								
SR 077	SB	389	386.2	SR 77 (HOLBROOK)	SR 377 (JCT SR 77)	2.8 mi	55 mph	3 min
SR 377	SB	33.7	0	SR 377	SR 277 (JCT SR 277)	33.7 mi	65 mph	31 min
SR 277	WB	312.5	302.7	SR 277	SR 277	9.8 mi	55 mph	11 min
						171.50 mi		156 min

Total detour length: 171.50 mi. Estimated travel time*: 2 hr 36 min. Estimated increase in travel time: 1 hr 41 min.

DETOUR OPTION 3

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 087	SB	252	235.7	PAYSON	SR 188	16.3 mi	65 mph	15 min
SR 188	EB	277	242	SR 087	SR 088	35.0 mi	65 mph	32 min
SR 088	WB	242	194	SR 188	US 060	48.0 mi	45 mph	64 min
US 060	EB	196	340	SR 088	SR 260	144.0 mi	65 mph	133 min
US 060 - at MP 228.1: Low Over Pass-or-Legal Weight Only Bridge -or-Fee for over weight vehicles-See MVD map								
SR 260	WB	340	302.7	US 060	HEBER	37.3 mi	65 mph	34 min
						280.60 mi		279 min

Total detour length: 280.60 mi. Estimated travel time*: 4 hr 39 min. Estimated increase in travel time: 3 hr 44 min.

* Travel times based on posted speed limits

CLOSURE DESCRIPTION

CLOSED ROUTE	DIR	BEG. MP	END. MP	BEGIN CLOSURE AT: (DESCRIPTIVE)	END CLOSURE AT: (DESCRIPTIVE)	LENGTH:	SPEED	TRAV. TIME:
US 093	NB	91.2	182.9	I-40	SR 071	91.7 mi	55 mph	100 min

PRIMARY DETOUR

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 071	NB	102.9	109.68	US 093	US 089	6.8 mi	55 mph	7 min
SR 071 - at MP 102.9: Low Over Pass-or-Legal Weight Only Bridge -or-Fee for over weight vehicles-See MVD map								
SR 089	NB	268	366	SR 071	ASHFORK	98.0 mi	55 mph	107 min
SR 089 - from MP 311.2 to MP 291.1: Length restricted route								
I-40	WB	146.25	72	ASHFORK	US 093	74.3 mi	75 mph	59 min
						179.03 mi		174 min

Total detour length: 179.03 mi. Estimated travel time*: 2 hr 54 min. Estimated increase in travel time: 1 hr 14 min.

DETOUR OPTION 2

ROUTE	DIR	BEG. MP	END. MP	BEGIN DETOUR LINK AT:	END DETOUR LINK AT:	LENGTH:	SPEED	TRAV. TIME:
SR 071	WB	102.9	85.81	US 093	US 060	17.1 mi	55 mph	19 min
US 060	WB	85.81	49.91	SR 071	SR 072	35.9 mi	65 mph	33 min
SR 072	WB	49.91	13.11	US 060	SR 095	36.8 mi	65 mph	34 min
SR 095	NB	131.8	202.02	SR 072	I-40	70.2 mi	65 mph	65 min
SR 095 - from MP 131.8 to MP 108.8: Escorts required for 12-feet wide and over								
I-40	EB	9.8	71.9	SR 095	US 093	62.1 mi	75 mph	50 min
I-40 - at MP 59: Low Over Pass-or-Legal Weight Only Bridge -or-Fee for over weight vehicles-See MVD map								
						222.11 mi		200 min

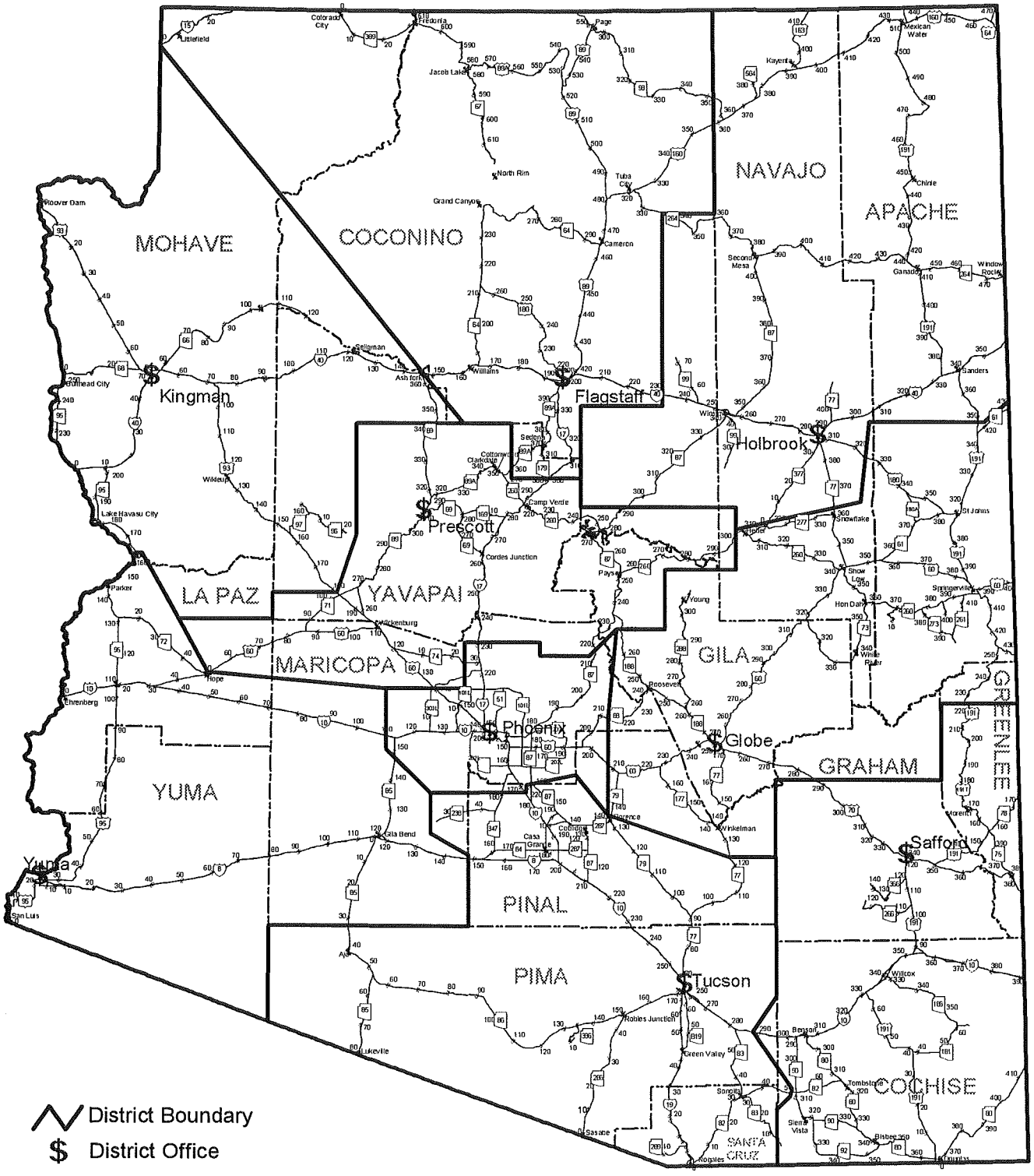
Total detour length: 222.11 mi. Estimated travel time*: 3 hr 20 min. Estimated increase in travel time: 1 hr 40 min.

* Travel times based on posted speed limits

APPENDIX C

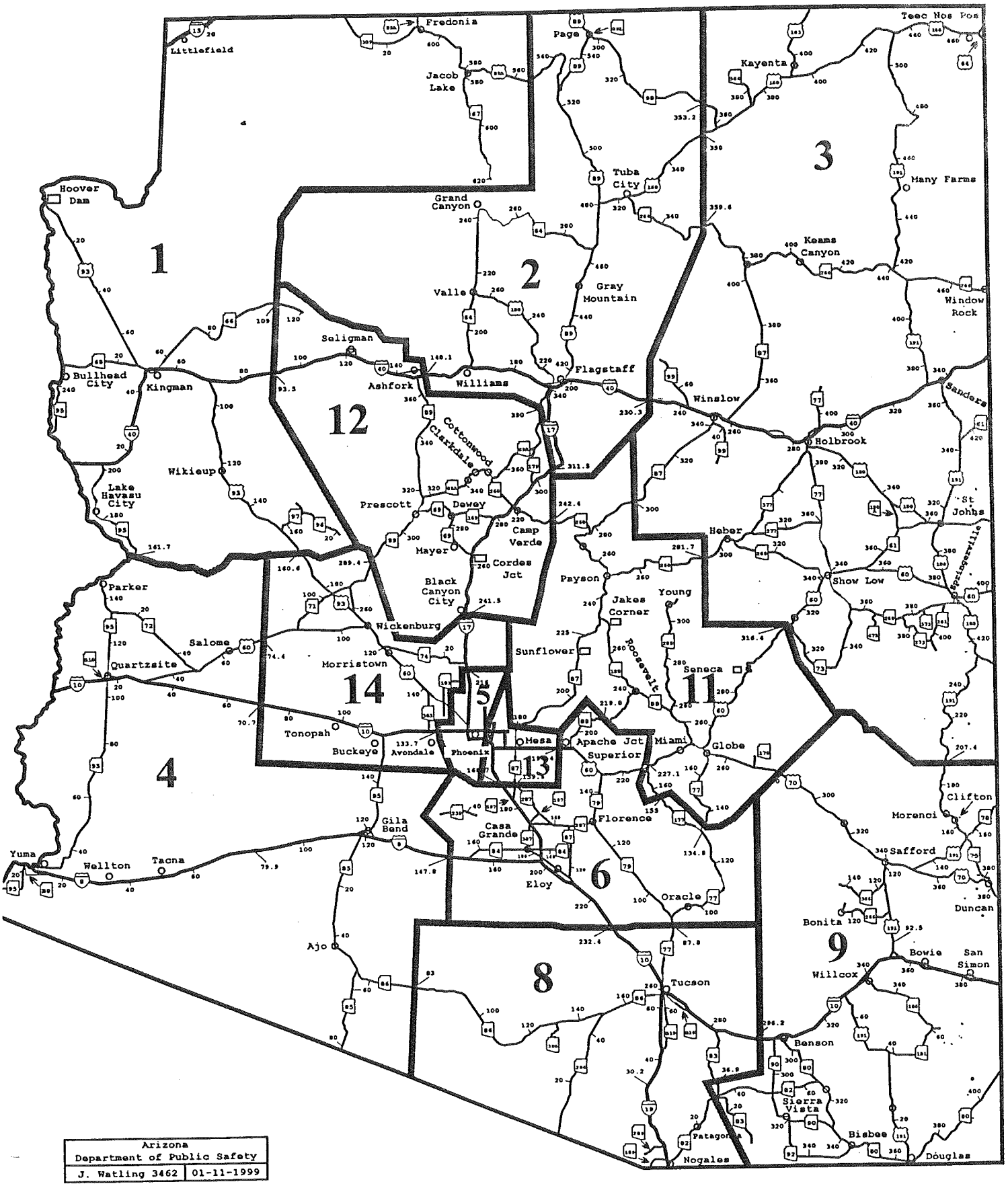
MAPS FROM THE STATEWIDE DETOUR PLAN WORKBOOK

1999 State Milepost System



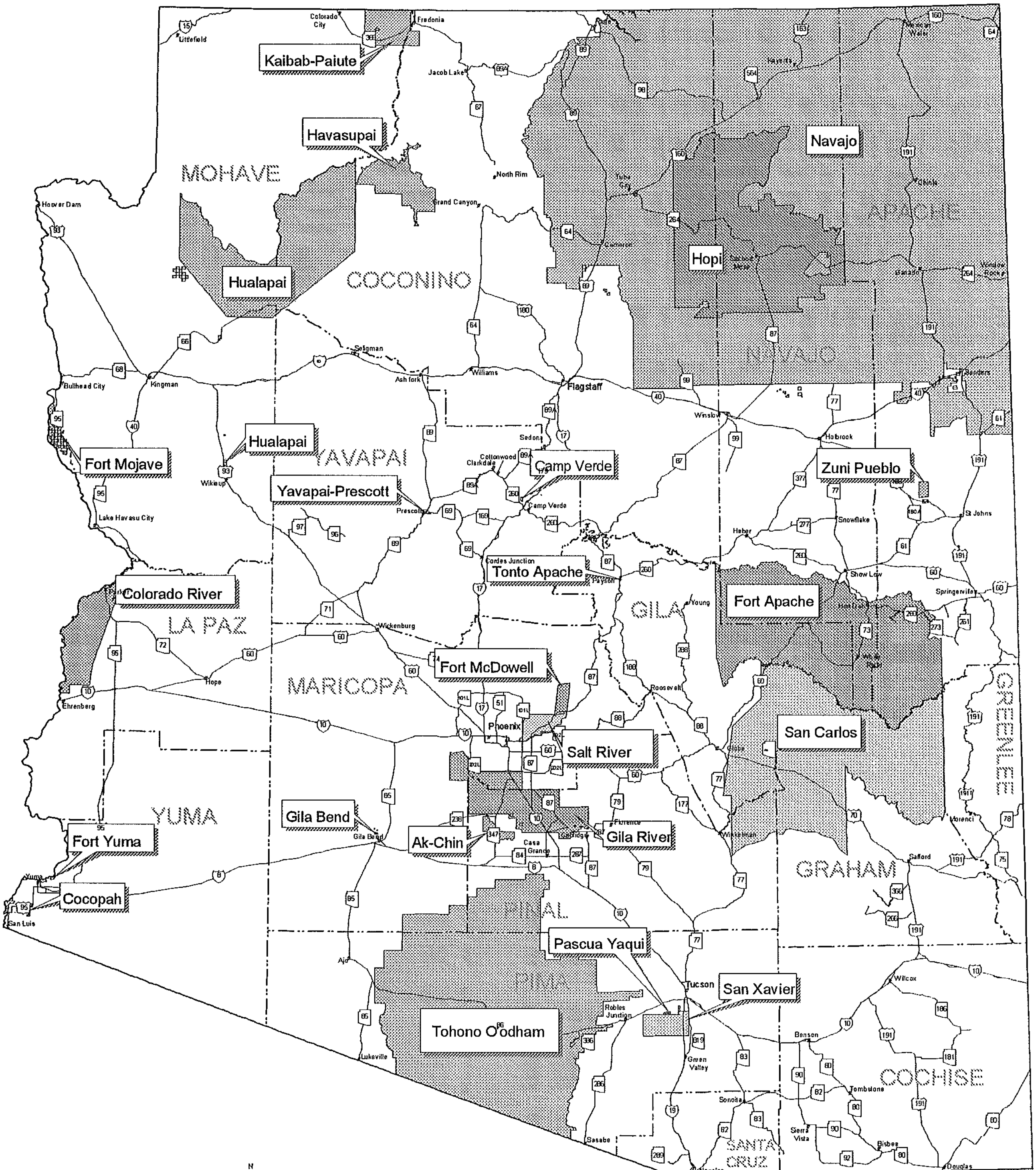
Arizona Department Of Transportation
Transportation Planning Group

tpg/tg/az_mp.apr/01-06-99



Arizona Department of Public Safety	
J. Watling 3462	01-11-1999

American Indian Reservations



0 25 50 75 100 Miles

Arizona Department of Transportation
Transportation Planning Division

tpg/tg/amer_ind.apr/03-12-99

APPENDIX D

WORKSHOP HANDOUTS AND MATERIALS FROM THE DEVELOPMENT OF THE STATEWIDE DETOUR PLAN WORKBOOK

Arizona Statewide Detour Plan, First Draft

Review Guidelines

August 16, 1999

REVIEW OBJECTIVES

The goal of this review is to develop three detour alternatives for each segment of the State Highway System (SHS) in Arizona. Specific objectives are:

- **Provide missing information and corrections as needed for existing ADOT detour descriptions. This includes, but is not limited to, beginning and ending mileposts for road closures and estimated travel times along each detour segment.**

- **Identify two additional detours for each SHS segment by selecting them from the draft workbook and/or providing your own alternative detour descriptions.**

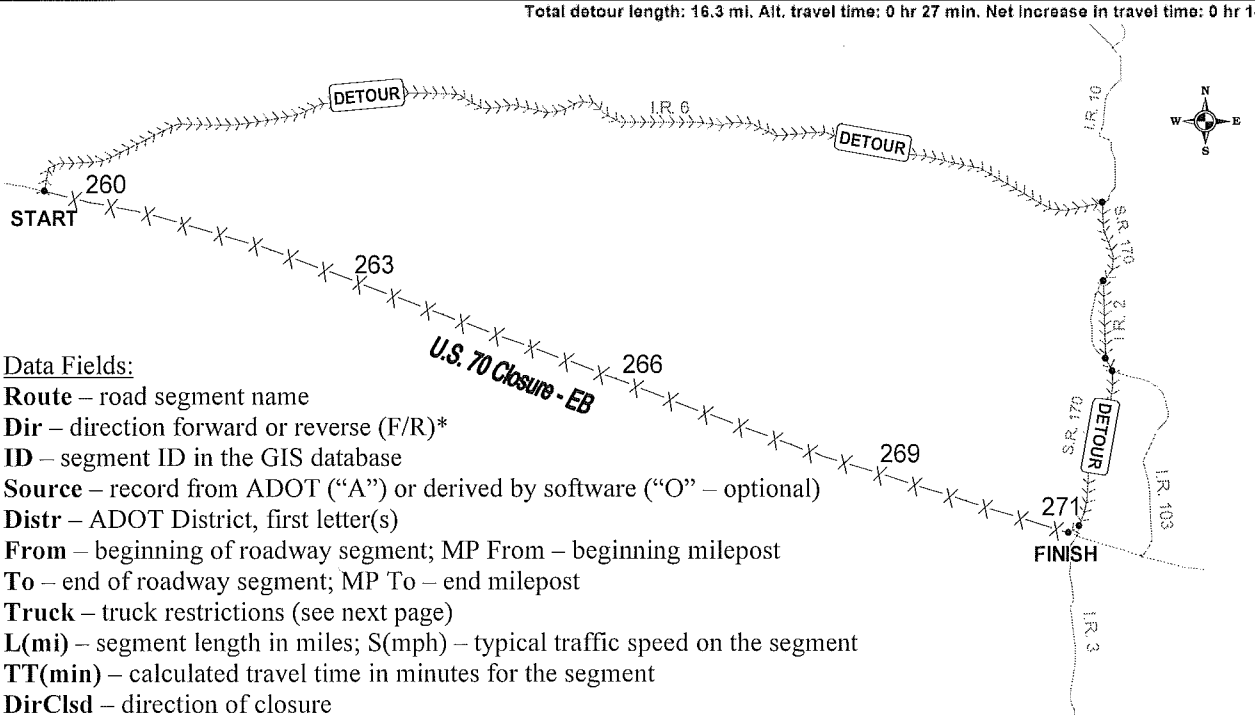
DETOUR WORKBOOK

The workbook contains a listing of existing ADOT detours transcribed from each District's Emergency Route Plan. In addition, two optional detours are provided for every[1] link on the SHS located outside of urban areas. These optional detours were developed in a Geographic Information System and minimize total travel time along each detour.

Detour descriptions in the workbook are sorted alphabetically by route. The detour records generally start at the northwest end of the route and progress southeast. A table of contents if provided. Detour description format is explained in the example below:

Route/Dir/ID/Source/Distr	From		CLOSURE	To	MP From:	MP To:	L(mi)	S(mph)	TT(min)	DirClsd
U 070 / F / 126003 / O / G	BIA 6 to Cutter			SY170 to S 170 North to San Carlos	258.86	271.06	12	55	12.75	E
Det# 1	*Route*		*TDir*	*From*	*To*	*MP From:*	*MP To:*	*Truck*	*L(mi)*	*S(mph)*	*TT(min)*
396689	IR06	↑	E	BIA 6 to Cutter	End S 170 at Entrance to San Carlos Indi	258.86	275.1		12.3	40	18.47
396429	S 170	DETOUR DESCRIPTION	S	End S 170 at Entrance to San Carlos Ind	S 170 & IR02	275.07	274	C	0.95	25	2.28
396415	IR02		S	S 170 & IR02	S 170 & IR02	274	273		0.96	40	1.45
396327	S 170		SE	S 170 & IR02	S 170 & IR03	273	273	C	0.16	25	0.39
396125	S 170		S	S 170 & IR03	SY170 to S 170 North to San Carlos	273	271.1	C	1.77	25	4.25
396079	SY170	↓	SW	SY170 to S 170 North to San Carlos	SY170 to S 170 North to San Carlos	271.06	271.1	C	0.15	55	0.16

Total detour length: 16.3 mi. Alt. travel time: 0 hr 27 min. Net increase in travel time: 0 hr 14.25 mir



Data Fields:

Route – road segment name
Dir – direction forward or reverse (F/R)*
ID – segment ID in the GIS database
Source – record from ADOT ("A") or derived by software ("O" – optional)
Distr – ADOT District, first letter(s)
From – beginning of roadway segment; MP From – beginning milepost
To – end of roadway segment; MP To – end milepost
Truck – truck restrictions (see next page)
L(mi) – segment length in miles; S(mph) – typical traffic speed on the segment
TT(min) – calculated travel time in minutes for the segment
DirClsd – direction of closure
**Note: for each closure, detours in forward and reverse direction are listed*

[1] It is up to the review process to determine what additional closures should be considered.

SUGGESTED STEPS FOR REVIEW

1. Using the Table of Contents provided, identify workbook pages that contain closures in your area of interest

2. Examine the detours provided for each closure. If a detour is not needed or is entirely invalid, strike its listing in the workbook. If a detour is valid but contains errors (wrong route name, mileposts, or speed), please provide as detailed corrections as possible.

3. If a detour is needed but is not listed in the workbook, use the form provided to fully describe the needed detour. Please provide as much information as possible to facilitate proper recording of the detour.

4. Do not constrain your detour segment selection by anything but the quality of the detour when correcting a listing in the workbook or developing your own detour alternatives. You are encouraged to use all available roadway segments to develop detour alternatives, not just the State Highway System. Possible jurisdictional issues related to using non-SHS roads for ADOT detours will be addressed at a later time. Detour selection should be based primarily on the shortest travel time.

5. The four E-size maps included with the workbook show all of the roadway links used in developing the optional detours. Feel free to use them to mark any corrections, additions, or deletions to the detour workbook.

6. **Note:** many of the optional detour listings are rather lengthy. This is due to the fact that the software used to develop these detours reports every detour segment separately, even if the detour continues along the same route for a number of segments. This is shown in the insert to the right. To avoid having to lookup every repetitious detour segment (such as "S 066" in the example shown) and to save time, it is suggested that you begin with the first occurrence of a route in the listing and "slide" all the way to where it appears last within a single detour listing.

Det# 2	*Route*		*TDir*	*From*
582696	S 066	← Begin here	W	S 066 & IR18
579221	~~S 066~~		SW	S 066 & IR1
579017	~~S 066~~	← Skip	NW	S 066 & COUNTY HWY 141
573898	~~S 066~~		SW	COUNTY HWY 149 & S 066
571949	S 066	← End here	SW	S 066
571793	GORDON DR		W	S 066 & GORDON DR

7. For valid detours, please note any specific truck / heavy vehicle restrictions and their exact locations (route and beginning and ending mileposts)

ADDITIONAL NOTES FOR REVIEWERS

1. Route naming for the SHS is based on standard ADOT naming convention used in the ATIS Roads GIS dataset. The "from", "to", and milepost information for each closure or detour segment was derived automatically from the 1997 ADOT SHS Log (from traffic interchange and junction data) and may contain errors.
2. We welcome any suggestions you may have regarding the content of closure/detour descriptions and the format of the workbook. Information that is available now and could be included in the final draft includes, for each roadway segment: state, county where the segment is located, town/city (as applicable), and truck restrictions published by MVD. Additional information may become available at later time, as the ADOT ATIS Roads database is updated.
3. We are aware that for certain road closures non-detour options may be more viable than detours. These options will be developed after this portion of the project is completed.
4. Truck restrictions listed in the workbook include: "A" – escorts required for 10'0" wide & over; "B" – class "C" permit required over 8'0" wide; "C" – escorts required for 12'0" wide & over; "D" – length restricted route; "K" – low overpass detour route; "CK" – "C" and "K" combined.

WHERE TO SEND YOUR COMMENTS

If you plan on attending one of the four review meetings (September 2, 7, 14, and 16), please bring your marked up workbook, maps, filled out detour forms to the meeting.

If you are unable to attend any of the review meetings, please send your comments to the address listed below or have someone else from your District bring them to the meeting.

Mail you comments to:
Andrew Kolcz
Kimley-Horn and Associates, Inc.
7600 N. 15th Street, Suite 250
Phoenix, AZ 85020
Tel.: 602.944.5500 / Fax: 602.944.7423 / email: akolcz@phx.kimley-horn.com

Kimley-Horn
and Associates, Inc.

Memorandum

Suite 250
7600 N. 15th Street
Phoenix, Arizona
85020

August 2, 1999

To: ADOT District Engineers
ADOT Regional Traffic Engineers
DPS District Commanders
Project Technical Advisory Committee
Other Project Participants

From: Andrew Kolcz, P.E.

Re: Statewide Detour Plan Research Project – Review Meetings

Draft detour workbooks will be sent out for your review no later than 13 August. The draft detour plan review meetings have been scheduled for the following dates and locations:

September 2, 1999 – Phoenix
Kimley-Horn and Associates, Inc.
7600 N. 15th Street, Suite 250
Tel.: (602) 944-5500 (ask for Andrew Kolcz)

September 7, 1999 – Flagstaff
ADOT Flagstaff District Office
1801 S. Milton Road
Tel.: (520) 779-7534 (Jean Diamond)

September 14, 1999 – Prescott
AZ DPS
1216 E. Sheldon Street
Tel.: (520) 778-3271 (Diana, Office Coordinator)

September 16, 1999 – Tucson
ADOT District Office
1221 S. Second Avenue
Tel: (520) 620-5417 (Janice)

* **Each meeting is scheduled to begin at 8:00 AM and meeting rooms are reserved until approximately 5:00 PM.**

If you have any questions regarding the review meeting or this project in general, please contact Steve Owen (602/712-6910) or myself (602/944-5500).

TEL 602 944 5500
FAX 602 944 7423