Appendix D. Cost Risk and Value Planning Workshops

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I-10, Near Term Improvements CRA Workshop Results, Design-Bid-Build Assumption, January 12–14, 2015

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I-17/Camelback TI CRA & Value Planning Workshop Results (in coordination with Valley Metro Phoenix West/Glendale Extension LRT), June 27–30, 2016

I-10/West Sky Harbor Access Value Planning Workshop Results, February 13–17, 2017

I-17/Central Avenue Bridge Replacement CRA Workshop Results (in coordination with Valley Metro South Central LRT), May 2, 2017

I-17/Mountain View CRA Workshop Results (in coordination with Valley Metro Northwest Extension LRT), May 3, 2017

I-17/Indian School TI, I-17/Northern TI, I-17/Glendale TI, I-17/Thunderbird TI, and I-17/Bell TI CRA Workshop Results, May 16 & 18, 2017

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I-10, Near Term Improvements CRA Workshop Results

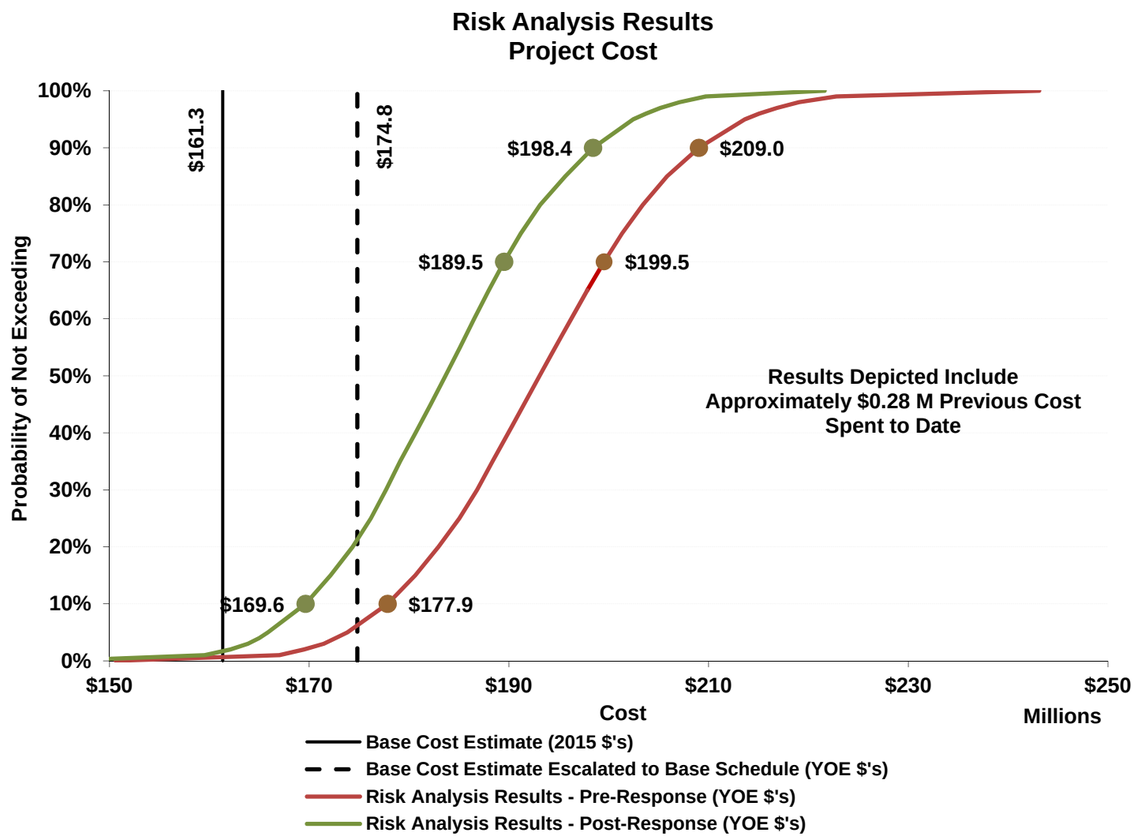
Design-Bid-Build Assumption

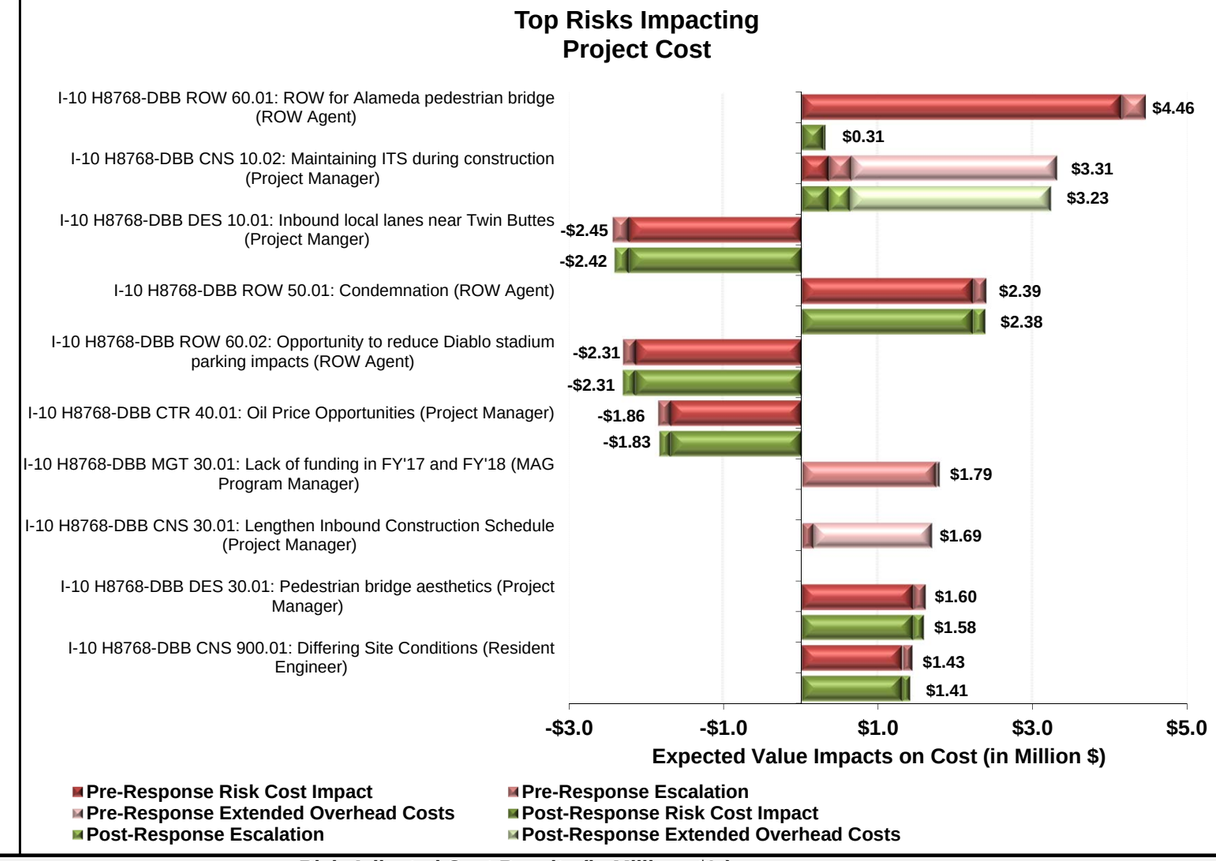
January 12-14, 2015

CRA Workshop Cost Summary Sheet	I-10, Maricopa (SR-143 – SR-202L, Santan) Near-Term Improvements Design-Bid-Build Scenario / TRACS# H8768-DBB Last Updated January 2015	Level of Project Design	Low Medium High	CRA Workshop Cost Summary Sheet

Project Description

A modified collector-distributor roadway system will be developed to eliminate the existing weaving conditions between SR-143, Broadway Road and US 60 that is causing significant congestion on I-10 during the morning and evening peak travel periods. All existing system and service interchange freeway access will be retained with the Recommended Alternative. South of Baseline Road, I-10 will be widened to provide additional freeway capacity within that segment of the project.





Cost Results

The S-curves reveal that, prior to risk response, there was a **70 percent** chance of the total project costs being less than **$199.5 million** in year-of-expenditure (YOE).

With the risk response strategies included, project costs now have a **70 percent** chance of being less than **$189.5 million** YOE.

These results indicate that by implementing the risk response strategies developed at the CRA workshop, project costs are expected to be reduced by **$10.0 million**.

Risk-Adjusted Cost Results (in Millions $'s)

Category	Base Cost 2015 $'s	Base Cost YOE $'s	Cost Range YOE $'s		
			10th Percentile	70th Percentile	90th Percentile
Pre-Response Results Total Project	$161.3	$174.8	$177.9	$199.5	$209.0
Post-Response Results Total Project			$169.6	$189.5	$198.4
Post-Response Preliminary Engineering	$13.9	$14.9	$14.5	$15.1	$15.3
Post-Response Right-of-Way	$12.0	$12.8	$10.4	$15.1	$17.2
Post-Response Construction	$135.4	$147.1	$141.8	$160.6	$168.9

Category	Base Cost 2015 $'s	Cost Range 2015 $'s		
		10th Percentile	70th Percentile	90th Percentile
Post-Response Results Total Project	$161.3	$155.8	$173.8	$181.6

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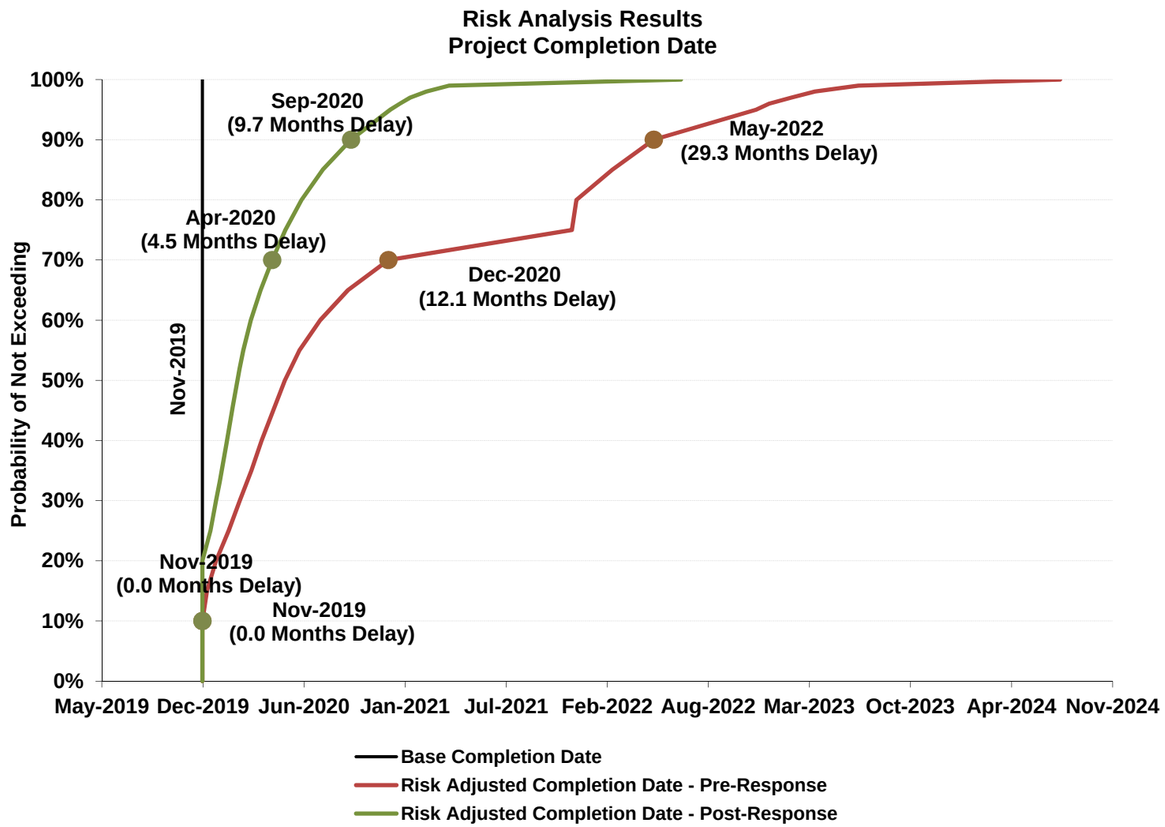
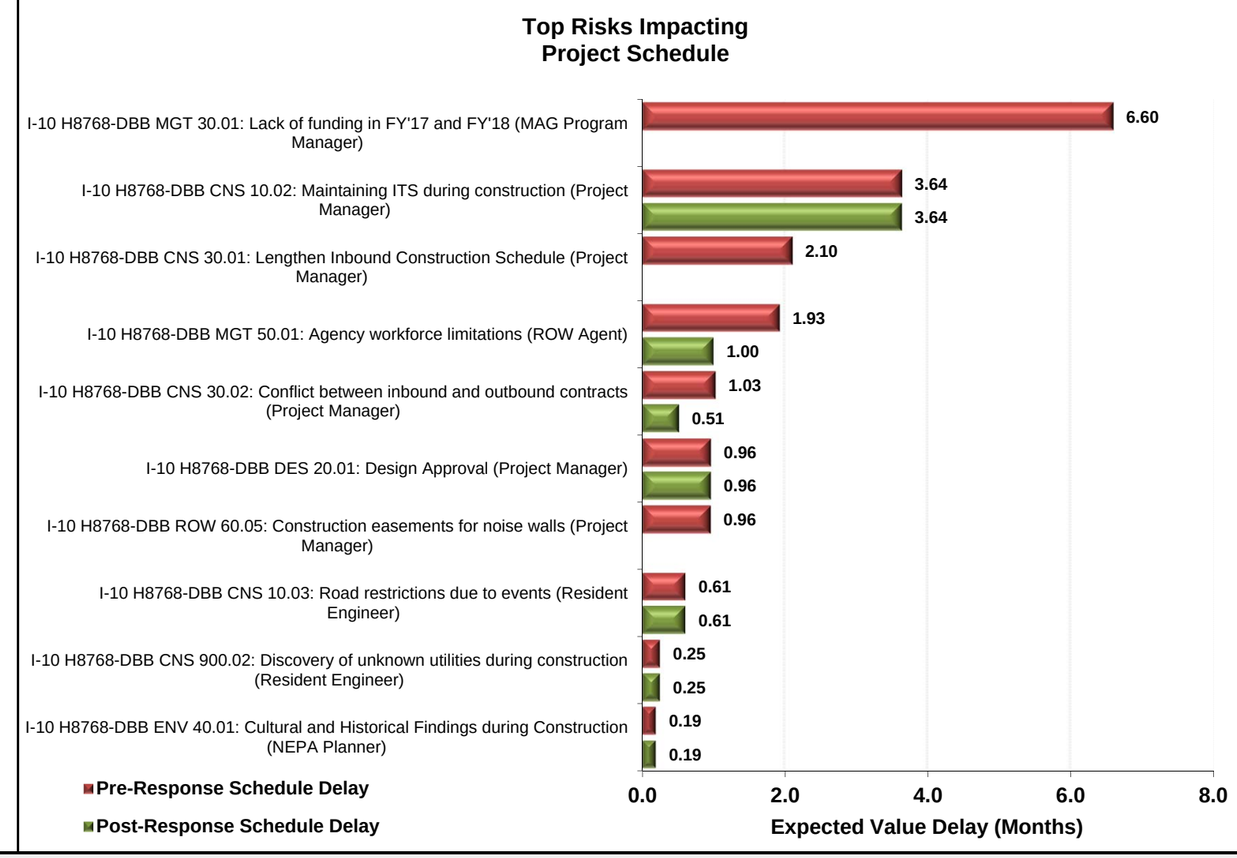
CRA Workshop Schedule Summary Sheet	I-10, Maricopa (SR-143 – SR-202L, Santan) Near-Term Improvements Design-Bid-Build Scenario / TRACS# H8768-DBB Last Updated January 2015	Level of Project Design	Low Medium High	CRA Workshop Schedule Summary Sheet





Schedule Results

Under the base schedule, the project is expected to be completed in **November, 2019**. The S-curves reveal that, prior to risk response, there is a **70 percent** chance that the project will be completed by **December, 2020** indicating a risk of potential delay to project completion of approximately **12.1 months**.

After including the risk response strategies developed at the CRA workshop, the project completion delay is reduced to approximately **4.5 months** with the project being completed in **April, 2020**.

By employing the risk response strategies developed within the CRA, project completion can be achieved **7.6 months** earlier.

Risk-Adjusted Schedule Results

Category	Base Date	Project Completion Date Range		
		10th Percentile	70th Percentile	90th Percentile
Pre-Response Results	Nov-2019	Nov-2019	Dec-2020	May-2022
Post-Response Results		Nov-2019	Apr-2020	Sep-2020
Post-Response Advertisement Date (Inbound)	Jun-2017	Jun-2017	Jun-2017	Oct-2017
Post-Response Construction Duration (Inbound)	18.0 Months	18.0 Months	20.3 Months	27.3 Months
Post-Response Advertisement Date (Outbound)	Jun-2018	Jun-2018	Jun-2018	Oct-2018
Post-Response Construction Duration (Outbound)	14.0 Months	14.0 Months	16.4 Months	22.5 Months

Key Risk Response Strategies

ROW 60.01 - ROW for Alameda pedestrian bridge Move the Alameda pedestrian bridge switchback ramps on the east side into the existing ROW that is owned. Would eliminate impacts on the east side. Move the Alameda pedestrian bridge switchback ramps on the west side closer to I-10 would minimize impacts to parking for Diablo stadium and the billboard that is in the stadium parking lot. There may be a requirement for an easement on the east side. Negotiations with city of Tempe about impacts to Diablo stadium parking impacts.

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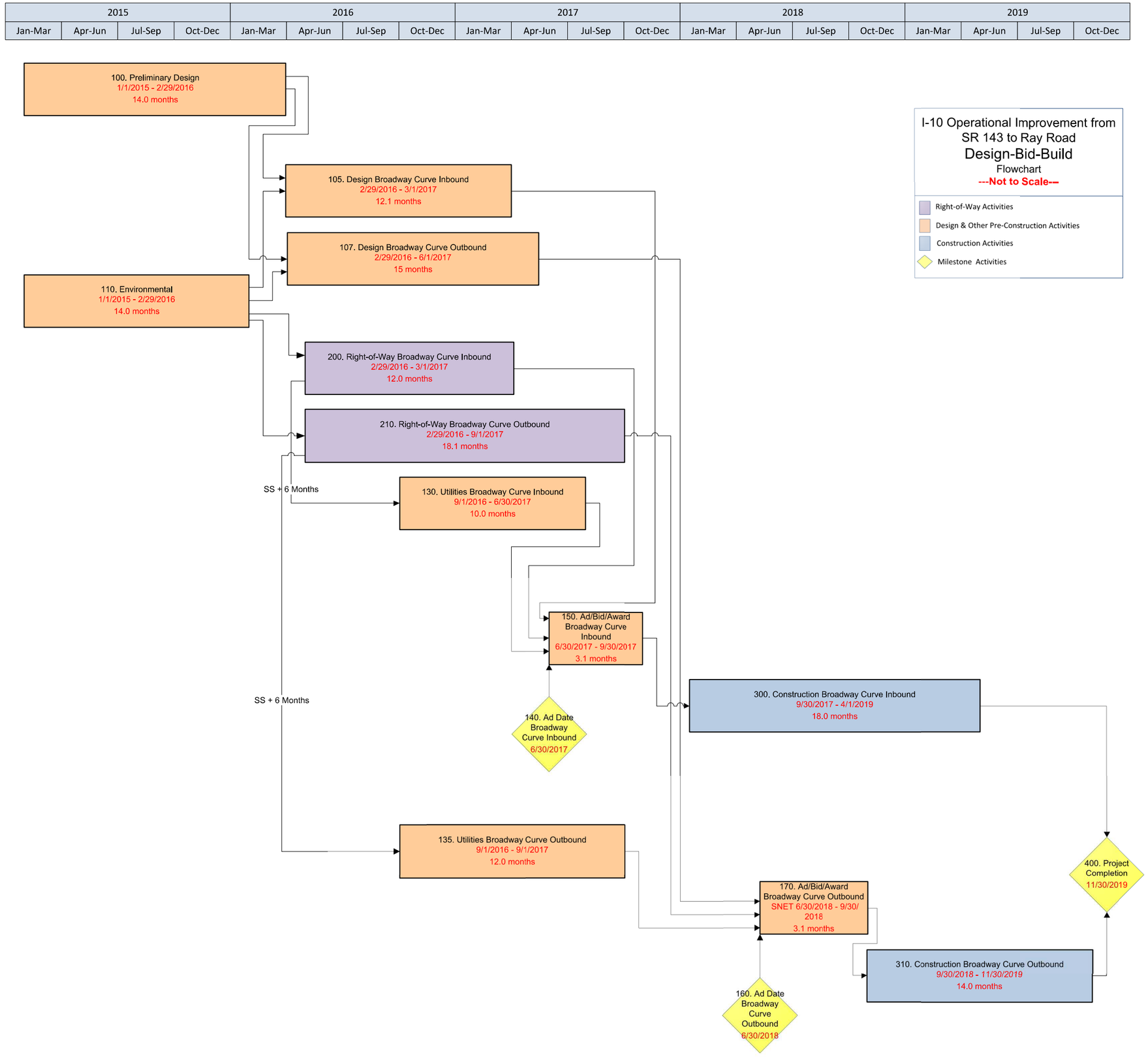
2015
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Oct-Dec
I-10 Operational Improvement from SR 143 to Ray Road
Design-Bid-Build
Flowchart
---Not to Scale---
Right-of-Way Activities
Design & Other Pre-Construction Activities
Construction Activities
Milestone Activities
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14.0 months
105. Design Broadway Curve Inbound
2/29/2016 - 3/1/2017
12.1 months
107. Design Broadway Curve Outbound
2/29/2016 - 6/1/2017
15 months
110. Environmental
1/1/2015 - 2/29/2016
14.0 months
200. Right-of-Way Broadway Curve Inbound
2/29/2016 - 3/1/2017
12.0 months
210. Right-of-Way Broadway Curve Outbound
2/29/2016 - 9/1/2017
18.1 months
SS + 6 Months
130. Utilities Broadway Curve Inbound
9/1/2016 - 6/30/2017
10.0 months
150. Ad/Bid/Award Broadway Curve Inbound
6/30/2017 - 9/30/2017
3.1 months
SS + 6 Months
140. Ad Date Broadway Curve Inbound
6/30/2017
300. Construction Broadway Curve Inbound
9/30/2017 - 4/1/2019
18.0 months
135. Utilities Broadway Curve Outbound
9/1/2016 - 9/1/2017
12.0 months
400. Project Completion
11/30/2019
170. Ad/Bid/Award Broadway Curve Outbound
SNET 6/30/2018 - 9/30/2018
3.1 months
310. Construction Broadway Curve Outbound
9/30/2018 - 11/30/2019
14.0 months
160. Ad Date Broadway Curve Outbound
6/30/2018

I-10, Near Term Improvements CRA Workshop Results

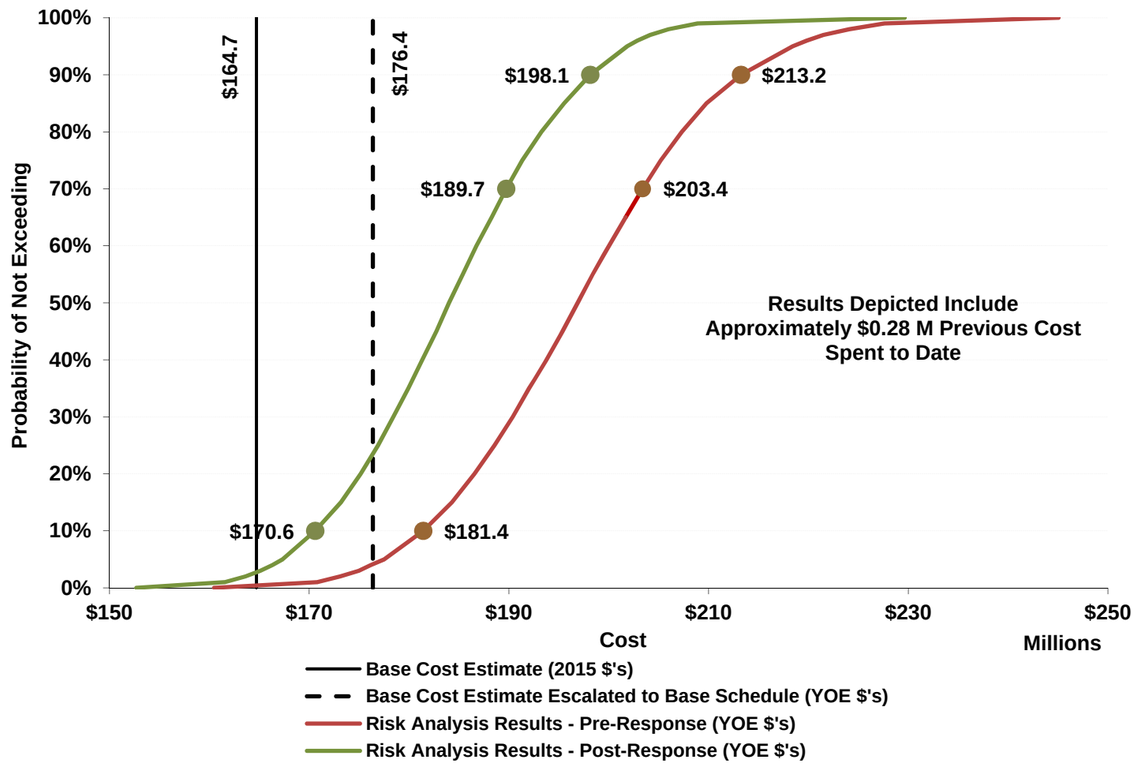
Design-Build Assumption

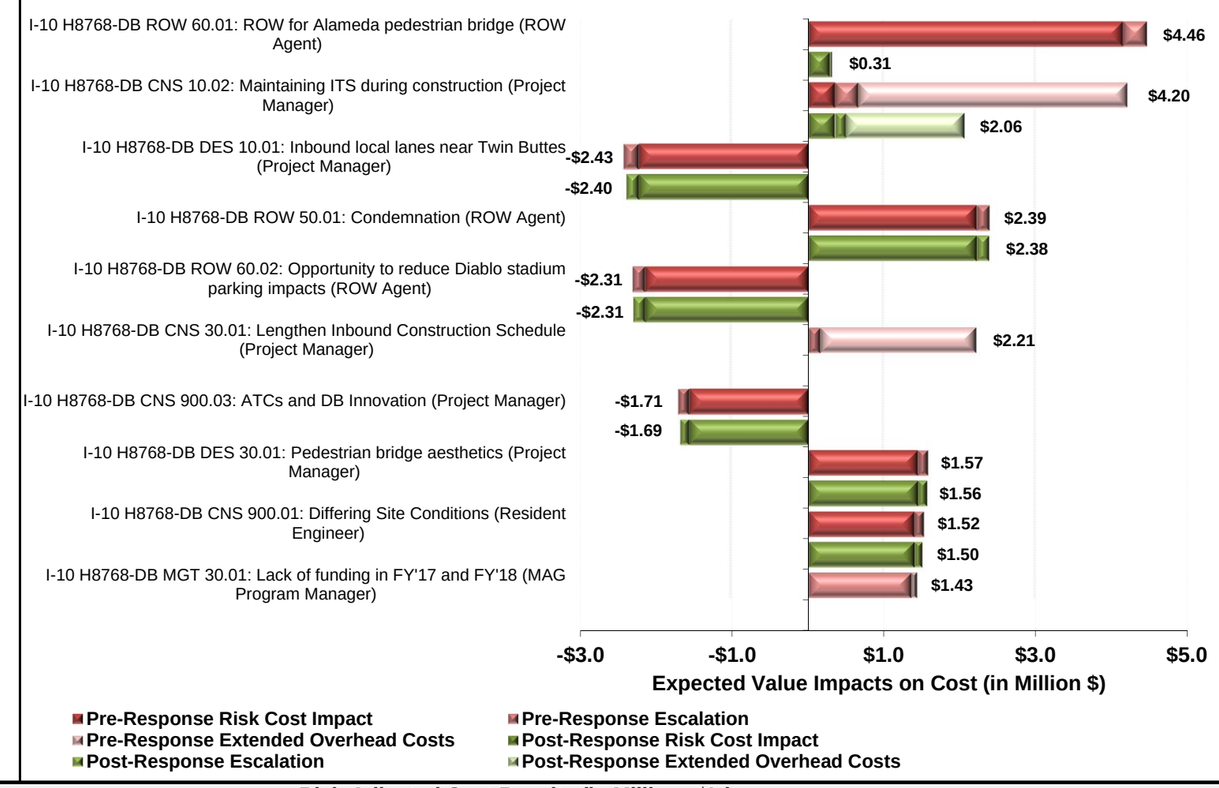
May 29, 2015

CRA Workshop Cost Summary Sheet	I-10, Maricopa (SR-143 – SR-202L, Santan) Near-Term Improvements Design-Build Scenario / TRACS# H8768-DB Last Updated June 2015	Level of Project Design	Low Medium High	CRA Workshop Cost Summary Sheet

Project Description

A modified collector-distributor roadway system will be developed to eliminate the existing weaving conditions between SR-143, Broadway Road and US 60 that is causing significant congestion on I-10 during the morning and evening peak travel periods. All existing system and service interchange freeway access will be retained with the Recommended Alternative. South of Baseline Road, I-10 will be widened to provide additional freeway capacity within that segment of the project.





Cost Results

The S-curves reveal that, prior to risk response, there was a **70 percent** chance of the total project costs being less than **$203.4 million** in year-of-expenditure (YOE).

With the risk response strategies included, project costs now have a **70 percent** chance of being less than **$189.7 million** YOE.

These results indicate that by implementing the risk response strategies developed at the CRA workshop, project costs are expected to be reduced by **$13.7 million**.

Risk-Adjusted Cost Results (in Millions $'s)

Category	Base Cost 2015 $'s	Base Cost YOE $'s	Cost Range YOE $'s		
			10th Percentile	70th Percentile	90th Percentile
Pre-Response Results Total Project	$164.7	$176.4	$181.4	$203.4	$213.2
Post-Response Results Total Project			$170.6	$189.7	$198.1
Post-Response Preliminary Engineering	$7.1	$7.4	$6.9	$7.7	$8.0
Post-Response Right-of-Way	$12.0	$12.8	$10.4	$15.1	$17.1
Post-Response Construction	$145.6	$156.1	$150.6	$168.0	$175.9
Category	**Base Cost 2015 $'s**		**Cost Range 2015 $'s**		
			10th Percentile	**70th Percentile**	**90th Percentile**
Post-Response Results Total Project	$164.7		$158.4	$176.0	$183.7

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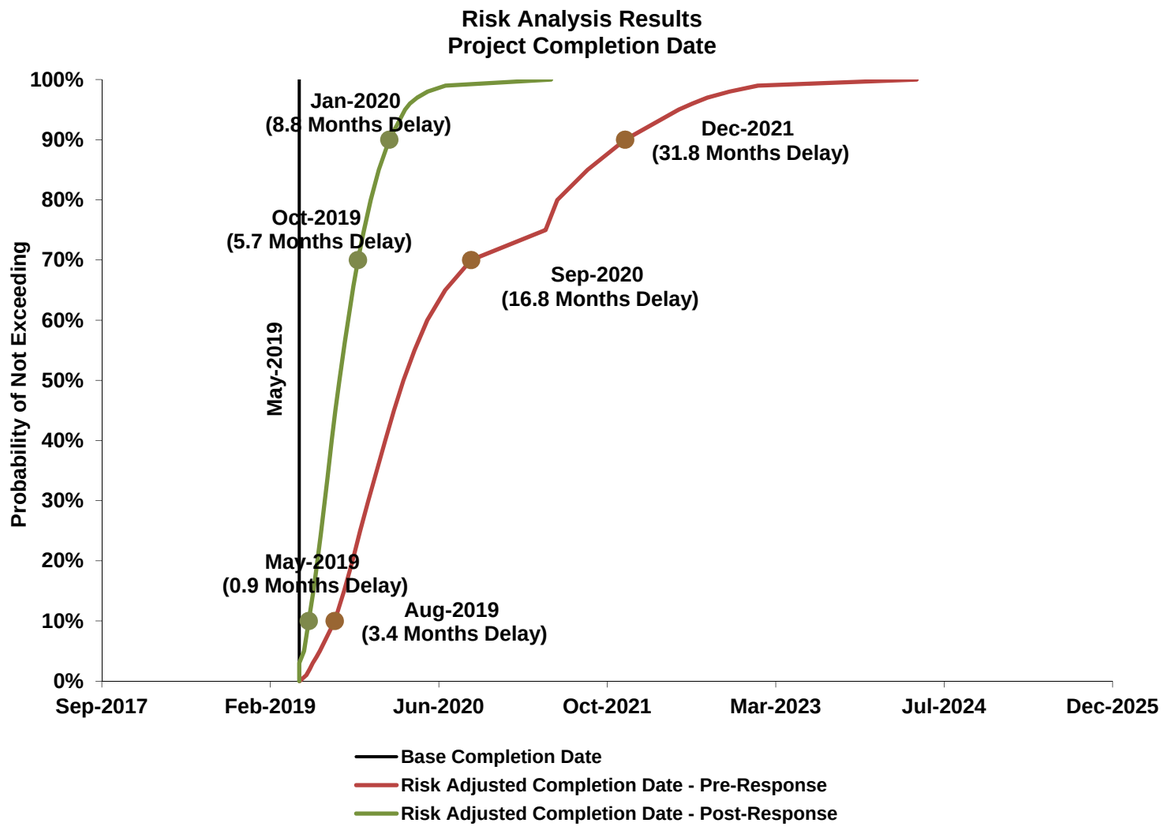
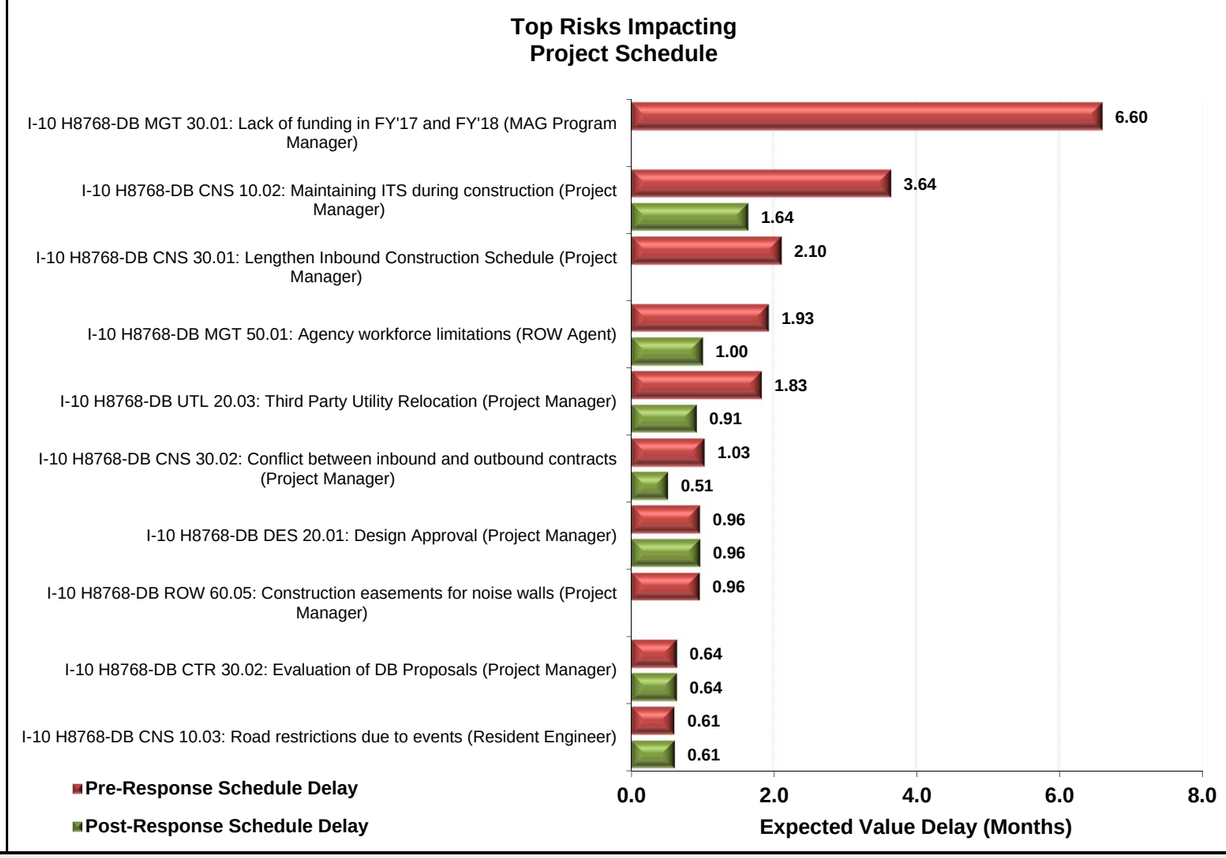
CRA Workshop Schedule Summary Sheet	I-10, Maricopa (SR-143 – SR-202L, Santan) Near-Term Improvements Design-Build Scenario / TRACS# H8768-DB Last Updated June 2015	Level of Project Design	Low Medium High	CRA Workshop Schedule Summary Sheet





Schedule Results

Under the base schedule, the project is expected to be completed in **May, 2019**. The S-curves reveal that, prior to risk response, there is a **70 percent** chance that the project will be completed by **September, 2020** indicating a risk of potential delay to project completion of approximately **16.8 months**.

After including the risk response strategies developed at the CRA workshop, the project completion delay is reduced to approximately **5.7 months** with the project being completed in **October, 2019**.

By employing the risk response strategies developed within the CRA, project completion can be achieved **11.0 months** earlier.

Risk-Adjusted Schedule Results

Category	Base Date	Project Completion Date Range		
		10th Percentile	70th Percentile	90th Percentile
Pre-Response Results	May-2019	Aug-2019	Sep-2020	Dec-2021
Post-Response Results		May-2019	Oct-2019	Jan-2020
Post-Response RFP Date (Inbound)	Mar-2017	Mar-2017	Mar-2017	Jul-2017
Post-Response Construction Duration (Inbound)	20.1 Months	20.1 Months	21.5 Months	24.2 Months
Post-Response RFP Date (Outbound)	Jul-2017	Jul-2017	Jul-2017	Jul-2017
Post-Response Construction Duration (Outbound)	20.0 Months	20.0 Months	22.3 Months	24.8 Months

Key Risk Response Strategies

ROW 60.01 - ROW for Alameda pedestrian bridge Move the Alameda pedestrian bridge switchback ramps on the east side into the existing ROW that is owned. Would eliminate impacts on the east side. Move the Alameda pedestrian bridge switchback ramps on the west side closer to I-10 would minimize impacts to parking for Diablo stadium and the billboard that is in the stadium parking lot. There may be a requirement for an easement on the east side. Negotiations with city of Tempe about impacts to Diablo stadium parking impacts.

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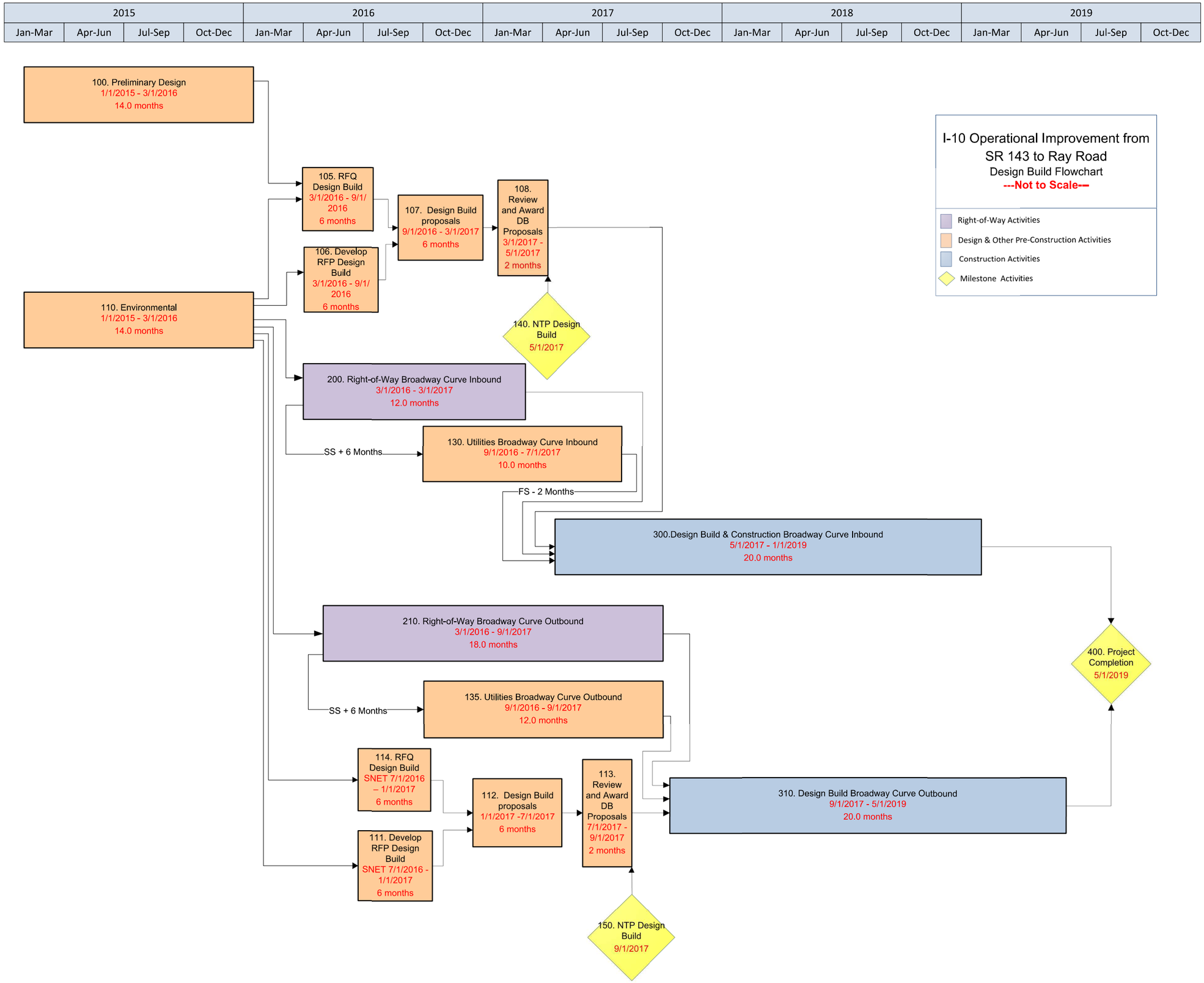
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I-10 Operational Improvement from SR 143 to Ray Road
Design Build Flowchart
---Not to Scale---
Right-of-Way Activities
Design & Other Pre-Construction Activities
Construction Activities
Milestone Activities
100. Preliminary Design
1/1/2015 - 3/1/2016
14.0 months
110. Environmental
1/1/2015 - 3/1/2016
14.0 months
105. RFQ Design Build
3/1/2016 - 9/1/2016
6 months
106. Develop RFP Design Build
3/1/2016 - 9/1/2016
6 months
107. Design Build proposals
9/1/2016 - 3/1/2017
6 months
108. Review and Award DB Proposals
3/1/2017 - 5/1/2017
2 months
140. NTP Design Build
5/1/2017
200. Right-of-Way Broadway Curve Inbound
3/1/2016 - 3/1/2017
12.0 months
SS + 6 Months
130. Utilities Broadway Curve Inbound
9/1/2016 - 7/1/2017
10.0 months
FS - 2 Months
300.Design Build & Construction Broadway Curve Inbound
5/1/2017 - 1/1/2019
20.0 months
210. Right-of-Way Broadway Curve Outbound
3/1/2016 - 9/1/2017
18.0 months
SS + 6 Months
135. Utilities Broadway Curve Outbound
9/1/2016 - 9/1/2017
12.0 months
400. Project Completion
5/1/2019
114. RFQ Design Build
SNET 7/1/2016 – 1/1/2017
6 months
111. Develop RFP Design Build
SNET 7/1/2016 - 1/1/2017
6 months
112. Design Build proposals
1/1/2017 -7/1/2017
6 months
113. Review and Award DB Proposals
7/1/2017 - 9/1/2017
2 months
310. Design Build Broadway Curve Outbound
9/1/2017 - 5/1/2019
20.0 months
150. NTP Design Build
9/1/2017

I-17, 19th Avenue to the I-10 Split CRA & Value Planning Workshop Results

January 25-26, 2016

February 8-10, 2016

I-17: I-10 Split to 19th Avenue
Cost Risk Assessment & Value Planning Study

Final Report

Prepared for:
Maricopa Association of Governments

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Ken Smith
Trent Eakin

Prepared By:
HDR Engineering, Inc.

Date:
CRA Workshop: January 26-27, 2016
Value Planning Study: February 8-10, 2016
Presentation: February 11, 2016

Disclaimer:

The information contained in this report is the professional opinions of the team members during the Cost Risk Assessment Workshop and Value Planning Study. These opinions were based on the information provided to the team at the time of these workshops. As the project continues to develop, new information will become available, and this information will need to be evaluated on how it may affect the recommendations and findings in this report. All costs displayed in the report are based on best available information at the time of the study and unless otherwise noted are in 2016 dollars.

This report was prepared by:

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Executive Summary

Introduction

This cost risk assessment (CRA) and value planning report summarizes the events of the workshops conducted for the Maricopa Association of Governments, facilitated by HDR, Inc. Value planning is a process of developing the appropriate scope of work using the Value Engineering process and tools.

Value Planning Summary

Near Term Project Cost: $70M (YOE)

Number of Planning Recommendations: 7

Total Number of Team Members: 14

MAG Employees: 6

ADOT Employees: 3

Consultant: 5

Facilitator: HDR Engineering, Inc.

The project under review was the I-17: I-10 Split to 19th Avenue Corridor. The CRA workshop was conducted January 25-26, 2016 while the Value Planning Study was held February 8-10, 2016. The risk register, initially developed during the CRA workshop, was again updated at the end of the Value Planning workshop. The presentation of both the preliminary CRA model results and Value Planning Recommendations was held February 11, 2016.

The primary objectives of the team through application of the Value Engineering Job Plan (see Appendix) were to:

- Conduct a thorough review and analysis of the key project issues using a multidiscipline, cross-functional team (i.e. review the Near Term project and design)
- Verify or improve upon the various concepts proposed for the corridor
- Improve the value of the project through innovative measures aimed at improving the performance while reducing costs of the project
- Identify high-risk areas in delivering this project
- Perform a cost risk assessment on both the baseline design and the Value Planning-recommended design (risk register adjusted with team at the end of the Value Planning Study)

Project Overview

Near Term Improvements

The purpose of this project is to improve the operation and safety of I-17. The proposed near-term improvements would add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions of travel between 16th Street and 19th Avenue and would extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp. The corridor is under evaluation to address a number of other deficiencies identified throughout the project. These include:

1. Narrow shoulder widths that do not meet current highway standards
2. Low overhead clearances for I-17 structures over city streets

3. Short merge distances between on/off ramps and the general purpose lanes

The Near Term Improvement 15% design plans include the addition of auxiliary lanes (merge lanes) between the I-10 Split Interchange and 19th Avenue. It also includes widening of existing structures to accommodate the additional roadway width. Walls would be constructed near the limits, at or near the shoulder of the Near Term roadway design widths to support the elevated freeway section throughout the majority of the corridor. The estimated cost of the Near Term project after factoring identified risks, at 70% certainty in 2016 dollars is just over $68 million. A direct cost comparison was then developed to compare the Near Term project costs with the Ultimate costs.

Ultimate Improvements

The proposed Ultimate Improvements, if the Near Term project is omitted, would also add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions between 16th Street and 19th Avenue and extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp. The project will replace all structures and pavement and bring the roadway up to meet current clearance standards. The Ultimate plans for the corridor include:

1. Raising of mainline profile to accommodate new structures at overcrossings to meet clearance requirements and geometric standards

Other Ultimate developments include the addition of HOV lanes, one in each direction, throughout the length of the corridor. For the purposes of this study, the team assumed the HOV lane construction would occur in the future, therefore the costs for including HOV lanes are not considered in the analysis.

Cost Risk Assessment

In performing the cost risk analysis, a risk-based modeling tool was incorporated to model the overall risk of the project, both schedule and cost. Pre-response results are based on the likelihood of an event prior to implementation of mitigation strategies, the backbone of a risk management plan. Post-response results are based on the likelihood that this risk may be reduced or even eliminated based on the risk mitigation strategies currently identified. During these workshops, the team identified 31 independent risks that may have both schedule and cost impacts, some of which were recognized as opportunities. In the workshop, a likely range of impact and probability of occurrence was identified for each risk (or opportunity). Due to the current level of design and based on the limited mitigation strategies identified at this stage, pre-response and post-response results are within a relatively close range. As the project (or potential projects) in the program advance, there will be additional opportunities to identify additional risk mitigation strategies as the risk profile evolves. The risks, their probability of occurrence, cost and schedule impacts, and the mitigation strategies currently in place are provided in the risk data sheets listed in the Appendix.

The results after considering the risk, cost and schedule impacts, and their probability of occurrence was incorporated into a model to consider 10,000 iterations, or the possibilities of

the risk occurring and the associated impacts. The results of the analysis for the Ultimate Project configuration are provided in Table 1. Base costs for the Ultimate project, excluding risk impacts, is estimated to be $195.8 million (2016 $) or $213 million at year of expenditure (YOE). Based on current risk, cost and schedule inputs, the project will be at or below **$210.5 million (2016 $) or $231.1 million (YOE)** at a 70% confidence level**.**

Table 1: Ultimate Project Risk-Adjusted Cost Results (in Millions $s)

Category	Base Cost 2016 $s	Base Cost YOE $s	70th Percentile 2016 $s	70th Percentile YOE $s
Total Project Pre-Response Results	$195.8	$213.0	$210.5	**$231.1**
Total Project Post-Response Results			$210.4	**$231.1**
Post-Response Preliminary Engineering	$16.4	$17.3	$19.2	$20.6
Post-Response Right-of-Way	$0.0	$0.0	$0.0	$0.0
Post-Response Construction	$179.4	$195.8	$191.2	$210.5

The schedule was evaluated by the team while considering both negative impacts and opportunities. Compared to the baseline schedule, while also considering the recommendations identified by the team, the project will be complete by December 2021 at the 70% confidence level. This is over four months beyond the baseline completion date of August 2021. A recommendation for a schedule opportunity was captured by the project team. Although the probability is not considered high, the recommendation focuses on preliminary traffic control scenario's that may reduce the overall schedule by six months. Please see Table 2 below and the 'Analysis of Results' section of this report for a more detailed analysis of the cost and schedule model output results.

Table 2: Ultimate Project Risk-Adjusted Schedule Results

Category	Base Schedule Completion Date	Project Completion Date Range		
		10th Percentile	70th Percentile	90th Percentile
Pre-Response Results	Aug-2021	Feb-2021	Dec-2021	Jun-2022
Post-Response Results		Feb-2021	**Dec-2021**	Jun-2022
Post-Response Advertisement Date	Apr-2018	Apr-2018	Nov-2018	May-2019
Post-Response Construction Duration	36.0 Months	30.0 Months	36.0 Months	36.0 Months

These tables illustrate the results of the model and show, based on a comparison to the baseline estimate and schedule, what costs and schedule risk reserve may be expected for the

ultimate project at this stage. Based on workshop discussion and preliminary analysis results, the team recommends that the Ultimate project provides the best overall value versus Near Term improvements proposed for the corridor.

Value Planning Study Summary

The Value Planning study evolved into an assessment of whether the Near Term project would benefit the Ultimate needs of the corridor and if an alternative approach with a longer term solution would be more beneficial. As discussions over the Ultimate plans progressed, it was understood other immediate needs include potential bridge replacements to alleviate current height restrictions on city streets and additional plans to accommodate both auxiliary lanes and general purpose lanes for future expansion projects. Other plans include construction of HOV lanes through the project, one lane in each direction.

The team discussed the time frame between when the Near Term project and when the Ultimate projects were scheduled. It was understood that the time frame between projects was within just a few years. A high level cost estimate was developed for the Ultimate option to provide a direct comparison between the Near Term and Ultimate project alternatives under consideration. Following development of the risk register for the Near Term project during the CRA workshop, a supplemental risk register was developed for the Ultimate project. A direct comparison between the Near Term, risk loaded cost results and the Ultimate risk loaded costs, both in current dollars and at year-of-expenditure, is provided in Table 3.

Table 3: Near Term & Ultimate Project Cost Comparison

	Near Term Project Cost Results			Ultimate Project CRA Results		
Category	Base Cost 2016 $s	70th Percentile 2016 $s	70th Percentile YOE $s	Base Cost 2016 $s	70th Percentile 2016 $s	70th Percentile YOE $s
Total Project Pre-Response Results	**$45.9**	**$68.2**	**$72.9**	**$195.8**	**$210.5**	**$231.1**
Post-Response Preliminary Engineering	$3.1	$4.3	$4.5	$16.4	$19.2	$20.6
Post-Response Right-of-Way	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Post-Response Construction	$42.8	$61.9	**$66.2**	$179.4	$191.2	**$210.5**
Total Project Post-Response Results	**$45.9**	**$66.2**	**$70.7**	**$195.8**	**$210.4**	**$231.1**

The majority of the Near Term construction improvements would essentially be replaced by the Ultimate project configuration. Based on the cost estimate results and short time frame between Near Term and Ultimate projects, the team assumed that the Ultimate project would be the baseline project, with the construction of the HOV lanes to be performed at a later time. The

remainder of the workshop focused directly on planning and identifying risks for the Ultimate corridor plan, where the remainder of this report will focus. Alternatives will be compared to the Ultimate plan and recommendations will be relevant to the Ultimate corridor plan, also referred to as the 'Ultimate' project alternative. Accommodations were also considered for the future HOV lane project. Additional information regarding the complete cost and schedule details is found in the 'Analysis of Results' section of this report. Near term project cost and risk analysis data is provided in the Appendix. The remainder of this report will focus on the Ultimate project configuration with HOV lane construction anticipated in the future.

Value Planning Recommendations

The Team generated seven recommendations for the Ultimate Project configuration. These ideas were evaluated against the baseline concept as developed by the project team, or the Ultimate improvement plan. Please keep in mind that based on project status, these design suggestions are iterative in nature and may likely cause project costs to rise, but at the same time will help improve the overall project value.

The recommendations developed by the Value Planning Team are shown in Table 4 and are detailed in the Development Phase section of this report. A cost impact for each recommendation and the probability of implementation of these recommendations is also provided. These recommendations show what the team developed over the course of the workshop and will allow project manager's a preliminary risk management plan to help improve the project, limit the impacts to mobility, and save cost. These recommendations are a starting point of incorporation of a Value Engineering and Risk Management Plan. These recommendations may or may not advance based on project circumstances but will provide the cornerstone to ensuring the project advances successfully.

Table 4: List of Recommendations

#	Description	Value ($M)	Probability of Implementation
1	Bridge Lengths	-7.4	90%
2	Remove 3rd Street Bridge	-0.7	75%
3	Accelerated Bridge Const. (ABC)	NQ	
4	Reverse Ramps	5.3	75%
5	Walls at Frontage Roads	12.8	
6	Roadway Width	8.1	
7	Maintenance of Traffic (MOT)	-12.5	60%

To facilitate implementation, a Value Engineering Recommendation Approval Form is included as Appendix. If the Agency elects to reject or modify a recommendation, please include a brief explanation of why.

Decision Support

The team has developed the following list of current alternatives proposed for the corridor. Again, the team analyzed both the Near Term improvements versus the Ultimate improvements and made recommendations based on accommodations for the Ultimate Configuration. The alternatives analyzed at the time of the workshop include:

1. **Near Term - Auxiliary Lanes with shoulder widening and existing structure widening)**
    a. Construction Duration: 18 to 20 months scheduled for completion in 2019
    b. Status – 15% design
    c. Base Cost Estimate: $45.9 million (2016 $) and $48.2 million (YOE)
    d. Risk Adjusted Cost Estimate (post-response): $66.2 million (2016 $) and $70.7 million (YOE)

Keep in mind that the majority of the project improvements proposed for the corridor in the Near Term plan will be replaced with the improvements proposed for the Ultimate plan (walls, existing structure widening, drainage improvements, etc.). The team believes that eliminating the Near Term project and replacing it with the Ultimate improvement project, with or without HOV lanes, will utilize funding more appropriately and better meet the Ultimate needs of the corridor.

2. **Ultimate Configuration – Value Planning**
    a. Construction Duration: 24 to 36 months scheduled for completion in 2022
    b. Status: 0% design
    c. Base Cost Estimate: $195.8 million (2016 $) and $213 million (YOE)
    d. Risk Adjusted Cost Estimate (post-response): $210.4 million (2016 $) and $231.1 million (YOE).

As the workshop progressed, the team also evaluated the addition of the HOV lanes through the project corridor. While the ultimate configuration described above does provide the accommodations for the HOV lanes in the future, it does not include the costs associated with HOV lane construction. This alternative is described below.

3. **Ultimate Configuration (with HOV lanes) – Value Planning**
    a. Construction Duration: 36 months scheduled for completion in 2022
    b. Current Status: 0% design
    c. Risk Adjusted Cost Estimate: $232 million @ the 70th percentile confidence level (2016 $)

The Team wishes to express its appreciation to the project design team and management for the excellent support they provided during the study. These value planning recommendations and other design considerations provided will assist in the management decisions necessary to move the project forward.

Ken L. Smith, PE, CVS®
Risk Lead and Value Planning Team Lead

Introduction

This report summarizes the events of the Cost Risk Assessment (CRA) Workshop and Value Planning Study conducted for the Maricopa Association of Governments (MAG), facilitated by HDR Engineering, Inc. The subject of the study was the I-17: I-10 Split to 19th Avenue Project.

Project Description

The primary need for the project is to provide auxiliary lanes, add capacity, develop standard shoulder widths, and meet overcrossing geometric standards and clearance requirements along the I-17 corridor between the I-10 Split and 19th Avenue. The Near Term project adds the auxiliary lanes and widens the existing roadway with the construction of new walls and modifications to the existing bridge structures. Ultimate plans are to raise the profile at the overcrossing locations, build new overcrossing structures, and widen the freeway to accommodate standard shoulder widths and add additional lane capacity. It was identified during the value planning study that HOV lanes are anticipated to be added to the corridor in the future as well.

Near Term Improvements

The proposed near-term improvements would add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions of travel between 16th Street and 19th Avenue and would extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp. The Near Term project addresses a number of roadway deficiencies that include:

1. Narrow shoulder widths that do not meet current highway standards.
2. Short merge distances between on/off ramps and the general purpose lanes :

The Near Term project, or Near Term improvement plans, includes the addition of auxiliary lanes (merge lanes) between the I-10 Split Interchange and 19th Avenue. It also includes widening of existing structures to accommodate additional roadway width. Walls would be constructed near the limits, at or near the shoulder of the Near Term roadway design widths to support the elevated freeway section throughout the majority of the corridor. The estimated cost of this project at 15% design is $45 million. A direct cost comparison was developed to compare the Near Term project costs with the Ultimate costs. The cost data and risk analysis results for the Near Term project are provided in the Appendices.

Ultimate Improvements

The proposed Ultimate improvements, if the Near Term project was forgone, would also add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions of travel between 16th Street and 19th Avenue and extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp. The project will replace all structures and pavement and bring the roadway profile up at

overcrossing locations to meet current clearance standards. The Ultimate plans for the corridor include:

1. Raising of mainline profile to accommodate new structures at overcrossings to meet clearance requirements and geometric standards
2. Replace existing roadway, the majority of which is concrete placed along the mainline
3. Construct walls at frontage roads to accommodate additional mainline width

Other Ultimate developments include the addition of HOV lanes, one in each direction, throughout the length of the corridor.

Value Engineering Approach

Value Engineering has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that value analysis can play to improve project performance. To address this issue, a performance-based VE approach was used.

The primary objective of any VE study is to improve the value of the project. A simple way to think of value in terms of an equation is shown at right. While project costs are fairly easy to quantify and compare through traditional estimating techniques, performance is not so easily quantifiable.

$$Value = \frac{Performance}{Cost}$$

The use of performance measures provides the cornerstone of the performance-based VE process by giving a systematic and structured way of considering the relationship of a project's performance and cost as it relates to value. Project performance must be properly defined and agreed on by the stakeholders at the beginning of the VE study. The performance attributes and requirements that are developed are then used throughout the study to identify, evaluate, and document alternatives.

The application of performance-based VE consists of the following steps:

1) Identify key project (scope and delivery) performance attributes and requirements for the project
2) Establish the hierarchy and impact of these attributes on the project
3) Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts
4) Identify the change in performance of alternative project concepts generated by the study
5) Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement.

The following are the key project performance attributes that were used in this VE study:

- Mainline Operations
- Local Operations
- Maintainability

- Construction Impacts
- Environmental Impacts
- Project Schedule

A detailed definition of the performance attributes can be found in the 'Performance Attribute' section of this report.

Scope of the CRA and Value Planning Study

The scope of the workshops was to verify or improve upon the concepts being proposed for I-17: I-10 Split to 19th Avenue Corridor.

To accomplish this, the CRA & Value Planning Teams:

- Applied the principles and practices of the VE Job Plan (see Appendix)
- Conducted a thorough review and analysis of the key project issues using a multidiscipline, cross-functional team (i.e. review the baseline design)
- Verified or improved upon the various concepts for the project
- Improved the value of the project through innovative measures aimed at improving the performance while reducing costs
- Identified high risk areas in delivering the project
- Performed a cost risk assessment on both the baseline design and the Value Planning recommended design

CRA and Value Planning Study Timing

The timing of the study was based on a 15% design for the Near Term improvement plan proposed for the project. The cost risk assessment workshop was held at the MAG building downtown Phoenix from January 25-26, 2016. The Value Planning portion of the study was held February 8-10, 2016. The presentation of findings for both workshops was held February 11, 2016.

CRA and Value Planning Team Members

The list of team members who participated in the study, either the CRA or Value Planning session, is provided in Table 5. Other attendees and their documented participation during the study are listed on the sign-in sheets provided in the Appendix.

Table 5: CRA & Value Planning Team Members

Name	Organization	Position/Discipline
Ken Smith	HDR	Risk/Value Planning Lead
Suresh Raghavendra	HDR	Workshop Assistant
Chaun Hill	MAG	Senior Transportation Engineer
Quinn Castro	MAG	Transportation
Trent Eakin	HDR	SME/Modeler
John Misik	HDR	Structures
Brian Bombardier	HDR	Interchange Design

Table 5: CRA & Value Planning Team Members

Name	Organization	Position/Discipline
Dave Moody	MAG	Associate
Madhu Reddy	ADOT	District Engineer – Central District
Kole Dea	ADOT	Resident Engineer – Central District
Bob Hazlett	MAG	Senior Engineering Manager
Trent Kelso	ADOT	Engineering Manager
Dale Drost	ADOT CD	Maintenance
Mustafa Muradvich	ADOT EP	Environmental Planner
John Louis	PB	Senior Engineer
Matt Tolman	ADOT	ROW/CPA Liaison
Dave Edwards	ADOT	R/W
Thomas O'Reilly	PB	Project Manager
Eric Prosnier	ADOT	Project Manager
Don Smith	PB	Environmental Manager
Abhishek Dayal	Valley Metro	Manager of Capital Development
Glenn Gaelick	ADOT	Roadway
Gary Sun	PB	Drainage
Maurice Goyette	COP	Light Rail Coordinator
Scott Gehrke	Valley Metro	Transit Engineer
Scott Miller	Valley Metro	Transit Planner
William Downes	ADOT	Bridge Group
Aryan Lirange	FHWA	
Rados Gluscevic	ADOT	Traffic Group
David Benton	ADOT	Bridge Engineer

Figure 1: CRA Team

Figure 2: Value Planning Team

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Information Phase

Summary of Analysis

The following analysis tools were used to study the project:

- Information provided to the CRA and Value Planning Team
- Constraints and Controlling Decisions
- Investigation Observations
- Base Cost Review
- Cost Model
- Uncertainty
- Project Schedule Review
- Project Escalation Assumptions
- Performance Attributes
- Performance Attribute Matrix
- Function Analysis
- FAST Diagram

Constraints and Controlling Decisions

As part of the project briefing, the CRA and Value Planning Teams were given the following project constraints and controlling factors when considering alternatives:

- Limit ROW impacts
- Utilize value planning with a Value Engineering Approach to develop best overall project concept strategies
- Develop preliminary planning and design concepts to guide the planning team as the project advances.

Investigation Observations

The first day of the CRA workshop study included a presentation from the Project Team. The following summarizes key project issues, project drivers and observations identified during the session.

- Project needs:
  - Maintenance of traffic
  - Future capacity for I-17 corridor
  - Address geometric deficiencies
  - Alternatives consistent with local development
  - Meet regulatory requirements for the corridor
- R/W requirements:
  - Limit ROW impacts as much as possible
- Funding:
  - This project currently has funding available, both for the Near Term and for the ultimate configurations

Base Cost Review

One of the objectives of a cost risk assessment is to review the base cost estimate in a collaborative setting with independent expert opinion and Project Team members. The base cost estimate represents the project cost that can reasonably be expected if the project materializes as planned, and there is no occurrence of significant risk.

A base cost estimate is unbiased and neutral - it is neither optimistic nor conservative. The base cost includes the known and quantified items and the known but not yet quantified items or miscellaneous item allowances. The base cost estimate does not include any risks (either threats or opportunities), unknown/unknowns, or contingencies. Table 6 provides a list of major items for the Ultimate Project configuration base costs. Table 7 shows the 'other items' or below the line items used for base costs.

Table 6: Ultimate Cost Estimate

Major Items	Cost	% of Project[1]
CONTRACTOR QUALITY CONTROL	$2,020,600	1.1%
CONTRACTOR SURVEYING	$2,020,600	1.1%
ROADSIDE DEVELOPMENT	$2,940,100	1.6%
ROADWAY APPURTENANCES ($1M/MILE)	$3,570,000	1.9%
DRAINAGE	$4,869,375	2.6%
OTHER ITEMS	$5,842,000	3.2%
CONSTRUCTION CONTINGENCIES	$7,092,300	3.8%
MOBILIZATION	$8,405,600	4.6%
EARTHWORK	$9,176,000	5.0%
CONSTRUCTION ENGINEERING	$12,766,000	6.9%
BASE AND SURFACE TREATMENT	$13,912,500	7.5%
PRELIM/FINAL DESIGN	$16,754,500	9.1%
STRUCTURES	$18,474,000	10.0%
MOT & TRAFFIC	$22,193,100	12.0%
WALLS - NOISE AND RETAINING	$25,893,400	14.0%

[1]Percentage based on total raw construction cost, excluding miscellaneous item allowance and below the line items.

Table 7: Ultimate Cost Estimate – Other Items	
MISCELLANEOUS ITEM ALLOWANCE	$27,908,852
PRELIM/FINAL DESIGN (10% of total)	$14,847,509
CONSTRUCTION ENGINEERING (9% of total)	$10,047,187
PRIOR RIGHT UTILITY RELOCATION & SERVICE AGREEMENTS ($1M/Mile)	$3,570,000
ICAP (10.35%)	$18,365,018

During the workshop, adjustments were made to the base cost estimate as additional information was acquired and more knowledge of the project was obtained. The base cost review results for this project are located within the Appendix of this report. All construction contingency estimate amounts were removed in the base costs and added in as risk items.

Cost Model

The CRA and Value Planning Team Leader prepared a cost model from the cost estimate developed by the team. The cost model is organized to identify major construction elements or trade categories (risk and miscellaneous categories are omitted in the chart), and the percent of total project cost for the significant cost items.

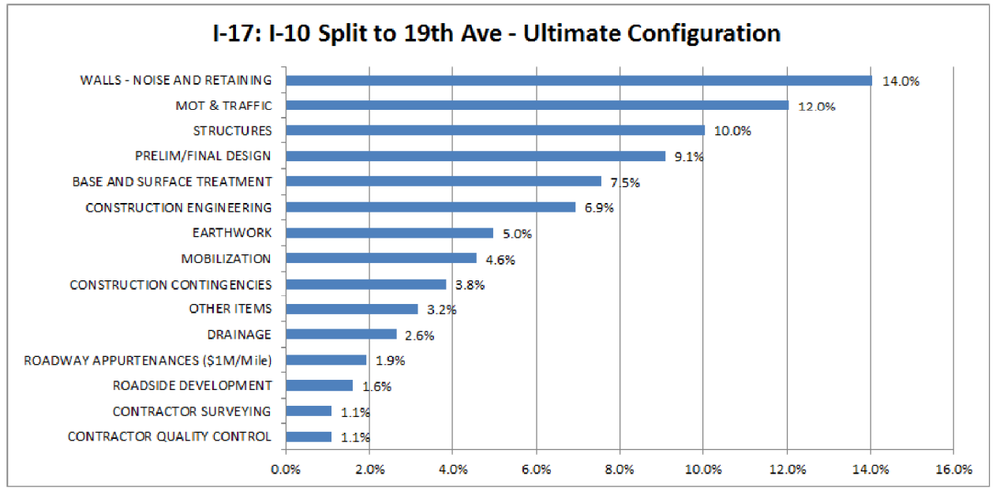

Figure 3: Ultimate Project Cost Model

The most significant cost for the project is attributed to wall construction to accommodate mainline widening followed by costs for maintenance of traffic. Structures, excluding walls, come in as the third highest cost. This chart omits the miscellaneous item category to provide more clarity as miscellaneous items are a 'group' of costs not related to one individual cost

category. This breakdown appears legitimate based on the type of project and the high level of impacts to mobility expected from construction.

Uncertainty

Estimating is not an exact science; a cost estimate is an approximation of the costs comprised of many elements that may not be completely or equally defined at the time the estimate is prepared. As a result, there is variability or uncertainty associated with any estimate. When applied to the project estimate, this uncertainty establishes the range that the base cost could fall within. A numerical value of uncertainty is, in essence, an estimate of the error or tolerance within the quantity and/or unit price of each item within the estimate.

For any given project, the level of uncertainty is directly related to its position in the project life cycle (i.e., the earlier in the project development process, the greater the uncertainty; conversely, the closer to completion, the less uncertainty).

In establishing the uncertainty ranges for each item, consideration was given to factors that might affect quantities or bid prices, such as project location (rural vs. urban), quantities (large or small), items that are difficult to construct or site constraints, methods of payments, timing of advertisement, specialty work, geotechnical and project delivery methods.

Uncertainty was established for the base cost estimate based upon all the available information at the time of the workshop. Doing this established an uncertainty or variability in the overall base cost estimate with a range of -15.4% of the base cost on the low side, or 17.5% above the base cost on the high side. This range was used in the model to simulate a range of typical costs seen on a bid. Table 8 illustrates the low, most likely, and high base estimate range values and the percentage below or above the most likely estimate value.

Table 8: Ultimate Baseline Estimate Uncertainty Range		
Low	Most Likely	High
$165,747,591	**$195,804,804**	**$230,151,067**
-15.4%		17.5%

Project Schedule Review

A preliminary schedule was developed to provide a date range for known project activities and milestones including environmental, design, utility and construction activities. These activities, provided in the below, are then cost loaded to allow the risks to impact a specific activity that will either lengthen or reduce the baseline schedule. This provides a more reasonable cost outcome based on risk impacts that carry schedule impacts. The activities and the amounts cost loaded into each are provided in the tables below. The preliminary schedule was reviewed by the entire team and updated as necessary throughout the workshop. Table 9 shows the activities and their estimated start and end dates. Table 10 portrays the amount allocated to each individual schedule activity, or the 'Cost Loaded' activity. Please see the Appendix for the flowchart activity diagram for an illustration of the project schedule.

Table 9: Project Activity Ultimate Baseline Schedule			
Activity ID	**Activity Name**	**Start Date**	**End Date**
300	Environmental	4/1/16	4/1/17
310	Preliminary Design	4/1/16	4/1/17
320	Final Design	4/1/17	4/1/18
400	Right-of-Way	4/1/17	4/1/18
500	Utilities	4/1/17	4/1/18
330	Procurement	4/1/18	8/1/18
510	Construction	8/1/18	8/1/21
520	Project Completion	8/1/21	8/1/21

Table 10: Cost Loaded Ultimate Schedule Activities				
Activity ID	**Activity Name**	**Cost**		
		Low	**Base**	**High**
001	Costs Spent to Date[1]	----	----	----
300	Environmental (Ultimate)	$693,137	$819,211	$960,547
310	Preliminary Design (Ultimate)	$2,633,921	$3,113,003	$3,650,078
320	Final Design (Ultimate)	$10,397,058	$12,288,170	$14,408,202
330	Procurement (Ultimate)	$138,627	$163,842	$ 192,109
400	Right of Way (Ultimate)	$0	$0	$0
500	Utilities (Ultimate)	$3,545,546	$3,939,495	$4,727,394
510	Construction	$148,339,301	$175,481,083	$206,212,738
	TOTAL	**$165,747,591**	**$195,804,804**	**$230,151,067**

[1]No assumed costs spent to date based on current level of design for the ultimate project

The baseline completion date for the Ultimate configuration is August 2021. The cost range, based on bid item uncertainty is between $165 million and $230 million in 2016 dollars, with a base cost of $195.8 million. Cost and risk loaded activity schedule model results are provide in the 'Analysis of Results' section of this report.

Project Escalation Assumptions

To account for increases in prices between the date the base cost estimate was created and when the actual work will be performed, the model for this project includes escalation rates

forecast for construction, preliminary engineering and right-of-way costs. Table 11 lists the annual escalation rates for construction, pre-construction, and right-of-way.

Table 11: Escalation Rates			
Year	**Construction Escalation Rate**	**Pre-Construction Escalation Rate**	**Right of Way Escalation Rate**
2015	1.83%	3.06%	3.54%
2016	2.04%	3.61%	3.69%
2017	2.27%	3.81%	3.50%
2018	2.30%	4.36%	3.33%
2019	2.27%	4.41%	3.50%
2020	2.27%	3.54%	2.89%
2021	2.27%	4.27%	3.25%
2022	2.27%	3.31%	3.03%
2023	2.44%	2.36%	2.80%
2024	2.61%	2.36%	2.80%
2025	2.61%	2.36%	2.80%
2026	2.61%	2.36%	2.80%
2027	2.61%	2.36%	2.80%
2028	2.59%	2.36%	2.80%
2029	2.56%	2.36%	2.80%
2030	2.56%	2.36%	2.80%
2031	2.56%	2.36%	2.80%

Performance Attributes

Performance attributes are an integral part of the value analysis process. The performance of each project must be properly defined and agreed upon by the Project Team, Value Planning Team, and stakeholders at the beginning of the each study. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

Performance attributes can generally be divided between project scope components (mainline operations, environmental impacts, maintainability, etc.) and project delivery components. It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory and binary in nature. All performance requirements MUST be met by any VE recommendation being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives could be acceptable that had different durations.

The Value Planning Team, along with the Project Team, identified and defined the performance attributes for this project and then defined the baseline concept as it pertains to these attributes. The following performance attributes shown in Table 12 were used throughout the study to identify, evaluate, and document ideas and recommendations.

Table 12: Performance Attributes

Performance Attribute	Definition	Baseline
Mainline Operations	An assessment of traffic operations and safety on I-17 within the project limits. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance and lane and shoulder widths.	3-12' through lanes, 12' inside shoulder, 12' aux lane, 12 outside shoulder each direction, X ramps for 7th St, 7th Ave, half at 16th St and half at 19th Ave. Two lane one way frontage roads dropping to one lane in vicinity of ramps
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure (cross streets). Operational considerations include level of service relative to the 20-year traffic projections; geometric considerations such as design speed, sight distance, lane and shoulder widths; bicycle and pedestrian operations and access.	Cross streets at 19th Ave, 15th Ave, 11th Ave, 7th Ave, Central Ave, 7th St, and 16th St. Structures 60' longer than current bridges.
Maintainability	An assessment of the long-term maintainability of the facility. Maintenance considerations include the overall durability, longevity, and maintainability of structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel, including sediment and debris removal.	Concrete pavement, with ACFC on I-17 concrete ramps and no repaving of exiting frontage roads. All bridges re-constructed with AASHTO girders
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access, visual effects, noise, vibration, dust, and construction traffic; environmental impacts.	Staged construction maintaining two lanes in each direction
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts; impacts to cultural, recreational and historic resources.	Minimal or no Environmental impacts
Project Schedule	An assessment of activities to determine if construction can be completed within the baseline schedule duration.	36 months of construction

Function Analysis

Function analysis results in a unique view of the project. It transforms project elements into functions, which moves the CRA and Value Planning Team mentally away from the original design and takes it toward a function view of the project.

Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level. Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions. The major functions identified by the team are shown in Table 13.

Table 13: Functions

Component	Verb	Noun
Roadway	Span	Roadway
Roadway	Widen	Roadway
MOT	Maintain	Traffic
Stakeholders	Reduce	Risk
MOT	Reduce	Conflict

FAST Diagram

The Function Analysis System Technique or FAST diagram arranges the functions in logical order so that when read from left to right; the functions answer the question “How?” If the diagram is read from right to left, the functions answer the question “Why?” Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column.

The FAST Diagram for this project shows “Reduce Conflicts” and “Improve Mobility” as the basic functions of this project. Key secondary functions included Widen Roadway and Span Roadway. This provided the Value Planning Team with an understanding of the project design rationale and which functions offer the best opportunity for cost or performance improvement.

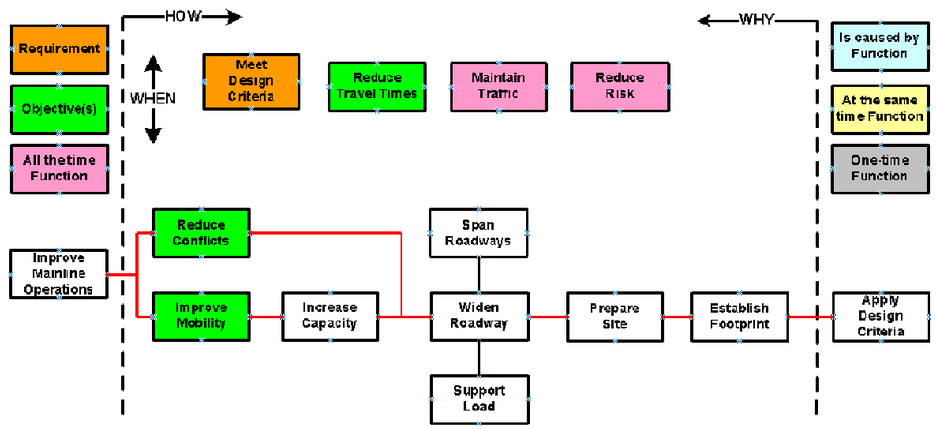

Figure 4: FAST Diagram

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Creative Phase

During the Creative Phase of the VE Job Plan, the Value Planning Team brainstormed ideas on how to achieve the various functions. These ideas were based on the available information given to them at the time of the study, taking into consideration the constraints and controlling decisions that were also defined for them. The ideas listed below coincide with each function being considered:

Creative Idea List

Function: Span Roadway

- Precast panels for the bridge deck
- Precast box beams
- 3-span structures with sidewalks on the end spans
- Use ABC construction
- Maintain/reduce 16th St bridge length
- Single span 16th St bridge for constructability
- Adjust HT power lane over I-17 in the vicinity of the 16th St bridge
- Eliminate the pedestrian crossing at 12th st
- Replace the pedestrian crossing at 12th st
- Single span 7th St bridge for constructability
- Remove 3rd St bridge
- Lower the mainline profile at 3rd St
- Convert Central Avenue to 2-span
- Maintain/reduce 7th Avenue bridge length
- Single span 7th Avenue bridge for constructability
- Do not replace 11th Avenue bridge
- Maintain/reduce 11th Avenue bridge length
- Replace only the bridge superstructure and widen as needed
- Lengthen 7th Avenue ramps (west side) and widen 11th Avenue bridge
- Single span 15th Avenue bridge for constructability
- Maintain/reduce 15th Avenue bridge length
- Adjust HT power lane over I-17 in the vicinity of the 19th Avenue bridge
- Close 7th Avenue west side ramps and add west side ramps at 19th Avenue
- Reverse the ramps between 7th Avenue and 19th Avenue

Function: Widen Roadway

- Maintain substandard shoulders (existing 7 feet and 10 feet)
- Use 10-foot inside and outside shoulders
- Use 14-foot inside and outside shoulders
- Do not use ARFC
- Use full depth asphalt on the mainline
- One-lane frontage roads in each direction

Function: Maintain Traffic

- Close entire section of the I-17 mainline (after opening of South Mountain)
- Add ramps east of 16th St and northbound on-ramp west of 19th Avenue and utilize frontage roads as detours; restripe frontage roads to 2 lanes
- Reversible mainline lanes; build half the freeway in one stage
- Median crossover with temporary widening; move traffic to one side and build half the freeway in one stage; this may require closing of existing ramps and adding temporary ramps
- Eliminate all on and off ramps during construction
- Eliminate every other on and off ramp during construction
- Permanently shift the alignment and build half the freeway at a time
- Hazardous material detour on frontage roads; corridor closed to all other traffic
- Close one direction of the mainline at a time
- Maintain major crossroads open at all time
- Execute Central Avenue as a standalone project
- Phase the wall construction prior to impacts to I-17

Function: Reduce Risk

- Drainage
  - Peak discharge mitigation basins; water quality BMP's
  - Obtain permits for discharge to the river
- Walls
  - Build the footing for the ultimate wall height
  - Build the walls full height at the inside edge of the frontage roads
- ITS/FMS

Evaluation Phase

Although each project is different, the evaluation process for each value engineering effort can be thought of in its simplest form as a way of combining, evaluating, and narrowing ideas until the Value Engineering team agrees on the proposals to be forwarded.

Taking into consideration the constraints and controlling decisions, the team discussed each idea and documented the advantages and disadvantages. Each idea was then carefully evaluated with the Value Engineering Team reaching consensus on the overall rating of the idea (zero through five). High-rated ideas (four or higher) were developed further; those that were considered to be equivalent to the baseline (rated three) were documented as design considerations; and low-rated ones (two or lower) were dropped from further consideration; however, the team provided a short description and justification to support the low rating. The rating values are shown below:

5 = Great Opportunity
4 = Good Opportunity
3 = Design Consideration (comparable to project team's approach)
2 = Minor Value Degradation
1 = Major Value Degradation
0 = Fatal Flaw (unacceptable impact or doesn't meet the project purpose and need)

= Advanced as recommendation

= Forwarded as design consideration

= Dropped from future consideration

Function: Span Roadway

#	Description	Advantages	Disadvantages
SR-1	Precast panels for the bridge deck	▪ Reduces construction duration ▪ Eliminates deck forming ▪ May avoid closure during deck placement	▪ Still requires an overlay ▪ Could cost more ▪ Could have long term maintenance issues

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍		👍

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
SR-2	Precast box beams	▪ Lower profile ▪ Less Earthwork required for mainline ▪ Reduces construction duration ▪ Eliminates deck forming ▪ May avoid closure during deck placement	▪ Could cost more ▪ Limited span length ▪ Maybe limited suppliers ▪ Utilities across the bridge may be hard to accommodate

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👍		👍

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4.5	

#	Description	Advantages	Disadvantages
SR-3	3-span structures with sidewalks on the end spans	▪ Eliminates piers from local street ▪ Eliminates fixed objects from centerline ▪ May reduce girder depth ▪ May help with construction staging (built outside existing infrastructure)	▪ Adds more substructure cost ▪ Limits the crossroad section for future expansion ▪ Increases construction schedule

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👍		👍👎		👍👎

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-4	Use ABC construction	▪ Could reduce construction time	▪ Needs a site for offsite construction ▪ Complicated for design-bid-build ▪ Could cost more

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👍		👍

Cost:	*Justification/Comments: Depends on delivery method and site specific opportunity. Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-5	Maintain/reduce 16th St bridge length	▪ Current roadway is at its ultimate configuration ▪ Reduce cost for 60-foot of length ▪ Reduction in maintenance	▪ Constrain future widening of 16th St ▪ May conflict with existing abutments

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍	👎		👍

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
SR-6	Single span 16th St bridge for constructability	▪ Removes centerline pier	▪ May increase girder depth

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👍	👍	👍		👍

Cost:	*Justification/Comments: This idea was moved forward for further development and combine with SR-5*
Rating: 4	

#	Description	Advantages	Disadvantages
SR-7	Adjust HT power line over I-17 in the vicinity of the 16th St bridge	▪ Provides vertical clearance	▪ None noted

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Assumes in base cost*
Rating:	

#	Description	Advantages	Disadvantages
SR-8	Eliminate the pedestrian crossing at 12th St	▪ Could reduce cost ▪ Land use compatible ▪ Reduces maintenance	▪ Added cost for removal

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍	👎		👎

Cost:	*Justification/Comments: Not in the base cost for removal. Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-9	Replace the pedestrian crossing at 12th St.	▪	▪ Costs more ▪ May not be warranted

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👎		👎

Cost:	*Justification/Comments: Dropped for further consideration.*
Rating: 1	

#	Description	Advantages	Disadvantages
SR-10	Single span 7th St bridge for constructability	▪ Removes centerline pier	▪ May increase girder depth ▪ May require steel girders ▪ May increase costs

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍		👍

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-11	Remove 3rd St bridge	▪ Reduces cost ▪ Reduces construction duration ▪ May help lower the I-17 profile and flatten the ramp grade	▪ Could lead to pedestrian crossing concerns

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍	👍		👍

Cost:	*Justification/Comments: Base assumes box culvert for pedestrian crossing. This idea was moved forward for further development.*
Rating: 4.5	

#	Description	Advantages	Disadvantages
SR-12	Lower the mainline profile at 3rd St	▪	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Assumes part of the base*
Rating:	

#	Description	Advantages	Disadvantages
SR-13	Convert Central Avenue to 2-span	▪	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This is the baseline*
Rating:	

#	Description	Advantages	Disadvantages
SR-14	Maintain/reduce 7th Avenue bridge length	▪ Reduce cost for 40-foot of length ▪ Reduction in maintenance	▪ May constrain future widening of 7th Avenue

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍			

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1.5	

#	Description	Advantages	Disadvantages
SR-15	Single span 7th Avenue bridge for constructability	▪ Removes centerline pier	▪ May increase girder depth ▪ May require steel girders ▪ May increase costs

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👍	👍	👍👎		

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
SR-16	Do not replace 11th Avenue bridge (Widen only)	▪ Reduces cost	▪ Vertical clearance issues with railroad ▪ May decrease sight distance

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👎	👍		👍

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 2	

#	Description	Advantages	Disadvantages
SR-17	Maintain/reduce 11th Avenue bridge length	▪ Reduction in maintenance	▪ May constrain future widening of 11th Avenue ▪ Decreases sight distance

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍	👍		

Cost:	*Justification/Comments: Considered skewed abutments to improve sight distance. Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-18	Replace only the bridge superstructure and widen as needed at 11th Avenue.	▪ Reduces cost	▪ Decreased sight distance ▪ May constrain future widening of 11th Avenue

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👎			

Cost:	*Justification/Comments: Raise the superstructure on the existing substructure. This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
SR-19	Lengthen 7th Avenue ramps (west side) and widen 11th Avenue bridge	▪ Flattens the 7th Avenue west side ramps	▪ Will result in a wider 11th Avenue bridge ▪ Will add cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍		👍👎		👍	

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4.5	

#	Description	Advantages	Disadvantages
SR-20	Single span 15th Avenue bridge for constructability	▪ Removes centerline pier	▪ May increase girder depth ▪ May increase costs ▪ May not improve sight distance issues

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👍	👍	👍		

Cost:	*Justification/Comments: Might reduce span length. This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
SR-21	Maintain/reduce 15th Avenue bridge length	▪ Reduction in maintenance ▪ May reduce cost ▪ May reduce structure depth	▪ May constrain future widening of 15th Avenue ▪ Decreases sight distance

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍			

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-22	Adjust HT power line over I-17 in the vicinity of the 19th Avenue bridge	▪ Constructability of the structure	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
SR-23	Close 7th Avenue west side ramps and add west side ramps at 19th Avenue	▪ Eliminates substandard profiles of the 7th Avenue west side ramps ▪ May eliminate the NB aux lane requirement between 7th Avenue and 19th Avenue ▪ May provide the ability to shift the 19th Avenue east side ramps further east	▪ Requires a change of access report ▪ Adds through traffic through 15th and 19th Avenues ▪ May have ROW impacts ▪ May require signal at 15th Avenue

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👍👎	👍	👍	👎	

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
SR-24	Reverse the ramps between 7th Avenue and 19th Avenue.	▪ Eliminates substandard profiles of the 7th Avenue west side ramps ▪ May eliminate aux lanes requirement between 7th Avenue and 19th Avenue	▪ Requires a change of access report ▪ Adds through traffic through 15th and 11th Avenues ▪ May have ROW impacts ▪ May require signal at 15th Avenue and possibly 11th Avenue

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👍👎	👍	👍	👎	

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

Function: Widen Roadway

#	Description	Advantages	Disadvantages
WR-1	Maintain substandard shoulders (existing 7 feet and 10 feet)	▪ Reduces cost	▪ Will result in walls in the wrong location ▪ Non-standard shoulder widths ▪ FHWA might not support

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎					

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1	

#	Description	Advantages	Disadvantages
WR-2	Use 10-foot inside and outside shoulders	▪ Reduces 4 feet of width ▪ Lower cost	▪ Requires ADOT design exception ▪ May have an impact on incident management

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎					

Cost:	*Justification/Comments: Meets AASHTO minimum but not ADOT standards. This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
WR-3	Use 14-foot inside and outside shoulders	▪ Could allow for future restriping to accommodate an extra lane ▪ Extra width for maintenance	▪ Extra width to maintain ▪ Added cost ▪ Wider shoulders could be perceived as a travel lane ▪ May have ROW impacts

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍		👍👎		👎	

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
WR-4	Do not use ARFC	▪ Reduced cost ▪ Reduces repaving requirement (frequency) ▪ May shorten construction schedule	▪ Road noise

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍👎		👎	👍

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 2	

#	Description	Advantages	Disadvantages
WR-5	Use full depth asphalt on the mainline	▪ May have additional flexibility on construction staging	▪ High truck percentage ▪ Increased paving cycles

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍		👍

Cost:	*Justification/Comments: Dropped from further consideration*
Rating: 1	

#	Description	Advantages	Disadvantages
WR-6	One-lane frontage roads in each direction	▪ Provides more width for mainline widening	▪ Extra width may not be required ▪ May impact incident management

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎					

Cost:	*Justification/Comments: Dropped from further consideration*
Rating: 2	

Function: Maintain Traffic

#	Description	Advantages	Disadvantages
MT-1	Close the entire section of I-17 mainline (after opening of South Mountain)	▪ May reduce 12 months of construction time	▪ No viable HAZMAT detour route for the I-10 tunnel ▪ May require temporary ramps to access frontage roads ▪ Requires an extensive public outreach campaign

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎		👎	👎	👍

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
MT-2	Add ramps east of 16th St and northbound on-ramp west of 19th Avenue and utilize frontage roads as detours; restripe frontage roads to 2 lanes	▪ Opens the freeway up for construction ▪ May reduce construction time	▪ May require temporary easements and paving ▪ May require temporary signals and revised signal timing at the crossroads

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👎	👎	👍

Cost:	*Justification/Comments: Coordination with Valley Metro's South Central Extension project. This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
MT-3	Reversible mainline lanes; build half the freeway in one stage	▪ None noted	▪ Will result in left hand access ramps ▪ Will require resigning and re-signaling ▪ No directional traffic split

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Dropped from further consideration*
Rating: 1	

#	Description	Advantages	Disadvantages
MT-4	Median crossover with temporary widening; move traffic to one side and build half the freeway in one stage; this may require closing of existing ramps and adding temporary ramps	▪ Opens up half of the freeway for construction ▪ Maintains traffic on the freeway and the frontage roads ▪ May reduce construction time	▪ May require temporary bridge widening ▪ May impact existing signal systems

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Temporary widening of the bridges can be done as a separate 2-lane wide structure. This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
MT-5	Eliminate all on and off ramps during construction	▪ Less temporary ramps required ▪ Less conflict points during construction	▪ May add a lot of traffic on the frontage roads and the arterial grid

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Combine with other ideas. This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
MT-6	Eliminate every other on and off ramp during construction	▪ This is currently allowed	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
MT-7	Permanently shift the alignment and build half the freeway at a time	▪ Opens up half the freeway for construction	▪ Eliminate a frontage road ▪ ROW impacts ▪ May add cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Dropped from further consideration*
Rating: 2	

#	Description	Advantages	Disadvantages
MT-8	Hazardous material detour on frontage roads; corridor closed to all other traffic	▪ Allows a viable detour for hazardous material	▪ Hard to enforce ▪ Public relations issues/concerns

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Similar to MT-1. Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
MT-9	Maintain major crossroads open at all time	▪	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This is the baseline*
Rating:	

#	Description	Advantages	Disadvantages
MT-10	Execute Central Avenue as a standalone project	▪ Accommodates Valley Metro schedule	▪ Might extend the construction staging of the I-17 corridor

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Only consider if this project doesn't move forward as planned. Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
MT-11	Phase the wall construction prior to impacts to I-17	▪ Minimizes impacts to I-17	▪ Could have major impacts on the Frontage Roads

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 3.5	

Function: Reduce Risk

#	Description	Advantages	Disadvantages
RR-1	Drainage 1: Peak discharge mitigation basins; water quality BMP's	▪	▪ May require ROW

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This is the baseline condition*
Rating:	

#	Description	Advantages	Disadvantages
RR-2	Obtain permits for discharge to the river	▪	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This is the baseline condition*
Rating:	

#	Description	Advantages	Disadvantages
RR-3	Build the footing for the ultimate wall height	▪ Reduce throw away ▪ Allows future flexibility for expansion	▪ Wall might still not be in the right place, horizontally ▪ Still needs an assumption for ultimate wall height ▪ May increase cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

#	Description	Advantages	Disadvantages
RR-4	Build the walls full height at the inside edge of the frontage roads	▪ Provides flexibility for future widening	▪ May increase cost ▪ May have ROW impacts with frontage road realignment ▪ Construction impacts to the frontage roads

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This idea was moved forward for further development.*
Rating: 4	

Development Phase

The VE recommendations are presented as written by the team during the Value Planning Study. While they have been edited from the CRA & Value Planning Report to correct errors or better clarify the recommendation, they represent the Value Planning Team's findings during the study. Table 14 provides a summary of all recommendations generated and their potential cost impact to the project.

Table 14: Summary of Recommendations

#	Description	Value ($M)	Probability of Implementation
1	Bridge Lengths	-7.4	90%
2	Remove 3rd Street Bridge	-0.7	75%
3	Accelerated Bridge Const. (ABC)	NQ	
4	Reverse Ramps	5.3	75%
5	Walls at Frontage Roads	12.8	
6	Roadway Width	8.1	
7	Maintenance of Traffic (MOT)	-12.5	60%

The cost comparisons reflect a difference or delta between the baseline idea and the VE recommendation. As the project progresses, these values can be updated to reflect actual implemented results.

FHWA Function Benefit Criteria

Each year, State Department of Transportation (DOT) offices are required to report on VE Recommendations to the Federal Highway Administration (FHWA). In addition to cost implications, FHWA requires the DOTs to evaluate each approved recommendation in terms of the project feature or features that recommendation benefits. If a specific recommendation can be shown to provide benefit to more than one feature described below, count the recommendation in *each category that is applicable*. These same criteria can be found on each of the individual recommendations that follow.

- **Safety:** Recommendations that mitigate or reduce hazards on the facility.
- **Operations:** Recommendations that improve real-time service and/or local, corridor, or regional levels of service of the facility.
- **Environment:** Recommendations that successfully avoid or mitigate impacts to natural and or cultural resources.
- **Construction:** Recommendations that improve work zone conditions, or expedite the project delivery.
- **Right-of-Way:** Recommendations that can be categorized as any impacts to base design right-of-way conditions.

Value Engineering Recommendation Approval

The VE Recommendation form is to aid in annual reporting of VE activities to FHWA. It is the intent that the project manager review and evaluate the report. The Project Manager would then complete the Recommendation Approval form shown in the Appendix.

Each recommendation that is not approved or is modified by the Project Manager should include a justification (a summary statement containing the Project Manager's decision not to use the recommendation in the project).

The completed Value Engineering Recommendation Approval form, including justification for any recommendations not approved or modified, shall be sent to the Program Manager so the results can be included in the annual VE Report to FHWA.

Recommendations

Based on the evaluation process, individual recommendations were developed. Each recommendation consists of a summary of the original concept, a description of the suggested change, a listing of its advantages and disadvantages, and a brief narrative that includes justification, sketches, photos, assumptions and calculations (where applicable) as developed by the Team.

VP RECOMMENDATION No. 01
BRIDGE LENGTH

Function: Span Roadway	**IDEA NO(s).SR-5, SR-6, SR-10, SR-14, SR-15, SR-20, SR-21**

Baseline:

- The baseline design assumes adding 30 feet of span length (total span length of 60 feet) to each side of the cross street to accommodate future needs of the existing street facility.
- The baseline design assumes the new bridges have the same number of spans as the existing bridges.

Recommendation:

- Maintain / reduce bridge length based on specific needs of each cross street.
- Look at a single span option at 16th Street, 7th Street, 7th Avenue and 15th Avenue.
- Look at 2-span option for Central Avenue Bridge to accommodate Valley Metro and reduce structure depth.

Advantages:	**Disadvantages**
♦ Current roadway is at its ultimate configuration	♦ Constrain future widening of cross street
♦ Reduce cost from 60-foot base line cost	♦ May conflict with existing abutments
♦ Reduction in maintenance	♦ Increases structure depth
♦ Remove pier where currently exists	

COST SUMMARY	**COST**
Baseline	**$17.7 M**
Recommendation	**$12.5 M**
Cost Savings	**$5.2 M + 42.4% markup = $7.4 M**

FHWA Functional Benefits

Safety	Operations	Environment	Construction	ROW
			✓	

VP RECOMMENDATION No. 01
BRIDGE LENGTH

Discussion/Justification/Sketches/Photos:

The following cross street classification (based on City of Phoenix Street Classification Map dated March 19, 2014) are assumed for this recommendation:

- 16th Street – Arterial
- 7th Street – Major Arterial
- Central Avenue – Arterial
- 7th Avenue – Arterial (assume a Major Arterial for this study)
- 15th Avenue – Minor Collector
- 19th Avenue - Major Arterial

The following cross street typical sections(based on City of Phoenix Street Classification Map (dated March 19, 2014) are assumed for this recommendation:

- Major Arterial - 3 through lanes, 2 left turn lanes, bike lane and sidewalk area in each direction for a total length of 130 feet.
- Arterial - 3 through lanes, 1 left turn lane, bike lane and sidewalk area in each direction for a total length of 110 feet.
- Minor Collector - 1 through lane, 1 left turn lane, bike lane and sidewalk area in each direction for a total length of 80 feet.

VP RECOMMENDATION No. 01
BRIDGE LENGTH

Assumptions and Calculations:

The following reduction in bridge length from the base estimate is assumed for this recommendation:

- 16th Street – Arterial 162' – 110' = 52', Assumed bridge width = 135'
  - Savings = 52' x 135' x 120/sq ft = $840,000
- 7th Street – Major Arterial 164' – 130' = 34', Assumed bridge width = 130'
  - Savings = 34' x 130' x 120/sq ft = $530,000
- Central Avenue – Arterial 185' – 110' = 75', Assumed bridge width = 152'
  - Savings = 75' x 152' x 120/sq ft = $1,360,000 (assume 2 span)
- 7th Avenue – Arterial (assume a Major Arterial for this study) 162 – 130' = 32', Assumed bridge width = 128'
  - Savings = 32' x 128' x 120/sq ft = $490,000
- 15th Avenue – Minor Collector 160' – 80' = 80', Assumed bridge width = 152'
  - Savings = 80' x 152' x 120/sq ft = $1,460,000
- 19th Avenue - Major Arterial 164' – 130' = 34', Assumed bridge width = 135'
  - Savings = 34' x 135' x 120/sq ft = $550,000

Total Savings = $5,230,000

VP RECOMMENDATION No. 02
Remove 3rd Street Bridge

Function: Span Roadway	**IDEA NO(s).** SR-11, SR-12

Baseline:

- The existing bridge at 3rd Street was originally spanning a railroad spur line. The spur line as since been abandoned and removed. The baseline design assumes the bridge is replaced with a reinforced box culvert to accommodate pedestrians.

Recommendation:

- Remove the pedestrian crossing and replace it with roadway embankment.
- The I-17 mainline profile grade was set to allow clearance over the railroad spur line. The revised use of the 3rd Street crossing allows lowering of the I-17 main line which improves the profile grade of the 7th Street ramps.

Advantages:

- Reduces cost
- Reduces construction duration
- May help lower the I-17 profile and flatten the ramp grade

Disadvantages

- Could lead to pedestrian crossing concerns

COST SUMMARY	COST
Baseline	**Not Quantified**
Recommendation	**Not Quantified**
Cost Savings	**$0.5 M + 42.4% markup = $0.7 M**

FHWA Functional Benefits

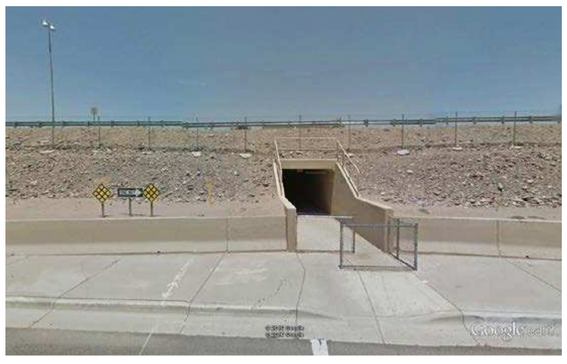
Safety	Operations	Environment	Construction	ROW
			✓	

VP RECOMMENDATION No. 02
Remove 3rd Street Bridge

Discussion/Justification/Sketches/Photos:

The existing crossing is a bridge over an abandoned rail line

The proposed pedestrian crossing is assumed to be a 10’ x 10’ reinforced box culvert with a length of 170 feet. Similar to what is shown below.



VP RECOMMENDATION No. 02
Remove 3rd Street Bridge

Assumptions and Calculations:

The unit cost of the box culvert is $60 / sq. ft.

- Remove 3rd Street pedestrian structure:
  - 10’ x 170’ x $60 / sq. ft. = $102,000
- Add roadway fill in place of box culvert:
  - (10’ x 10’ x 170’)/27 x $7/CY = $5000
- Estimated savings of earthwork and walls from lowering profile grade of I-17 = $400,000

Total savings = $102,000 - $5000 + $400,000 ~ $500,000

VP RECOMMENDATION No. 03
ABC Construction

Function: Span Roadway	**IDEA NO(s).SR-1, SR-2, SR-4**

Baseline:

- The base line design assumed conventional bridge construction

Recommendation:

- Use Accelerated Bridge Construction (ABC)
- Use precast panels for the bridge deck
- Use adjacent precast concrete box beams

Advantages:

- Reduces construction duration
- Precast panels for the bridge deck
  - Eliminates deck forming
  - May avoid closure during deck placement
- Precast concrete box beams
  - Lower profile
  - Less Earthwork required for mainline
  - Reduces construction duration
  - Eliminates deck forming
  - May avoid closure during deck placement

Disadvantages

- Precast panels for the bridge deck
  - Still requires an overlay
  - Could cost more
  - Could have Long Term maintenance issues
- Precast concrete box beams
  - Could cost more
  - Limited span length
  - Maybe limited suppliers
  - Utilities across the bridge may be hard to accommodate

COST SUMMARY	COST
Baseline	**Not Quantified**
Recommendation	**Not Quantified**
Cost Savings	**Not Quantified**

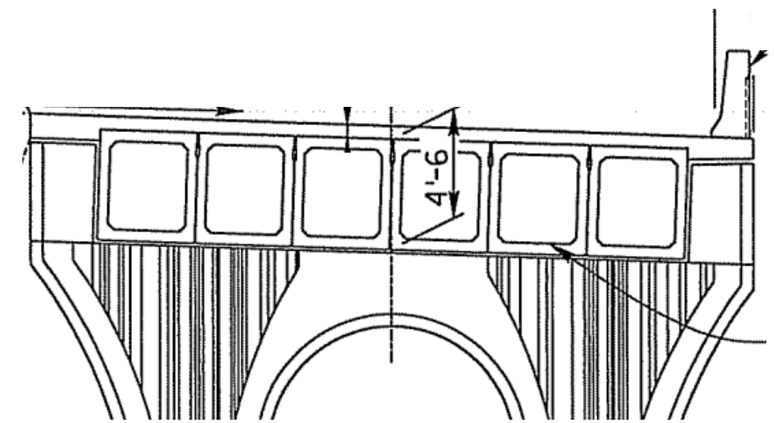
FHWA Functional Benefits

Safety	Operations	Environment	Construction	ROW

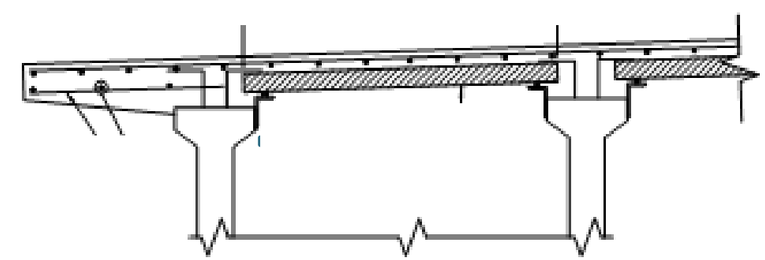
VP RECOMMENDATION No. 03
ABC Construction

Discussion/Justification/Sketches/Photos:

Typical Precast Box Beam (130' span) shown below:



Typical Deck Panel shown below:



VP RECOMMENDATION No. 03
ABC Construction

Assumptions and Calculations:

Consider using precast panels or precast box beams at the following locations:

- 16th Street
- 7th Street
- Central Avenue
- 7th Avenue
- 15th Avenue
- 19th Avenue

VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

Function: Widen Roadway	**IDEA NO(s).** SR-24

Baseline: Baseline design assumes replacing all bridges and pavement on the mainline and ramps, adding 7 feet through the corridor length to bring shoulders up to standards, and adding auxiliary lanes between 19th Avenue to 7th Avenue, 7th Avenue to 7th St, and 7th St to 16th Street.

Recommendation: This recommendation proposes to reverse the ramp configuration between 19th Avenue and 7th Avenue with a split diamond at 11th Avenue and 15th Avenue, and between 7th Street and 16th Street with a frontage road level collector-distributor road. Reverse ramps do not appear to be feasible between 7th Avenue and 7th Street due to the increase in traffic crossing volume of Central Avenue, and how this will conflict with the LRT line in that corridor.

Advantages:

- Eliminates Off-ramp to crossroad weave section at the westbound 19th Avenue off ramp, the eastbound 7th Avenue off ramp, the westbound 7th Street off ramp, and the eastbound 16th Street off ramp.
- Shifts four aux lanes from the elevated mainline to the at grade frontage road, saving money on embankment, walls, and mid mile bridge widening's.
- Steep west side 7th Avenue ramps are replaced with much flatter ramps.
- Ramps can be located where space permits to avoid pinch points. Leaves adequate width for mainline HOV lane.
- Mainline operations are improved by shifting the "weave" to off the mainline. Off-ramps will likely not backup onto mainline now.
- 7th Avenue eastbound off and westbound on ramps, and the 7th Street eastbound on and westbound off ramps, could be used to access frontage roads for certain MOT phasing schemes.

Disadvantages

- Additional bridge widening at 19th Avenue, 7th Avenue, 16th Street, and possibly 7th Street.
- May need to add mainline eastbound aux lane between 7th Street on-ramp and I-10 off ramp.
- 12th Street pedestrian tunnel will need to be removed / abandoned.
- Some ROW would be warranted, but the ramps can be shifted horizontally to acquire vacant or low utilized parcels. Do not expect the incremental ROW to induce significant impacts.
- Westbound 19th Avenue traffic now has to cross 11th Avenue (RR spur crossing) and 15th Avenue at grade. Eastbound 7th Avenue traffic now has to cross 15th Avenue and 11th Avenue (RR spur crossing) at grade. These are lightly traveled roadways, so operational issues are not expected to be significant with proper signal design.
- Westbound off-ramp to 11th/15th/19th Avenue could queue up onto mainline during times when a train passes on 11th Avenue. A traffic micro-simulation will need to be performed based on train frequency, length and time of day use to determine if this is an issue. If it is, westbound off-ramp gore may need to shift as far east as possible to maximize queuing storage on the ramp and consider making it a two-lane exit condition.
- Will require a change of access report

COST SUMMARY	COST
Baseline	**$0 M**
Recommendation	**$3.7 M**
Cost Added	**$3.7 M x 42.4% markups = $5.3 M**

FHWA Functional Benefits

Safety	Operations	Environment	Construction	ROW

VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

Discussion/Justification/Sketches/Photos:

Between 19th Avenue and 7th Avenue, reversing the ramps will avoid the steep profile ramp grades on the west side 7th Avenue TI due to the RR spur crossing at 11th Avenue. The frontage road between 15th Avenue and 11th Avenue will continue to operate as a connector roadway between those two cross streets, essentially creating a split diamond configuration that avoids ROW issues. Possible ROW issues (access) may exist north of freeway between 11th Avenue and 7th Avenue, and north of freeway between 19th Avenue and 15th Avenue, but they appear to be minor.

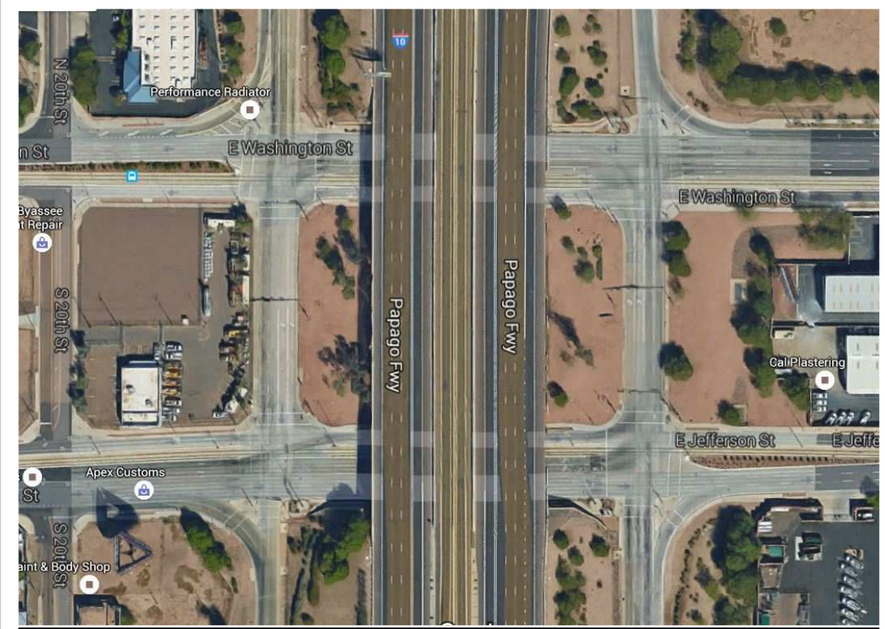
Between 7th Street and 16th Street, the right-in/right-out intersections on the frontage road with 12th Street will require special treatment by barrier separating the intersection from the frontage road ramp weave section. See detail below.

<u>19th Avenue to 7th Avenue (Split diamond at 15th/11th Avenue):</u>

Frontages roads between 15th Avenue and 11th Avenue remain as is. Realign frontage roads between 19th Avenue and 15th Avenue to take advantage of low utilized or vacant parcels to improve ramp geometry and location. Would suggest cul-de-sacing 16th Avenue on south side of freeway to eliminate frontage road connection. If not possible, utilize strategy shown below to barrier separate a right-in/right-out connection to 16th Avenue.

The split diamond configuration proposed between 15th Avenue and 11th Avenue with full signal control at all four frontage road/ramp terminal intersections (including railroad gates at 11th Avenue) should alleviate any access control concerns. Similar applications have been applied around the country. The first occurs right here in Phoenix at the Washington/Jefferson split diamond at I-10 in which light rail tracks run down both of the one-way arterials (similar to the railroad spur in 11th Avenue). A second application can be seen on I-20 in southwest Dallas. Exhibits for both installations are shown below:

VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

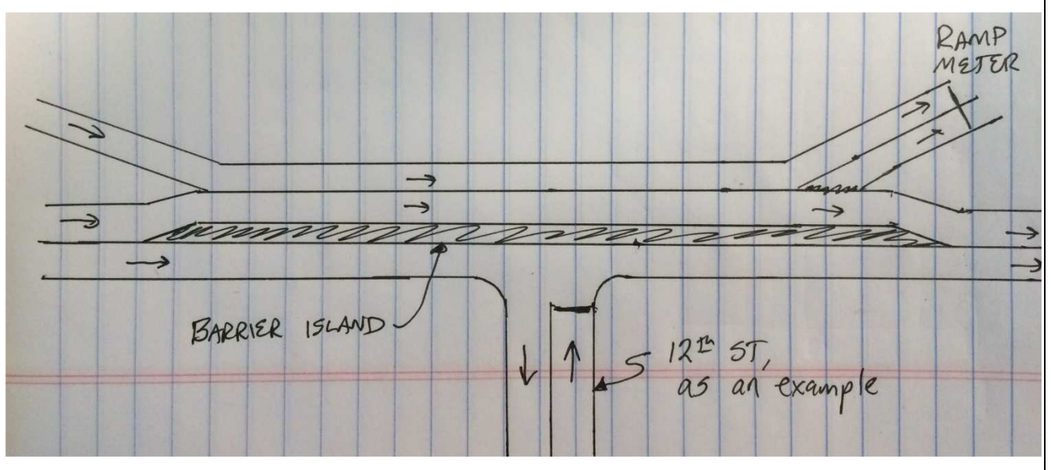


VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

7th Street to 16th Street (C-D at frontage road)

Suggest realigning WB frontage road approaching 7th Street to utilize vacant parcel up to Durango Street to maximize desirability of ramp geometry. Because of the local street and driveway access along both frontage roads within weave section, need to split the road as shown below. Because of this design, the 12th Street pedestrian tunnel needs to be removed or abandoned.

7th Street to 16th Street Frontage Road modification to add C-D road:



VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

Assumptions and Calculations:

19th Avenue to 7th Avenue, WB direction: (cost increase of $800K w/o markups)

Assume: Ramp and Aux lane paving, walls, drainage, and paving items the same.

Cost Savings: (-$390K)

- Aux Lane EW embankment – 25K CY borrow @ $7/CY = $175K
- 15th Avenue Bridge widening 12' reduction – 960 SF @ $120/SF = $115K
- 11th Avenue Bridge widening 12' reduction – 840 SF @ $120/SF = $100K

Cost Additions: (+$1,192K)

- 1250' frontage road realignment – 4000 SY @ $45/SQ = $180K
- New ROW (triangular parcel with 2 billboards) – 1.75 AC = $500K
- 7th Avenue WB structure widening for 19th Avenue exit taper – 2600SF @ $120/SF = $312K
- New frontage road/15th Avenue and 11th Avenue signals (2 total @ $100K ea) = $200K

19th Avenue to 7th Avenue, EB direction: (cost increase of $550K w/o markups)

Assume: Ramp and Aux lane paving, walls, drainage, and paving items the same.

Cost Savings: (-$390K)

- Aux Lane EW embankment – 25K CY borrow @ $7/CY = $175K
- 15th Avenue Bridge widening 12' reduction – 960 SF @ $120/SF = $115K
- 11th Avenue Bridge widening 12' reduction – 840 SF @ $120/SF = $100K

Cost Additions: (+$942K)

- 1250' frontage road realignment – 4000 SY @ $45/SQ = $180K
- New ROW sliver between 19th Avenue and 16th Avenue – 1.0 AC = $150K
- 19th Avenue EB structure widening for 7th Avenue exit taper – 2600SF @ $120/SF = $312K
- Cul-de-sac 16th Avenue = $100K
- New frontage road/15th Avenue and 11th Avenue signals (2 total @ $100K ea) = $200K

7th St to 16th St, WB direction: (cost increase of $860K w/o markups)

Assume: Ramp and Aux lane paving, walls, drainage, and paving items the same.

Cost Savings: (-$175K)

- Aux Lane EW embankment – 25K CY borrow @ $7/CY = $175K

Cost Additions: (+$1,036K),

VP RECOMMENDATION No. 04
Reverse Ramps, 19th Avenue to 7th Avenue, 7th Street to 16th Street

- 1250' frontage road realignment – 4000 SY @ $45/SQ = $180K
- New ROW sliver south of Durango Road – 1.0 AC = $100K
- 7th St WB structure widening for 16th St entrance taper – 2600SF @ $120/SF = $312K
- 16th St WB structure widening for 7th St. exit taper – 2200SF @ $120/SF = $264K
- WB frontage road barrier separation – 3000 ft @ $60/ft = $180K

7th St to 16th St, EB direction: (cost increase of $1.5M w/o markups)

Assume: Ramp and Aux lane paving, walls, drainage, and paving items the same.

Cost Savings: (-$175K)

- Aux Lane EW embankment – 25K CY borrow @ $7/CY = $175K

Cost Additions: (+$1,720K),

- 7th Street to I-10 Aux Lane Paving – 6000 SY @ $45/SQ = $270K
- 7th Street to I-10 Aux Lane E/W – 25K CY borrow @ $7/CY = $175K
- 7th Street to I-10 Aux Lane barrier, traffic, drainage – 2500 (linear feet) lf @ $150/LF = $375K
- 7th St EB structure widening for 16th St exit taper – 2600SF @ $120/SF = $312K
- 16th St EB structure widening for 7th St. entrance taper – 2200SF @ $120/SF = $264K
- EB frontage road barrier separation – 3000 ft @ $60/ft = $180K
- 1000' frontage road realignment – 3200 SY @ $45/SQ = $144K

VP RECOMMENDATION No. 05
Walls at Frontage Roads

Function: Reduce Risk	**IDEA NO(s).** RR-3

Baseline: Install permanent walls to accommodate bridge/roadway widening to ADOT and AASHTO standards and raise vertical profile of the roadway to accommodate underpass vertical clearances. Replace with like-kind lanes, full shoulders, and add auxiliary lanes in certain locations (i.e. between on/off ramps and I-10 EB to I-17 NB). No provisions for future HOV lanes or other widening is included in the baseline design.

Recommendation: Place permanent walls to the inside edge of frontage roads to allow the widest possible mainline width in order to accommodate both present and future widening so that the walls will never need to be removed.

Advantages:

- Provides flexibility for future widening.
- Ease of construction building walls near the frontage road as opposed to near the elevated mainline.
- Improved construction phasing.

Disadvantages

- Will increase cost
- May have ROW impacts with frontage road realignments in pinch areas.
- Construction impacts to the frontage roads, both in terms of pavement removals and replacement, and frontage road traffic impacts.

COST SUMMARY	COST
Baseline	**$24.0M**
Recommendation	**$33.0 M**
Cost Increase	**$9.0 M + 42.4% markup = $12.8 M**

FHWA Functional Benefits

Safety	Operations	Environment	Construction	ROW

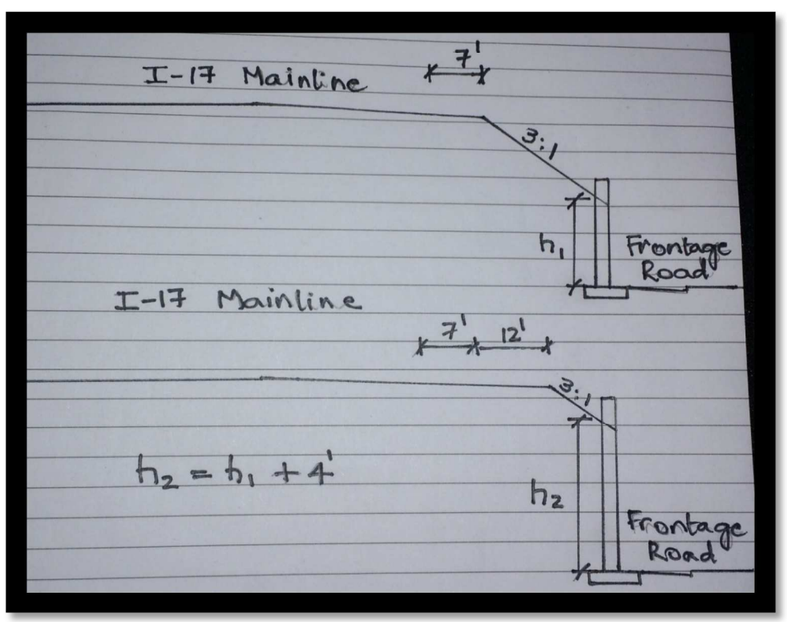
VP RECOMMENDATION No. 05
Walls at Frontage Roads

Discussion/Justification/Sketches/Photos:

The base includes almost $24 million (without markups) of wall area that will accommodate Near Term widening to replace the existing roadway to meet AASHTO standard roadway shoulder widths and auxiliary lanes in certain locations. These walls may then require replacement when the project corridor is widened to accept a future HOV lane. To avoid potential replacement of these Near Term walls, the alternative is to install walls at the inside shoulders of the frontage roads and to the ultimate height to accommodate a future 12' mainline widening project.

A detailed analysis was undertaken to locate wall locations with the base design described above. As part of this analysis, 475,000 SF of wall was computed over a total wall length of 40,700 LF. At $50/SF, this equates to about $24M in wall costs without markups. This analysis assumed the walls were located at either the inside of the frontage road, or the left edge of the ramps, which ever applied. Height was computed based on Google mapping elevation information, and available offset for 3:1 slopes between the mainline/ramp and the frontage road. Three extra feet was added for foundations and parapets.

Because of the methodology used for the base design, the incremental wall height would have to increase approximately 4 feet everywhere to accommodate an additional 12 feet of widening on the mainline in each direction. 40,700 LF X 4 FT = 163,000 SF. At $50/SF (without markups), this equates to $8.2M more dollars just in wall cost.



VP RECOMMENDATION No. 05
Walls at Frontage Roads

Assumptions and Calculations:

Added Wall Height:

Assume 40,700 LF of wall is increased 4 extra feet in height: (40,700)(4)($50/SF) = $8.2M

Added Embankment:

Assume 40,700 LF long, 4 LF high, and 25 LF wide (25 feet being the assumed average width remaining between the mainline and the frontage road after the HOV widening): (40,700)(4)(25)/27 = 150,000 CY borrow at $7/CY = $1.05M

Item Description	Unit	Baseline			Recommendation		
		Qty	Unit Cost	Total	Qty	Unit Cost	Total
Retaining Wall	SF	475,000	$50	$24,000,000	638,000	$50	$31,900,000
Borrow	CY				150,000	$7	$1,050,000
Total Cost			**Baseline**	**$24,000,000**		**Recommendation**	**$32,950,000**
						Cost Added	**$8,950,000**

VP RECOMMENDATION No. 06
Roadway Section

Function: Widen Roadway	**IDEA NO(s).** WR-3

Baseline: The baseline assumes three GP lanes and 12-foot inside and outside shoulders

Recommendation: Build the roadway and bridges to accommodate future HOV lane

Advantages:

- Eliminates impacts to I-17 when additional HOV is added
- Extra width for maintenance

Disadvantages

- Extra width to maintain
- Added cost
- May not need extra width for several years
- May have ROW impacts

COST SUMMARY	COST
Baseline	
Recommendation	**See Calculations**
Cost Added	**$5.68 M + 42.4% markup = $8.09 M**

FHWA Functional Benefits

Safety	Operations	Environment	Construction	ROW

VP RECOMMENDATION No. 06
Roadway Section

Discussion/Justification/Sketches/Photos:

The baseline assumes 12-foot inside and outside shoulders

Baseline Roadway with Aux Lanes

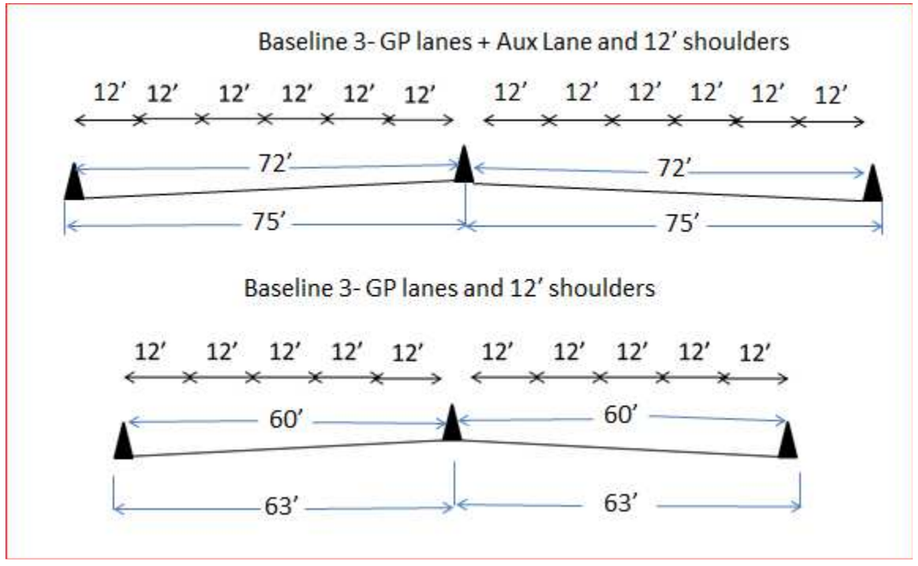
= 2 x 12-foot shoulders + 3 x 12-foot GP Lanes + 1 x 12-foot Aux lane

= 72 feet (inside to inside); 75 feet (centerline of barrier to outside of barrier)

Baseline Roadway without Aux Lanes

= 2 x 12-foot shoulders + 3 x 12-foot GP Lanes

= 60 feet (inside to inside); 63 feet (centerline of barrier to outside of barrier)



VP RECOMMENDATION No. 06

Roadway Section

This recommendation is to widen the roadway and bridges to accommodate the ultimate need of an HOV GP lane in each direction. This will eliminate the future impacts to I-17 to widen for this additional capacity requirement. Adding HOV to this section is in the current long term program. It does not make since to complete the Aux lane project in 2021 and come back in 2023 to add HOV.

By implementing the recommendations for the X-ramps and walls there is enough room to build to full standards including HOV

Recommended Roadway 3 GP lane 1 HOV lane and 1 Aux Lanes between 7th Street and 7th Avenue

= 2 x 12-foot shoulders + 3 x 12-foot GP Lanes + 1 x 12-foot Aux lane + 1 12 foot HOV lane

= 84 feet (inside to inside); 87 feet (centerline of barrier to outside of barrier)

Recommended Roadway without Aux Lanes

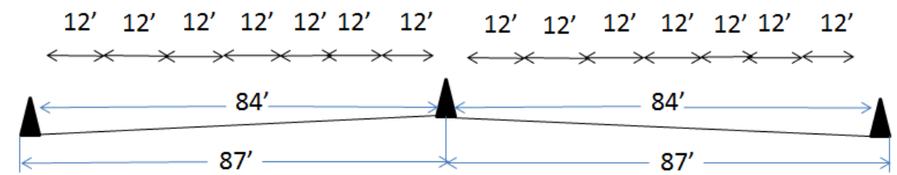
= 2 x 12 -foot shoulders + 3 x 12-foot GP Lanes + 1 12-foot HOV lane

= 72 feet (inside to inside); 75 feet (centerline of barrier to outside of barrier)

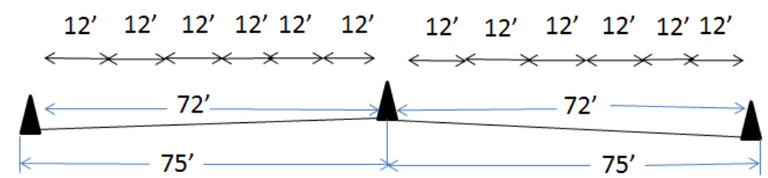
VP RECOMMENDATION No. 06

Roadway Section

Recommend 7th St to 7th Ave
3- GP lanes + HOV+ Aux Lane and 12' shoulders



Recommend 3- GP lanes + HOV and 12' shoulders



VP RECOMMENDATION No. 06

Roadway Section

Assumptions and Calculations:

For adding an HOV lane in each direction

Pavement:

Length: 3.57 miles *5280 feet/mile -1200 feet (for bridge lengths)

Width: 24 feet (one lane in each direction)

Area: 47,066 sq. yd.

Price: $45 per sq. yd.

Cost: $2,117,952

ARFC:

ARFC Overlay: 47,066*118/2000 = 2,777 Tons

Price: $40 per ton

Cost: $111,076

Bridge costs 1200 feet by 24' wide =28,800 sf

Price $120 sf

Cost $3,456,000

Total Cost: $5,684,028

$5,864,028 * 42.2% markups = $8.09M

48.09M/24 =$0.34M per foot of widening

If we use 10" shoulders you can reduce the roadway width by 8 feet and reduce the cost by $2.7M

Recommend full standards

VP RECOMMENDATION No. 07

MOT & Project Staging

Function: Maintain Traffic	**IDEA NO(s).**

Baseline: The base project is to construct the corridor in the ultimate configuration with a raised profile, revised ramps to place auxiliary lanes on both the frontage roads and mainline, and construct retaining walls to accommodate both current and future widening plans (HOV and auxiliary lanes). The base cost for MOT assumes that a median traffic shift will be implemented with temporary widening on one side of the freeway to accommodate both NB and SB I-17 traffic. This allows one side of the freeway to be constructed all at once. Traffic will then shift to the new side and the remaining construction will be completed. All ramps will be closed along the corridor with the exception of the utilization of ramps North of 19th Ave and new ramps to be placed east of 16th Street.

Recommendation: The recommendation is to use the frontage roads to accommodate detour traffic from I-17 following installation of permanent drainage, retaining walls, and any temporary features required to accommodate traffic along the frontage roads. Once traffic is diverted to the frontage roads, the mainline of I-17 will be closed to allow construction to be completed using detours and bypass routes. Traffic will be returned to the mainline once construction is complete. This scenario is dependent on a traffic study to determine if the frontage roads need to be widened to possibly three lanes in certain areas and the permanent wall locations do not limit the traffic volume through the detour section. It is also dependent on the opening of the South Mountain Freeway to accommodate the main alternate route for both hazardous materials and bypass traffic. Both frontage roads and other arterial routes will be used to accommodate local traffic.

Advantages:

- Develops preliminary traffic/construction staging plan
- May improve mobility during construction
- May improve local traffic flow
- May decrease construction schedule

Disadvantages

- May add cost
- May require additional analysis prior to implementation
- Scenario 1 depending upon opening of South Mountain Freeway
- Restricts access
- May increase construction schedule

COST SUMMARY	COST
Baseline	**$17M**
Recommendation	**$8.5M**
Cost Savings	**$8.5M x Effective Markup 42.4% = $12.5M**

FHWA Functional Benefits				
Safety	**Operations**	**Environment**	**Construction**	**ROW**

VP RECOMMENDATION No. 07
MOT & Project Staging

Discussion/Justification/Sketches/Photos:

There have been three scenarios established to accommodate MOT through the project corridor.

Scenario 1 utilizes a median crossover option with both NB and SB traffic moved to one side of the freeway. This option involves temporarily widening one side of the existing freeway to accommodate both NB and SB I-17 traffic. This widening will still allow many permanent features to be installed, including retaining walls, drainage and embankment that will be left in place, shortening the time frame that traffic is shifted. Once either NB or SB traffic is moved to one side, the other side of the freeway may be constructed. Once the first stage is complete, traffic will then be moved to the new alignment, allowing the remaining side of the freeway to be constructed. It is assumed that temporary ramps will be constructed at the beginning and end of the corridor to accommodate the exit ramps and entrance ramps that will be closed for one side of traffic.

Scenario 2 assumes that the frontage roads will accommodate detour traffic from I-17 following installation of both permanent drainage and retaining walls along the frontage roads. Once traffic is diverted to the frontage roads, the mainline of I-17 will be closed to allow construction to be completed using detours and bypass routes. Traffic will be returned to the mainline once construction is complete. This scenario is dependent on a traffic study to determine if the frontage roads need to be widened to possibly three lanes in certain areas and the permanent wall locations do not limit the traffic volume through the detour section. It is also dependent on the opening of the South Mountain Freeway to accommodate the main alternate route for both hazardous materials and bypass traffic. Both frontage roads and other arterial routes will be used to accommodate local traffic.

Scenario 3 has been established to consider an alternative of incorporating both Scenario 1 and Scenario 2 together. The frontage road work with permanent walls will be constructed first, followed by the implementation of a median crossover configuration to accommodate I-17 NB and NB traffic. This alternative would essentially limit the adverse affects to mobility, allow construction of one side of the freeway at a time, and decrease the amount of time I-17 capacity is limited. The option does increase MOT costs based on the requirement to both manage traffic on the frontage roads during the first phase of construction and develop the median crossover and temporary ramps during the next phase(s) of construction. In summary, the frontage road work with permanent drainage and wall construction would be performed during the first phase. Next, the median crossover would place both NB and SB I-17 on one side of the freeway, requiring temporary widening as described in Scenario 1. The configuration would then allow one side of the freeway to be constructed at a time, switching traffic to the new alignment once the first side, either NB or SB is complete. This option is the least restrictive to mobility, allowing the frontage roads and the temporary alignment to accommodate the same volume of traffic that exists today.

VP RECOMMENDATION No. 07
MOT & Project Staging

Scenario 1: This scenario is the base traffic plan.

Stage 1:

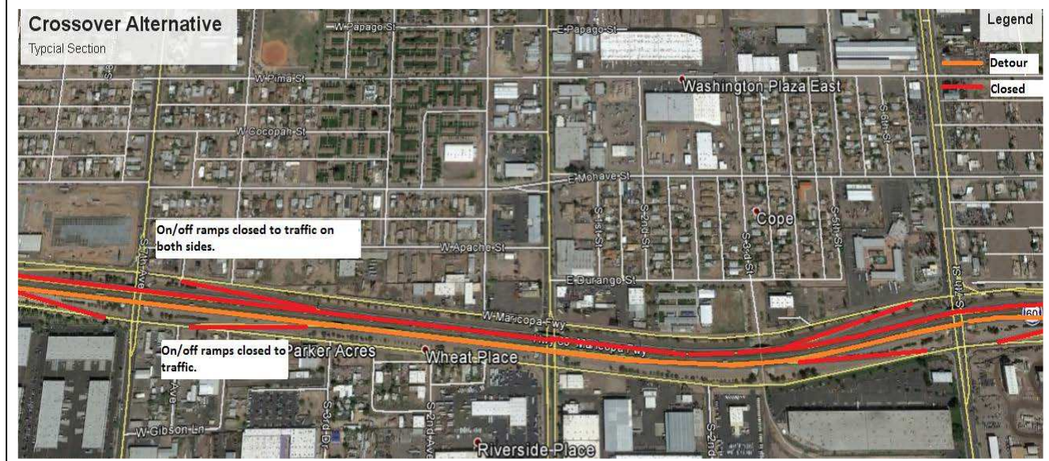
1) Close frontage as needed to install permanent drainage features, retaining walls, and roadway/structure widening on one side required for median crossover configuration. Close lanes of mainline as required to install median crossover ramps, striping, temporary barrier, etc.
2) Shift either the NB traffic to the SB side or vice-versa.
3) Construct the NB or SB side of the entire corridor.

Stage 2:

1) Shift both NB and SB traffic to the completed side of the newly constructed corridor.
2) Complete construction on the other side of the freeway.

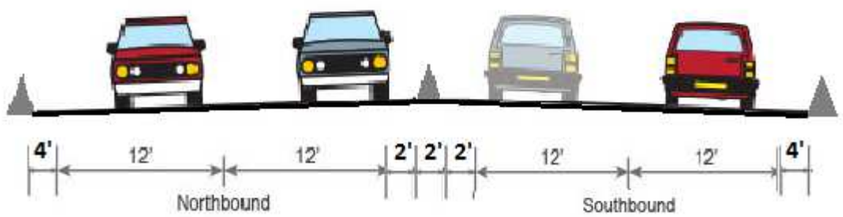
Stage 3:

1) Open all traffic to the new alignments.



Median Crossover Typical Section

VP RECOMMENDATION No. 07
MOT & Project Staging



Median Crossover Cross Section

Scenario 2:

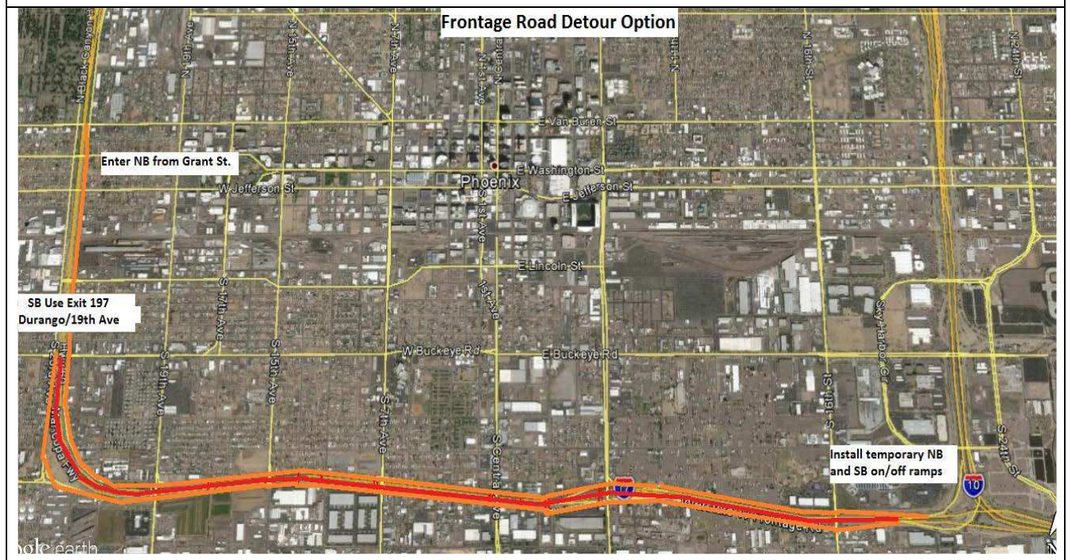
Stage 1 :

1) Close frontage roads.
2) Install permanent drainage on frontage roads and temporarily tie mainline drainage to permanent drainage on frontage roads. Drainage will run parallel with mainline and crossings will occur at cross streets.
3) Construct permanent retaining walls on frontage roads to accommodate mainline widening.
4) Complete temporary frontage road traffic modifications to accommodate detour traffic

Stage 2: **This requires South Mountain Freeway to be open first**

1) Close I-17 between 16th Street on the South and Buckeye Street to the North
2) Detour I-17 local traffic to frontage roads. Traffic will utilize I-10 and the South Mountain Freeway.
3) Construct I-17 mainline bridges and widen roadway
4) Open I-17 once construction is complete.

VP RECOMMENDATION No. 07
MOT & Project Staging



Scenario 3

Stage 1 :

1) Close frontage roads.
2) Install permanent drainage on frontage roads and temporarily tie mainline drainage to permanent drainage on frontage roads. Drainage will run parallel with mainline and crossings will occur at cross streets.
3) Construct permanent retaining walls on frontage roads to accommodate mainline widening.
4) Complete temporary frontage road traffic modifications to accommodate detour traffic

Stage 2

1) Close lanes of mainline as required to install median crossover ramps, striping, temporary barrier, etc.
2) Shift either the NB traffic to the SB side or vice-versa.
3) Construct the NB or SB side of the entire corridor.

Stage 3:

1) Shift both NB and SB traffic to the completed side of the newly constructed corridor.
2) Complete construction on the other side of the freeway.

Stage 4:

1) Open all traffic to the new alignments.

VP RECOMMENDATION No. 07
MOT & Project Staging

Assumptions and Calculations:

Base estimate has $17M allocated for MOT to perform the planned median traffic switch and close the ramps. The recommendation assumes approximately $2.5M per mile to perform frontage road upgrades, both for the NB and SB side. The potential savings is estimated to be $8.5M. Scenario 3, due to the complexity and combination of both Scenario 1 and Scenario 2 configurations, is estimated to be slightly higher in cost versus Scenario 1, potentially raising the MOT costs to $20M. This would increase the baseline costs $3M to accommodate traffic.

Item Description	Unit	Baseline			Recommendation		
		Qty	Unit Cost	Total	Qty	Unit Cost	Total
Traffic Control	LS	1	$17,000,000	$17,000,000	1	$8,500,000	$8,500,000
Total Cost			**Baseline**	**$17,000,000**		**Recommendation**	**$8,500,000**
						Cost Avoidance	**$8,500,000**

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Analysis of Results

In evaluating the risk for the project, a cost risk assessment/value engineering or CRAVE process was utilized. The cost risk assessment portion of the evaluation was used to identify the range of unexpected project costs as it relates to total project cost, as well as potential delays in schedule that might arise.

The Value Planning Team discussed the potential risk events and elements facing the project. During the discussion of the project, the Team identified high risk elements or potential events, which may occur and that would impact the project. For each significant risk event that was identified, the probability of the risk and its impact to cost, schedule, or both was estimated.

The risk assessment process includes identifying high risk areas and risk elements as threats (or opportunities where appropriate) to a project, quantifying the identified risk elements, developing appropriate risk response strategies, and quantifying the effects of the risk response strategies to be employed.

The risk assessment process quantified risk events by establishing the expected probability of occurrence and range of impacts through elicitation of information from the Value Planning Team. The range of impacts defines the representative distribution to be used when modeling the risk. The probability determines the relative frequency (or likelihood) of an event transpiring.

Risk Analysis

New and innovative approaches inherently carry risk; the team identified the risks associated with these types of VE recommendations and risk response strategies.

To quantify these impacts, the VE recommendations and the response strategies were input into scenario models as opportunities or threats in terms of their likely impact, as well as the probability of the implementation of the recommendation. Risk response strategies were defined and quantified for each of the risks that were not modified by VE recommendations.

At this point, a cumulative cost curve was generated that represented both the impacts of responding to the risk elements and partially or fully implementing the VE recommendations. By treating the VE recommendations as an opportunity to increase value through performance increases and cost reductions, it was demonstrated that further cost and schedule efficiencies could be obtained for the project.

The Team identified 25 active risks that pose potential schedule and/or cost threats as well as opportunities for the project:

1. CNS 10.01 Maintenance of Traffic Ultimate Configuration
2. CNS 10.02 Detour Costs
3. CNS 900.02 Construction Change Orders
4. CTR 10.01 Change in Project Delivery
5. DES 10.01 ADA at Intersections
6. DES 10.02 Sidewalks on Frontage Roads

7. DES 10.04 Third Avenue Bridge
8. DES 10.05 Structure Length Modifications
9. DES 10.06 SR-30 Connection at Durango Curve
10. DES 10.08 Unsuitable Material
11. DES 10.09 Reverse Ramps
12. DES 50.03 ITS/FMS Ultimate
13. DES 900.02 Opportunity to Reduce Design Time
14. DES 900.03 Design Schedule
15. ENV 10.01 Environmental Documentation – Ultimate
16. ENV 40.01 Cultural
17. ENV 50.01 Hazardous Materials in Existing Structures
18. ENV 70.01 Drainage – Ultimate
19. PSP 900.01 Coordination with Stakeholders
20. ROW 60.01 ROW Impacts (Drainage, Intersections, ADA, Access Control) – Ultimate
21. RR 20.01 Railroad Coordination and Flagging
22. STG 10.02 Central Avenue – Ultimate
23. STG 10.03 11th Avenue Substructure
24. STG 10.04 Wall Types – Ultimate
25. STG 900.01 ABC and Other Bridge Construction Methods

Other risks that were either changed to 'Inactive' status or 'Retired' based on current input include:

26. DES 10.03 Design Elements
27. DES 10.07 19th Avenue Overpass
28. STG 20.02 Geotechnical Opportunity – Ultimate
29. ENV 90.01 Noise Walls – Ultimate
30. PSP 20.01 Public Relations
31. STG 20.01Slopes - Ultimate

The Risk Data Sheets provided in the Appendix of this report shows additional information specific to each risk as identified by the team.

Top Risk Factors

After the risks were identified, the Value Planning Team focused on responding to those risks that were the most likely to happen or which held a significant impact if the risk event occurs. Using the information portrayed in the tornado diagrams, the highest risk elements received the most focus.

The expected value (likelihood multiplied by expected risk outcome) tornado diagrams depict the actual expected values of the identified risks and help summarize the evolution the project has gone through by engaging in the CRAVE process (see appendix). Not all risks identified require immediate management. Often, a project team needs to prioritize the risks for which it plans to develop strategies in the future in an effort to make the best use of the time available. An example would be to begin with the risks with the highest cost and schedule impacts.

Within the diagrams, the risks have the expected values plotted prior to responding to the risks and implementing the VE recommendations and risk response strategies (red bars) and after responding to the risks and implementing VE recommendations at their expected likelihood (green bars).

The tornado diagrams for the top risks impacting both cost and schedule for the project are provided in Figure 5 and Figure 6 respectively.

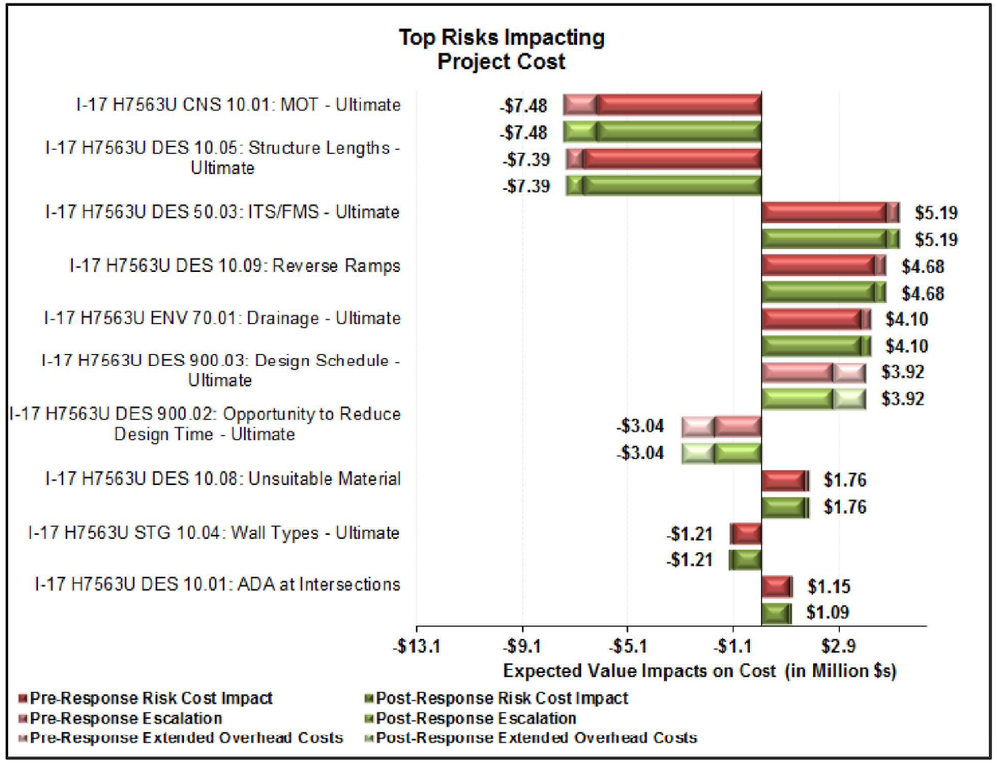


Figure 5: Top Cost Risks

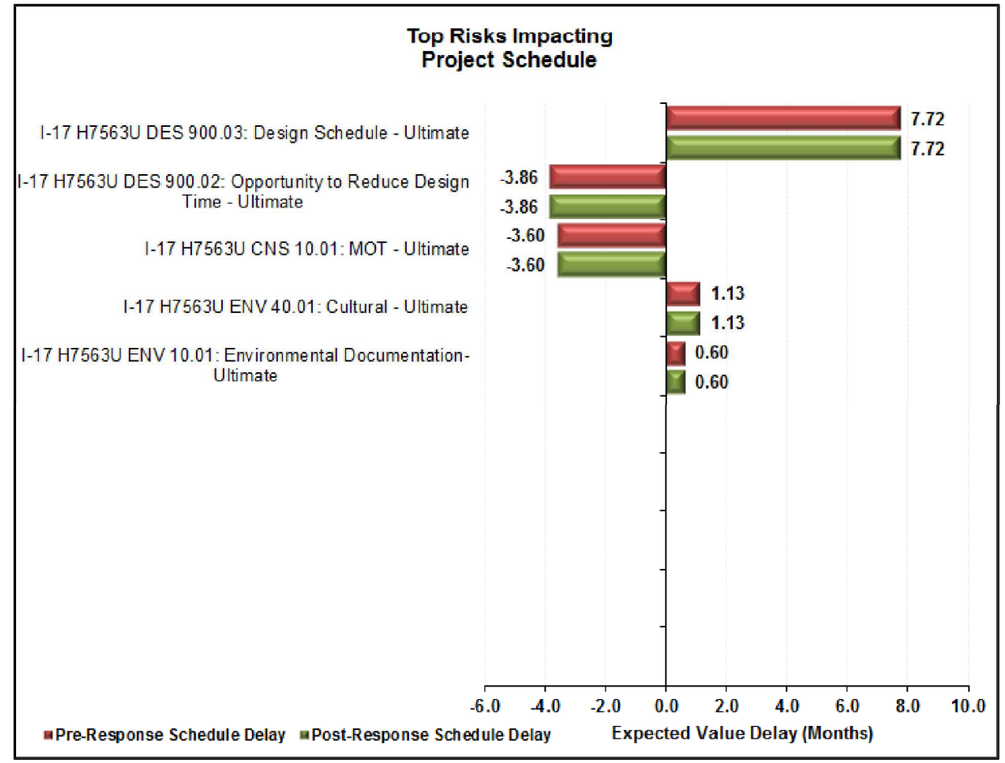


Figure 6: Top Schedule Risks

The next step was to determine the appropriate risk response strategies for the identified high risk areas. Four risk response strategies, are considered when addressing threat risks. Those strategies are to avoid, accept, transfer, or mitigate the risk threat (opportunity).

Avoiding a risk may cost more money up front, but may prevent or reduce a more significant impact.

Accepting a risk means that there is not much that can be done or relatively little benefit in addressing the risk.

Transferring a risk allows for the risk owner to move the liability of the risk to another party that is better able to respond to the risk.

Mitigation of a risk addresses risk by reducing (enhancing) the likelihood of the risk occurring or lessen (increasing) the impact through proactive efforts.

Each of the risks that were identified had a unique response strategy developed to address it, as well as the identification of the risk owner. Identifying a risk response and risk owner, along with review intervals for the risk, a framework for a risk management plan is established. This allows proactive management of risk throughout the life of the project.

For risks that did not have a VE recommendation, the Value Planning Team Leader and the Project Manager determined the appropriate risk response strategies.

Tracking, Monitoring, and Control

By engaging in this cost risk analysis process to evaluate the project, the overall expectations of cost and schedule were quantified in relation to identified risks, the associated impacts of those risk elements, the use of a Risk Management Plan to respond to those risk elements, and impacts to the project bottom line of creating value for the project.

Through this process, value can simultaneously be created for the project through the VE portion of the workshop, while risks can be proactively monitored and controlled to reduce potential impacts to the project cost and schedule.

The risk register provided in the Appendix can serve as a risk tracking tool and contains columns for risk response and planning. The project team should assign a “risk owner” to track and record the effectiveness of the strategies and any changes to the project risk profile, as follows:

- Document the response action by describing the action, the work activities it will affect, and the cost of the response action.
- Identify the person(s) responsible for successful implementation of the response action.
- Document whether response actions have a positive or negative effect on achieving project objectives in the Risk Management Plan.
- Consider the time impacts of the response action and how the risk response may affect the overall project and/or other risks.

Risk Analysis Results

The risk analysis results are given in the form of graphs showing the relationship between cost and the probability of not exceeding that cost. Risk-based analysis provides a distribution of probabilities that a project will not exceed an estimated dollar figure. Typically, agencies report the project risk-based estimation using the 70 percent confidence interval. Each graph represents the best opinion of the cost ranges by the workshop participants at the time of the analysis.

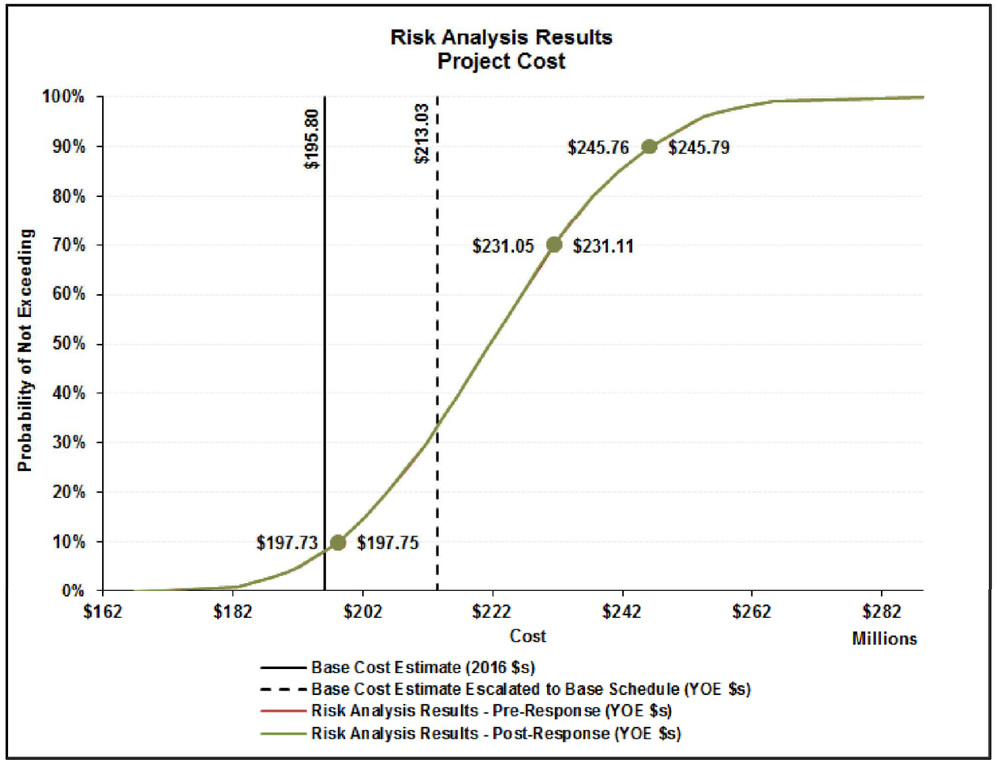


Figure 7: Ultimate Project Cost Risk Analysis Results

The base cost is the cost without any contingencies or any factored escalation. The gray vertical solid line shown in Figure 7 above (small dashes) represents the base cost in 2016 dollars, at $195.87 million. This amount, represented by the vertical dashed line is $231.03 million at year of-expenditure. The s-curve, with risk results factored into the analysis, shows that the project will be less than **$231.05 million** at a 70% confidence level with current mitigation strategies in place.

The same analysis was performed to generate results for the schedule and is shown in Figure 8.

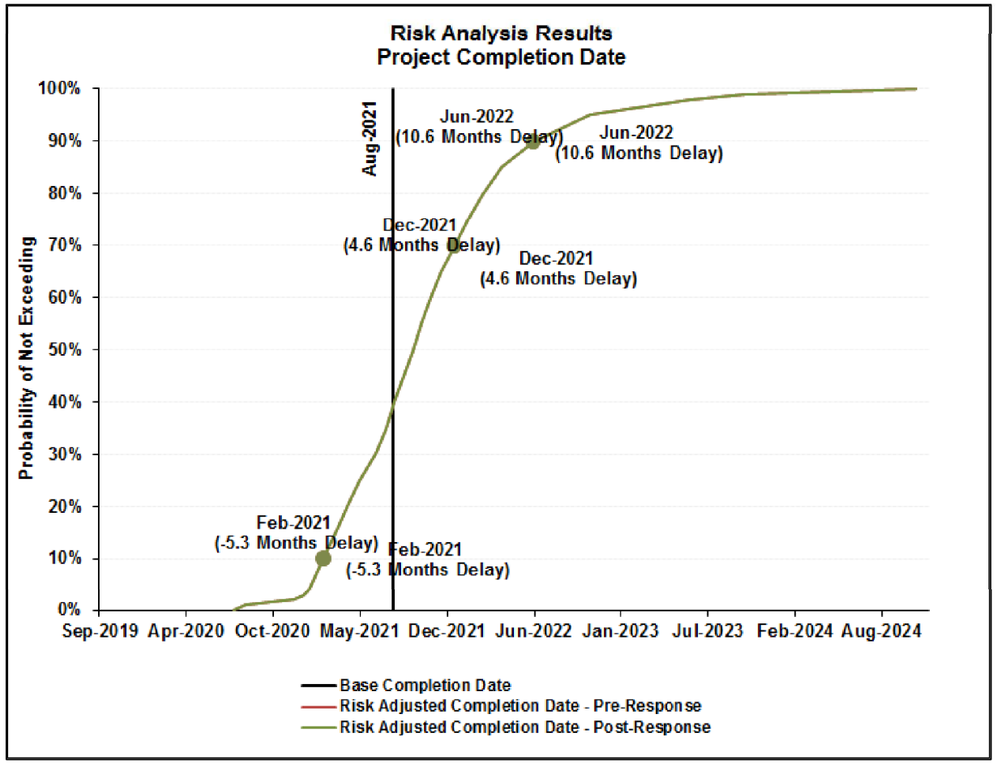


Figure 8: Ultimate Construction Schedule Risk Analysis Results

The baseline schedule had a completion date of August 2021 after 36 months of construction. The confidence interval, described by the completion range between the 10th percentile and 90th percentile figures, reveals that the completion of construction will fall between February 2021 and June 2022. There is 70 percent probability that the project will be completed by **December 2021**.

CRAVE Process Summary

The cost risk analysis provided an evaluation of the estimated project total cost and schedule and included four major steps.

The first step was to establish a base cost and schedule and then identify and quantify the major risk elements and how they impact cost and schedule. The second step was to identify how to respond to the highest likelihood and impact risk elements. The third step was to quantify the effects of implementation of the risk response strategies. The final step was to quantify the effects on project cost and schedule by implementing the VE recommendations.

The information provided by a CRA Workshop and the Value Planning Study gives valuable tools to project managers to help them deliver a successful project on time and within budget. When a multi-disciplined team of experts is assembled in a workshop environment, maximum benefit can be achieved by using this combined cost risk assessment/value engineering process.

Appendix

- Near Term Project Cost Estimate/Schedule Review and Risk Analysis
- Base Cost Estimate and Schedule Review - Ultimate
- Risk Data Sheets – Ultimate
- Value Planning Study Agenda
- CRAVE Study Attendees
- CRAVE Study Report Out Presentation
- Value Engineering Process
- VE Study Process
- CRAVE Process
- Performance Based Results
- Reporting
- VE Study Recommendation Approval Form

Near Term Project Cost Estimate and Risk Analysis

During the workshop, the team began with an assessment of Near Term project costs and risks. As the workshop progressed, this Near Term project was recommended to be replaced with the ultimate project configuration. Much of the cost estimate data used for the ultimate configuration comes from the Near Term base cost estimate. These costs and quantities developed for the ultimate project configuration were then verified by the project team based on revised quantities and other known information. Please see the following pages for the base cost estimate for the Near Term project. A cost and schedule model analysis was also performed to compare the Near Term project analysis results with the ultimate project analysis results.

Base Cost Estimate Review – Near Term Project

			Unit Cost					Quantity					Total			Reviewed previously awarded projects for a comparison of unit prices
	Item	Unit	Low	%	Most Likely	%	High	Low	%	Most Likely	%	High	Low	Most Likely	High	Cost Lead Revisions
2010011	CLEARING AND GRUBBING	ACRE	$1,350	-10%	$1,500	10%	$1,650	5.7	-5%	6.0	5%	6.3	$7,695	$9,000	$10,395	
2020021	REMOVAL OF CONCRETE CURB AND GUTTER	L.FT.	$2.25	-10%	$2.50	10%	$2.75	24,452	-5%	25,739	5%	27,026	$55,017	$64,348	$74,321	
2020027	REMOVAL OF CONCRETE BARRIER (WITH SCREEN WALL)	L.FT.	$27	-10%	$30	10%	$33	6,261	-5%	6,591	5%	6,921	$169,059	$197,730	$228,378	
2020029	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ.YD	$1.75	-13%	$2.00	50%	$3.00	42,746	-5%	44,996	5%	47,246	$74,806	$89,992	$141,737	
2020042	REMOVAL OF PIPE (36" AND UNDER)	L.FT.	$18.00	-10%	$20.00	10%	$22.00	335	-5%	353	5%	371	$6,036	$7,060	$8,154	
2020052	REMOVE (CONDUCTORS)	L.SUM	$9,000	-10%	$10,000	10%	$11,000	1	0%	1	0%	1	$9,000	$10,000	$11,000	
2020053	REMOVE (PULL BOX)	EACH	$135	-10%	$150	10%	$165	22	0%	22	0%	22	$2,970	$3,300	$3,630	
2020054	REMOVE (CATCH BASINS)	EACH	$540	-10%	$600	10%	$660	38	0%	38	0%	38	$20,520	$22,800	$25,080	
2020071	REMOVE GUARD RAIL	L.FT.	$1.80	-10%	$2.00	10%	$2.20	24,452	-5%	25,739	5%	27,026	$44,014	$51,478	$59,457	
2020081	REMOVE BITUMINOUS PAVEMENT (MILLING) (1")	SQ.YD	$0.75	-12%	$0.85	12%	$0.95	158,220	-5%	166,547	5%	174,874	$118,665	$141,565	$166,131	
2020157	REMOVE (MANHOLE)	EACH	$550	-8%	$600	8%	$650	1	0%	1	0%	1	$550	$600	$650	
2020201	SAW CUTTING	L.FT.	$0.90	-10%	$1.00	10%	$1.10	26,250	-5%	27,632	5%	29,014	$23,625	$27,632	$31,915	
2030301	ROADWAY EXCAVATION	CU.YD	$9.00	-10%	$10.00	10%	$11.00	80,750	-5%	85,000	5%	89,250	$726,750	$850,000	$981,750	
2090005	FURNISH WATER	M.GAL	$2.75	-8%	$3.00	8%	$3.25	95,000	-5%	100,000	5%	105,000	$261,250	$300,000	$341,250	
3030022	AGGREGATE BASE, CLASS 2	CU.YD.	$27	-10%	$30	10%	$33	7,077	-5%	7,449	5%	7,821	$191,067	$223,470	$258,108	
4010009	PORTLAND CEMENT CONCRETE PAVEMENT (9")	SQ. YD.	$27	-10%	$30	17%	$35	63,686	-5%	67,038	5%	70,390	$1,719,525	$2,011,140	$2,463,647	
4040111	BITUMINOUS TACK COAT	TON	$450	-10%	$500	10%	$550	76	-5%	80	5%	84	$34,200	$40,000	$46,200	
4040116	APPLY BITUMINOUS TACK COAT	HOUR	$135	-10%	$150	10%	$165	50	-5%	53	5%	56	$6,797	$7,950	$9,182	
4140040	ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER)	TON	$35	-13%	$40	13%	$45	11,938	-5%	12,566	5%	13,194	$417,820	$502,640	$593,744	
4140042	ASPHALT RUBBER MATERIAL (FOR AR-ACFC)	TON	$550	-8%	$600	8%	$650	1,074	-5%	1,131	5%	1,188	$590,948	$678,600	$771,908	
4140044	MINERAL ADMIXTURE (FOR AR-ACFC)	TON	$80	-11%	$90	11%	$100	107	-5%	113	5%	119	$8,588	$10,170	$11,865	
5010107	PIPE, CORRUGATED METAL, SLOTTED, 18"	L.FT.	$90	-10%	$100	10%	$110	456	-5%	480	5%	504	$41,040	$48,000	$55,440	
5012524	STORM DRAIN PIPE, 24"	L.FT.	$40	-11%	$45	11%	$50	3,189	-5%	3,357	5%	3,525	$127,566	$151,065	$176,243	
5030192	ADJUST CATCH BASIN TO GRADE	EACH	$450	-10%	$500	10%	$550	2	0%	2	0%	2	$900	$1,000	$1,100	
5030604	CONCRETE CATCH BASIN (C-15.80)	EACH	$2,075	-10%	$2,300	10%	$2,525	3	0%	3	0%	3	$6,225	$6,900	$7,575	
5030605	CONCRETE CATCH BASIN (C-15.92)	EACH	$2,250	-10%	$2,500	10%	$2,750	111	0%	111	0%	111	$249,750	$277,500	$305,250	
5030606	CONCRETE CATCH BASIN (CONCRETE CAP)	EACH	$450	-10%	$500	10%	$550	32	0%	32	0%	32	$14,400	$16,000	$17,600	
5050001	MANHOLE (C-18.10) (NO. 1) (FOR PIPES 6" TO 36")	EACH	$3,150	-10%	$3,500	10%	$3,850	4	0%	4	0%	4	$12,600	$14,000	$15,400	
5050089	MANHOLE (ADJUST TO GRADE)	EACH	$360	-10%	$400	10%	$440	1	0%	1	0%	1	$360	$400	$440	
6011110	F-SHAPED BRIDGE CONCRETE BARRIER (32")	L.FT.	$50	-9%	$55	9%	$60	26,490	-5%	27,884	5%	29,278	$1,324,490	$1,533,620	$1,756,692	
6060046	BRIDGE SIGN STRUCTURE (SD9.20, TYPE 2F)	EACH	$54,000	-10%	$60,000	10%	$66,000	2	0%	2	0%	2	$108,000	$120,000	$132,000	
6060076	FOUNDATION FOR BRIDGE SIGN STRUCTURE (SD9.20, TYPE 2F)	EACH	$6,300	-10%	$7,000	11%	$7,750	4	0%	4	0%	4	$25,200	$28,000	$31,000	
6060133	CANTILEVER SIGN STRUCTURE (SD9.10, TYPE 3C)	EACH	$32,400	-10%	$36,000	10%	$39,600	7	0%	7	0%	7	$226,800	$252,000	$277,200	
6060134	CANTILEVER SIGN STRUCTURE (SD9.10, TYPE 4C)	EACH	$40,500	-10%	$45,000	10%	$49,500	10	0%	10	0%	10	$405,000	$450,000	$495,000	
6060256	FOUNDATION FOR CANTILEVER SIGN STRUCTURE (SD9.10, TYPE 3C)	EACH	$6,300	-10%	$7,000	10%	$7,700	7	0%	7	0%	7	$44,100	$49,000	$53,900	
6060257	FOUNDATION FOR CANTILEVER SIGN STRUCTURE (SD9.10, TYPE 4C)	EACH	$6,300	-10%	$7,000	10%	$7,700	10	0%	10	0%	10	$63,000	$70,000	$77,000	
6061001	SIGN MOUNT ASSEMBLY (FOR BRIDGE FASCIA)	EACH	$2,475	-10%	$2,750	10%	$3,025	1	0%	1	0%	1	$2,475	$2,750	$3,025	
6070002	BREAKAWAY SIGN POST S4X7.7	L.FT.	$22	-12%	$25	12%	$28	154	-5%	162	5%	170	$3,386	$4,050	$4,763	
6070004	BREAKAWAY SIGN POST W6X12	L.FT.	$31	-11%	$35	11%	$39	374	-5%	394	5%	414	$11,603	$13,790	$16,134	
6070022	FOUNDATION FOR BREAKAWAY SIGN POST S4X7.7	EACH	$225	-10%	$250	10%	$275	12	0%	12	0%	12	$2,700	$3,000	$3,300	
6070024	FOUNDATION FOR BREAKAWAY SIGN POST W6X12	EACH	$450	-10%	$500	10%	$550	22	0%	22	0%	22	$9,900	$11,000	$12,100	
6070038	SLIP BASE (FOR PERFORATED POST)	EACH	$120	-8%	$130	10%	$143	36	0%	36	0%	36	$4,320	$4,680	$5,148	
6070054	SIGN POST (PERFORATED) (2 S)	L.FT.	$7.25	-9%	$8.00	10%	$8.80	452	-5%	476	5%	500	$3,278	$3,808	$4,398	
6070055	SIGN POST (PERFORATED) (2 1/2 S)	L.FT.	$9.00	-10%	$10.00	10%	$11.00	627	-5%	660	5%	693	$5,643	$6,600	$7,623	
6070057	SIGN POST (PERFORATED) (2 1/2 T)	L.FT.	$10.75	-10%	$12.00	10%	$13.25	228	-5%	240	5%	252	$2,451	$2,880	$3,339	
6070060	FOUNDATION FOR SIGN POST (CONCRETE)	EACH	$165	-11%	$185	11%	$205	88	0%	88	0%	88	$14,520	$16,280	$18,040	

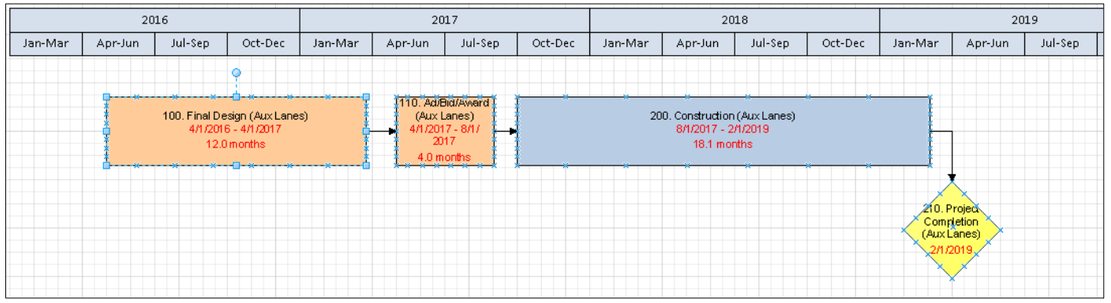
			Unit Cost					Quantity					Total			Reviewed previously awarded projects for a comparison of unit prices
	Item	Unit	Low	%	Most Likely	%	High	Low	%	Most Likely	%	High	Low	Most Likely	High	Cost Lead Revisions
6080005	REGULATORY,WARN, OR MARKER SIGN PANEL W/TYP IX/XI SHEET	SQ.FT.	$22	-12%	$25	8%	$27	742	-5%	781	5%	820	$16,323	$19,525	$22,341	
6080018	EXTRUDED ALUMINUM SIGN PANEL,TYP IX/XI SHEET	SQ.FT.	$22	-12%	$25	8%	$27	3,275	-5%	3,447	5%	3,619	$72,042	$86,175	$97,722	
6080025	FLAT SHEET ALUM W/DIR-APP OR SLK SCRN CHAR.,TYP IX/XI SHEET	SQ.FT.	$26	-10%	$29	10%	$32	160	-5%	168	5%	176	$4,150	$4,872	$5,645	
6080101	MISCELLANEOUS WORK (SIGNS) (REMOVE AND SALVAGE)	L.SUM	$78,300	-10%	$87,000	10%	$95,700	1	0%	1	0%	1	$78,300	$87,000	$95,700	
7015052	OBLITERATE PAVEMENT MARKING (STRIPE)	L.FT.	$0.45	-10%	$0.50	10%	$0.55	39,822	-5%	41,918	5%	44,014	$17,920	$20,959	$24,208	
7020008	IMPACT ATTENUATION DEVICE (SMART CUSHION)	EACH	$18,000	-10%	$20,000	10%	$22,000	3	0%	3	0%	3	$54,000	$60,000	$66,000	
7030090	REFERENCE MARKER (M-30)	EACH	$90	-10%	$100	10%	$110	18	0%	18	0%	18	$1,620	$1,800	$1,980	
7030095	MILEPOST MARKER (S-10)	EACH	$270	-10%	$300	10%	$330	6	0%	6	0%	6	$1,620	$1,800	$1,980	
7040005	PAVEMENT MARKING (WHITE THERMOPLASTIC) (ALKYD EXTRUDED) (0.090")	L.FT.	$0.32	-10%	$0.35	10%	$0.39	104,991	-5%	110,517	5%	116,043	$33,072	$38,681	$44,676	
7040006	PAVEMENT MARKING (YELLOW THERMOPLASTIC) (ALKYD EXTRUDED) (0.09	L.FT.	$0.32	-9%	$0.35	10%	$0.39	72,070	-5%	75,863	5%	79,656	$23,062	$26,552	$30,668	
7040072	PAVEMENT MARKING (TRANSVERSE) (THERMOPLASTIC) (ALKYD) (0.090")	L.FT.	$0.45	-10%	$0.50	9%	$0.55	513	-5%	540	5%	567	$231	$270	$309	
7040073	PAVEMENT LEGEND (EXTRUDED THERMOPLASTIC) (ALKYD) (0.090")	EACH	$110	-8%	$120	8%	$130	12	0%	12	0%	12	$1,320	$1,440	$1,560	
7040074	PAVEMENT SYMBOL (EXTRUDED THERMOPLASTIC) (ALKYD) (0.090")	EACH	$100	-9%	$110	9%	$120	41	0%	41	0%	41	$4,100	$4,510	$4,920	
7042031	PRIMER-SEALER FOR PCCP THERMOPLASTIC STRIPING	L.FT.	$0.25	-17%	$0.30	17%	$0.35	10,481	-5%	11,033	5%	11,585	$2,620	$3,310	$4,055	
7050047	PAVEMENT MARKING, PREFORMED, PATTERNED, WHITE STRIPE	L.FT.	$2.70	-10%	$3.00	10%	$3.30	51,780	-5%	54,505	5%	57,230	$139,805	$163,515	$188,860	
7060013	PAVEMENT MARKER, RAISED, TYPE C	EACH	$3.60	-10%	$4.00	10%	$4.40	4,379	0%	4,379	0%	4,379	$15,764	$17,516	$19,268	
7060017	PAVEMENT MARKER, RAISED, TYPE E	EACH	$3.60	-10%	$4.00	10%	$4.40	1,622	0%	1,622	0%	1,622	$5,839	$6,488	$7,137	
7080001	PERMANENT PAVEMENT MARKING (PAINTED) (WHITE)	L.FT.	$0.11	-8%	$0.12	25%	$0.15	122,002	-5%	128,423	5%	134,844	$13,420	$15,411	$20,227	
7080011	PERMANENT PAVEMENT MARKING (PAINTED) (YELLOW)	L.FT.	$0.11	-8%	$0.12	25%	$0.15	48,046	-5%	50,575	5%	53,104	$5,285	$6,069	$7,966	
7080301	PAINT BULL NOSE	EACH	$68	-9%	$75	11%	$83	6	0%	6	0%	6	$408	$450	$498	
7310060	POLE (TYPE F)	EACH	$3,150	-10%	$3,500	10%	$3,850	1	0%	1	0%	1	$3,150	$3,500	$3,850	
7310070	POLE (TYPE G) (STANDARD BASE)	EACH	$1,170	-10%	$1,300	10%	$1,430	45	0%	45	0%	45	$52,650	$58,500	$64,350	
7310130	POLE (TYPE Q)	EACH	$3,150	-10%	$3,500	10%	$3,850	2	0%	2	0%	2	$6,300	$7,000	$7,700	
7310190	POLE (55 FT CCTV WITH CAMERA LOWERING DEVICE)	EACH	$9,000	-10%	$10,000	10%	$11,000	2	0%	2	0%	2	$18,000	$20,000	$22,000	
7310197	BREAKAWAY BASE FOR LIGHTING POLE OR SIGNAL FLASHER	EACH	$360	-10%	$400	10%	$440	45	0%	45	0%	45	$16,200	$18,000	$19,800	
7310250	POLE FOUNDATION (TYPE F)	EACH	$1,350	-10%	$1,500	10%	$1,650	1	0%	1	0%	1	$1,350	$1,500	$1,650	
7310260	POLE FOUNDATION (TYPE G) (STANDARD BASE)	EACH	$675	-10%	$750	10%	$825	45	0%	45	0%	45	$30,375	$33,750	$37,125	
7310310	POLE FOUNDATION (TYPE Q)	EACH	$1,350	-10%	$1,500	10%	$1,650	2	0%	2	0%	2	$2,700	$3,000	$3,300	
7310371	POLE FOUNDATION (CCTV POLE)	EACH	$2,700	-10%	$3,000	10%	$3,300	5	0%	5	0%	5	$13,500	$15,000	$16,500	
7310500	MAST ARM (8 FT.) (TAPERED)	EACH	$270	-10%	$300	10%	$330	1	0%	1	0%	1	$270	$300	$330	
7310506	MAST ARM (6 FT.) (TAPERED)	EACH	$225	-10%	$250	10%	$275	45	0%	45	0%	45	$10,125	$11,250	$12,375	
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	$720	-10%	$800	10%	$880	3	0%	3	0%	3	$2,160	$2,400	$2,640	
7310561	MAST ARM (25 FT.) (TAPERED)	EACH	$1,080	-10%	$1,200	10%	$1,320	2	0%	2	0%	2	$2,160	$2,400	$2,640	
7310812	REMOVE AND SALVAGE EXISTING LIGHTING POLES	EACH	$225	-10%	$250	10%	$275	23	0%	23	0%	23	$5,175	$5,750	$6,325	
7320030	ELECTRICAL CONDUIT (1") (PVC)	L.FT.	$3.60	-10%	$4.00	10%	$4.40	428	-5%	450	5%	473	$1,539	$1,800	$2,079	
7320050	ELECTRICAL CONDUIT (2") (PVC)	L.FT.	$4.50	-10%	$5.00	10%	$5.50	12,246	-5%	12,890	5%	13,535	$55,105	$64,450	$74,440	
7320070	ELECTRICAL CONDUIT (3") (PVC)	L.FT.	$5.40	-10%	$6.00	10%	$6.60	8,255	-5%	8,689	5%	9,123	$44,575	$52,134	$60,215	
7320073	ELECTRICAL CONDUIT (2-3") (PVC)	L.FT.	$13.50	-10%	$15.00	10%	$16.50	6,650	-5%	7,000	5%	7,350	$89,775	$105,000	$121,275	
7320291	ELECTRICAL CONDUIT (2-3" HDPE, DIRECTIONAL DRILL)	L.FT.	$23	-8%	$25	12%	$28	950	-5%	1,000	5%	1,050	$21,850	$25,000	$29,400	
7320293	ELECTRICAL CONDUIT (3-3" HDPE, DIRECTIONAL DRILL)	L.FT.	$27	-10%	$30	10%	$33	950	-5%	1,000	5%	1,050	$25,650	$30,000	$34,650	
7320294	ELECTRICAL CONDUIT (1-3" HDPE, DIRECTIONAL DRILL)	L.FT.	$20	-11%	$22.00	11%	$25	190	-5%	200	5%	210	$3,705	$4,400	$5,145	
7320297	ELECTRICAL CONDUIT (3-3") (PVC)	L.FT.	$13.50	-10%	$15.00	10%	$16.50	3,800	-5%	4,000	5%	4,200	$51,300	$60,000	$69,300	
7320298	ELECTRICAL CONDUIT (4-3") (PVC)	L.FT.	$18.00	-10%	$20.00	10%	$22.00	190	-5%	200	5%	210	$3,420	$4,000	$4,620	
7320420	PULL BOX (NO. 7)	EACH	$540	-10%	$600	10%	$660	39	0%	39	0%	39	$21,060	$23,400	$25,740	
7320437	PULL BOX (NO. 4B)	EACH	$495	-10%	$550	10%	$605	44	0%	44	0%	44	$21,780	$24,200	$26,620	
7320438	PULL BOX (NO. 6B)	EACH	$675	-10%	$750	10%	$825	6	0%	6	0%	6	$4,050	$4,500	$4,950	
7320455	PULL BOX (NO. 9)	EACH	$2,250	-10%	$2,500	10%	$2,750	3	0%	3	0%	3	$6,750	$7,500	$8,250	
7320456	PULL BOX (SPLIT NO.9)	EACH	$3,600	-10%	$4,000	10%	$4,400	17	0%	17	0%	17	$61,200	$68,000	$74,800	
7320503	CONDUCTOR (NO. 12)	L.FT.	$0.35	-13%	$0.40	13%	$0.45	855	-5%	900	5%	945	$299	$360	$425	
7320510	CONDUCTOR (NO. 10)	L.FT.	$0.45	-10%	$0.50	10%	$0.55	24,491	-5%	25,780	5%	27,069	$11,021	$12,890	$14,888	

			Unit Cost					Quantity					Total			Reviewed previously awarded projects for a comparison of unit prices
	Item	Unit	Low	%	Most Likely	%	High	Low	%	Most Likely	%	High	Low	Most Likely	High	Cost Lead Revisions
7320520	CONDUCTOR (NO. 8)	L.FT.	$0.55	-8%	$0.60	8%	$0.65	26,940	-5%	28,358	5%	29,776	$14,817	$17,015	$19,354	
7320530	CONDUCTOR (NO. 6)	L.FT.	$0.80	-11%	$0.90	11%	$1.00	40,410	-5%	42,537	5%	44,664	$32,328	$38,283	$44,664	
7320540	CONDUCTOR (NO. 4)	L.FT.	$1.10	-8%	$1.20	8%	$1.30	18,136	-5%	19,090	5%	20,045	$19,949	$22,908	$26,058	
7320560	CONDUCTOR (NO. 2)	L.FT.	$1.70	-8%	$1.85	11%	$2.05	13,470	-5%	14,179	5%	14,888	$22,899	$26,231	$30,520	
7320580	CONDUCTOR (BARE BOND)	L.FT.	$0.55	-8%	$0.60	8%	$0.65	13,898	-5%	14,629	5%	15,360	$7,644	$8,777	$9,984	
7320765	SINGLE MODE FIBER OPTIC CABLE (12 FIBERS)	L.FT.	$1.55	-11%	$1.75	11%	$1.95	2,375	-5%	2,500	5%	2,625	$3,681	$4,375	$5,119	
7320787	SINGLE MODE FIBER OPTIC CABLE (144 FIBERS)	L.FT.	$1.75	-13%	$2.00	10%	$2.20	6,175	-5%	6,500	5%	6,825	$10,806	$13,000	$15,015	
7320794	FIBER OPTIC SPLICE CLOSURE (FMS)	EACH	$1,350	-10%	$1,500	10%	$1,650	14	0%	14	0%	14	$18,900	$21,000	$23,100	
7330060	TRAFFIC SIGNAL FACE (TYPE F)	EACH	$360	-10%	$400	10%	$440	4	0%	4	0%	4	$1,440	$1,600	$1,760	
7330135	TRAFFIC SIGNAL FACE (TYPE R)	EACH	$450	-10%	$500	10%	$550	1	0%	1	0%	1	$450	$500	$550	
7330211	PEDESTRIAN SIGNAL (COUNT DOWN)	EACH	$315	-10%	$350	10%	$385	1	0%	1	0%	1	$315	$350	$385	
7330310	TRAFFIC SIGNAL MOUNTING ASSEMBLY (TYPE II)	EACH	$135	-10%	$150	10%	$165	5	0%	5	0%	5	$675	$750	$825	
7330340	TRAFFIC SIGNAL MOUNTING ASSEMBLY (TYPE V)	EACH	$315	-10%	$350	10%	$385	1	0%	1	0%	1	$315	$350	$385	
7330410	POLE FLASHER	EACH	$1,800	-10%	$2,000	10%	$2,200	12	0%	12	0%	12	$21,600	$24,000	$26,400	
7330446	RAMP METER SIGNAL AND SUPPORT ASSEMBLY	EACH	$2,700	-10%	$3,000	10%	$3,300	12	0%	12	0%	12	$32,400	$36,000	$39,600	
7340103	CONTROL CABINET (CCTV)	EACH	$2,250	-10%	$2,500	10%	$2,750	2	0%	2	0%	2	$4,500	$5,000	$5,500	
7340304	CONTROL CABINET FOUNDATION (RAMP & COUNTER WITH TRANSFORMER)	EACH	$720	-10%	$800	10%	$880	10	0%	10	0%	10	$7,200	$8,000	$8,800	
7340305	CONTROL CABINET FOUNDATION (DMS WITH TRANSFORMER)	EACH	$720	-10%	$800	10%	$880	2	0%	2	0%	2	$1,440	$1,600	$1,760	
7340401	TRANSFORMER FOUNDATION	EACH	$540	-10%	$600	10%	$660	5	0%	5	0%	5	$2,700	$3,000	$3,300	
7350030	LOOP DETECTOR FOR TRAFFIC SURVEILLANCE (6' X 6')	EACH	$540	-10%	$600	10%	$660	128	0%	128	0%	128	$69,120	$76,800	$84,480	
7350051	DETECTOR CARD	EACH	$110	-8%	$120	8%	$130	64	0%	64	0%	64	$7,040	$7,680	$8,320	
7350165	LOOP DETECTOR LEAD-IN CABLE	L.FT.	$0.54	-10%	$0.60	10%	$0.66	24,700	-5%	26,000	5%	27,300	$13,338	$15,600	$18,018	
7360078	LUMINAIRE (HIGH MAST) (LED)	EACH	$1,350	-10%	$1,500	10%	$1,650	106	0%	106	0%	106	$143,100	$159,000	$174,900	
7360104	LUMINAIRE (HORIZONTAL MOUNT) (LED)	EACH	$675	-10%	$750	10%	$825	48	0%	48	0%	48	$32,400	$36,000	$39,600	
7370403	TRANSFORMER (3KV-A)	EACH	$1,800	-10%	$2,000	10%	$2,200	2	0%	2	0%	2	$3,600	$4,000	$4,400	
7370426	ELECTRICAL SYSTEM (FLASHER UNIT-MODEL 204)	EACH	$45	-10%	$50	10%	$55	12	0%	12	0%	12	$540	$600	$660	
7370457	MISCELLANEOUS ELECTRICAL (1" INNERDUCT)	L.FT.	$0.70	-7%	$0.75	7%	$0.80	2,375	-5%	2,500	5%	2,625	$1,663	$1,875	$2,100	
7370666	SWITCH PACK (LOAD SWITCH) (MODEL 200)	EACH	$63	-10%	$70	10%	$77	6	0%	6	0%	6	$378	$420	$462	
7370705	CCTV FIELD EQUIPMENT	EACH	$4,500	-10%	$5,000	10%	$5,500	2	0%	2	0%	2	$9,000	$10,000	$11,000	
8070001	LANDSCAPING ESTABLISHMENT ($50K PER ACRE FOR 6 ACRES)	L.SUM	$270,000	-10%	$300,000	10%	$330,000	1	0%	1	0%	1	$270,000	$300,000	$330,000	
9100008	CONCRETE BARRIER (C-10.52) (4.5' GUTTER)	L.FT.	$45	-10%	$50	10%	$55	11,332	-5%	11,932	5%	12,529	$510,093	$596,600	$689,073	
9100009	CONCRETE BARRIER (WITH SCREEN WALL) (DETAIL X)	L.FT.	$59	-10%	$65	11%	$72	6,261	-5%	6,591	5%	6,921	$366,295	$428,415	$498,280	
9100114	CONCRETE BARRIER TRANSITION (For DMS Structure)	EACH	$13,500	-10%	$15,000	10%	$16,500	4	0%	4	0%	4	$54,000	$60,000	$66,000	
9140153	RETAINING WALL (REINFORCED CONCRETE)	SQ.FT.	$55	-8%	$60	8%	$65	203,780	-5%	214,505	5%	225,230	$11,207,886	$12,870,300	$14,639,966	How tall? How many locations?
9240119	MISCELLANEOUS WORK (SIGN MOUNT BRACKET FOR LIGHT OR SIGNAL POI	EACH	$225	-10%	$250	10%	$275	14	0%	14	0%	14	$3,150	$3,500	$3,850	
9240120	MISCELLANEOUS WORK (CCTV POLE, CAMERA,CABINET AND TRANSFORME	EACH	$3,600	-10%	$4,000	10%	$4,400	3	0%	3	0%	3	$10,800	$12,000	$13,200	
9240121	MISCELLANEOUS WORK (RAMP METERING/COUNTER CABINET & TRANSFOI	EACH	$1,800	-10%	$2,000	10%	$2,200	10	0%	10	0%	10	$18,000	$20,000	$22,000	
9240122	MISCELLANEOUS WORK (DMS, CABINET AND TRANSFORMER)	EACH	$2,700	-10%	$3,000	10%	$3,300	2	0%	2	0%	2	$5,400	$6,000	$6,600	
999X003	BRIDGE WIDENING (16TH STREET TIOP NB)	SQ.FT.	$110	-8%	$120	13%	$135	1,329	-2%	1356	2%	1,383	$146,177	$162,720	$186,721	What are the bridge types and span lengths?
999X003	BRIDGE WIDENING (3RD STREET OP NB)	SQ.FT.	$110	-8%	$120	13%	$135	3,522	-2%	3,594	2%	3,666	$387,433	$431,280	$494,894	
999X003	BRIDGE WIDENING (3RD STREET OP SB)	SQ.FT.	$110	-8%	$120	13%	$135	2,946	-2%	3,006	2%	3,066	$324,047	$360,720	$413,926	
999X003	BRIDGE WIDENING (CENTRAL AVENUE OP NB)	SQ.FT.	$135	-10%	$150	10%	$165	1,964	-2%	2,004	2%	2,044	$265,129	$300,600	$337,273	
999X003	BRIDGE WIDENING (CENTRAL AVENUE OP SB)	SQ.FT.	$135	-10%	$150	10%	$165	2,030	-2%	2,071	2%	2,112	$273,993	$310,650	$348,549	
999X003	BRIDGE WIDENING (11TH AVENUE OP NB)	SQ.FT.	$135	-10%	$150	10%	$165	3,847	-2%	3,926	2%	4,005	$519,410	$588,900	$660,746	
999X003	BRIDGE WIDENING (11TH AVENUE OP SB)	SQ.FT.	$135	-10%	$150	10%	$165	1,503	-2%	1,534	2%	1,565	$202,948	$230,100	$258,172	
999X003	BRIDGE WIDENING (15TH AVENUE OP NB)	SQ.FT.	$110	-8%	$120	13%	$135	1,096	-2%	1,088	2%	1,110	$117,280	$130,560	$149,818	
999X003	BRIDGE WIDENING (15TH AVENUE OP SB)	SQ.FT.	$110	-8%	$120	13%	$135	1,145	-2%	1168	2%	1,191	$125,910	$140,160	$160,834	
												Bid Item subtotal	$23,568,901	$27,069,344	$31,008,033	

	Maintenance and Protection of Traffic	10.00%	$2,356,890	$3,100,000	$3,100,803						$2,356,890	$3,100,000	$3,100,803		
	Dust and Water Palliative	0.75%	$176,767	$203,020	$232,560						$176,767	$203,020	$232,560		
	Contractor Quality Control	0.75%	$176,767	$203,020	$232,560						$176,767	$203,020	$232,560		
	Contractor Surveying	1.25%	$294,611	$338,367	$387,600						$294,611	$338,367	$387,600		
	Erosion Control	0.50%	$117,845	$135,347	$155,040						$117,845	$135,347	$155,040		
										Subtotal A	**$26,691,780**	**$31,049,097**	**$35,116,597**		
	Miscellaneous Item Allowance (Unidentified Items)	5.00%	$1,334,589	$1,552,455	$1,755,830						$1,334,589	$1,552,455	$1,755,830	was 20% lowered to 5%, very detailed estimate	
										Subtotal B	**$28,026,369**	**$32,601,552**	**$36,872,427**		
	Mobilization	8.00%	$2,242,110	$2,608,124	$2,949,794						$2,242,110	$2,608,124	$2,949,794	was $3.3 M	
										Subtotal C	**$30,268,479**	**$35,209,676**	**$39,822,221**		
										Contract Total	**$30,268,479**	**$35,209,676**	**$39,822,221**		
										Uncertainty	-14.0%		13.1%		
	Engineering & Contingency														
	Construction Engineering	9.00%	$2,724,163	$3,168,871	$3,584,000						$2,724,163	$3,168,871	$3,584,000		
	Design	8.00%	$2,286,478	$2,666,774	$3,020,778						$2,286,478	$2,666,774	$3,020,778		
	Construction Contingency	5.00%	$1,513,424	$1,760,484	$1,991,111										
										Subtotal D	**$35,279,120**	**$41,045,521**	**$46,420,998**		
	Non-Bid Project Costs														
	Environmental Mitigation (Unknown at this lime)														
	PCCP Quality Incentive	SY	$2	$2	$2	65,697	-2%	67,038	2%	68,379	$ 98,546	$ 100,557	$ 102,568		
	AR-ACFC Smoothness Incentive	MILE	$11,000	$11,000	$11,000	30.0	0%	30.0	0%	30.0	$330,000	$330,000	$330,000		
	Right-of-Way	LS	$0	$0	$0						$0	$0	$0		
	Ad-Bid-Award		$135,000	$150,000	$165,000						$135,000	$150,000	$165,000	subtracted from design costs	
											$35,842,666	**$41,625,878**	**$47,024,567**		
	Indirect Cost Allocation	10.35%	$3,709,716	$4,308,278	$4,867,043						$3,709,716	$4,308,278	$4,867,043		
	Costs spent to date										$0		$0		
										Project Total	**$39,552,382**	**$45,934,157**	**$51,891,609**		
												$ 3,496,849	CE with ICAP		
												$ 39,328,998	Raw CN with ICAP		

Unit costs provided for the Near Term project were used to develop the ultimate configuration cost estimate, with verification conducted during the Value Planning portion of the workshop. Please see the next pages for the detailed breakdown of the ultimate configuration project costs.

Base Schedule Review – Near Term



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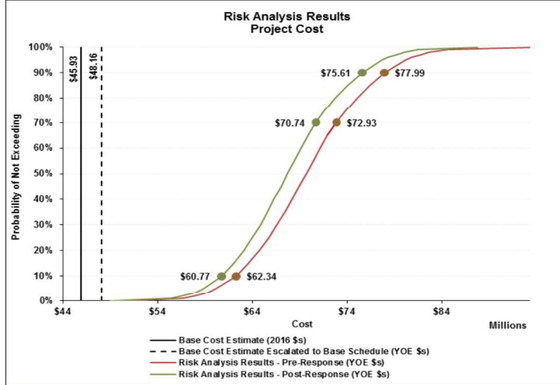
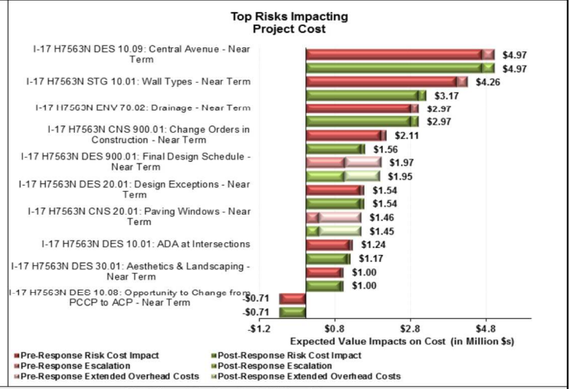
Analysis of Results – Near Term

CRA Workshop Cost Summary Sheet	I-17 I-10 Near-Term Improvements Last Updated February 2016	Level of Project Design: Low – Medium – High

Project Description

The purpose of this project is to improve the operation and safety of I-17. The proposed near-term improvements would add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions of travel between 16th Street and 19th Avenue and would extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp.





Cost Results

The S-curves reveal that, prior to risk response, there was a **70 percent** chance of the total project costs being less than **$72.9 million** in year-of-expenditure (YOE).

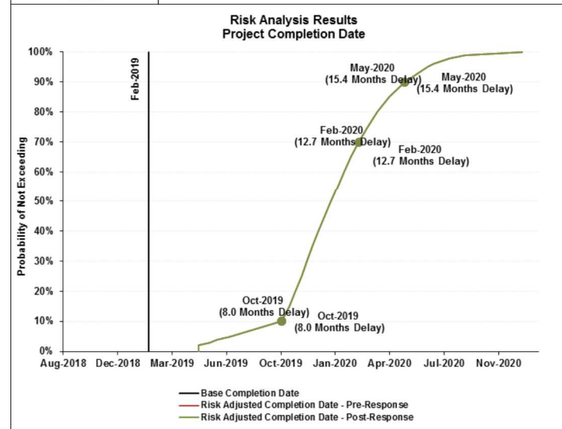
With the risk response strategies included, project costs now have a **70 percent** chance of being less than **$70.7 million** YOE.

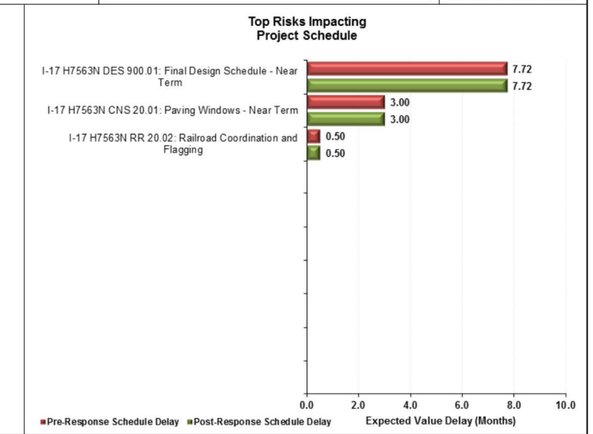
These results indicate that by implementing the risk response strategies developed at the CRA workshop, project costs are expected to be reduced by **$2.2 million**.

Risk-Adjusted Cost Results (in Millions $s)

Category	Base Cost 2016 $s	Base Cost YOE $s	70th Percentile 2016 $s	70th Percentile YOE $s
Pre-Response Results Total Project	$45.9	$48.2	$68.2	$72.9
Post-Response Results Total Project			$66.2	$70.7
Post-Response Preliminary Engineering	$3.1	$3.2	$4.3	$4.5
Post-Response Right-of-Way	$0.0	$0.0	$0.0	$0.0
Post-Response Construction	$42.8	$45.0	$61.9	$66.2

CRA Workshop Schedule Summary Sheet	I-17 I-10 Near-Term Improvements Last Updated February 2016	Level of Project Design: Low – Medium – High





Schedule Results

Under the base schedule, the project is expected to be completed in **February, 2019**. The S-curves reveal that, prior to risk response, there is a **70 percent** chance that the project will be completed by **February, 2020** indicating a risk of potential delay to project completion of approximately **12.7 months**.

After including the risk response strategies developed at the CRA workshop, the project completion delay is reduced to approximately **12.7 months** with the project being completed in **February, 2020**.

By employing the risk response strategies developed within the CRA, project completion can be achieved **0.0 months** earlier.

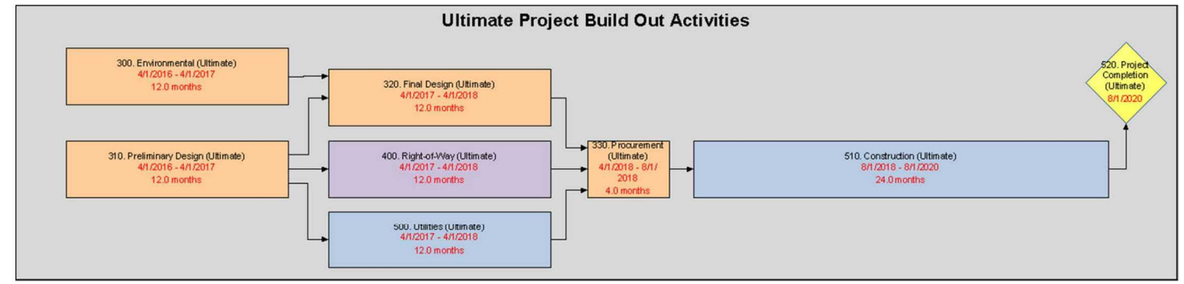
Risk-Adjusted Schedule Results

Category	Base Date	Project Completion Date Range: 10th Percentile	70th Percentile	90th Percentile
Pre-Response Results	Feb-2019	Oct-2019	Feb-2020	May-2020
Post-Response Results		Oct-2019	Feb-2020	May-2020
Post-Response Advertisement Date	Apr 2017	Aug 2017	Jan 2018	Apr 2018
Post-Response Construction Duration	18.0 Months	21.1 Months	21.1 Months	21.1 Months

Base Cost Estimate Review – Ultimate

Item	Unit	Unit Cost Low	%	Unit Cost Most Likely	%	Unit Cost High	Quantity Low	%	Quantity Most Likely	%	Quantity High	Total Low	Total Most Likely	Total High	Cost Lead Revisions
CLEARING & GRUBBING ($100K/Mile)	MILE	$85,000	-15%	$100,000	25%	$125,000	3.57	0%	3.57	0%	3.57	$303,450	$357,000	$446,250	
REMOVAL, BRIDGE	SQ.FT.	$30	-14%	$35	14%	$40	98,895	-5%	104,100	5%	109,305	$2,966,850	$3,643,500	$4,372,200	
REMOVAL, PAVEMENT (CEMENT CONCRETE PAVEMENT)	SQ.YD.	$10.00	-17%	$12.00	25%	$15.00	211,090	-5%	222,200	5%	233,310	$2,110,900	$2,666,400	$3,499,650	Pavement removal is concrete.
REMOVAL, OTHER ($250K/Mile)	MILE	$200,000	-20%	$250,000	20%	$300,000	3.57	0%	3.57	0%	3.57	$714,000	$892,500	$1,071,000	
ROADWAY EXCAVATION	CU.YD.	$12.00	-20%	$15.00	20%	$18.00	9,500	-5%	10,000	5%	10,500	$114,000	$150,000	$189,000	Range between 12 to 15 dollars. Increased from 'most likely from 5 to 15 due to urban setting
BORROW (Less Topsoil)	CU.YD.	$7.00	-30%	$10.00	20%	$12.00	192,660	-5%	202,800	5%	212,940	$1,348,620	$2,028,000	$2,555,280	Bid data shows between 12 and 30/cy for similar quantities. I moved this up from 7 to 15/cy due to access limitations. This was lowered down to $10/cy during the value planning portion of the workshop.
FURNISH WATER SUPPLY (10% of Total Earthwork Cost)	L.SUM	$176,607	-30%	$253,500	26%	$319,053	1	0%	1	0%	1	$176,607	$253,500	$319,053	
CONCRETE PAVEMENT (Includes Base Material)	SQ.YD.	$40	-11%	$45	11%	$50	279,015	-5%	293,700	5%	308,385	$11,160,600	$13,216,500	$15,419,250	Appears reasonable based on large quantity. Bumped up 'most likely' category up from $45 to $50/sy to accommodate base material.
ARFC OVERLAY (1" Rubberized Overlay)	TONS	$35	-13%	$40	13%	$45	16,530	-5%	17,400	5%	18,270	$578,550	$696,000	$822,150	
ON-SITE DRAINAGE (Various 25% of Pvmt Cost)	L.SUM	$2,934,788	-16%	$3,478,125	17%	$4,060,350	1	0%	1	0%	1	$2,934,788	$3,478,125	$4,060,350	Should we increase 'most likely' $3.5M to $5M due to urban setting and possibility of jack and bore methods
OFF-SITE DRAINAGE (Various 10% of Pvmt Cost)	L.SUM	$1,173,915	-16%	$1,391,250	17%	$1,624,140	1	0%	1	0%	1	$1,173,915	$1,391,250	$1,624,140	Should we increase 'most likely' value from $1.5 to $2M due to similar issue as that listed above.
19th AVE OP	SQ. FT.	$110	-8%	$120	8%	$130	21,090	-5%	22,200	5%	23,310	$2,319,900	$2,664,000	$3,030,300	
17TH AVE OP	SQ. FT.	$110	-6%	$120	6%	$130	23,100	-5%	24,400	5%	25,620	$2,543,000	$2,928,000	$3,330,600	
11TH AVE OP	SQ. FT.	$110	-8%	$120	8%	$130	19,285	-5%	20,300	5%	21,315	$2,121,350	$2,436,000	$2,770,950	
7TH AVE OP	SQ. FT.	$110	-8%	$120	8%	$130	19,760	-5%	20,800	5%	21,840	$2,173,600	$2,496,000	$2,839,200	Adjustments were made to structure costs during the value planning workshop based on more accurate information.
CENTRAL AVE OP	SQ. FT.	$110	-8%	$120	8%	$130	26,695	-5%	28,100	5%	29,505	$2,936,450	$3,372,000	$3,835,650	
7TH ST OP	SQ. FT.	$110	-8%	$120	8%	$130	20,330	-5%	21,400	5%	22,470	$2,236,300	$2,568,000	$2,921,100	
16TH ST OP	SQ. FT.	$110	-8%	$120	8%	$130	20,805	-5%	21,900	5%	22,995	$2,288,550	$2,628,000	$2,989,350	
3RD ST PED CROSSING	SQ. FT.	$55	-8%	$60	8%	$65	1,615	-5%	1,700	5%	1,785	$88,825	$102,000	$116,025	
12TH ST PED CROSSING	SQ.FT.	$55	-8%	$60	8%	$65	0	-5%	0	5%	0	$0	$0	$0	Assume protect existing ped x-ing.
SIGNING & PAVEMENT MARKING ($0.5M/Mile)	MILE	$450,000	-10%	$500,000	10%	$550,000	3.57	0%	3.57	0%	3.57	$1,606,500	$1,785,000	$1,963,500	
LIGHTING/FMS ($1M/Mile)	MILE	$800,000	-20%	$1,000,000	25%	$1,250,000	3.57	0%	3.57	0%	3.57	$2,856,000	$3,570,000	$4,462,500	
LANDSCAPING ($450K/Mile)	MILE	$400,000	-11%	$450,000	11%	$500,000	3.57	0%	3.57	0%	3.57	$1,428,000	$1,606,500	$1,785,000	
TOPSOIL	CU.YD.	$9.00	-10%	$10.00	20%	$12.00	47,500	-5%	50,000	5%	52,500	$427,500	$500,000	$630,000	
RETAINING WALLS	SQ.FT.	$45	-10%	$50	10%	$55	451,250	-5%	475,000	5%	498,750	$20,306,250	$23,750,000	$27,431,250	Assume reinf. Concrete cantilever wall. Changed in workshop from $65 to $50 based on discussion of wall price and large quantity.
SOUND WALLS	SQ.FT.	$30	-14%	$35	14%	$40	143,260	-5%	150,800	5%	158,340	$4,297,800	$5,278,000	$6,333,600	Appears reasonable. Noise wall was 30 - 40 per sf on aother ADOT project.
ROADWAY APPURTENANCES ($1M/Mile)	MILE	$900,000	-10%	$1,000,000	25%	$1,250,000	3.57	0%	3.57	0%	3.57	$3,213,000	$3,570,000	$4,462,500	
DPS TRAFFIC CONTROL ($250K/Mile)	MILE	$225,000	-10%	$250,000	10%	$275,000	3.57	0%	3.57	0%	3.57	$803,250	$892,500	$981,750	Department of Public Safety - Highway Patrol
											Bid Item subtotal	**$75,235,355**	**$88,918,775**	**$104,261,598**	
EROSION CONTROL (1% of Bid Items)	1%	$793,354	-15%	$999,189	17%	$1,043,614	1	0%	1	0%	1	$793,354	$999,189	$1,043,614	
TRAFFIC CONTROL (20% of Bid Items)	20%	$15,047,071	-15%	$17,783,755	17%	$20,852,320	1	0%	1	0%	1	$15,047,071	$17,783,755	$20,852,320	Large range established based on high impact to traveling public, existing profile, urban environment and high profile area.
CONTRACTOR QUALITY CONTROL (2% of Bid Items)	2%	$1,504,707	-15%	$1,778,376	17%	$2,085,232	1	0%	1	0%	1	$1,504,707	$1,778,376	$2,085,232	Applied range around original assumption
CONSTRUCTION SURVEYING (2% of Bid Items)	2%	$1,504,707	-15%	$1,778,376	17%	$2,085,232	1	0%	1	0%	1	$1,504,707	$1,778,376	$2,085,232	Applied range around original assumption
CONTRACTOR INCENTIVES (3.5% of Pvmt Cost)	4%	$410,870	-16%	$486,938	17%	$568,449	1	0%	1	0%	1	$410,870	$486,938	$568,449	Increased slightly from base due to adjustment in pavement costs above
											Subtotal A	**$94,455,063**	**$111,635,406**	**$130,895,447**	
Miscellaneous Item Allowance	25%	$23,613,766		$27,908,852		$32,723,862	1	0%	1	0%	1	$23,613,766	$27,908,852	$32,723,862	
											Subtotal B	**$118,068,829**	**$139,544,258**	**$163,619,308**	
MOBILIZATION (8% of Subtotal B)	8%	$9,445,506.34	-15%	$11,163,540.63	17%	$13,089,544.65	1		1		1	$7,556,405	$8,930,833	$10,471,636	
											Contract Total	**$125,625,234**	**$148,475,090**	**$174,090,944**	
											Uncertainty	-15.4%		17.3%	
PRELIM/FINAL DESIGN (10% of contract total)	10%	$12,562,523	-15%	$14,847,509	17%	$17,409,094	1	0%	1	0%	1	$12,562,523	$14,847,509	$17,409,094	
CONSTRUCTION ENGINEERING (9% of Contract total	9%	$8,500,956	-15%	$10,047,187	17%	$11,780,590	1	0%	1	0%	1	$8,500,956	$10,047,187	$11,780,590	
PRIOR RIGHT UTIL RELOC & SERV AGREEMENTS ($1M/Mile)	MILE	$900,000	-10%	$1,000,000	20%	$1,200,000	3.57	0%	3.57	0%	3.57	$3,213,000	$3,570,000	$4,284,000	
CONSTRUCTION CONTINGENCIES (5% contract total)	5%	$3,781,768	-15%	$4,445,939	17%	$5,213,080	0	0%	0	0%	0	$0	$0	$0	
Public Relations	LS	$300,000	-40%	$500,000	100%	$1,000,000	1		1		1	$300,000	$500,000	$1,000,000	
											Project Subtotal	**$150,201,713**	**$177,439,786**	**$208,544,628**	
ICAP	10.35%	$15,545,877	-15%	$18,365,018	18%	$21,586,439						$15,545,877	$18,365,018	$21,586,439	
											Contract Total	**$165,747,591**	**$195,804,804**	**$230,151,067**	
												-15.4%		17.5%	

Base Schedule Review – Ultimate

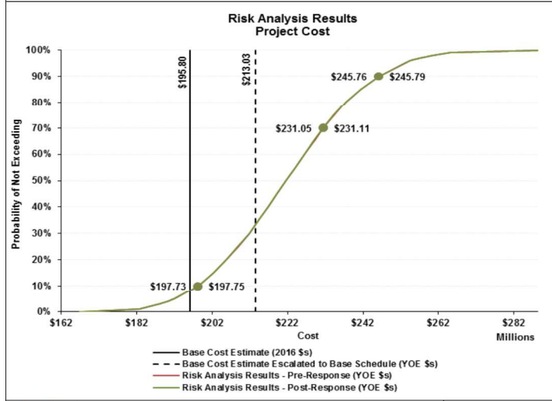


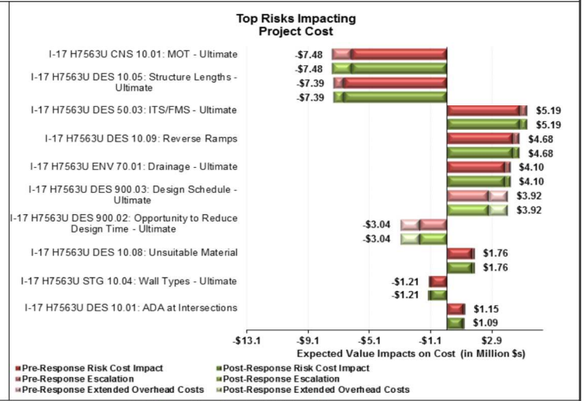
Analysis of Results – Ultimate

CRA Workshop Cost Summary Sheet	I-17 I-10 Ultimate Last Updated February 2016	Level of Project Design	Low	Medium	High

Project Description

The purpose of this project is to improve the operation and safety of I-17. The proposed ultimate improvements would add auxiliary lanes between the entrance and exit ramps in both the northbound and southbound directions of travel between 16th Street and 19th Avenue and extend the I-10/I-17 Traffic Interchange (TI) East-to-North (EN) Ramp auxiliary lane to the Seventh Street Northbound Exit Ramp. The project will replace all structures and pavement and brings the roadway up to current standards.





Cost Results

The S-curves reveal that, prior to risk response, there was a **70 percent** chance of the total project costs being less than **$231.1 million** in year-of-expenditure (YOE).

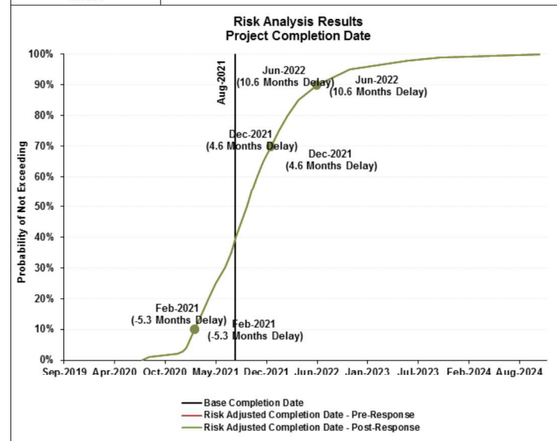
With the risk response strategies included, project costs now have a **70 percent** chance of being less than **$231.1 million** YOE.

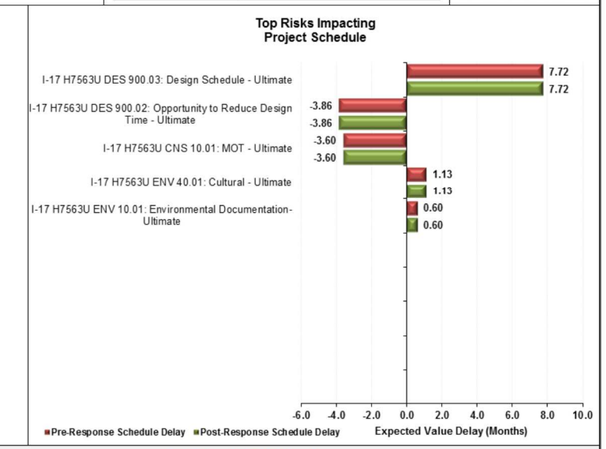
These results indicate that by implementing the risk response strategies developed at the CRA workshop, project costs are expected to be reduced by **$0.1 million**.

Risk-Adjusted Cost Results (in Millions $s)

Category	Base Cost 2016 $s	Base Cost YOE $s	70th Percentile 2016 $s	70th Percentile YOE $s
Pre-Response Results Total Project	$195.8	$213.0	$210.5	$231.1
Post-Response Results Total Project			$210.4	$231.1
Post-Response Preliminary Engineering	$16.4	$17.3	$19.2	$20.6
Post-Response Right-of-Way	$0.0	$0.0	$0.0	$0.0
Post-Response Construction	$179.4	$195.8	$191.2	$210.5

CRA Workshop Schedule Summary Sheet	I-17 I-10 Ultimate Last Updated February 2016	Level of Project Design	Low	Medium	High





Schedule Results

Under the base schedule, the project is expected to be completed in **August, 2021**. The S-curves reveal that, prior to risk response, there is a **70 percent** chance that the project will be completed by **December, 2021** indicating a risk of potential delay to project completion of approximately **4.6 months**.

After including the risk response strategies developed at the CRA workshop, the project completion delay is reduced to approximately **4.6 months** with the project being completed in **December, 2021**.

By employing the risk response strategies developed within the CRA, project completion can be achieved **0.0 months** earlier.

Risk-Adjusted Schedule Results

Category	Base Date	Project Completion Date Range		
		10th Percentile	70th Percentile	90th Percentile
Pre-Response Results	Aug-2021	Feb-2021	Dec-2021	Jun-2022
Post-Response Results		Feb 2021	Dec 2021	Jun 2022
Post-Response Advertisement Date	Apr-2018	Apr-2018	Nov-2018	May-2019
Post-Response Construction Duration	36.0 Months	30.0 Months	36.0 Months	36.0 Months

Risks Data Sheets – Ultimate

Project	I-17	**Risk ID**	I-17 H7563U CNS 10.01
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

MOT - Ultimate

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
	15%	60%	25%		3	4	
Cost ($M)	$0.00	-$8.50	$3.00	-$4.35	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)	0.00	-6.00	0.00	-3.60	3	4	

Scenario 1: The base assumes $17M in MOT cost and 3 years for construction. Scenario 2: Assumes routing the traffic down the frontage roads with improvements to the frontage roads and temporary ramps; closing I-17 mainline for construction. This will be 2.5 years of construction and $8.5M cost. Scenario 3: Assumes improvements of the frontage roads and shift mainline traffic, half at a time. This is 3 years of construction and $20 M cost.

Post-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
	15%	60%	25%			
Cost ($M)	$0.00	-$8.50	$3.00	-$4.35	**Strategy**	2/10/2016
Schedule (Mo)	0.00	-6.00	0.00	-3.60		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

February 23, 2016 Risk Register Page 1 of 31

Project	I-17	**Risk ID**	I-17 H7563U CNS 10.02
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Detour Costs - Ultimate

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%					14	6	
Cost ($M)	$0.25	$0.50	$1.00	$0.27	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	14	6	

Added costs for repairing local streets used as detours. Local agencies may require repairs.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.25	$0.50	$1.00	$0.27	**Strategy**	1/27/2016
Schedule (Mo)				0.00		

Coordinate with the local agencies

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	1/27/2016
Next Review	**Risk Assignment**
	Owner

MARICOPA ASSOCIATION of GOVERNMENTS
HDR

Project	I-17	**Risk ID**	I-17 H7563U CNS 900.02
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Change Orders in Construction - Ultimate

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					2	6	
Cost ($M)	$5.40	$6.90	$8.40	$5.18	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	2	6	

Use 3 to 5% of construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$5.40	$6.90	$8.40	$5.18	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Hold a reserve for change orders

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U CTR 10.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Change in Project Delivery - Ultimate

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)				0.00	16	6	

Base assumes DBB. If funds are available, there could be a change to DB or CMAR. This is a watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U DES 10.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

ADA at Intersections

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
95%					8	6	
Cost ($M)	$0.40	$0.60	$1.20	$0.63	Project Rank Cost	Project Rank Schedule	1/26/2016
Schedule (Mo)				0.00	8	6	

Current design does not include items for ADA at the intersections. There is a significant risk that at the time of final design or construction, the sidewalks and ramps might need to be brought up to ADA standards. There is a potential that this may trigger some ROW and/or utility impacts. Assume most likely is 6 intersections at 100k each.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
95%						
Cost ($M)	$0.40	$0.60	$1.20	$0.63	Strategy	2/10/2016
Schedule (Mo)				0.00		

Have a discussion with ADOT roadway design to exempt this project from ADA improvements, since this project is not impacting the intersections.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	1/26/2016
Next Review	**Risk Assignment**
5/1/2016	Owner

Project	I-17	**Risk ID**	I-17 H7563U DES 10.02
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Sidewalks on Frontage Roads

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
90%					9	6	
Cost ($M)	$0.40	$0.60	$0.70	$0.53	Project Rank Cost	Project Rank Schedule	1/26/2016
Schedule (Mo)				0.00	9	6	

Currently most of the frontage road stretches do not have sidewalks. Assume 40,000 lf @ $15/lf.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
90%						
Cost ($M)	$0.40	$0.60	$0.70	$0.53	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Have a discussion with ADOT Roadway group.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

February 23, 2016 Risk Register Page 6 of 31

Project	I-17	**Risk ID**	I-17 H7563U DES 10.04
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Third Ave - Ultimate

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation	Modeling Note: No Markups		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					9	6	
Cost ($M)	-$0.75	-$0.70	-$0.65	-$0.53	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	9	6	

Consider closing the Third Ave or minimizing the structure. Value planning recommendation #2: Remove 3rd St Bridge. The base assumed a 10x10 box; Value Planning removes the box. By filling this in, it may change the drainage pattern. Total removal of bridge may necessitate adding a box culvert. Majority of the savings is in lowering the mainline profile and reducing the wall height.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	-$0.75	-$0.70	-$0.65	-$0.53	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Project	I-17	Risk ID	I-17 H7563U DES 10.05
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Structure Lengths - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation	Modeling Note: No markups		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
90%					1	6	
Cost ($M)	-$8.00	-$7.40	-$7.00	-$6.69	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	1	6	

Construct the bridge to accommodate future widening of cross streets. Value Planning recommendation #1 evaluated the required length for each crossing and calculated a savings of approximately $7.4M

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
90%						
Cost ($M)	-$8.00	-$7.40	-$7.00	-$6.69	Strategy	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U DES 10.06
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

SR-30 Connection at Durango Curve - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)				0.00	16	6	

Possible provisions for an interchange at 19th Avenue. This is a watch list risk, which could have potential impacts to cost and schedule of this project. Also, the footprint at the west end of the project might increase.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	**Risk ID**	I-17 H7563U DES 10.08
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Unsuitable Material

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					7	6	
Cost ($M)	$1.00	$1.50	$2.00	$1.13	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	7	6	

There is a risk that the base material might be unsuitable and might require over excavation. Replacing all of the pavement, there might be some unsuitable material, which might need to be replaced.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$1.00	$1.50	$2.00	$1.13	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	**Risk ID**	I-17 H7563U DES 10.09
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Reverse Ramps

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation	Modeling Note: No Markups		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					4	6	
Cost ($M)	$5.00	$5.30	$6.50	$4.09	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	4	6	

Value Planning Recommendation #4 recommends reconfiguring the ramps. This adds a cost of $5.3M. This allows the project to be built at full standards among other things and improves the operations of the current ramps.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$5.00	$5.30	$6.50	$4.09	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	**Risk ID**	I-17 H7563U DES 50.03
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

ITS/FMS - Ultimate

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					6	6	
Cost ($M)	$1.50	$1.75	$2.00	$1.31	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	6	6	

The base has $0.5M/mile. This risk accounts for technology changes, unsalvageable hardware, and upgrades.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$1.50	$1.75	$2.00	$1.31	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	**Risk ID**	I-17 H7563U DES 900.02
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Opportunity to Reduce Design Time - Ultimate

Risk Trigger		**Flowchart Activity**	310, 320
Dependency & Correlation	Full Impact to both activities equally		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					16	3	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)	-6.00	-6.00	-4.00	-4.25	16	3	

Base assumes 12 months for Environmental and Preliminary Design and 12 months for Final Design. The opportunity is to have the preliminary design and final design as one design project. This could reduce the time by 6 months.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)				$0.00	**Strategy**	2/10/2016
Schedule (Mo)	-6.00	-6.00	-4.00	-4.25		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U DES 900.03
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Design Schedule - Ultimate

Risk Trigger		Flowchart Activity	300, 310
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
95%					16	2	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)	5.00	6.00	12.00	6.49	16	2	

Base assumes design schedule beginning 4/1/16. The decision for the ultimate vs. the near term may not be until March 2016. Needs 3 months time to procure a designer.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
95%						
Cost ($M)				$0.00	Strategy	2/10/2016
Schedule (Mo)	5.00	6.00	12.00	6.49		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U ENV 10.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Environmental Documentation- Ultimate

Risk Trigger		Flowchart Activity	300
Dependency & Correlation			

Pre-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
	15%	75%	2%		16	1	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)	-3.00	12.00	24.00	9.03	16	1	

The risk is that if this project expands and has significant impacts, an EA, even an EIS, might be required. EA typically takes 24 months. If the impacts are mitigated an EIS might not be needed. It could be part of a larger document. The base has 12 months for the environmental document. Prob1 - revision to CE; prob 2 - EA; prob 3 - EIS.

Post-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
	15%	75%	2%			
Cost ($M)				$0.00	Strategy	2/10/2016
Schedule (Mo)	-3.00	12.00	24.00	9.03		

Minimize significant impacts to cover with a CE.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	**Risk ID**	I-17 H7563U ENV 40.01
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Cultural - Ultimate

Risk Trigger		**Flowchart Activity**	300
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					16	5	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)	1.00	1.50	2.00	1.13	16	5	

If TCE's are required, additional cultural consultation will be required.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)				$0.00	**Strategy**	2/10/2016
Schedule (Mo)	1.00	1.50	2.00	1.13		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

February 23, 2016 Risk Register Page 16 of 31

Project	I-17	**Risk ID**	I-17 H7563U ENV 50.01
Sub-Project	I-10 Split to 19th Aux Lanes	**Status**	Active

Hazardous Materials in Existing Structures

Risk Trigger		**Flowchart Activity**	510
Dependency & Correlation	Full impact to each		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
95%					12	6	
Cost ($M)	$0.20	$0.25	$1.00	$0.35	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	12	6	

Existing structures may contain lead paint or other hazardous materials, which need to be accounted for in the construction cost. Central Ave and RR bridges are the most likely. The risk is that hazardous materials might have to be treated with this project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
95%						
Cost ($M)	$0.20	$0.25	$1.00	$0.35	**Strategy**	2/10/2016
Schedule (Mo)				0.00		

Add in bid items for removal of lead paint.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

May 25, 2016 Risk Register Page 17 of 31

Project	I-17	Risk ID	I-17 H7563U ENV 70.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Drainage - Ultimate

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%					5	6	
Cost ($M)	$2.00	$3.50	$5.00	$2.63	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	5	6	

If widening to full standards or adding capacity, the additional impervious surface would require upsizing the existing drainage system. This could trigger ROW, utility, and environmental impacts. The base has $4.8M for drainage.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$2.00	$3.50	$5.00	$2.63	Strategy	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U PSP 900.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Coordination with Stakeholders

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)				0.00	16	6	

Coordination with COP, Valley Metro, Railroads, airport, and other relevant stakeholders. Will require continuous coordination regarding sports and other events as the project progresses to final design. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U ROW 60.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

ROW Impacts (Drainage, Intersection, ADA, Access Control) - Ultimate

Risk Trigger		Flowchart Activity	400
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/26/2016
Schedule (Mo)				0.00	16	6	

There are potential ROW impacts from drainage, intersection improvements, ADA compliance, and access control. This could be a significant impact. ADA and drainage improvements would be the most probable impacts. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U RR 20.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Railroad Coordination and Flagging

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%					15	6	
Cost ($M)	$0.05	$0.10	$0.20	$0.11	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	15	6	

Base cost does not include cost for flagging. There may be additional coordination required during design.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	$0.05	$0.10	$0.20	$0.11	Strategy	2/10/2016
Schedule (Mo)				0.00		

Coordinate with the Railroad during final design and add appropriate quantities to the final estimate.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	1/27/2016
Next Review	**Risk Assignment**
	Owner

Project	I-17	Risk ID	I-17 H7563U STG 10.02
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Central Avenue - Ultimate

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)				0.00	16	6	

A 3-span or a 2-span bridge at Central Avenue. Foundations would need to be put into place prior to January 2022. The construction of the bridge needs to be completed by October 2022. Valley Metro project may begin ROW acquisition by the end of 2017 - need decision on ultimate Central Avenue structure by June 2017 for design; but would prefer to have the decision by June 2016 for the purpose of grant application. This is a watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U STG 10.03
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

11th Ave Substructure - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%					11	6	
Cost ($M)	-$1.20	-$1.00	-$0.75	-$0.50	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	11	6	

There might be an opportunity to reuse some of the existing substructures. Since we are not lengthening this structure, there is an opportunity to potentially reuse some of the substructure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	-$1.20	-$1.00	-$0.75	-$0.50	Strategy	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U STG 10.04
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

Wall Types - Ultimate

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
90%					13	6	
Cost ($M)	-$4.00	$0.00	$2.00	-$0.30	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	13	6	

Base assumes CIP cantilever walls; some areas may not have room for construction and might require a different wall type or provide temporary shoring. There may be areas where MSE might work and there may be areas where soil nail might be required.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
90%						
Cost ($M)	-$4.00	$0.00	$2.00	-$0.30	Strategy	2/10/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

February 23, 2016 Risk Register Page 24 of 31

Project	I-17	Risk ID	I-17 H7563U STG 900.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Active

ABC and Other Bridge Construction Methods - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	1/27/2016
Schedule (Mo)				0.00	16	6	

There might be opportunities to use accelerated bridge construction methods. See Value Planning Recommendation #3.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

February 23, 2016 Risk Register Page 25 of 31

Project	I-17	Risk ID	I-17 H7563U DES 10.03
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Inactive

Design Elements - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

Standards per value planning exercise

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Risk ID	I-17 H7563U DES 10.07
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Inactive

19th Ave Overpass - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

In the ultimate, the 19th Ave structure needs to be reconstructed. There might be significant utility conflicts. 19th Ave structure reconstruction is included in the base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Risk ID	I-17 H7563U STG 20.02
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Inactive

Geotechnical Opportunity - Ultimate

Risk Trigger		Flowchart Activity	310
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

Consider a load test for foundation requirements on bridge widening. There is not enough substructure to justify the cost of load test. This is a retired risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U ENV 90.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Retired

Noise Walls - Ultimate

Risk Trigger		Flowchart Activity	510
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
20%					16	6	
Cost ($M)	-$1.00	$0.00	$0.50	$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

Adding capacity and/or widening to standards could trigger noise walls in the areas of high density receptors. Base has $5.0M for noise walls. This risk is covered in the base cost uncertainty; retire the risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
20%						
Cost ($M)	$2.00	$3.00	$4.00	$0.00	Strategy	1/26/2016
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Risk ID	I-17 H7563U PSP 20.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Retired

Public Relations - Ultimate

Risk Trigger		Flowchart Activity	320, 510
Dependency & Correlation	Weighted		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%					16	6	
Cost ($M)	$1.00	$1.50	$2.00	$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

There is a possibility that in case of full closure, public outreach efforts will be needed. Detour routes, website, public information campaigns, etc. might be needed. This may require alternate modes of transportation. This risk is retired; cost included in the updated base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$1.00	$1.50	$2.00	$0.00	Strategy	1/27/2016
Schedule (Mo)				0.00		

Design and implement a public awareness program.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	1/27/2016
Next Review	**Risk Assignment**
	Owner

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Project	I-17	Risk ID	I-17 H7563U STG 20.01
Sub-Project	I-10 Split to 19th Aux Lanes	Status	Retired

Slopes - Ultimate

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
					16	6	
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/10/2016
Schedule (Mo)				0.00	16	6	

There might be an opportunity to reevaluate the side slopes to use 2:1 reinforced slopes to reduce wall heights and/or change wall types and foot print. Revised design retires this risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Value Planning Study Agenda

I-17, I-10 Split to 19th Avenue

February 8-10, 2016

Location: MAG 302 N 1st Ave. Suite 200, Multiple Conference Rooms

Meeting Objectives:

This Value Planning Study is directed at improving constructability, reducing risk, capital and/or operating costs.

Monday February, 08, 2016	Topic
8:30 - 8:45	Welcome, sign-in, updates, etc. Introductions Agenda Review
8:45 - 9:00	Overview of Value Planning
9:00 - 10:00	Review of Cost Estimate
10:00 - 10:15	Break
10:15 - 10:30	Flowchart (Schedule)
10:30 - 10:45	Review of Top Risks from CRA
10:45 - 12:00	Brainstorm (Speculation)
12:00 - 1:00	Lunch
1:00 - 3:00	Brainstorm Issues (Speculation)
3:00 - 3:15	Break
3:15 - 5:00	Evaluation of Ideas

Tuesday February, 09, 2016	Topic
8:30 - 10:30	Evaluation (continued)
10:30 - 10:45	Break
10:45 - 12:00	Development
12:00 - 1:00	Lunch
1:00 - 3:00	Development (continued)
3:00 - 3:15	Break
3:15 - 5:00	Development (continued)

Wednesday February, 10, 2016	Topic
8:30 - 10:30	Development (continued)
10:30 - 10:45	Break
10:45 - 12:00	Development (continued)
12:00 - 1:00	Lunch
1:00 - 3:00	Development (continued)
3:00 - 3:15	Break
3:15 - 5:00	Re-evaluate risks

Workshop Attendees

CRA and Value Planning Study Attendees
I-17: I-10 Split to 19th Avenue Project

2016 January (CRA) 26	27	February (VE) 8	9	10	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE Office	Cell	E-MAIL
☒	☒	☒	☒	☒	Ken Smith	HDR	Risk/VE Lead	360-570-4415	360-451-2527	Ken.l.smith@hdrinc.com
☒	☒	☒	☒	☒	Suresh Raghavendra	HDR	Workshop Assistant	602-522-4328		Suresh.raghavendra@hdrinc.com
☒	☒	☒	☒	☒	Chaun Hill	MAG	Senior Transportation Engineer	602-254-6300		chill@azmag.gov
☒	☒	☒	☒	☒	Quinn Castro	MAG	Transportation Engineer	602-254-6300		Qcastro@azmag.gov
		☒	☒	☒	Trent Eakin	HDR	SME/Modeler	360-570-7270		trent.eakin@hdrinc.com
☒		☒	☒	☒	John Misik	HDR	VE/Structures	602-522-7735	480-294-5715	John.misik@hdrinc.com
☒	☒	☒	☒	☒	Brian Bombardier	HDR	Spine Study Liaison/SME	602-778-7324		Brian.bombardier@hdrinc.com
☒	☒	☒	☒	☒	Dave Moody	MAG	Associate		602-809-0358	dmoody@azmag.gov
☒	☒	☒	☒	☒	Madhu Reddy	ADOT	District Engineer – Central District	602-712-8965		mreddy@azdot.gov
		☒	☒	☒	Kole Dea	ADOT	Resident Engineer – Central District		602-708-8992	kdea@azdot.gov

CRA and Value Planning Study Attendees
I-17: I-10 Split to 19th Avenue Project

2016 January (CRA) 26	27	February (VE) 8	9	10	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE Office	Cell	E-MAIL
		☒		☒	Bob Hazlett	MAG	Senior Engineering Manager	602-254-6300		bhazlett@azmag.gov
			☒		Trent Kelso	ADOT	Engineering Manager		602-291-7433	tkelso@azdot.gov
☒	☒				Dale Drost	ADOT CD	Maintenance	602-245-0241	602-712-8395	ddrost@azdot.gov
☒					Mustafa Muradvich	ADOT EP	Environmental Planner	602-712-7760		mmuradvich@azdot.gov
☒	☒				John Louis	PB	Senior Engineer	480-449-7738	623-229-8642	Louis@pbworld.com
☒					Matt Tolman	ADOT	ROW/CPA Liaison	602-712-4701		mtolman@azdot.gov
☒					Dave Edwards	ADOT	R/W	602-712-8803		dedwards@azdot.gov
☒	☒				Thomas O'Reilly	PB	Project Manager	480-449-4937		oreillyt@pbworld.com
☒	☒				Eric Prosnier	ADOT	Project Manager			eprosnier@azdot.gov
☒					Don Smith	PB	Environmental Manager	480-449-4604	480-403-1377	smithdon@pbworld.com
☒					Abhishek Dayal	Valley Metro	Manager of Capital Development		602-744-5572	adayal@valleymetro.org

CRA and Value Planning Study Attendees
I-17: I-10 Split to 19th Avenue Project

2016					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
January (CRA)		February (VE)						Office	Cell
26	27	8	9	10				E-MAIL	
☒	☒				Glenn Gaelick	ADOT	Roadway	602-712-7039	
								rgaelick@azdot.gov	
☒	☒				Gary Sun	PB	Drainage	480-921-6897	602-790-0585
								sung@pbworld.com	
☒	☒				Maurice Goyette	COP	Light Rail Coordinator	602-206-4495	
								Maurice.gayette@phoenix.gov	
☒	☒				Scott Gehrke	Valley Metro	Transit Engineer	480-254-0174	
								sgehrke@valleymetro.org	
☒	☒				Scott Miller	Valley Metro	Transit Planner	602-744-5558	480-363-3985
								smiller@valleymetro.org	
☒					William Downes	ADOT	Bridge Group	602-712-7115	
								wdownes@azdot.gov	
☒					Aryan Lirange	FHWA		602-382-8973	602-999-2921
								Aryan.lirange@dot.gov	
☒	☒				Rados Gluscevic	ADOT	Traffic Group	602-712-7311	
								rgluscevic@azdot.gov	
	☒				David Benton	ADOT	Bridge Engineer	602-712-7910	
								Dbenton@azdot.gov	

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CRAVE Study Report Out

Safety First

- *Emergency Exits*
  - *Muster point*
- *CPR*
- *The number for "911"*

2

Plan the Work and Work the Plan

Introductions

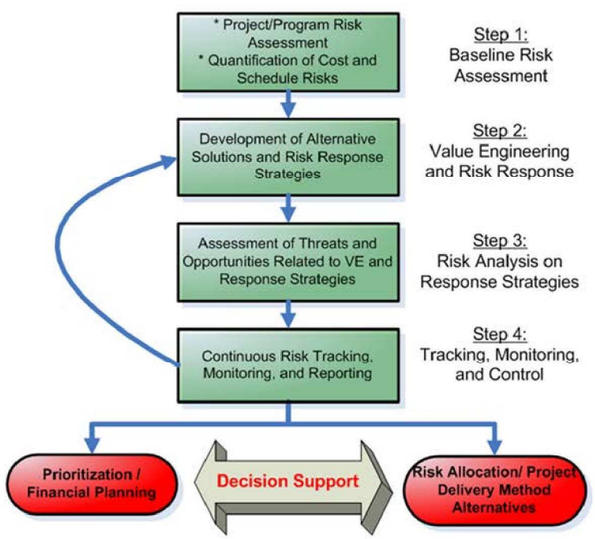
- Who are you?
- What do you do?
- Have you been on a Cost Risk Assessment or Value Engineering workshop before?

Comparison of the two processes

Both use a team approach

Cost Risk Assessment	Value Engineering
Learn about project	Investigate
Identify Risks	**Functional analysis**
Strategize how to handle	Creative
Qualify and Quantify	Evaluate
Develop response plans and triggers	Develop

5



Decision Support

- **I-17 I-10 split to 19th Ave (Near Term Auxiliary lanes) 15% design**
  - Auxiliary Lanes on I-17 between ramps, below standard roadway widths and geometrics
  - Widen existing bridges and roadway
  - Potential for throwaway for walls, structures and pavement
  - Within existing ROW
- **I-17 I-10 split to 19th Ave (Ultimate) 0% design – Value Planning**
  - Replace bridges and mainline and ramp pavement
  - Walls in ultimate location to accommodate future widening
  - Fix below standard roadway widths and geometrics
  - Minimal ROW impacts

Addressing Cost and Schedule Concerns

Usual Questions

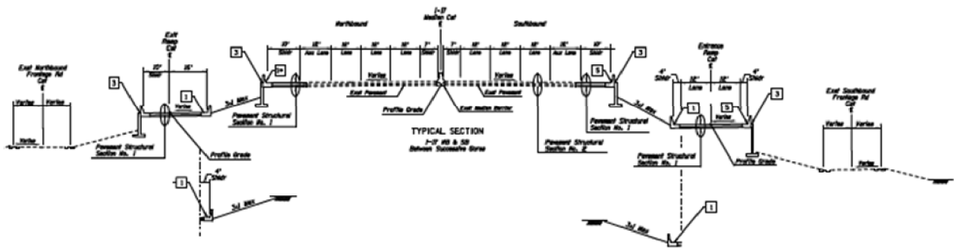
- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

Analysis Needs

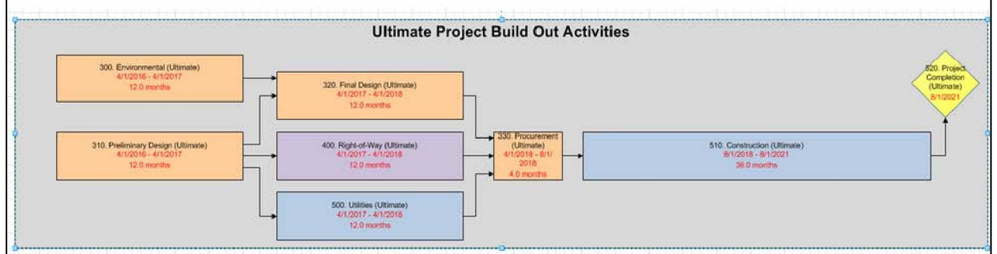
- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Value Engineering &Mitigation Strategies
- Risk Monitoring & Control

8

I-17, I-10 Split to 19th Ave
Near Term Auxiliary Lane Project



$45M- $50M in 2015$
Construction duration 18 months complete in 2019



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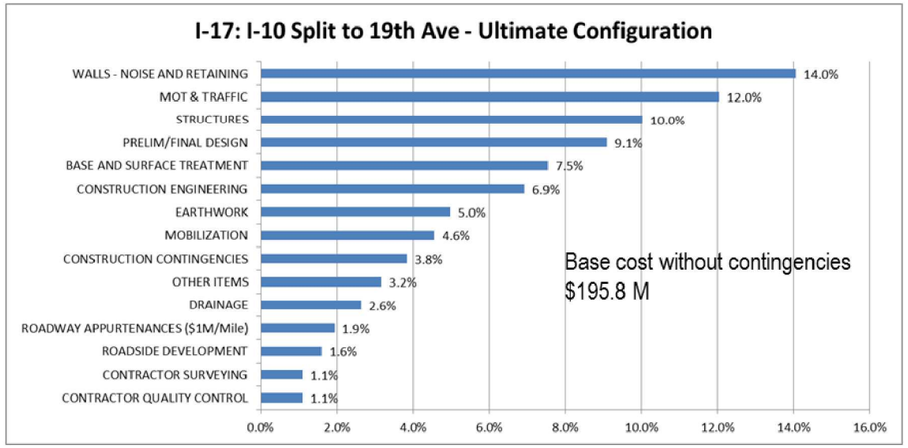
Value Planning



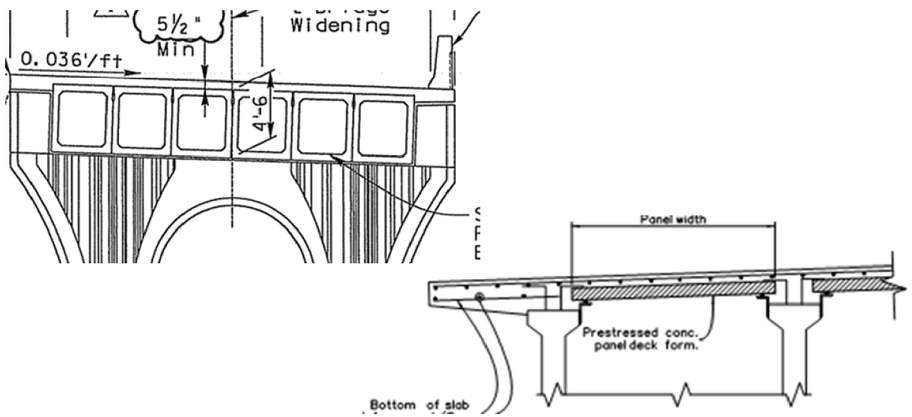
Recommendation #1 Bridge Lengths

The base line assumes adding 30 feet of span length (total span length of 60 feet) to each side of the cross street to accommodate future needs of the existing street facility

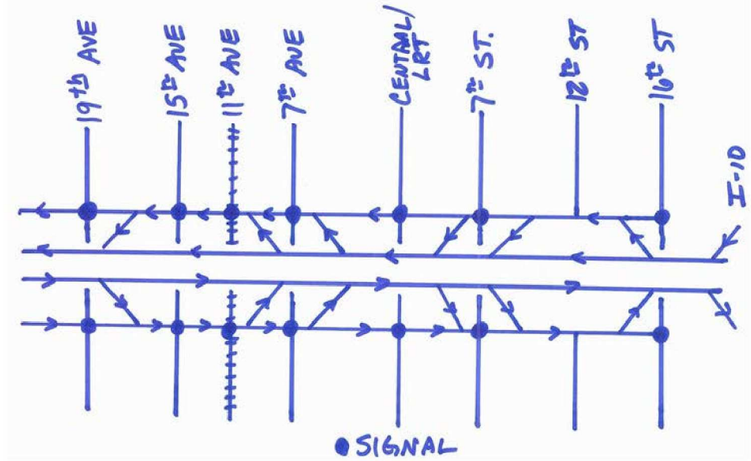
16th Street – Arterial
7th Street – Major Arterial
Central Avenue – Arterial
7th Avenue – Arterial (assume a Major Arterial for this study)
15th Avenue – Minor Collector
19th Avenue - Major Arterial

Recommendation # 2 Remove 3rd St Bridge

Recommendation # 3 Accelerated Bridge Construction (ABC)



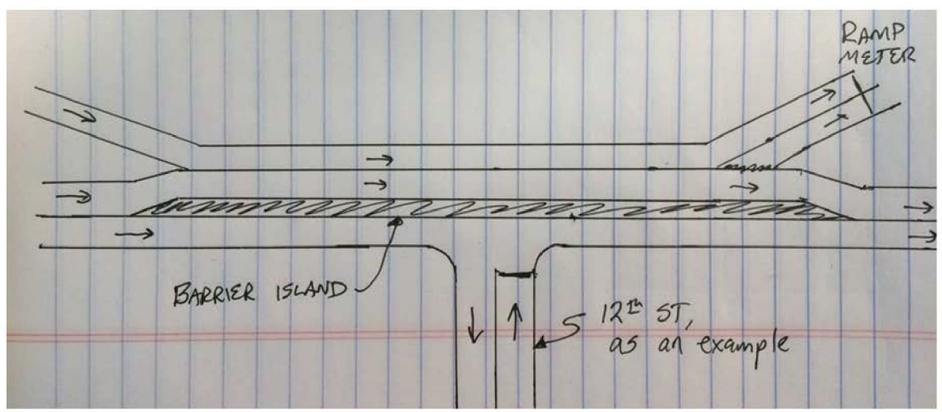
Recommendation #4 Reverse Ramps



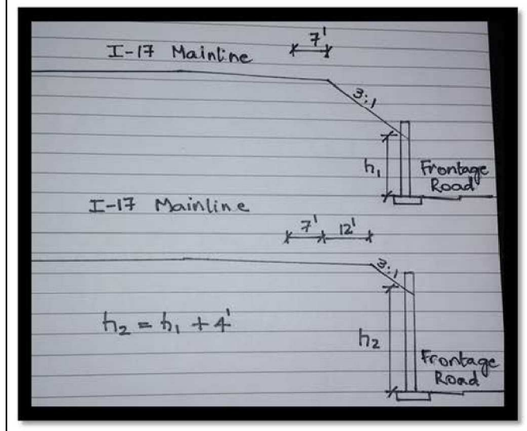
Recommendation #4 Reverse Ramps

Recommendation #4 Reverse Ramps

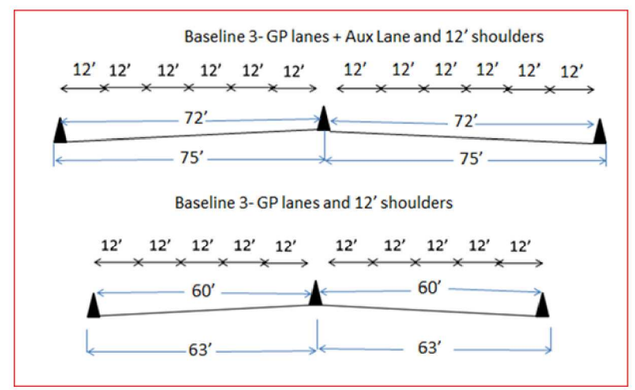
Recommendation #4 Reverse Ramps



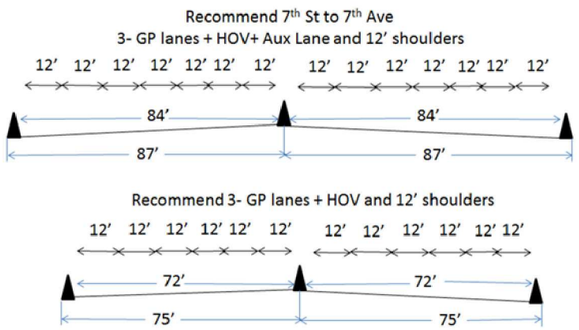
Recommendation #5 Walls at Frontage Roads



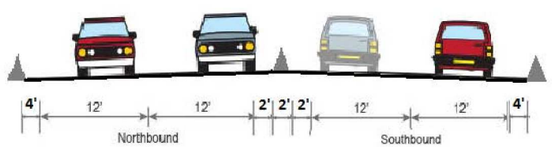
Recommendation # 6 Roadway Width



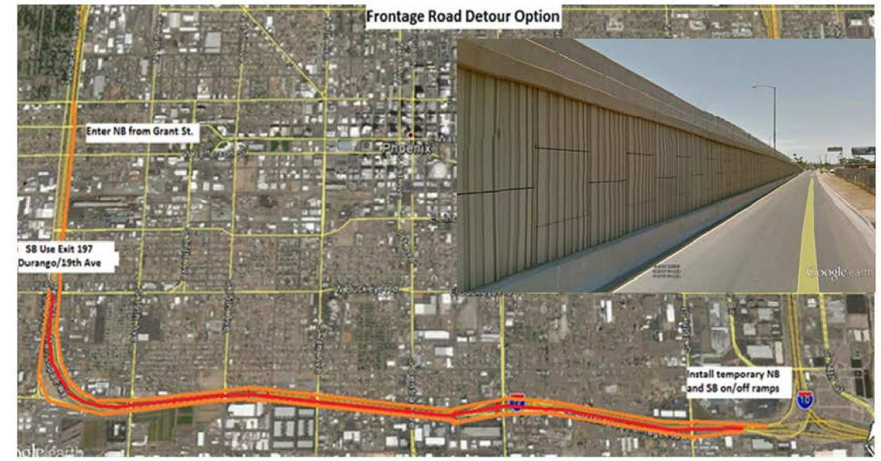
Recommendation # 6 Roadway Width



Recommendation # 7 MOT $17M 36 months



Recommendation # 7 MOT $8.5M 30 months

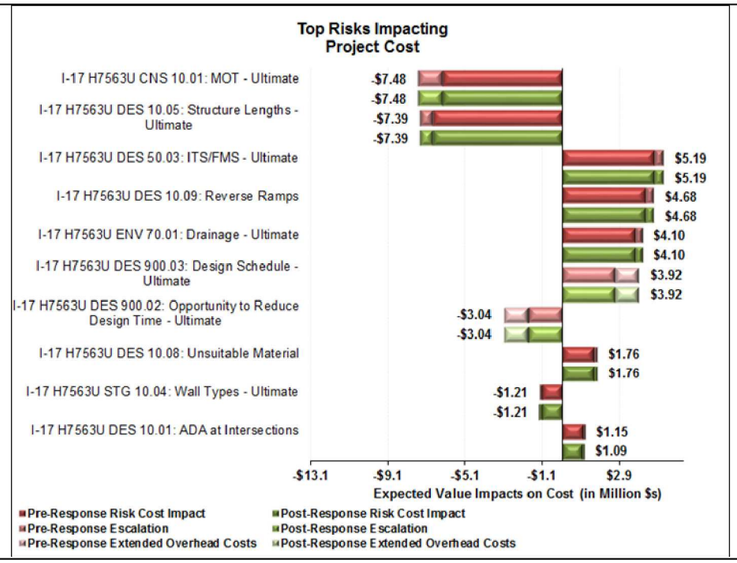


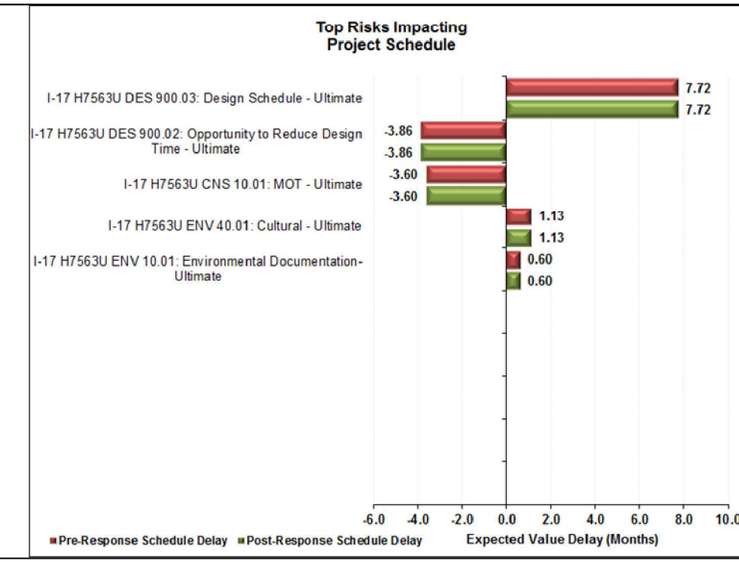
MOT Scenarios

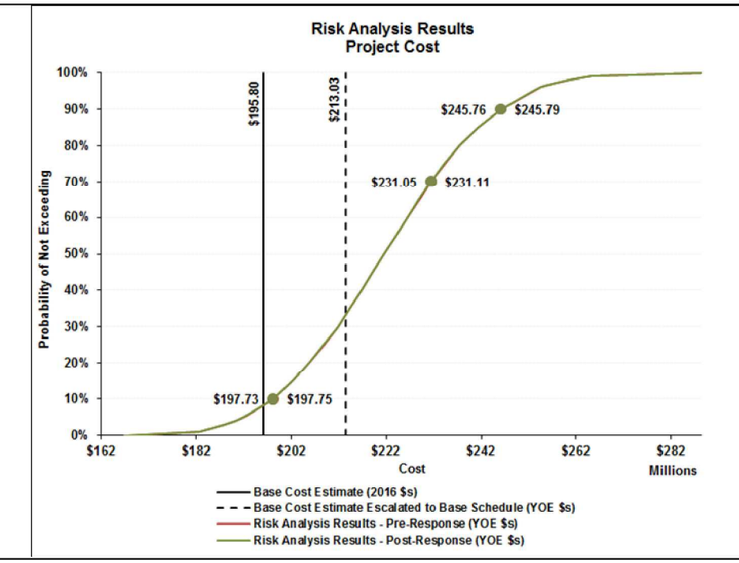
- 15% Scenario A $17M 36 months two lanes in each direction on I-17
- 60% Scenario B $8.5M 30 months two lane on frontage roads I-17 closed
- 25% Scenario C $20M 36 months two lane each direction on I-17 and improvements to Frontage roads

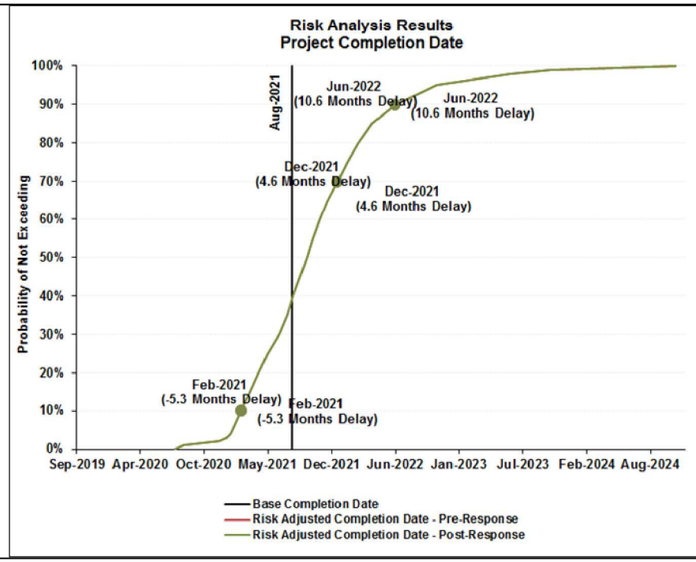
Value Planning Recommendation Summary

#	Description	Value ($M)	Probability
1	Bridge Lengths	-7.4	90%
2	3rd Street Bridge	-0.7	75%
3	ABC Bridge	NQ	
4	Reverse Ramps	5.3	75%
5	Walls - HOV	12.8	
6	Roadway & Bridge Widths –HOV	8.09	
7	MOT	-12.5	60%









Decision Support

- **I-17 I-10 split to 19th Ave (Near Term Auxiliary lanes) 15% design**
  - 18-20 months construction complete in 2019
  - $45.9 M (2015$); $66.2 M @ 70th Percentile (2016 $)
- **I-17 I-10 split to 19th Ave (Ultimate) 0% design – Value Planning**
  - 24-36 months construction complete in 2022
  - $210.6M @ 70th percentile (2016 $)
- **I-17 I-10 split to 19th Ave (Ultimate) + HOV 0% design – Value Planning**
  - 24-36 months construction complete in 2022
  - $232M @ 70th percentile (2016 $)

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Value Engineering Process

Value Engineering (VE) is a systematic process using a multidisciplinary team to improve the value of a project through the analysis of its functions. The VE process incorporates, to the extent possible, the values of design; construction; maintenance; contractor; state, local and federal approval agencies; other stakeholders; and the public.

The primary objective of a VE Study is value improvement. The value improvements might relate to scope definition, functional design, constructability, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impacts, reduced public inconvenience, or reduced project cost.

Value Engineering Job Plan

The Value Engineering Job Plan was employed in analyzing the project. This process is recommended by SAVE International and is composed of the following phases:

Information - The objective of this phase was to obtain a thorough understanding of the project's design criteria and objectives by reviewing the project's documents and drawings, cost estimates, and schedules.

Function Analysis - The purpose of this phase was to identify and define the primary and secondary functions of the project. A Function Analysis System Technique (FAST) was used to quickly define the functions of the project.

Creative - During this phase the team employed creative techniques such as team brainstorming to develop a number of alternative concepts that satisfy the project's primary functions.

Evaluation - The purpose of this phase was to evaluate the alternative concepts developed by the VE Team during the brainstorming sessions. The team used a number of tools to determine the qualitative and quantitative merits of each concept.

Development - Those concepts that ranked highest in the evaluation were further developed into VE recommendations. Narratives, drawings, calculations, and cost estimates were prepared for each recommendation.

Presentation - The VE Team presented their finding in the form of a written report. In addition, an oral presentation was made to the owner and the design team to discuss the VE recommendations.

Implementation/Resolution - Evaluate, resolve, document and implement all approved recommendations.

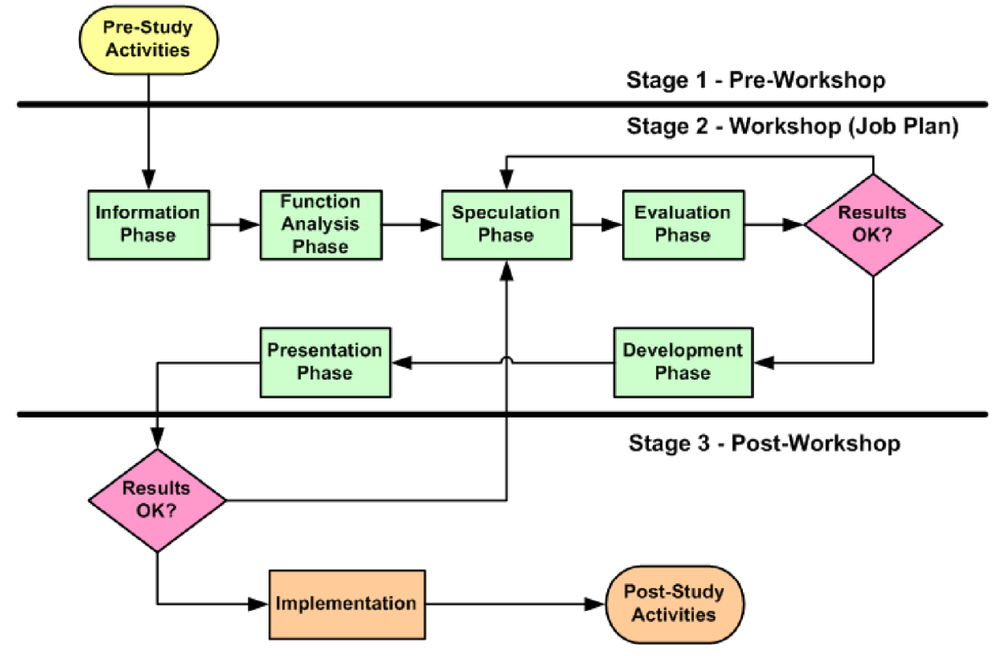

Figure 1 – Value Engineering Job Plan

CRAVE Process

CRAVE is an advanced project management process that has combined the proven tools and processes from Cost Risk Assessment Workshops and Value Engineering Studies into a single process. Each of these processes has been extremely successful in assisting agencies in delivering capitol projects. CRAVE is an iterative process between risk analysis and value engineering, in order to seek the most effective and efficient solutions to deliver the projects and therefore provide decision support throughout the project delivery lifecycle.

The main objectives of CRAVE can be summarized as follows:

- Encouraging pro-activity and early planning;
- Building confidence and credibility in project's plans and estimates;
- Developing targeted mitigation strategies for all anticipated threats;
- Better allocation of risks and identification of project delivery methods; and
- Ensuring transparency, integrity, and accountability throughout the life-cycle of the project.
- Deliverables: Risk Management Plan and Value Engineering Recommendations

Step 1: Baseline Risk Assessment

a) Review baseline cost
b) Review baseline schedule
c) Identify risks related to baseline project
d) Assess and quantify risks in terms of project's cost and schedule

Step 2: Value Engineering & Risk Response

a) Develop value engineering recommendations that further mitigate or avoid high risk elements
b) Develop recommendations that add value by modifying project scope and/or schedule

Step 3: Risk Analysis on Response Strategies

a) Identify risks related to response strategies
b) Assess and quantify threats and opportunities in terms of project's cost and schedule

Step 4: Tracking, Monitoring, and Control

a) Identify risk owners, monitoring frequency
b) Continuously update risk management plan
c) Document and report progress
d) At key milestones, update cost and schedule

Pre-CRAVE Study

Prior to the start of a CRAVE Study, the Project Manager, CRAVE Team Leader, and the State Value Engineering Coordinator/Manager typically carry out the following three activities:

- Initiate Study
  - Prepare CRAVE Study request
  - Define scope, objective and goals of the study
  - Define study timing

- Organize Study
  - Conduct Pre-Study meeting
  - Select team members
  - Identify performance attributes (if applicable)
- Prepare Data
  - Collect and distribute data
  - Prepare cost models
  - Prep for study.

All of the information gathered prior to the CRAVE Study is given to the team members for their use.

Performance Based Results

Using performance attributes process is an integral part of the value engineering process. This process provides the cornerstone of the VE process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the value study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

Value analysis has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VE can play with regard to improving project performance. Project costs are fairly easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The VE Team Leader will lead the team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops forms the basis for the VE Teams' understanding of the performance requirements of the project, and to what degree the current design concept is meeting those requirements. From this baseline, the VE Team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Performance based value engineering yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives

- Develops a baseline understanding of how the project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VE process
- Develops a better understanding of a VE recommendation's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions

Methodology
The application of performance based value engineering consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project
2. Establish the hierarchy and impact of these attributes upon the project
3. Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts
4. Identify the change in performance of alternative project concepts generated by the study
5. Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement

The primary goal of value engineering is to improve project value. A simple way to think of value in terms of an equation is as follows:

$$Value = \frac{Performance}{Cost}$$

Assumptions
Before embarking on the details of this methodology some assumptions need to be identified. The methodology described in the following steps assumes the project functions are well established. Project functions are "the what" the project delivers to its users and stakeholders; a good reference for the project functions can be found in the environmental document's purpose and need statement. Project functions are generally well defined prior to the start of the value study. In the event that project functions have been substantially modified, the methodology must begin a new from the beginning (Step 1).

Step 1 – Determine the Major Performance Attributes
Performance attributes can generally be divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components.

It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory. All performance requirements MUST be met by any idea being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be Project Schedule which means that a wide range of alternatives could be acceptable that had different durations.

The VE Team Leader will initially request that representatives from project team and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually four to seven attributes are selected. It is important that all potential attributes be thoroughly discussed.

The information that comes out of this discussion will be valuable to both the VE Team and the Project Owner. It is important that the attribute be discretely defined, and they must be quantifiable in some form. The vast majority of performance attributes that typically appear in transportation value studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Step 2 – Determine the Relative Importance of the Attributes
Once the group has agreed upon the project's performance attributes, the next step is to determine their relative importance in relation to each other. This is accomplished through the use of an evaluative tool termed in this report as the "Performance Attribute Matrix."

This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?" A letter code (e.g., "a") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of essentially equal importance, both letters (e.g., "a/b") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed.

When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote", as it made the list in the first place and should be given some degree of importance.

Step 3 – Establish the Performance "Baseline" for the Original Design
The next step is to define the baseline as it pertains to each performance attribute. The baseline is then given a score of 5 on a scale of 0 to 10 for each attribute.

Step 4 – Evaluate the Performance of the CRAVE Recommendations

Once the performance of the baseline has been established for the original design concept, it can be used to help the VE Team develop performance ratings for individual VE recommendations as they are developed during the course of the value study. The Performance Measures form at the back of each recommendation is used to capture this information.

It is important to consider the recommendation's impact on the entire project, rather than on discrete components.

Step 5 – Compare the Performance Ratings of Recommendations to the "Baseline" Project

The last step in the process is to develop the performance ratings for the original design concept. The VE Team groups the recommendation into a scenario (or scenarios) to provide the decision makers a clear picture of how the recommendations fit together into possible solutions. At least one scenario is developed to present the VE Team's consensus of what should be implemented. Additional scenarios are developed as necessary to present other combinations to the decision makers that should be considered. The scenario(s) of VE recommendations are rated and compared against the original concept. The performance ratings developed for the VE Scenarios are entered into the matrix, and the summary portion of is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations.

- % Performance Improvement = Δ Performance VE Strategy / Total Performance Original Concept
- Value Index = Total Performance / Total Cost (in Millions)
- % Value Improvement = Δ Value Index VE Strategy / Value Index Original Concept

Reporting

Following the CRAVE Study, the Team Leader assembles all study documentation into the draft/final reports:

- Publish Results – Prepare a draft and a final CRAVE Study Report; distribute printed and electronic copies as needed.

The CRAVE Study is complete when the report is issued as a record of the CRAVE Team's analysis and development work, as well as the Project Team's implementation dispositions for the recommendations.

VE Study Recommendation Approval Form

I-17: I-10 Split to 19th Avenue Project

	Recommendation	Approved Y/N	FHWA Functional Benefit: Safety	Operations	Environment	Construction	ROW	VE Team Estimated Cost Avoidance or Cost Added (millions $)	Project Manager Justification for not recommending or potential implementation issues
1	Bridge Lengths					✓		-7.4	
2	Remove 3rd Street Bridge					✓		-0.7	
3	Accelerated Bridge Const. (ABC)							NQ	
4	Reverse Ramps							5.3	
5	Walls at Frontage Roads							12.8	
6	Roadway Width							8.1	
7	Maintenance of Traffic (MOT)							-12.5	

Please provide justification if the value engineering workshop recommendations are **not** approved or are implemented in a modified form.

The Project Manager will review and evaluate the VE Team's recommendation(s) that are included in the Final Report. The Project Manager shall complete the VE Recommendation Approval form that is included in this report.

For each recommendation that is not approved or is modified by the Project Manager, justification needs to be provided. This justification shall include a summary statement containing the Project Manager's decision not to use the recommendation in the project.

The completed VE Recommendation Approval form including justification for any recommendations not approved or modified shall be sent to the Project Manager by October 1 of each year so the results can be included in the annual Value Engineering Report to FHWA.

Signature Project Manager _____ Date _____

Name (please print) _____

FHWA Functional Benefit Criteria

Each year, State DOT's are required to report on VE recommendations to FHWA. In addition to cost implications, FHWA requires the DOT's to evaluate each approved recommendation in terms of the project feature or features that recommendation benefits. If a specific recommendation can be shown to provide benefit to more than one feature described below, count the recommendation in ***each category that is applicable.***

Safety: Recommendations that mitigate or reduce hazards on the facility.
Operations: Recommendations that improve real-time service and/or local, corridor, or regional levels of service of the facility.
Environment: Recommendations that successfully avoid or mitigate impacts to natural and or cultural resources.
Construction: Recommendations that improve work zone conditions, or expedite the project delivery.
Right of Way: Recommendations that can be categorized as any impacts to base design right of way conditions.

I-17/Camelback TI CRA & Value Planning Workshop Results

(in coordination with Valley Metro Phoenix West/Glendale Extension LRT)

June 27-30, 2016

I-17 / Camelback Road / Light Rail Crossing
Value Planning Study

Final Report

Prepared for:
Maricopa Association of Governments

Lead Authors:
Ken Smith
Suresh Raghavendra

Prepared By:
HDR

Date:
June 27-30, 2016

Disclaimer:

The information contained in this report is the professional opinions of the Team members during the Value Planning Study. These opinions were based on the information provided to the Team at the time of these workshops.

As the project continues to develop, new information will become available, and this information will need to be evaluated on how it may affect the recommendations and findings in this report. All costs displayed in the report are also based on best available information at the time of the study and, unless otherwise noted, are in 2016 dollars.

This report was prepared by:

3200 East Camelback Road
Suite 350
Phoenix, AZ 85018

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Executive Summary

Introduction

This Value Planning report summarizes the events of the workshop conducted for the Maricopa Association of Governments (MAG) and facilitated by HDR, Inc. The project under review was I-17 / Camelback Road / Light Rail Crossing. The workshop was conducted on June 27-30, 2016. The presentation of the Value Planning recommendations (alternatives) was held on June 30, 2016.

Value Planning Summary

Number of Alternatives: 4

Total Number of Team Members: 38

MAG: 6

Valley Metro: 3

ADOT: 9

FHWA: 2

City of Phoenix: 8

City of Glendale: 1

AECOM: 2

HDR: 7

Facilitator: HDR Engineering, Inc.

The primary objectives of the Team through the application of Value Engineering tools were to:

- Conduct a thorough review and analysis of the key project issues using a multidisciplinary, cross-functional Team;
- Develop, verify or improve upon the various concepts for each alternative;
- Improve the value of each alternative through innovative measures aimed at improving the performance while reducing costs; and,
- Perform a cost risk analysis on each alternative.

Project Overview

The Regional Transportation Plan (RTP) identifies a five-mile West Phoenix/Central Glendale (WPCG) corridor in Glendale and Phoenix, Arizona as a future high-capacity transit (HCT) route and part of the RTP adopted in 2004. This corridor would connect the existing light rail transit (LRT) line at 19th Avenue with downtown Glendale.

In 2013, Valley Metro, in partnership with cities of Phoenix and Glendale, initiated a transit corridor study for the West Phoenix/Central Glendale area to identify HCT service options to connect downtown Glendale to the existing light rail system. The purpose of the WPCG Transit Corridor Study is to determine the type of transit and route that will best meet mobility needs by providing a dependable and efficient service to connect employment, activity centers, educational facilities, and residential areas in West Phoenix and Central Glendale.

The leading alternative is a seven-mile route that includes about 3 miles on Camelback Road in the City of Phoenix, 2 miles on 43rd Avenue (which forms the boundary between the cities of Phoenix and Glendale), and about 2 miles on Glendale Avenue and Glenn Drive within the City of Glendale.

Concurrently, MAG initiated the “Spine” project that is studying the I-10 / I-17 corridor, approximately 35 miles long, from I-10 / SR-202L (Santan) intersection in the south to I-17 / SR-

101L (North Stack) in the north. The Spine project is developing a Corridor Master Plan, which, among other recommendations, is considering improving I-17 / Camelback Road intersection in the City of Phoenix. In addition to the overlap in the project area of I-17 / Camelback Road intersection, the project schedules also appear to overlap / conflict.

In order to minimize rework and throwaway, and reduce inconvenience to travelling public and businesses in the area, MAG commissioned this Value Planning workshop to study the I-17 / Camelback Road / Light Rail Crossing location and develop comprehensive solution alternatives to this key intersection.

Value Planning Study

Within the Camelback Road portion of the LRT corridor, MAG’s Spine project is considering options to improve the I-17 / Camelback Road Traffic Interchange (TI). This TI work will directly impact both the design and schedule of the LRT project. Therefore, a Risk Assessment and Value Planning workshop was commissioned to comprehensively study the I-17 / Camelback Road / Light Rail Crossing location and suggest solution alternatives. The key considerations of the study Team were:

- Restricted left turn access on Camelback Road;
- Potential for changes to property access;
- Impacts and duration of construction;
- Visibility of businesses;
- Right-of-way requirements; and
- Pedestrian safety.

As the risk assessment process began, it was apparent that without a defined project, the risks were largely unquantifiable and that there were multiple alternatives for both the LRT project and the roadway project (I-17 / Camelback Road TI). Therefore, a “design competition” was conducted to evaluate the various LRT and TI scenarios comprehensively. Each Team was tasked to develop combined transit and roadway solutions by identifying the best LRT option for each of the TI alternatives. This became the basis of the Value Planning exercise.

Value Planning Alternatives

The Teams developed four alternatives, which combined LRT and TI options in each of them. The Value Planning alternatives are shown in Table 1 and are detailed in the Development Phase section of this report. These alternatives show what the Team’s developed over the course of the workshop and will provide a preliminary solution that will likely be acceptable to the agency stakeholders involved.

While these alternatives may or may not advance, - perhaps even be modified as the project progresses - they will provide the basis to ensure that the project moves forward successfully.

Table 1: List of Alternatives				
Alternatives		Performance	Cost	Value Index
1	SPUI with LRT Elevated to North	571	$51.2 M	11.16
2	Tight Diamond with LRT Fly Over	662	$64.8 M	10.22
3	Platform Diamond with LRT Fly Over	752	$56.6 M	13.29
4	SPUI with Elevated LRT and Fly Over	638	$51.9 M	12.29

The Value Planning Team wishes to express its appreciation to the project design Team and management for the excellent support they provided during the workshop. It is the Team's expectation that their evaluation of each alternative will assist management in the decision support process to move the project forward.

Ken L. Smith, PE, CVS®
Value Planning Team Lead

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Introduction

This report summarizes the events of the Value Planning study conducted for the Maricopa Association of Governments (MAG), facilitated by HDR Engineering, Inc. The subject of the study was the I-17 / Camelback Road / Light Rail Crossing project.

Project Description

The Regional Transportation Plan (RTP) identifies a five-mile West Phoenix/Central Glendale (WPCG) corridor in Glendale and Phoenix, Arizona as a future high-capacity transit (HCT) route and part of the RTP adopted in 2004. This corridor would connect the existing light rail transit (LRT) line at 19th Avenue with downtown Glendale.

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The leading alternative is a seven-mile route that includes about 3 miles on Camelback Road in the City of Phoenix, 2 miles on 43rd Avenue (which forms the boundary between the cities of Phoenix and Glendale), and about 2 miles on Glendale Avenue and Glenn Drive within the City of Glendale.

Concurrently, MAG initiated the “Spine” project that is studying the I-10 / I-17 corridor, approximately 35 miles long, from I-10 / SR-202L (Santan) intersection in the south to I-17 / SR-101L (North Stack) in the north. The Spine project is developing a Corridor Master Plan, which, among other recommendations, is considering improving I-17 / Camelback Road intersection in the City of Phoenix. In addition to the overlap in the project area of I-17 / Camelback Road intersection, the project schedules also appear to overlap / conflict.

In order to minimize rework and throwaway, and reduce inconvenience to travelling public and businesses in the area, MAG commissioned this Value Planning workshop to study the I-17 / Camelback Road / Light Rail Crossing location and develop comprehensive solution alternatives to this key intersection.

Scope of the Value Planning Study

The scope of the workshop was to develop alternative concepts for the I-17 / Camelback Road / Light Rail Crossing project. The primary objectives of the Team through the application of Value Engineering tools were to:

- Conduct a thorough review and analysis of the key project issues using a multidisciplinary, cross-functional Team;
- Develop, verify or improve upon the various concepts for each alternative;

- Improve the value of each alternative through innovative measures aimed at improving the performance while reducing costs; and,
- Perform a cost risk analysis on each alternative.

Value Planning Study Timing

The timing of the study was based on a conceptual layout for the project. The workshop was held at the MAG building in downtown Phoenix from June 27 - 30, 2016. The presentation of the findings was held on June 30, 2016.

Value Planning Team Members

The list of Team members who participated in the Value Planning is provided in Table 2. Other attendees and their participation during the workshop are identified on the sign-in sheets provided in the Appendix.

Table 2: CRA & Value Planning Team Members

Name	Organization	Position/Discipline
Ken Smith	HDR	Risk/Value Planning Lead
Suresh Raghavendra	HDR	Workshop Assistant
Bob Hazlett	MAG	Transportation Manager
Chaun Hill	MAG	Senior Transportation Engineer
Audra Koester Thomas	MAG	Transit Planning Project Manager
Quinn Castro	MAG	Transportation Engineer
David Moody	MAG	Associate
Abhishek Dayal	Valley Metro	Capital Development Manager
Jay Yenerich	Valley Metro	Conceptual Design
Jennifer Pyne	AECOM	Project Manager
Omar Jaff	AECOM	Transit & Rail Manager
Trent Eakin	HDR	Construction SME/Modeler
Brian Bombardier	HDR	Roadway SME
Jason Nauman	HDR	Structures SME
Scott Gehrke	HDR	Transit SME
James Slaker	HDR	Transit SME
David Lochner	ADOT	Construction Central District
Clem Ligocki	ADOT	Planning & Programming Manager
Dale Drost	ADOT	Maintenance
Raul Amavisca	ADOT	Maintenance
Eric Prosnier	ADOT	Project Manager
Maurice Goyette	COP	Lead Light Rail Engineer

Figure 1: Value Planning Team

Information Phase

Summary of Analysis

The following analysis tools were used to study the project:

- Constraints and Controlling Decisions
- Investigation Observations
- Project Schedule Review
- Performance Attributes
- Performance Attribute Matrix

Constraints and Controlling Factors

As part of the project briefing, the Value Planning Teams were given the following project constraints and controlling factors when considering alternatives:

- Limit right-of-way impacts;
- Maintain access to businesses during and after construction.
- Regional significance of the Camelback Road corridor.
- Current and future expansion plans for Grand Canyon University.
- Traffic movements through the I-17 / Camelback Road intersection
- Utilize Value Planning with a Value Engineering Approach to develop best comprehensive solutions.
- Develop preliminary planning and design concepts to guide the design Team as the project advances.

Investigation Observations

The first day of the workshop included a presentation from the Project Team. The following summarizes key project drivers, observations, and considerations identified during the session.

- Coordination between LRT and roadway projects and the corresponding stakeholders is crucial.
- Development of a solution that is compatible with the needs and objectives of both LRT and roadway projects is needed.
- Mitigation of potentially conflicting schedules of LRT and roadway projects is a priority.
- Maintenance of access and Minimization of visual impacts to the adjoining businesses – such as the car dealerships – during and after construction is important.
- Current and future land use and expansion plans of the Grand Canyon University should be considered.
- Right-of-way and Environmental Justice issues within the corridor are important factors of consideration.
- Safety of pedestrians and bikes, and their access should be accommodated.
- Congestion of I-17 / Camelback Road TI, especially during morning and evening peak hours should be considered while designing the TI.

- Camelback Road is a roadway of regional significance beyond the section containing the Light Rail; the east-west through movement should be considered in the design.

Table 3 presents a list of project issues identified by the Value Planning Team, and the number of participants identifying the issue.

Table 3: Project Issues	
Description	**No. of Participants Identifying the Issue**
Project Coordination	10
Grade Separation/Geometrics	7
Safety/Conflicts	7
Right-of-way/Environmental Documentation	6
East-West/North-South Movements	5
Grand Canyon University	4
Public Involvement	3
Modal Interconnectivity (e.g. bikes and peds)	3
Drainage	2
Stakeholder Impacts;-Continuous Involvement	2
Utility Relocation/Coordination	2
Schedule	2
Light Rail Alignment	1
2 Designers/2 Contractors	1
FHWA/NEPA	1
Construction Staging/Coordination	1
Structure Modifications	1
Signalization	1
Federal Funds-Competitiveness	1

Project Schedule Review

A preliminary schedule was developed to provide a date range for known project activities and milestones including environmental, design, right-of-way, utility, and construction activities. These activities, highlighted in yellow in Table 4, are then cost loaded to allow the risks to impact a specific activity that will either lengthen or reduce the baseline schedule. This provides a more reasonable cost outcome based on risk impacts that carry schedule impacts. The preliminary schedule was reviewed by the entire Team and updated as necessary throughout the workshop. Table 4 on the following page shows the activities and their estimated start and end dates. Please see the Appendix for the flowchart activity diagram for an illustration of the project schedule.

Table 4: Project Activity Ultimate Baseline Schedule			
Activity ID	**Activity Name**	**Start Date**	**End Date**
100	Alt. Analysis / Preliminary Engineering	6/16/2016	7/1/2017
110	Environmental	6/16/2016	6/30/2017
115	Approval to Enter Engineering	6/16/2016	6/30/2017
120	Final Engineering	6/16/2016	6/30/2017
125	FFGA	6/16/2016	6/30/2017
130	Right-of-Way Acquisition	11/1/2016	6/30/2017
140	Utilities	6/30/2017	6/30/2017
150	Ad/Bid/Award	6/30/2017	10/31/2017
160	Transit Vehicle Procurement	10/31/2017	10/31/2017
200	Construction	10/31/2017	10/31/2019
210	Revenue Service Date	10/31/2019	10/31/2019
220	Project Closeout	10/31/2019	10/31/2019
230	Project Completion	10/31/2019	10/31/2019

Performance Attributes

Performance attributes are an integral part of the value analysis process. The performance of each project must be properly defined and agreed upon by the Project Team, Value Planning Team, and stakeholders at the beginning of the study. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

Performance attributes can generally be divided between project scope components (roadway operations, transit operations, etc.) and project delivery components (construction impacts, environmental impacts, etc.). It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory and binary in nature. All performance requirements **must** be met by any Value Planning alternative being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was to design and construct a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives that have different durations could be acceptable.

The Value Planning Team, along with the Project Team, identified and defined the performance attributes for this project. The performance attributes shown in Table 5 were used throughout the study to identify, evaluate, and document ideas and alternatives.

Table 5: Performance Attributes	
Performance Attribute	**Definition**
Roadway Operations	An assessment of traffic operations and safety on I-17 mainline and ramps, Camelback Road and all cross streets within the project limits. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance and lane and shoulder widths.
Transit Operations	An assessment of transit operations and safety on the guideway and associated stations. Operational considerations include level of service relative to the projections, geometric considerations and operations of the stations.
Maintainability	An assessment of the long-term maintainability of the facility. Maintenance considerations include the overall durability, longevity, and maintainability of structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel, including sediment and debris removal.
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access, visual effects, noise, vibration, dust, and construction traffic; environmental impacts.
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts; impacts to cultural, recreational and historic resources.
Promotes Economic Growth	An assessment how the alternative assists in promoting growth and Transit Oriented Development (TOD) along the corridor.

Performance Attribute Matrix

A matrix was used to determine the relative importance of the individual performance attributes for the project. The Project and Value Planning Teams evaluated the relative importance of the performance attributes that would be used to evaluate the creative ideas.

These attributes were compared in pairs, asking the question: "Which one is more important to the purpose and need of the project?" The letter code (e.g., "A") was entered into the matrix for each pair. After all pairs were discussed they were tallied (after normalizing the scores by adding a point to each attribute) and the percentages calculated.

Table 6 - Performance Attributes Criteria Matrix								
Paired Comparison								
							Total points	% of Total
Roadway Operations	**A**	**A/B**	**A**	**A**	**A**	**A/F**	**5.0**	**23.8%**
Transit Operations		**B**	**B**	**B**	**B**	**B/F**	**5.0**	**23.8%**
Maintainability			**C**	**C**	**C**	**F**	**3.0**	**14.4%**
Construction Impacts				**D**	**E**	**F**	**1.0**	**4.7%**
Environmental Impacts					**E**	**F**	**2.0**	**9.5%**
Promotes Economic Growth						**F**	**5.0**	**23.8%**
						Total	**21.0**	**100.0%**

A = A is of greater importance

A/B = A and B are of equal importance

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Creative Phase

The Value Planning Team brainstormed six LRT routes and three different TI alternatives. These ideas were based on the available information given at the time of the study.

LRT Routes:

- LRT median running at grade, alignment shifted north
- LRT median running elevated, alignment shifted north (assume vertical clearance over frontage roads only)
- LRT North side running at grade (just north of Camelback Road)
- LRT North side running, elevated (just north of Camelback Road)
- LRT North alignment along Colter Road/Street
- LRT North side running along Camelback, elevated from 19th Ave. to 43rd Ave.

TI Alternatives

- I-17 / Camelback Road platform diamond TI
- I-17 / Camelback Road tight diamond TI
- I-17 / Camelback Road maintaining SPUI

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Design Competition

In order to develop combined solutions, a design competition was organized. The Value Planning Team was divided into three groups. Each group was tasked with identifying the best LRT solution for one of the three TI alternatives.

To achieve consistency in the design competition, the groups were given the following directions and assumptions:

Design Assumptions

- Camelback Road six lanes (three in each direction) 33' minimum width per direction (curb to curb:12'-11'-11') with min 9' curb to right-of-way
- Camelback Road project limits 23rd Avenue to 27th Avenue – 3275' Linear Feet (LF)
- LRT width 26.5' on roadway, 32' on structure
- One station near 27th Avenue

Design Instructions

- I-17 – do not reduce current width of 120'
- Accommodate all current turn movements
- Document any current access that will be closed or modified

Cost Assumptions

Structures

- Precast roadway $100 Square Feet (SF)
- Precast transit $110 SF
- Cast in Place (CIP) roadway $120 SF
- CIP transit $135 SF
- Steel long span roadway $200 SF
- Steel long span transit $220 SF
- Walls $60 SF

Pavements

- Concrete $45 Square Yard (SY)
- Asphalt $35 SY
- Sidewalks $4 SF

Right-Of-Way

- $25 SF for acquisitions

Utilities

- $700 LF for high allowance
- $400 LF for medium allowance

Traffic Signals Systems

- $ 300,000 each

Transit

- $ 2,200 per LF of track
- $ 3,000,000 for station

Markups Total 60%

- Maintenance of traffic (MOT) 10%
- Miscellaneous item allowance 15%
- Mobilization 8%
- Design engineering 12%
- Construction administration 10%
- Construction change orders 5%

Development Phase

Based on the evaluation process, individual alternatives were developed. Each alternative consists of a description of the alternative, a listing of its advantages and disadvantages, and a brief narrative that includes justification, sketches, photos, assumptions and calculations (where applicable) as developed by the Team. It is to be noted that the cost of the alternative is only the blended cost of the LRT and roadway solutions within the project boundary defined in the design competition.

The Value Planning Alternatives are presented as written by the groups during the workshop. While they have been edited in the report to correct errors or better clarify the alternative, they represent the Team's findings during the study.

Alternative No. 1 - SPUI with Light Rail elevated to the North

This option constructs a new bridge just north of the existing single point urban interchange for the light rail line.

Advantages:	Disadvantages
▪ Right-of-way needed only on the north side ▪ May reduce the right-of-way cost ▪ Minimizes utility impacts ▪ Minimizes construction impacts to Camelback Road ▪ Grade separates the LRT from the ramps and frontage roads ▪ Minimizes impacts to the existing TI operations	▪ Crossover to and from the median at 21st. and 26th avenues ▪ 6-minute headways interrupts westbound Camelback at 21st and 26th avenues ▪ Signal progression band on Camelback Road is shortened because of the staging area for westbound Camelback traffic at 26th avenue ▪ Visual impacts due to added structure

Cost Summary	
Alternative No. 1	**$24.66 M @ 60% markup + $2.39 M right-of-way = $41.85 M**

Evaluation of Light Rail Options for Alternative No. 1

#	Description	Advantages	Disadvantages
LT-1	LRT median running at grade, alignment shifted north	▪ Reduces cost ▪ Access management is easiest ▪ Equal access to both sides of the road ▪ Accommodates TOD ▪ Avoid purchasing right-of-way on the south side of Camelback Road	▪ Relocate Utilities ▪ May need to rebuild the entire I-17 structure ▪ Temporary closure of Camelback Road ▪ May require a configuration change to the interchange ▪ Potential for traffic queuing onto the freeway
Justification/Comments: Significant construction impacts, right-of-way and left turn movements. Dropped from consideration with this alternative.			
#	**Description**	**Advantages**	**Disadvantages**
LT-2	LRT median running elevated, alignment shifted north (Assume vertical clearance over frontage roads only)	▪ Access management is easiest ▪ Equal access to both sides of the road ▪ Accommodates TOD ▪ Avoid purchasing right-of-way on the south side of Camelback Road	▪ No left turns between 23rd Ave. and I-17 and I-17 and 27th Ave. ▪ Increases Cost ▪ Relocate Utilities ▪ May need to rebuild the entire I-17 structure ▪ Temporary closure of Camelback Road ▪ May require a configuration change to the interchange ▪ Visual impacts
Justification/Comments: Extensive existing bridge reconstruction costs and new bridge construction. Dropped from consideration with this alternative.			

Alternative No. 1 - SPUI with Light Rail elevated to the North

#	Description	Advantages	Disadvantages
LT-3	North side running at grade (just north of Camelback Road)	▪ Right-of-way needed only on the north side ▪ May reduce the right-of-way cost ▪ Minimizes utility impacts ▪ Minimized construction impacts to Camelback Road	▪ Crossover out of the median at 21st Ave. ▪ 6-minute headways shuts down Camelback Road ▪ Signal progression on Camelback Road could get worse ▪ North side business access (Cactus Jack's)
Justification/Comments: At-grade crossings are required at the on/off ramps to from I-17 on the north side. This did not rate quite as high as the elevated crossing on the north side of Camelback for the light rail.			
#	**Description**	**Advantages**	**Disadvantages**
LT-4	North side running, elevated (just north of Camelback Road)	▪ Right-of-way needed only on the north side ▪ May reduce the right-of-way cost ▪ Minimizes utility impacts ▪ Minimized construction impacts to Camelback Road ▪ Grade separates the ramps and frontage roads ▪ Minimized impacts to the existing TI operations	▪ Crossover out of the median at 21st Ave. ▪ 6-minute headways shuts down Camelback Road ▪ Signal progression on Camelback Road could get worse
Justification/Comments: This was moved forward as the option to use with the existing interchange.			
#	**Description**	**Advantages**	**Disadvantages**
LT-5	North alignment along Colter Road	▪ Does not constrain the I-17 improvements ▪ Could add additional bike and ped crossing I-17 ▪ Minimize impacts to Camelback Road	▪ Significant traffic impacts due to train turning movements ▪ Trains through the neighborhood ▪ May increase costs ▪ High Maintenance costs due to curves ▪ Extra travel time (adverse travel) added to the route ▪ Noise impacts ▪ Potential EJ issues
Justification/Comments: This requires Environmental Justice and has other issues including additional turns and construction through a non-arterial corridor. Dropped from consideration with this alternative.			

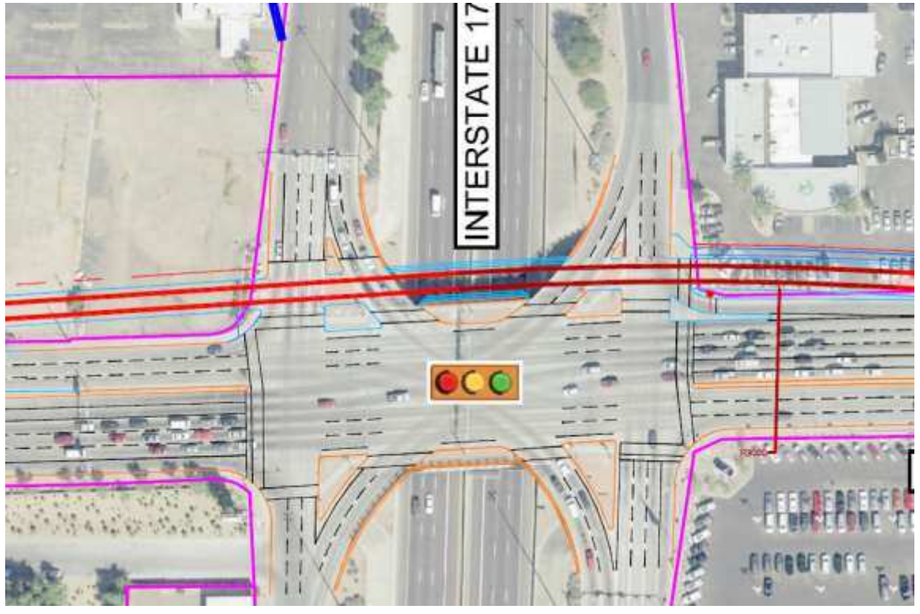
Alternative No. 1 - SPUI with Light Rail elevated to the North

#	Description	Advantages	Disadvantages
LT-6	North side running along Camelback, elevated from 19th to 43rd avenues.	▪ Minimizes business impacts on Camelback Road ▪ Minimal impact to traffic ▪ Operational speed of the LRT ▪ Minimal impacts to cross traffic on Camelback Road ▪ Could minimize construction impacts	▪ Visual impacts ▪ Elevated stations ▪ May increase cost ▪ May impact TOD ▪ Less visibility of users of the station ▪ May impact the sight distance ▪ Public acceptance of elevated structures

Justification/Comments: This was not moved forward based on costs and access issues. Valley Metro stressed the importance of at-grade facilities for aesthetics, safety and public perception.

Discussion/Justification/Sketches/Photos:

LRT elevated via a new bridge constructed just north of the existing Camelback Road overpass over I-17 for the LRT. This configuration requires LRT to run on the north side of Camelback from 23rd to 27th avenues. The current SPUI at I-17 and Camelback Road will be essentially left intact with no modifications required.



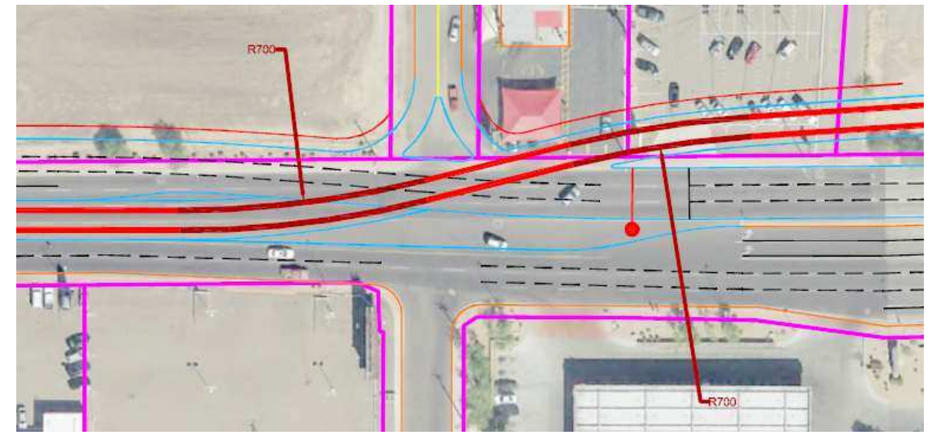
Intersection Plan View

Traffic on I-17 mainline and frontage roads and Camelback Road will be maintained during construction in the current configuration while the light rail structure is built on the north side

Alternative No. 1 - SPUI with Light Rail elevated to the North

of Camelback Road.

At- grade transitions will occur where LRT transitions from the north side to the median. Signals may be required where these transitions occur.



Transition Section Plan View

Item Description	Unit	Recommendation		
		Qty	Unit Cost	Total
Roadway - Asphalt	SY	216,150	$35	$7,565,250
Light Rail Structure	SF	19,200	$110	$2,112,000
Light Rail	LF	3,375	$2,200	$7,425,000
Walls	SF	16,000	$60	$960,000
Wall Backfill	Cubic Yards (CY)	10,000	$10	$100,000
Station	EA	1	$3,000,000	$3,000,000
Traffic Signals	EA	3	$300,000	$900,000
Utilities (Medium Impact)	LF	1,500	$400	$600,000
I-17 Widening Construction Accommodations	LS	1	$2,000,000	$2,000,000
Construction Total				$24,662,250
Plus 60% Markup (Construction x 1.6)				**$39,459,600**
Right-of-way	SF	95,546	$25	$2,388,650
Total Cost				**$41,848,250**

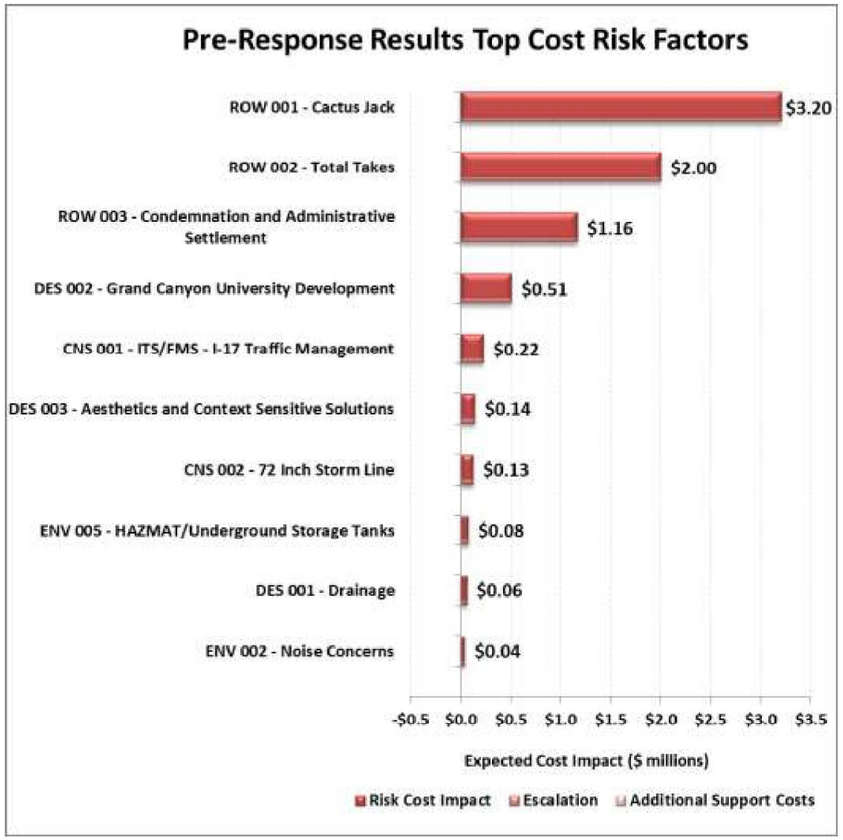
Alternative No. 1 - SPUI with Light Rail elevated to the North

Risk Identification and Quantification

After the alternative was developed the Value Planning Team discussed the potential risk events and elements that would be facing the alternative. For each significant risk event that was identified, the probability of the risk and its impact to cost, schedule, or both were estimated. The risk assessment process included identifying high risk areas and risk elements as threats (or opportunities where appropriate) to a project and quantifying the identified risk elements.

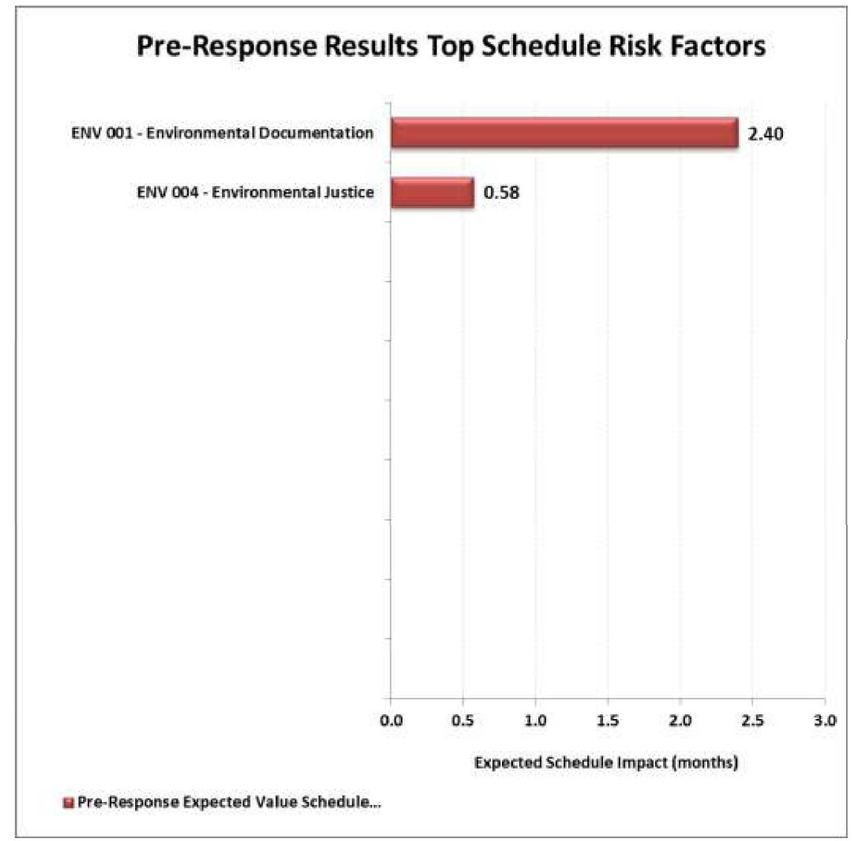
The Risk Data Sheets provided in the Appendix of this report shows additional information specific to each risk as identified by the Team for all the alternatives.

The tornado diagrams for the top risks impacting both cost and schedule for this alternative are provided below.



Alternative No. 1 - SPUI with Light Rail elevated to the North

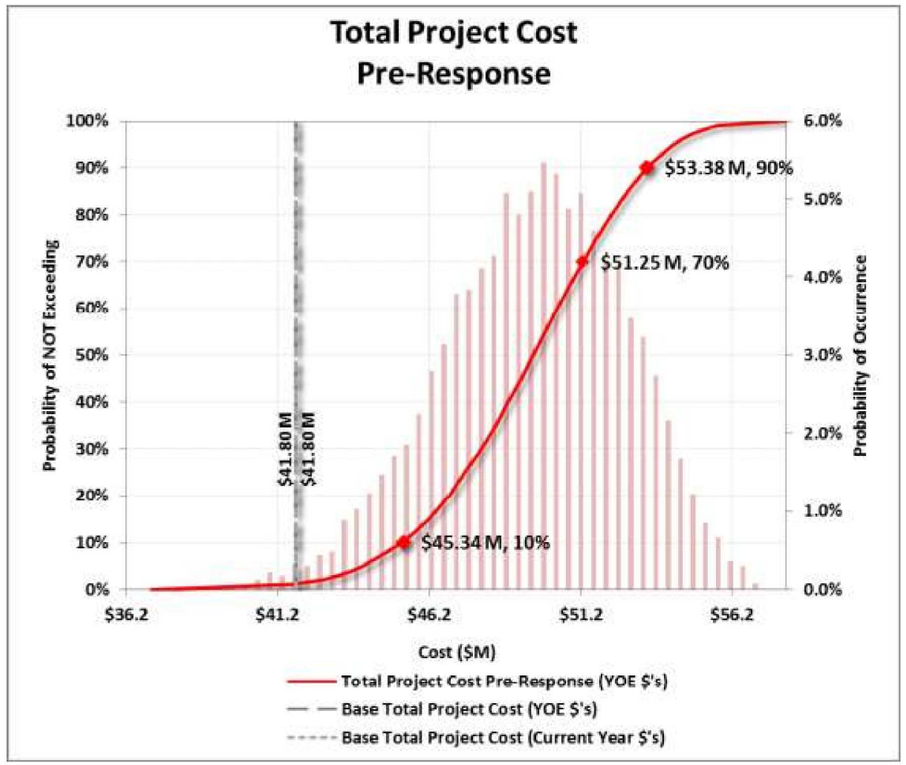
The expected value (likelihood multiplied by expected risk outcome) tornado diagrams depict the actual expected values of the identified risks. Not all risks identified require immediate management. Often, a project Team needs to prioritize the risks for which it plans to develop strategies in the future in an effort to make the best use of the time available. An example would be to begin with the risks with the highest cost and schedule impacts.



Alternative No. 1 - SPUI with Light Rail elevated to the North

Risk Analysis Results

The risk analysis results are given in the form of graphs showing the relationship between cost and the probability of not exceeding that cost. Risk-based analysis provides a distribution of probabilities that a project will not exceed an estimated dollar figure. Typically, agencies report the project risk-based estimation using the 70 percent confidence interval. Each graph represents the best opinion of the cost ranges by the workshop participants at the time of the analysis.



The total project base cost is the cost without any contingencies or factored escalation, shown by the gray vertical lines at $41.80 million.

The s-curve, with risk results factored into the analysis, shows that the Alternative 1 will be less than **$51.25 million** at a 70% confidence level.

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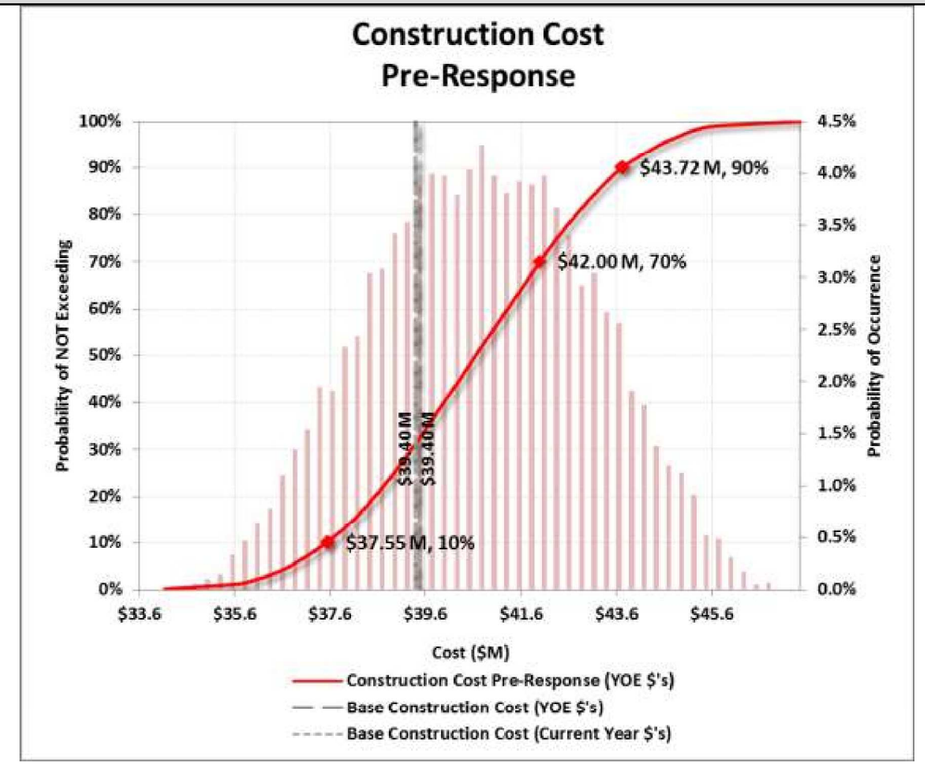
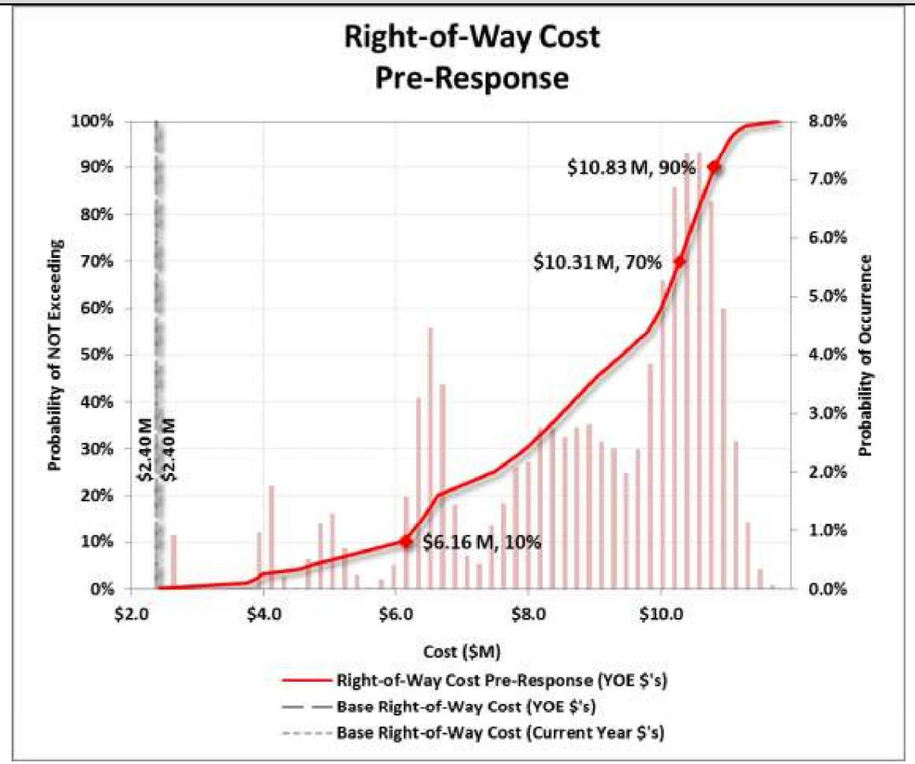
Alternative No. 1 - SPUI with Light Rail elevated to the North



The total base cost for design/construction for Alternative #1 is $39.40 million.

The s-curve, with risk results factored into the analysis, shows that the design/construction costs for Alternative 1 will be less than **$42.00 million** at a 70% confidence level.

Alternative No. 1 - SPUI with Light Rail elevated to the North



The total base cost for right-of-way for Alternative #1 is $2.40 million.

The s-curve, with risk results factored into the analysis, shows that the right-of-way costs for Alternative 1 will be less than **$10.31 million** at a 70% confidence level.

The next step will be to determine the appropriate risk response strategies for the identified high risk areas. Risk response strategies were not identified as part of this Value Planning workshop. Four risk response strategies are considered when addressing threat risks. Those strategies are to avoid, accept, transfer, or mitigate the risk threat (opportunity).

Alternative No. 1 - SPUI with Light Rail elevated to the North

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation		Alternative Scoring
Roadway Operations	Rating	5
- LRT crossing westbound lanes of Camelback at 26th and 21st avenues + LRT is grade separated from frontage road and ramps - Does not provide additional capacity to the roadway structures	Weight	23.8
	Contribution	119.0
Transit Operations	Rating	6
- LRT crossing westbound lanes of Camelback at 26th and 21st avenues - Slowdown due to curves + Exclusive guideway through interchange preserves travel times	Weight	23.8
	Contribution	142.8
Maintainability	Rating	6
- No bridge replacement (older bridge to maintain) + No pavement replacement - Additional bridge - Additional maintenance for gates (double gates)	Weight	14.4
	Contribution	86.4
Construction Impacts	Rating	7
- Temporary closures of Camelback Road and I-17 + Building offline and minimal impacts to Camelback Road + No bridge removal	Weight	4.7
	Contribution	32.9
Environmental Impacts	Rating	5
- Visual impacts - Tall walls in front of businesses - Limits access to businesses on the north side of Camelback Road	Weight	9.5
	Contribution	47.5
Promotes Economic Growth	Rating	6
- Traffic operations might be adversely impacted + Least amount of elevated structures	Weight	23.8
	Contribution	142.8
	Total Performance:	**571.0**

Alternative No. 2 - Tight Diamond with LRT Fly Over

Description

This alternative changes the existing traffic interchange from a single point urban interchange (SPUI) to a tight diamond interchange.

Advantages:	Disadvantages
♦ Separates modes ♦ Increases safety for pedestrians and bikes ♦ Improves transit operations ♦ Improves traffic operations by adding left turn storage ♦ Shortens the distance between stop bars ♦ Reduces right-of-way impacts ♦ Improves access management with median running LRT ♦ Provides equal access to both sides of the road ♦ Avoids purchasing right-of-way on the south side of Camelback Road	♦ Eliminates left turns between 23rd Ave. and I-17 and I-17 and 27th Ave. ♦ Structure expands with longer elevated LRT ♦ Increases adverse visual impacts ♦ Constricts the ability to widen Camelback Road due to the straddle bent ♦ Potential utility impacts ♦ Complications associated with building approximately 150 feet long straddle bents ♦ Closes through North-South traffic on 22nd Ave. ♦ Does little to improve capacity of East-West Camelback Road

Cost Summary	
Alternative No. 2 Cost	**$32.93 M @ 60% markup + $1.75 M right-of-way = $54.44 M**

Evaluation of Light Rail Options for Alternative No. 2

#	Description	Advantages	Disadvantages
LT-1	LRT median running at grade, alignment shifted north	▪ Provides more left-turn storage length on Camelback Road ▪ Increases safety for peds and bikes ▪ Improves traffic operations ▪ Shortens the distance between stop bars ▪ Cheaper compared to the grade-separated option ▪ Requires one structure as opposed to two – easier than the grade-separated option to construct ▪ Minimal utility impacts (assume utilities are located on the south side of Camelback Road)	▪ May need to rebuild the entire I-17 structure ▪ Temporary closure of Camelback Road ▪ Requires widening of the bridge (approximately 15 feet) ▪ Might delay transit operations ▪ Will have adverse right-of-way impacts to Cactus Jack's and GCU

Justification/Comments: Dropped from further consideration with this alternative.

Alternative No. 2 - Tight Diamond with LRT Fly Over

#	Description	Advantages	Disadvantages
LT-2	LRT median running elevated, alignment shifted north (Assume vertical clearance over frontage roads only)	▪ Separation of modal traffic ▪ Increases safety for peds and bikes ▪ Improves transit operations ▪ Improves traffic operations ▪ Shortens the distance between stop bars ▪ Moderate right-of-way impacts ▪ Access management is easiest ▪ Equal access to both sides of the road ▪ Accommodates TOD ▪ Avoid purchasing right-of-way on the south side of Camelback Road	▪ No left turns between 23rd Ave. and I-17 and I-17 and 27th Ave. ▪ Increases Cost ▪ May need to rebuild the entire I-17 structure ▪ Temporary closure of Camelback Road ▪ Visual impacts ▪ More structure; costs more ▪ Adverse visual impacts ▪ Constricts the ability to widen Camelback Road ▪ Potential utility impacts

Justification/Comments: Moved to further development with this alternative

Alternative No. 2 - Tight Diamond with LRT Fly Over

#	Description	Advantages	Disadvantages
LT-3	North side running at grade (just north of Camelback Road)	▪ Provides more left-turn storage length on Camelback Road ▪ Increases safety for peds and bikes ▪ Improves traffic operations ▪ Shortens the distance between stop bars ▪ Cheaper compared to the grade-separated option ▪ Requires one structure as opposed to two – easiest to construct ▪ Minimal utility impacts (assume utilities are located on the south side of Camelback Road) ▪ Separates LRT from the Roadway ▪ Right-of-way needed only on the north side ▪ May reduce the right-of-way cost ▪ Minimizes utility impacts ▪ Minimized construction impacts to Camelback Road	▪ Crossover out of the median at 21st Ave. ▪ 6-minute headways shuts down Camelback Road ▪ Signal progression on Camelback Road could get worse ▪ North side business access (Cactus Jack's) ▪ Requires widening of the bridge (approximately 15 feet) ▪ Might delay transit operations ▪ Will have adverse right-of-way impacts to Cactus Jack's and GCU ▪ SB I-17 exiting traffic will be adversely impacted, potentially backing on to the I-17 ▪ Safety concerns with turning traffic possibly stuck on the light rail track ▪ SB I-17 exit and northbound I-17 entrance movements will be significantly constricted ▪ Inherently less safe for the access (to cross two directions of LRT traffic) ▪ Issues associated with shifting of LRT from the median to the north and back to the median

Justification/Comments: This LRT option was dropped from further consideration with alternative.

Alternative No. 2 - Tight Diamond with LRT Fly Over

#	Description	Advantages	Disadvantages
LT-4	North side running, elevated (just north of Camelback Road)	▪ Right-of-way needed only on the north side ▪ May reduce the right-of-way cost ▪ Minimizes utility impacts ▪ Minimized construction impacts to Camelback Road ▪ Grade separates the ramps and frontage roads ▪ Minimized impacts to the existing TI operations ▪ Separation of modal traffic ▪ Increases safety for peds and bikes ▪ Improves transit operations ▪ Improves traffic operations ▪ Shortens the distance between stop bars ▪ Minimal utility impacts (assume utilities are located on the south side of Camelback Road) ▪ Moderate right-of-way impacts	▪ Crossover out of the median at 21st Ave. ▪ 6-minute headways shuts down Camelback Road ▪ Signal progression on Camelback Road could get worse ▪ More structure; costs more ▪ Adverse visual impacts ▪ Constricts the ability to widen Camelback Road ▪ Inherently less safe for the access (to cross 2 directions of light rail traffic) ▪ Issues associated with shifting of LRT from the median to the north and back to the median

Justification/Comments: This option was dropped from further consideration with this alternative.

#	Description	Advantages	Disadvantages
LT-5	North alignment along Colter	▪ Does not constrain the I-17 improvements ▪ Could add additional bike and ped crossing I-17 ▪ Minimize impacts to Camelback Road	▪ Significant traffic impacts due to train turning movements ▪ Trains through the neighborhood ▪ May increase costs ▪ High Maintenance costs due to curves ▪ Extra travel time (adverse travel) added to the route ▪ Noise impacts ▪ Potential EJ issues

Justification/Comments: Not evaluated due to non-applicability to this exercise.

Alternative No. 2 - Tight Diamond with LRT Fly Over

#	Description	Advantages	Disadvantages
LT-6	North side running along Camelback, elevated from 19th to 43rd avenues	▪ Minimizes business impacts on Camelback Road ▪ Minimal impact to traffic ▪ Operational speed of the LRT ▪ Minimal impacts to cross traffic on Camelback Road ▪ Could minimize construction impacts ▪ Separation of modal traffic ▪ Increases safety for peds and bikes ▪ Improves transit operations ▪ Improves traffic operations ▪ Shortens the distance between stop bars ▪ Minimal utility impacts (assume utilities are located on the south side of Camelback Road) ▪ Moderate right-of-way impacts	▪ Visual impacts ▪ Elevated stations ▪ May increase cost ▪ May impact TOD ▪ Less visibility of users of the station ▪ May impact the sight distance ▪ Public acceptance of elevated structures ▪ More structure; significantly more costs ▪ Most adverse visual impacts ▪ Constricts the ability to widen Camelback Road

Justification/Comments: This option was dropped from further consideration with this alternative.

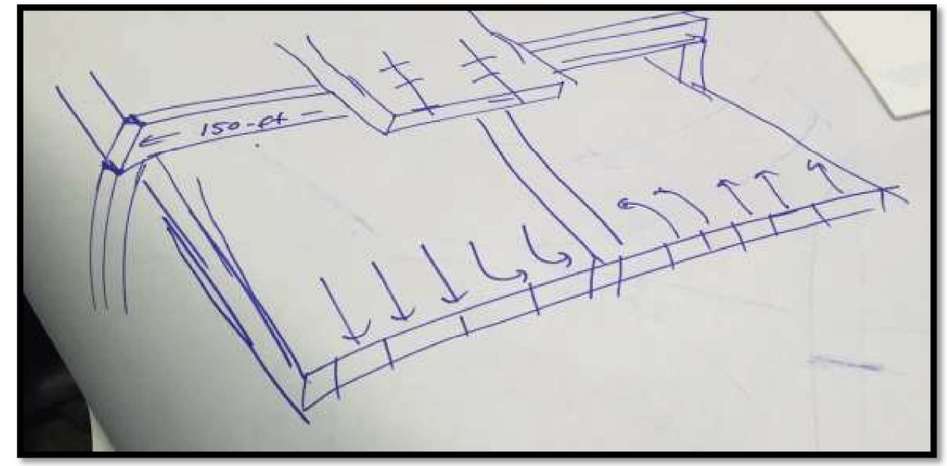
Discussion/Justification/Sketches/Photos:

This alternative changes the existing TI from a SPUI to a Tight Diamond Interchange. This alternative largely preserves existing TI and right-of-way with LRT overhead. LRT bridge structure is constructed using straddle bents.

LRT will run along the median of Camelback Road and will be elevated over the I-17 / Camelback Road TI. LRT will traverse on an elongated bridge to the east to preserve view-shed between and access to the two car dealerships.

- Provides for median left-turn only lane instead of bi-directional left turns.
- Structure extended eastward to preserve view-shed of car dealers.
- Left turn access out of both the car dealerships is restricted leaving only ¾ access, allowing for entering left turns to the property.
- Eliminate through North-South movement on 22nd Ave., across Camelback Road; preserves through-movements at 23rd and 21st avenues.
- 26th Ave. only right-in, right-out access.
- Quick Trip only right-in, right-out access.
- The LRT station will be located west of 27th Ave.
- Existing I-17 / Camelback Road bridge will be rehabbed (re-decked/striped/surfaced)

Alternative No. 2 - Tight Diamond with LRT Fly Over



Alternative No. 2 - Tight Diamond with LRT Fly Over

Assumptions and Calculations:

- 11-foot lanes through the TI on Camelback Road.
- Straddle bents at I-17 / Camelback Road.
- LRT structure will not be attached to the existing TI structure.
- Existing TI structure will not need to be widened.
- Maintaining the existing ADOT access control.
- Right-of-way needs are vastly minimized and limited to north side only.
- Assume $ 20 per SF for bridge re-decking.
- Assumes use of straddle bents allows alternative to be constructible.

Item Description	Unit	Recommendation		
		Qty	Unit Cost	Total
LRT Structure	SF	48,000	110	5,280,000
Approaches (East and West)	SF	54,000	110	5,940,000
Straddle Bent	L. Sum	3	750,000	2,250,000
Retaining Wall (East and West)	SF	42,460	60	2,547,600
Retained Fill	CY	35,000	10	350,000
Traffic Signal Work	Each	5	150,000	750,000
Bridge Re-decking	L.Sum	1	416,000	416,000
Removal	SF	2,500	15	37,500
Rail	LF	3,275	2,200	7,205,000
Utilities	LF	1,000	400	400,000
AC Pavement	SY	78,000	35	2,730,000
Portland Cement Concrete Pavement (PCCP)	SY	600	45	27,000
Light Rail Station	Each	1	3,000,000	3,000,000
I-17 Widening Construction Accommodations	LS	1	$2,000,000	$2,000,000
Construction Total				**$32,933,100**
Plus 60% Markup (Construction x 1.6)				$52,692,960
Right-of-way	SF	70,000	25	$1,750,000
Total Cost				**$54,442,960**

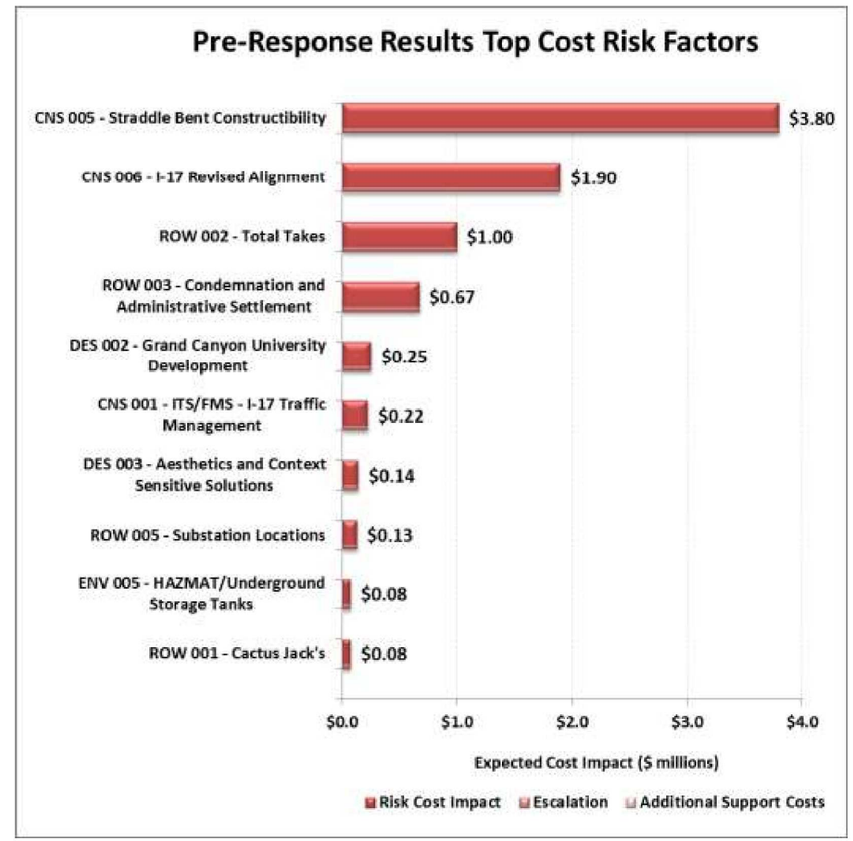
Alternative No. 2 - Tight Diamond with LRT Fly Over

Risk Identification and Quantification

After the alternative was developed, the Value Planning Team discussed the potential risk events and elements that would be facing the alternative. For each significant risk event that was identified, the probability of the risk and its impact to cost, schedule, or both were estimated. The risk assessment process included identifying high risk areas and risk elements as threats (or opportunities where appropriate) to a project and quantifying the identified risk elements.

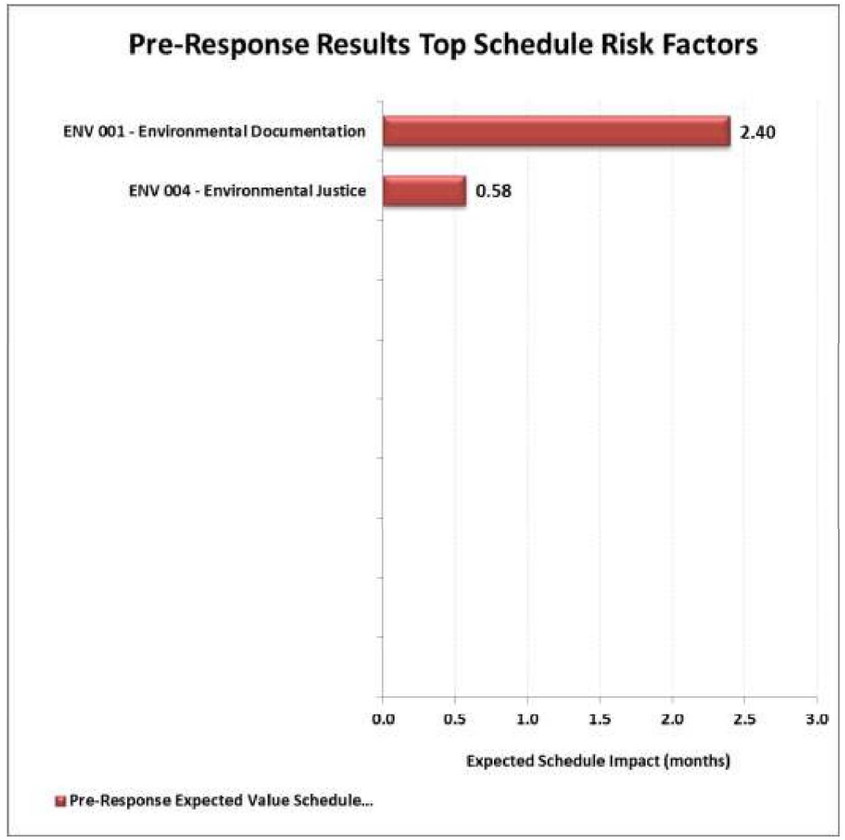
The Risk Data Sheets provided in the Appendix of this report shows additional information specific to each risk as identified by the Team for all the alternatives.

The tornado diagrams for the top risks impacting both cost and schedule for this alternative are provided below.



Alternative No. 2 - Tight Diamond with LRT Fly Over

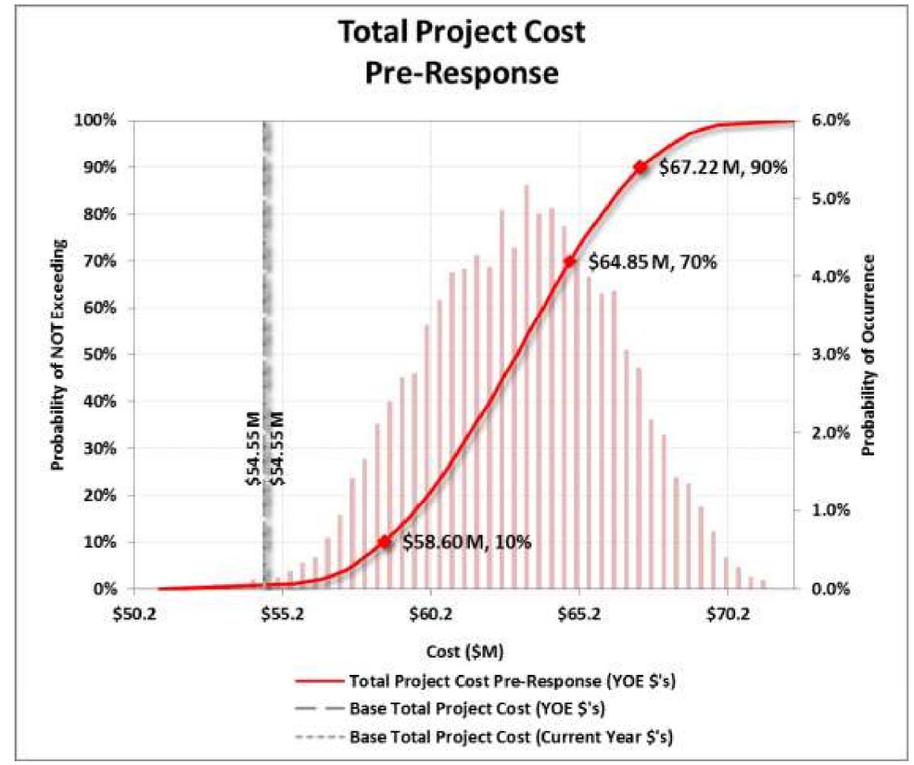
The expected value (likelihood multiplied by expected risk outcome) tornado diagrams depict the actual expected values of the identified risks. Not all risks identified require immediate management. Often, a project Team needs to prioritize the risks for which it plans to develop strategies in the future in an effort to make the best use of the time available. An example would be to begin with the risks with the highest cost and schedule impacts.



Alternative No. 2 - Tight Diamond with LRT Fly Over

Risk Analysis Results

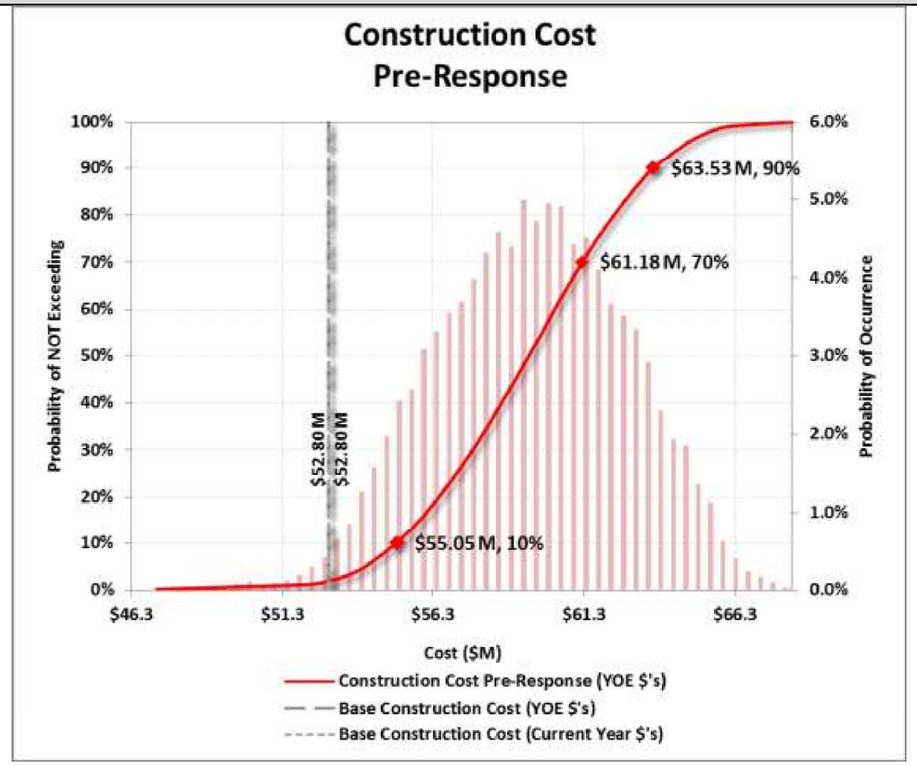
The risk analysis results are given in the form of graphs showing the relationship between cost and the probability of not exceeding that cost. Risk-based analysis provides a distribution of probabilities that a project will not exceed an estimated dollar figure. Typically, agencies report the project risk-based estimation using the 70 percent confidence interval. Each graph represents the best opinion of the cost ranges by the workshop participants at the time of the analysis.



The base cost is the cost without any contingencies or factored escalation, is at $54.55 million.

The s-curve, with risk results factored into the analysis, shows that the Alternative 2 will be less than **$64.85 million** at a 70% confidence level.

Alternative No. 2 - Tight Diamond with LRT Fly Over



The base cost for design/construction for Alternative 2 is $52.80 million.

The s-curve, with risk results factored into the analysis, shows that the design/construction costs for Alternative 2 will be less than **$61.18 million** at a 70% confidence level.

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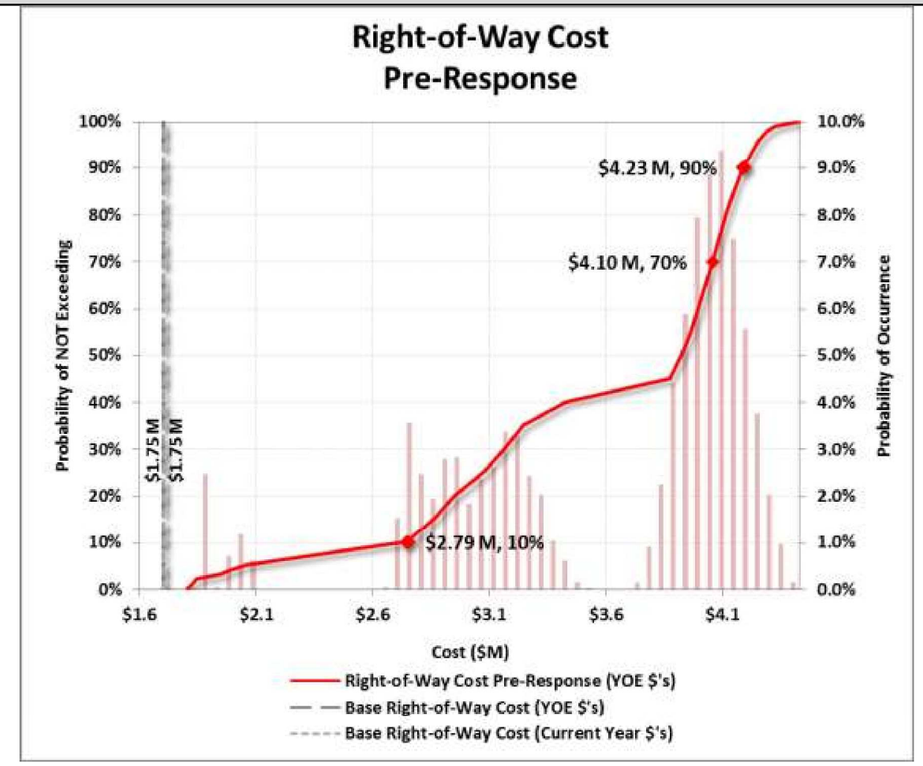
Alternative No. 2 - Tight Diamond with LRT Fly Over



The base cost for right-of-way for Alternative 2 is $1.75 million.

The s-curve, with risk results factored into the analysis, shows that the right-of-way costs for Alternative 2 will be less than **$4.10 million** at a 70% confidence level.

The next step will be to determine the appropriate risk response strategies for the identified high risk areas. Risk response strategies were not identified as part of this Value Planning workshop. Four risk response strategies are considered when addressing threat risks. Those strategies are to avoid, accept, transfer, or mitigate the risk threat (opportunity).

Alternative No. 2 - Tight Diamond with LRT Fly Over

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation		Alternative Scoring
Roadway Operations + Minimizes modal conflicts + Provides access management along Camelback Road + Increases storage length for left turns on Camelback Road, increasing the green time for exiting I-17 exiting traffic	Rating	6
	Weight	23.8
	Contribution	142.8
Transit Operations + Dedicated right-of-way, minimized modal conflict + LRT has increased speed due to grade separation and reduced traffic conflict + Straight LRT alignment - Shorter touchdown ramps	Rating	9
	Weight	23.8
	Contribution	214.2
Maintainability - No bridge replacement; older bridge to maintain - Additional structures to maintain - Longer LRT bridge + Maintains existing TI while rehabbing the deck	Rating	5
	Weight	14.4
	Contribution	72.0
Construction Impacts - Temporary closures of I-17 and Camelback Road + No bridge removals - Large columns in I-17 median for straddle bents - Constructability issues with large straddle bent caps	Rating	2
	Weight	4.7
	Contribution	9.4
Environmental Impacts - Visual impacts due to longer elevated span of LRT + Minimal impacts to businesses	Rating	6
	Weight	9.5
	Contribution	57.0
Promotes Economic Growth + Maintaining business access + Enhancement of traffic movement and access	Rating	7
	Weight	23.8
	Contribution	166.6
	Total Performance:	**662.0**

Alternative No. 3 - Platform Diamond with Median LRT

Alternative Description:

Build a third level over the existing interchange to create a platform (or 3-level diamond TI) that would accommodate double-track LRT and two traffic lanes in each direction (about 90 feet total).

Advantages:	Disadvantages:
♦ Allows free-flowing east-west traffic movements (heaviest flows) that are separated from the turning movements associated with the interchange. Significant increase in capacity of the interchange. ♦ Benefits transit travel time by removing conflicts with vehicular turning movements. ♦ Improves safety by isolating turning movements from through-traffic and transit. ♦ Avoid relocation of utilities currently through the south side of the bridge. ♦ Perpetuates right-in/right-out access along both sides of Camelback.	♦ Right-of-way requirements would significantly impact properties on the north side of Camelback Road. ♦ Awkward left turns at 27th and 23rd avenues (southbound) from Camelback would need to be addressed. ♦ Visual impacts resulting from new third level structure.

Cost Summary	
Alternative Cost	**$25.78 M @ 60% markup + $3.0 M right-of-way = $44.25 M**

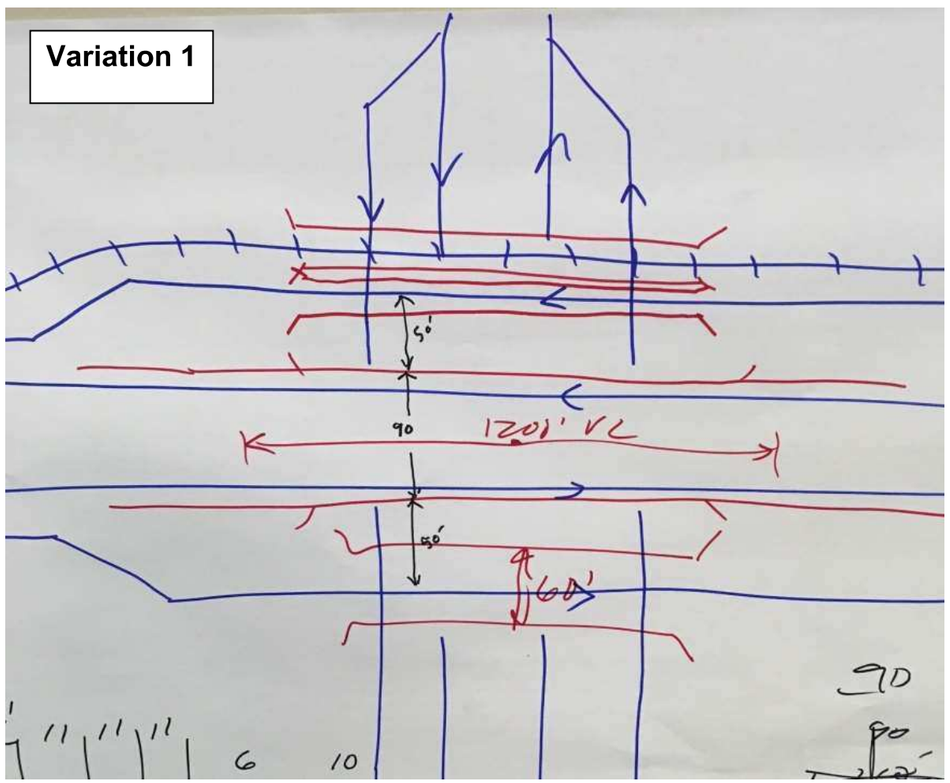
Alternative No. 3 - Platform Diamond with Median LRT

Evaluation of Light Rail Options for Alternative No. 3

Alternative Variations Discussed and Dropped:

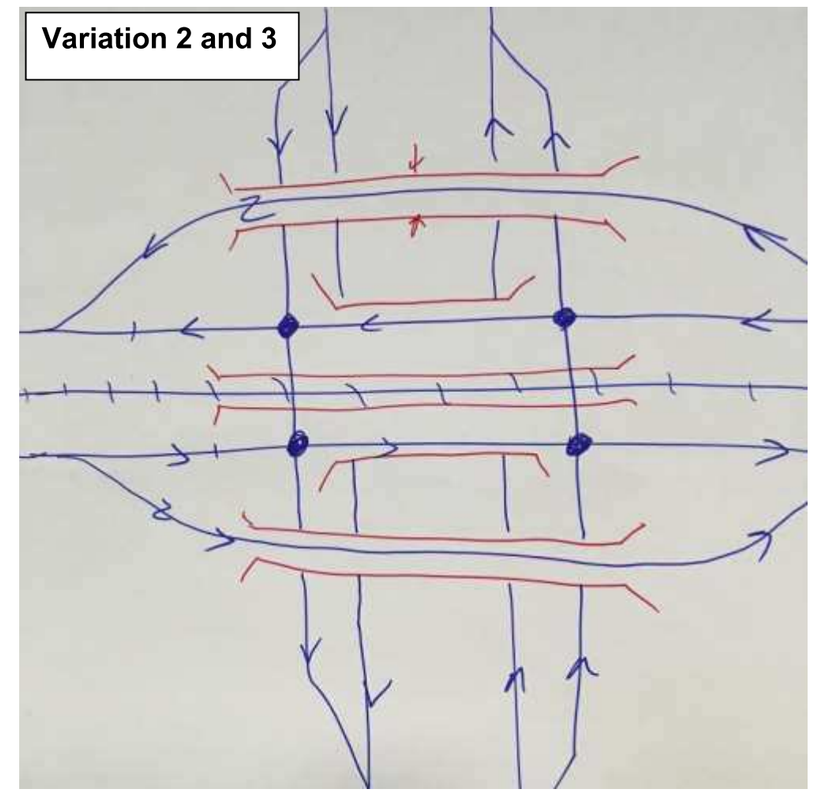
Three alternative variations of the platform diamond interchange configuration were briefly discussed and dismissed during the evaluation of this alternative:

1. Variation 1 stripped the LRT out of the median EB-WB flyover and put it on a separate grade separated flyover over the I-17 TI to the north of the proposed westbound Camelback Road travelway. This variation was dismissed because the Team concluded that it lost the combined benefit of a single bridge for both roadway and LRT, complicated construction, increased cost, and made the LRT alignment less desirable from both an operations and economic growth perspective.



Alternative No. 3 - Platform Diamond with Median LRT

2. Variation 2 splits the eastbound and westbound through movements on Camelback Road into their own separate flyovers on the outside of the interchange as opposed to the inside. With this variation, the LRT would remain at-grade through the median through the middle of the interchange turning platform. The advantage would be that the LRT stays at-grade and in the median of the road – the most desirable from and LRT perspective. The disadvantage of this variation is that the LRT would have to run through the TI turning movements at-grade, and would add two additional signals (for a total of six) within the platform level. This variation was dismissed as the LRT crossings within the TI would be highly undesirable for both Valley Metro and ADOT, and the exterior flyover ramps would sever access to the adjacent parcels completely between 23rd and 27th avenues.

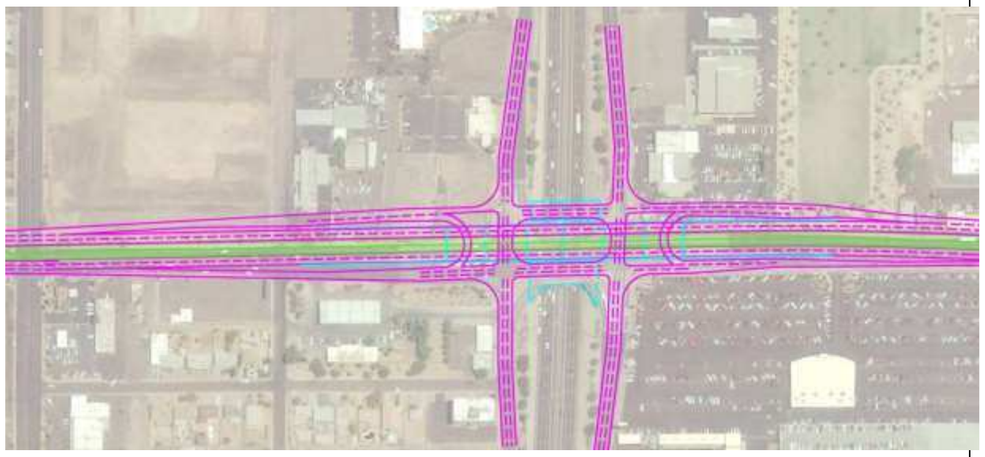


3. Variation 3 would utilize the same layout as Variation 2, but would grade separate the LRT movement through the center with a third dedicated LRT flyover over the TI movements. While an overall good solution for operations, the right-of-way and access impacts between 23rd and 27th avenues are still significant due to the exterior flyover ramps.

Alternative No. 3 - Platform Diamond with Median LRT

Discussion/Justification/Sketches/Photos:

Build a third level over the existing interchange to create a platform (or 3-level diamond TI) that would accommodate double track light rail and two traffic lanes in each direction (about 90 feet total). Modify and expand the at-grade bridge to accommodate three traffic lanes in each direction, a bike lane, and sidewalks (about 60 feet on the south side and 50 feet on the north side). All turning movements at the TI would occur at this level; design options include four 2-phase signals or four small modern roundabouts. Total width of the facility would expand to about 210 feet from the current 130 feet.



Assumptions:

- Entire TI PCCP replaced.
- EB-WB flyover ramp approaches are all PCCP.
- All other pavements are asphalt.
- Estimate assumes signals at all four platform intersections, and new signals at 23rd and 27th avenues.
- Concept includes U-turns under flyover abutments.
- Major utilities within TI are avoided (by keeping south 60 feet of existing bridge). Utility relocations within the arterial under the approaches are accounted for.
- MOT phasing would construct new westbound Camelback Road direction first, shift traffic, and then open the Camelback Road median to construct the long flyover.
- Right-of-way take is based on neat line, but probably underestimates total takes and business relocations.

Alternative No. 3 - Platform Diamond with Median LRT

Assumptions and Calculations:

3 level structure	Unit	Unit cost	Quantity	Total
LRT Guideway	TF	$2,200	3,275	$7,205,000
EB/WB/LRT Flyover	SF	$110	58,000	$6,380,000
WB Camelback Bridge	SF	$100	9,000	$900,000
Removals - Structure	SF	$15	17,000	$255,000
Retaining walls	SF	$60	20,000	$1,200,000
Fill	CY	$10	70,000	$700,000
LRT Platform	Each	$3,000,000	1	$ 3,000,000
Traffic signals	Each	$300,000	4	$1,200,000
Pavement				
Concrete	SY	$45	8,000	$360,000
Asphalt	SY	$35	12,000	$ 420,000
Sidewalk	SF	$4	5,000	$140,000
Utility				
Major	LF	$700	2,600	$1,820,000
Medium	LF	$400	500	$200,000
I-17 Widening Construction Accommodations	LS	$2,000,000	1	$2,000,000
Construction subtotal				$25,780,000
MARK-UP	**Plus 60% Markup (Construction x 1.6)**			$41,248,000
Right-of-way	LS	$ 3,000,000	1	$3,000,000
Total				**$44,248,000**

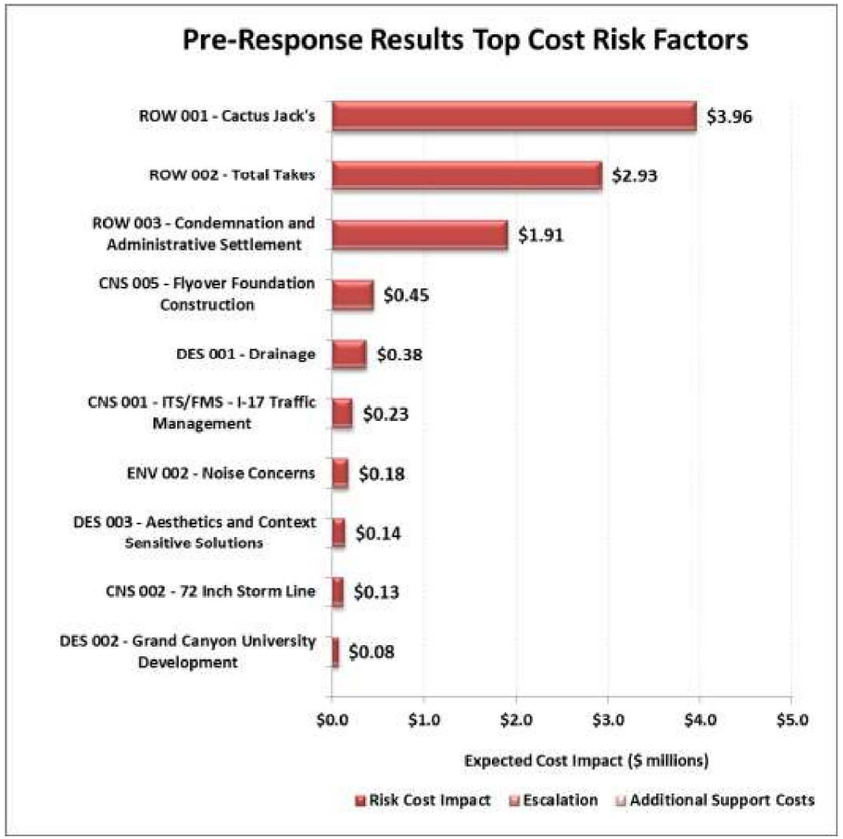
Alternative No. 3 - Platform Diamond with Median LRT

Risk Identification and Quantification

After the alternative was developed the Value Planning Team discussed the potential risk events and elements that would be facing the alternative. For each significant risk event that was identified, the probability of the risk and its impact to cost, schedule, or both were estimated. The risk assessment process included identifying high risk areas and risk elements as threats (or opportunities where appropriate) to a project and quantifying the identified risk elements.

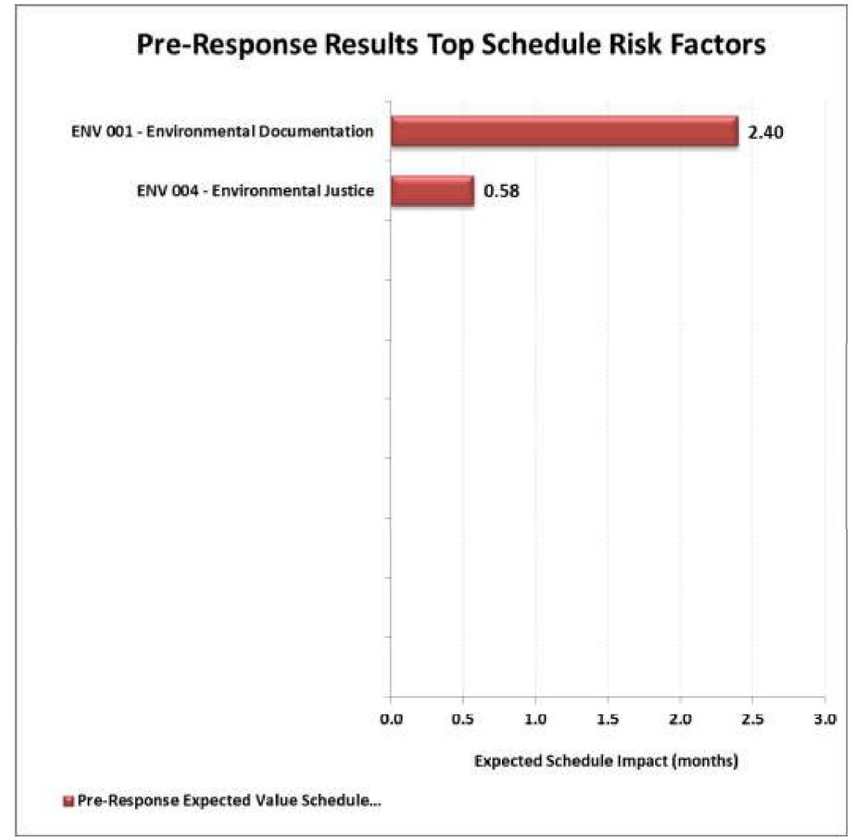
The Risk Data Sheets provided in the Appendix of this report shows additional information specific to each risk as identified by the Team for all the alternatives.

The tornado diagrams for the top risks impacting both cost and schedule for this alternative are provided below.



Alternative No. 3 - Platform Diamond with Median LRT

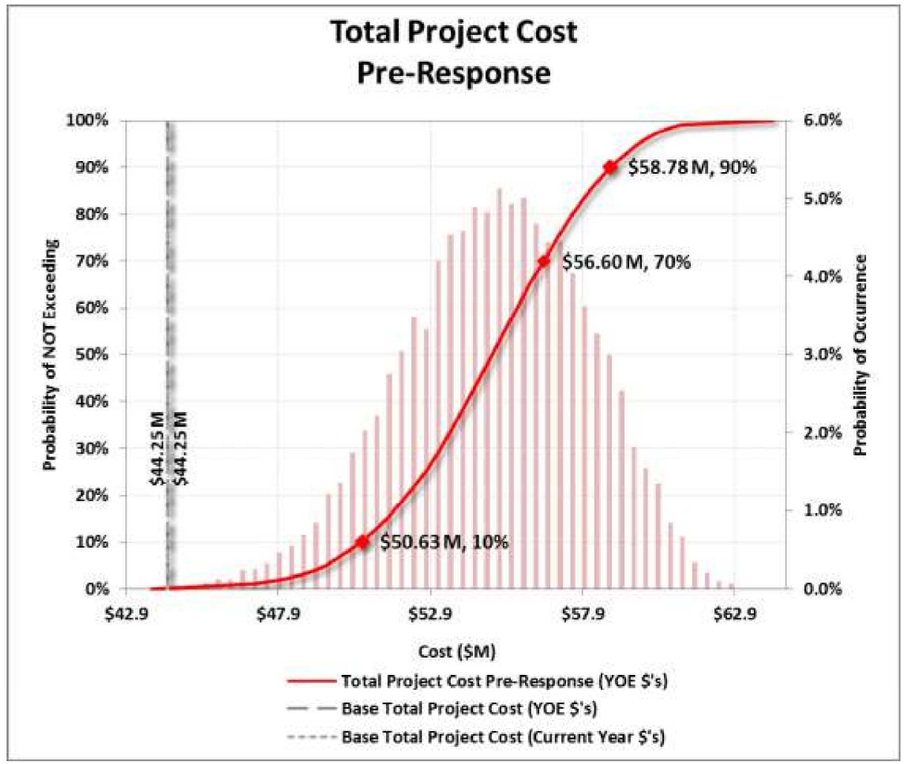
The expected value (likelihood multiplied by expected risk outcome) tornado diagrams depict the actual expected values of the identified risks. Not all risks identified require immediate management. Often, a project Team needs to prioritize the risks for which it plans to develop strategies in the future in an effort to make the best use of the time available. An example would be to begin with the risks with the highest cost and schedule impacts.



Alternative No. 3 - Platform Diamond with Median LRT

Risk Analysis Results

The risk analysis results are given in the form of graphs showing the relationship between cost and the probability of not exceeding that cost. Risk-based analysis provides a distribution of probabilities that a project will not exceed an estimated dollar figure. Typically, agencies report the project risk-based estimation using the 70 percent confidence interval. Each graph represents the best opinion of the cost ranges by the workshop participants at the time of the analysis.



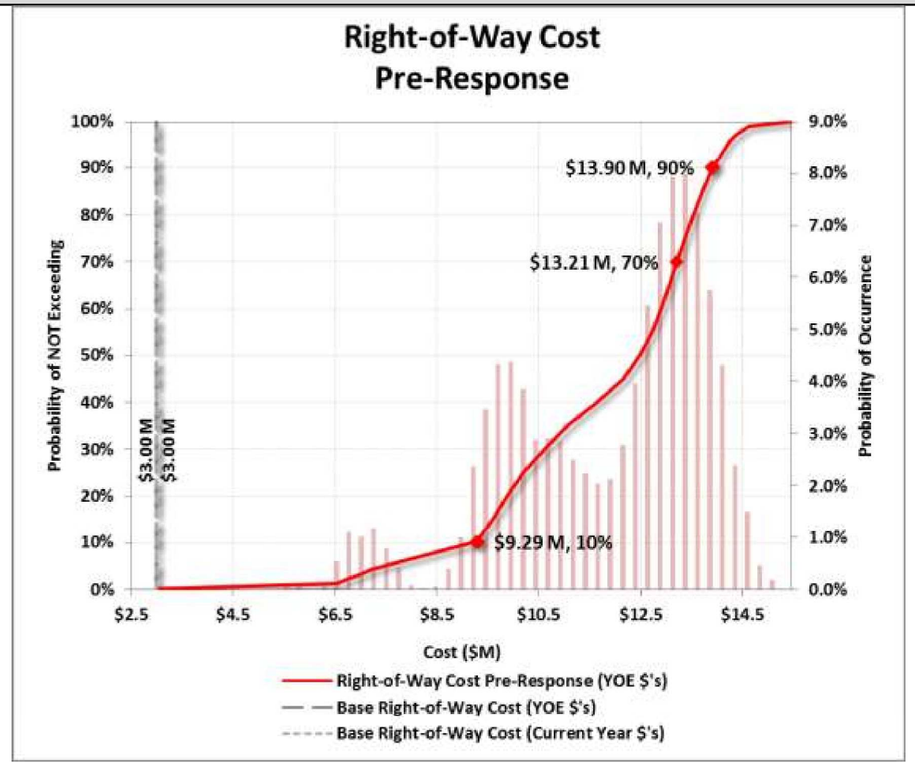
The base cost is the cost without any contingencies or factored escalation, shown by the gray vertical lines at $44.25 million. The s-curve, with risk results factored into the analysis, shows that the Alternative 3 will be less than **$56.60 million** at a 70% confidence level.

Alternative No. 3 - Platform Diamond with Median LRT

The base cost for design/construction for Alternative 3 is $41.25 million.

The s-curve, with risk results factored into the analysis, shows that the design/construction costs for Alternative 3 will be less than **$44.38 million** at a 70% confidence level.

Alternative No. 3 - Platform Diamond with Median LRT



The base cost for right-of-way for Alternative 3 is $3.00 million.

The s-curve, with risk results factored into the analysis, shows that the right-of-way costs for Alternative 3 will be less than **$13.21 million** at a 70% confidence level.

The next step will be to determine the appropriate risk response strategies for the identified high risk areas. Risk response strategies were not identified as part of this Value Planning workshop. Four risk response strategies are considered when addressing threat risks. Those strategies are to avoid, accept, transfer, or mitigate the risk threat (opportunity).

Alternative No. 3 - Platform Diamond with Median LRT

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation		Alternative
Roadway Operations + Emphasizes East-West movement on Camelback by having this heavy movement avoid the TI signal(s). + 2-phase signals at all TI ramp terminals, but could also be roundabouts. - Left turn movements to the on-ramps and from the off-ramps have three signal systems to pass through (this may be eliminated with the use of roundabouts). - Potential weaving traffic where roadway connects back to grade near the 27th and 23rd avenues intersections. + U-turns under flyover help maintain driveway and business access along retaining walls. - Design speed of flyover would be between 45 mph and 35 mph.	Rating	8
	Weight	23.8
	Contribution	190.4
Transit Operations + Preferred center running + No signal to crossing. + Serves both sides of Camelback outside of TI block.	Rating	9
	Weight	23.8
	Contribution	214.2
Maintainability - Adds much more bridge. - New concrete pavement. - Access to the LRT bridge from the roadway.	Rating	5
	Weight	14.4
	Contribution	72.0
Construction Impacts + Minimal if phased properly (construct westbound level 2, demo half of existing and build new structure). - Requires LRT and the Camelback Road flyover to be built as one bridge. - Temporary driveway and business impacts will be substantial for the duration of construction, which will probably be close up to 2 yrs.	Rating	5
	Weight	4.7
	Contribution	23.5
Environmental Impacts - Business impacts along north side of Camelback Road. - Visual impacts; walls in front of the businesses. - Right-in right-out access to businesses. - May increase traffic noise.	Rating	4
	Weight	9.5
	Contribution	38.0
Promotes Economic Growth + With center running, both side of Camelback Road can be developed to support LRT. + Facility promotes regional East-West movement, making the Camelback Road corridor more attractive to users.	Rating	9
	Weight	23.8
	Contribution	214.2
	Total Performance:	**752.0**

Alternative No. 4 -SPUI with Elevated LRT and Fly Over

Alternative Description:

The existing single point urban interchange (SPUI) and Camelback Road will largely remain unchanged. LRT will run along the median of Camelback Road east and west of I-17 but crosses to the north side of Camelback Road to cross I-17. This concept would use an LRT viaduct from east of 21st Ave. to approximately the 25th Ave. alignment.

Advantages:	Disadvantages
♦ Separation of modal traffic. ♦ Increases safety for pedestrians and bikes. ♦ Minor right-of-way impacts. ♦ Access management is fairly simple. ♦ Equal access to both sides of the road. ♦ Avoid purchasing right-of-way on the south side of Camelback Road. ♦ Retains line of sight along Camelback Road to the businesses between I-17 and 23rd avenues. ♦ Relatively low cost. ♦ Largely preserves the existing TI.	♦ No left turns between 23rd Ave. and I-17 and between 23rd and 21st avenues. ♦ No notable capacity changes to Camelback Road or the I-17 TI. ♦ Temporary closure of Camelback Road to construct the viaduct and straddle bents. ♦ More structure; more maintenance. ♦ Adds adverse visual impacts. ♦ Constricts the ability to widen Camelback Road. ♦ Potential significant utility impacts. ♦ Does little to improve capacity for East-West Camelback traffic.

Cost Summary	
Alternative No. 4 Cost	**$26.67 M @ 60% markup + $1.67 M right-of-way = $44.34 M**

Alternative No. 4 -SPUI with Elevated LRT and Fly Over

Discussion/Justification/Sketches/Photos:

The existing single point urban interchange (SPUI) and Camelback Road will largely remain unchanged. LRT will run along the median of Camelback Road east and west of I-17 but crosses to the north side of Camelback Road to cross I-17. This concept would use an LRT viaduct from east of 21st Ave. to approximately the 25th Ave. alignment.

- Median instead of bi-directional left turns.
- Structure extended east of 23rd Ave. to preserve view-shed of car dealers.
- Left turn access out of both the car dealerships are restricted (provide only 3/4 access).
- Eliminate through movement on 22nd Ave., across Camelback Road; preserve through movements at 23rd and 21st avenues.
- 26th Ave. only right-in right-out access.
- Quick Trip only right-in right-out access.
- The LRT station will be located west of 27th Ave.
- Existing I-17 / Camelback Road bridge will only be re-decked.
- The main advantage of Alternative 4 over Alternative 2 is that the very long and difficult to construct straddle bents have been replaced by a few short straddle bents that only span over WB Camelback Road.

Alternative No. 4 -SPUI with Elevated LRT and Fly Over

Assumptions and Calculations:

- 11-foot lanes
- Straddle bents needed to cross LRT from median to north roadway edge on both sides of the TI. Straddle bents only span the westbound roadway of Camelback Road and we assume we only need one on the east side of the TI, and two on the west side of I-17.
- LRT structure will not be attached to the existing structure.
- The existing structure will not need to be widened.
- Maintaining the existing ADOT access control.
- Right-of-way needs are minimized and limited to north side only.
- Assume, if necessary, $ 20/SF for bridge re-decking

Item Description	Unit	Recommendation		
		Qty	Unit Cost	Total
LRT Structure	SF	60,800	$110	$6,688,000
Straddle Bents	L. Sum	3	$400,000	$1,200,000
Retaining Wall (East and West)	SF	19,800	$60	$1,188,000
Retained Fill	CY	20,000	$10	$200,000
Traffic Signal Work	Each	2	$300,000	$600,000
Bridge Re-decking	L.Sum	1	$416,000	$416,000
Rail	Lf	3,375	$2,200	$7,425,000
Utilities	Lf	3,000	$400	$1,200,000
AC Pavement	SY	78,000	$35	$2,730,000
PCCP	SY	600	$45	$27,000
Light Rail Station	Each	1	$3,000,000	$3,000,000
I-17 Widening Construction Accommodations	LS	1	$2,000,000	$2,000,000
Total				$26,674,000
Plus 60% Markup (Construction x 1.6)				**$42,678,400**
Right-of-way	SF	$66,600	25	$1,665,000
Total Cost				**$44,343,400**

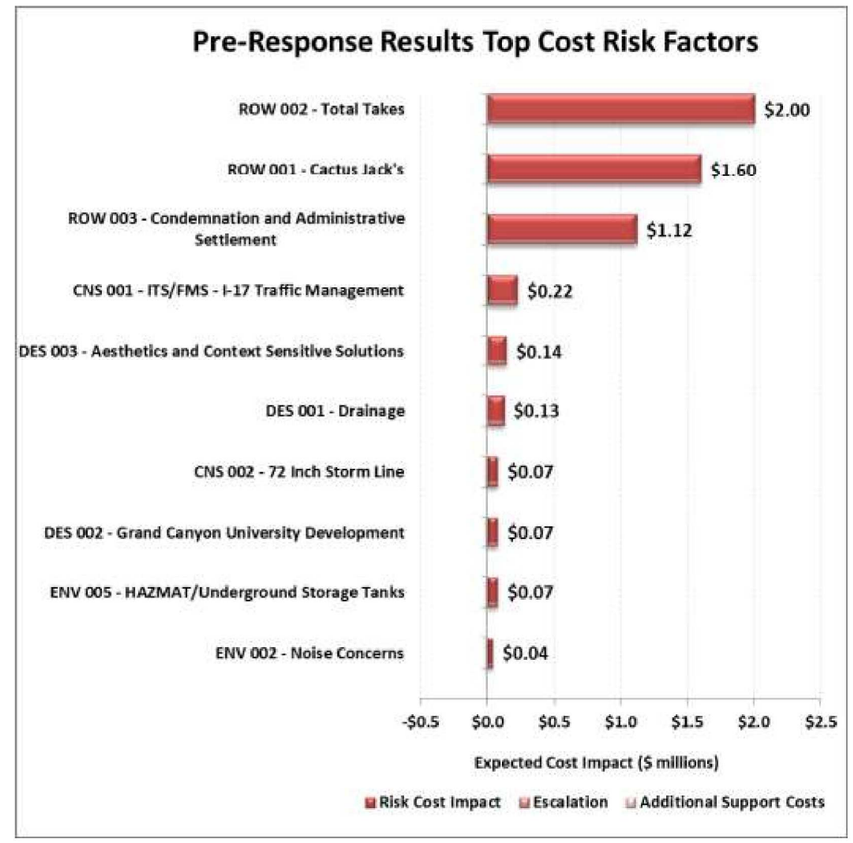
Alternative No. 4 -SPUI with Elevated LRT and Fly Over

Risk Identification and Quantification

After the alternative was developed the Value Planning Team discussed the potential risk events and elements that would be facing the alternative. For each significant risk event that was identified, the probability of the risk and its impact to cost, schedule, or both were estimated. The risk assessment process included identifying high risk areas and risk elements as threats (or opportunities where appropriate) to a project and quantifying the identified risk elements.

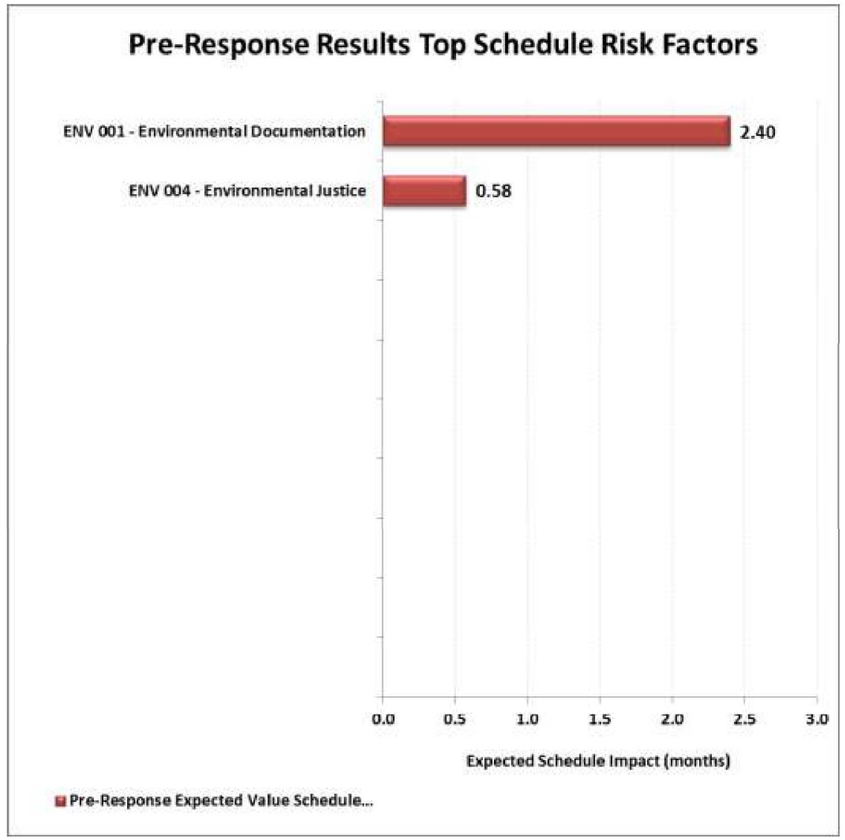
The Risk Data Sheets provided in the Appendix of this report shows additional information specific to each risk as identified by the Team for all the alternatives.

The tornado diagrams for the top risks impacting both cost and schedule for this alternative are provided below.



Alternative No. 4 -SPUI with Elevated LRT and Fly Over

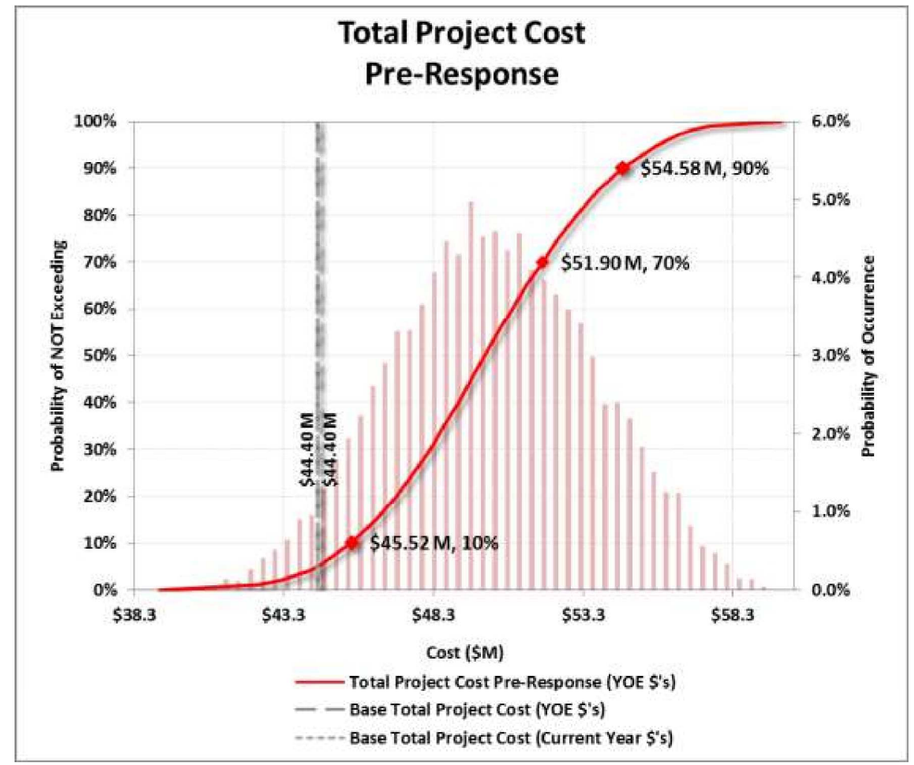
The expected value (likelihood multiplied by expected risk outcome) tornado diagrams depict the actual expected values of the identified risks. Not all risks identified require immediate management. Often, a project Team needs to prioritize the risks for which it plans to develop strategies in the future in an effort to make the best use of the time available. An example would be to begin with the risks with the highest cost and schedule impacts.



Alternative No. 4 -SPUI with Elevated LRT and Fly Over

Risk Analysis Results

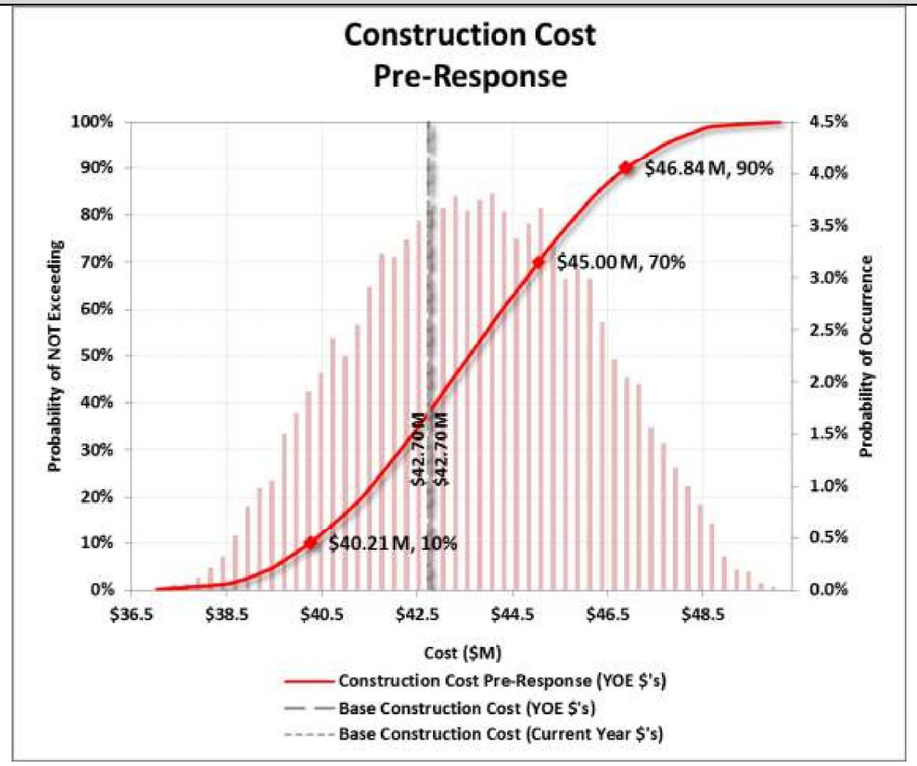
The risk analysis results are given in the form of graphs showing the relationship between cost and the probability of not exceeding that cost. Risk-based analysis provides a distribution of probabilities that a project will not exceed an estimated dollar figure. Typically, agencies report the project risk-based estimation using the 70 percent confidence interval. Each graph represents the best opinion of the cost ranges by the workshop participants at the time of the analysis.



The base cost is the cost without any contingencies or factored escalation, shown by the gray vertical line at $44.40 million.

The s-curve, with risk results factored into the analysis, shows that the Alternative 4 will be less than **$51.90 million** at a 70% confidence level.

Alternative No. 4 -SPUI with Elevated LRT and Fly Over



The base cost for design/construction for Alternative 4 is $42.70 million.

The s-curve, with risk results factored into the analysis, shows that the design/construction costs for Alternative 4 will be less than **$45.00 million** at a 70% confidence level.

MARICOPA ASSOCIATION of GOVERNMENTS

Alternative No. 4 -SPUI with Elevated LRT and Fly Over

The base cost for right-of-way for Alternative 4 is $1.70 million.

The s-curve, with risk results factored into the analysis, shows that the right-of-way costs for Alternative 4 will be less than **$8.06 million** at a 70% confidence level.

The next step will be to determine the appropriate risk response strategies for the identified high risk areas. Risk response strategies were not identified as part of this Value Planning workshop. Four risk response strategies are considered when addressing threat risks. Those strategies are to avoid, accept, transfer, or mitigate the risk threat (opportunity).

Alternative No. 4 -SPUI with Elevated LRT and Fly Over

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation		Alternative
Roadway Operations + Minimizes modal conflicts. + Maintains most access along Camelback Road, except along touch down ramp lengths.	Rating	6
	Weight	23.8
	Contribution	142.8
Transit Operations + Dedicated right-of-way, minimized conflict. + Increased speed. + Straight LRT alignment, except for shoe-fly alignment at I-17 crossing. + Approximately 5% grades on approaches.	Rating	8
	Weight	23.8
	Contribution	190.4
Maintainability - Additional structures to maintain. - Longer LRT bridge. + New bridge deck structure. - Not replacing bridge; older bridge to maintain.	Rating	5
	Weight	14.4
	Contribution	72.0
Construction Impacts - Temporary closures of I-17 and Camelback Road. - Most of Camelback Road will have to be reconstructed due to impacts of constructing the LRT bridge overhead.	Rating	4
	Weight	4.7
	Contribution	18.8
Environmental Impacts - Visual impacts. + Minimal impacts to businesses.	Rating	5
	Weight	9.5
	Contribution	47.5
Promotes Economic Growth + Maintaining TOD compatibility. + Maintaining traffic movement and access for business access.	Rating	7
	Weight	23.8
	Contribution	166.6
	Total Performance:	**638**

Value Planning Approach

Understanding the relationship of cost, performance, and value is essential in evaluating different alternatives. Comparing the performance and cost suggests which recommendations are potentially as good as or better than the project baseline concept in terms of overall value.

Value Engineering, Analysis or Planning has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that value analysis can play to improve project performance. To address this issue, a performance-based approach was used.

The primary objective of any workshop is to improve the value of the project. A simple way to think of value in terms of an equation is shown at right. While project costs are fairly easy to quantify and compare through traditional estimating techniques, performance is not so easily quantifiable.

$$Value = \frac{Performance}{Cost}$$

The use of performance attributes acts the cornerstone of this performance-based process by giving a systematic and structured way of considering the relationship of a project's performance and cost as it relates to value. Project performance must be properly defined and agreed on by the stakeholders at the beginning of the workshop. The performance attributes and requirements that are developed are then used throughout the study to identify, evaluate and document alternatives.

The application of performance-based value planning consists of the following steps:

1) Identify key project (scope and delivery) performance attributes and requirements for the project.
2) Establish the hierarchy and impact of these attributes on the project.
3) Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts.
4) Identify the change in performance of alternative project concepts generated by the study.
5) Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement.

The following are the key project performance attributes that were used in this Value Planning Study:

- Roadway Operations
- Transit Operations
- Maintainability
- Construction Impacts
- Environmental Impacts
- Promotes Economic Growth

Alternatives Performance Assessment and Summary

As the Value Planning Team developed the alternatives, the performance of each is rated against the others. Changes in performance are always based upon the overall impact to the total project. Once performance and cost data have been developed by the Team, the net change in value of the alternatives can be compared to the baseline concept.

The resulting value improvement scores provide a way to assess the potential impact of each alternative on total project value.

Table 7 - Recommendation Total Performance				
Performance Attribute Ratings				
Attribute	Attribute Weight	Alternative	Performance Rating	Total Performance
Roadway Operations	23.8	1	5	119.0
		2	6	142.8
		3	8	190.4
		4	6	142.8
Transit Operations	23.8	1	6	142.8
		2	9	214.2
		3	9	214.2
		4	8	190.4
Maintainability	14.4	1	6	86.4
		2	5	72.0
		3	5	72.0
		4	5	72.0
Construction Impacts	4.7	1	7	32.9
		2	2	9.4
		3	5	23.5
		4	4	18.8
Environmental Impacts	9.5	1	5	47.5
		2	6	57.0
		3	4	38.0
		4	5	47.5
Promotes Economic Growth	23.8	1	6	142.8
		2	7	166.6
		3	9	214.2
		4	7	166.6

The performance score thus developed is divided by the risk adjusted total project cost to compute the value index of each alternative developed. Table 8 provides a summary of the alternatives generated and their performance, cost, and value index. It can seen from Table 8

that Alternative 3 (Platform Diamond with LRT Fly Over), with the highest value index, is the best of the alternatives developed.

Table 8: List of Alternatives				
Alternatives		Performance	Cost	Value Index
1	SPUI with LRT elevated to North	571	$51.2 M	11.16
2	Tight Diamond with LRT Fly Over	662	$64.8 M	10.22
3	Platform Diamond with LRT Fly Over	752	$56.6 M	13.29
4	SPUI with Elevated LRT and Fly Over	638	$51.9 M	12.29

Appendix

- Base Schedule Review
- Risk Data Sheets
- Value Planning Agenda
- Value Planning Attendees
- Value Planning Report Out
- Performance Based Results

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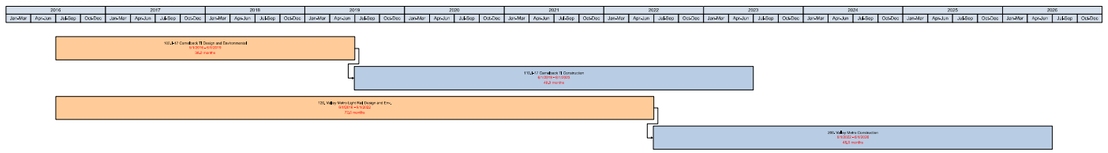
Base Schedule Review



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Risk Data Sheets – Alternative 1

Project	I-17 & Camelback Alternative 1	Risk ID	CNS 001

ITS/FMS - I-17 Traffic Management

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.50 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.23 M	0.00 Mo.

There is a risk that would add ITS/FMS alternatives for the I-17 corridor. This may result in infrastructure upgrades that would add costs to the project to accommodate these additional facilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 1 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	CNS 002

72 Inch Storm Line

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.25 M	$0.50 M	$0.75 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.13 M	0.00 Mo.

The 72 inch line is running along the west side of I-17 and may conflict with bridge pier construction. The risk is to relocate the storm line or revise the bridge design to avoid the line.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 2 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	DES 001

Drainage

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.05 M	$0.08 M	$0.10 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.06 M	0.00 Mo.

There is a risk that the existing drainage basin will need to be replaced or modified to accommodate additional capacity. This alternative is filling in part of the flood control basin.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 3 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	DES 002

Grand Canyon University Development

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$1.00 M	$2.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.51 M	0.00 Mo.

This alternative is removing access from I-17 to 26th Ave that may impact known development plans for GCU. Design modifications may be required to accommodate their plans. These modifications could include pedestrian and vehicle access that will add costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 1	Risk ID	DES 003

Aesthetics and Context Sensitive Solutions

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.14 M	0.00 Mo.

Extensive stakeholder involvement may add costs for mitigation for design elements not yet captured in the base costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 1	Risk ID	ENV 001

Environmental Documentation

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	12.00 Mo.	24.00 Mo.	36.00 Mo.	Yes	$0.00 M	2.40 Mo.

It is assumed that there will be 2 different environmental documents (one for I-17 and one for VM). These documents might conflict and need to be coordinated. Two federal agencies requiring different levels of documentation and different public outreach requirements. Light Rail needs a NEPA decision by September 2018. The base schedule has not been defined for the I-17 environmental work (the earliest start of this work is FY 2018, after the CMP is approved).

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 6 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	ENV 002

Noise Concerns

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.04 M	0.00 Mo.

Evaluation of noise and mitigation will depend on impacts to sensitive receptors and mitigation will be implemented as necessary. The light rail is elevated to the north and an analysis will need to be performed to determine the impacts to the surrounding residences and businesses. Noise mitigation may be required that will add costs to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 7 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	ENV 003

Historical/Cultural

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.

This location is previously disturbed and there are no known historical/cultural locations. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 8 of 13

Project	I-17 & Camelback Alternative 1	Risk ID	ENV 004

Environmental Justice

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
5%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	3.00 Mo.	12.00 Mo.	18.00 Mo.	Yes	$0.00 M	0.58 Mo.

This a potential schedule risk for time required to evaluate additional factors as they arise. The probability is low based on the time frame between when the process begins and when construction starts.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 1	Risk ID	ENV 005

HAZMAT/Underground Storage Tanks

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.20 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

There is a risk of encountering hazardous materials and underground storage tanks during construction.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 1	Risk ID	ROW 001

Cactus Jack

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
80%				Active	Right-of-Way	
Cost ($M)	$3.00 M	$4.00 M	$5.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$3.20 M	0.00 Mo.

The retaining wall and access revisions results in a total take of the dealership property. This location is the headquarters for all of their other dealerships in the region.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 1	Risk ID	ROW 002

Total Takes

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
80%				Active	Right-of-Way	
Cost ($M)	$2.00 M	$2.50 M	$3.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$2.00 M	0.00 Mo.

The estimate was developed for neat line of ROW required. There is a risk that total takes are required that will result in an increase of 100,000 sf of ROW to be purchased at $25/sf.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 1	Risk ID	ROW 003

Condemnation and Administrative Settlement

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Right-of-Way	
Cost ($M)	$1.30 M	$1.55 M	$1.80 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.16 M	0.00 Mo.

The risk adjusted ROW costs is approximately $4.4M. Typically a ROW contingency is held for 30 to 40% of ROW costs. This includes relocation and demolition.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Risk Data Sheets – Alternative 2

Project	I-17 & Camelback Alternative 2	Risk ID	CNS 001

ITS/FMS - I-17 Traffic Management

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.50 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.23 M	0.00 Mo.

There is a risk that would add ITS/FMS alternatives for the I-17 corridor. This may result in infrastructure upgrades that would add costs to the project to accommodate these additional facilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 1 of 15

Project	I-17 & Camelback Alternative 2	Risk ID	CNS 005

Straddle Bent Constructability

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
95%				Active	Construction	
Cost ($M)	$3.00 M	$4.00 M	$5.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$3.80 M	0.00 Mo.

There are three straddle bents for this option, two end bents and one in the median. There are significant construction challenges associated with construction of these straddle bents over Camelback that involve falsework construction, MOT, staging, and sequencing that involve significant risk. There is no available area in the median or along the structure on Camelback over I-17 that allow construction of falsework towers and increased permanent structure height to accommodate falsework beams.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 2 of 15

Project	I-17 & Camelback Alternative 2	Risk ID	CNS 006

I-17 Revised Alignment

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
95%				Active	Construction	
Cost ($M)	$1.00 M	$2.00 M	$3.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.90 M	0.00 Mo.

The median of I-17 requires widening to accommodate the new structure foundation along the new Camelback overpass. This will require a new traffic alignment for I-17.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	DES 001

Drainage

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
15%				Active	Construction	
Cost ($M)	$0.05 M	$0.08 M	$0.10 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.01 M	0.00 Mo.

There is a risk that the existing drainage basin will need to be replaced or modified to accommodate additional capacity. The flood control area may need to be modified due to widening of Camelback.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	DES 002

Grand Canyon University Development

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.05 M	$0.50 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.25 M	0.00 Mo.

This alternative is removing access from I-17 to 26th Ave that may impact known development plans for GCU. Design modifications may be required to accommodate their plans. These modifications could include pedestrian and vehicle access that will add costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	DES 003

Aesthetics and Context Sensitive Solutions

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.14 M	0.00 Mo.

Extensive stakeholder involvement may add costs for mitigation for design elements not yet captured in the base costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	ENV 001

Environmental Documentation

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	12.00 Mo.	24.00 Mo.	36.00 Mo.	Yes	$0.00 M	2.40 Mo.

It is assumed that there will be 2 different environmental documents (one for I-17 and one for VM). These documents might conflict and need to be coordinated. Two federal agencies requiring different levels of documentation and different public outreach requirements. Light Rail needs a NEPA decision by September 2018. The base schedule has not been defined for the I-17 environmental work (the earliest start of this work is FY 2018, after the CMP is approved).

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	ENV 002

Noise Concerns

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.04 M	0.00 Mo.

Evaluation of noise and mitigation will depend on impacts to sensitive receptors and mitigation will be implemented as necessary. The light rail is elevated to the north and an analysis will need to be performed to determine the impacts to the surrounding residences and businesses. Noise mitigation may be required that will add costs to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	ENV 003

Historical/Cultural

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.

This location is previously disturbed and there are no known historical/cultural locations. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	ENV 004

Environmental Justice

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
5%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	3.00 Mo.	12.00 Mo.	18.00 Mo.	Yes	$0.00 M	0.58 Mo.

This a potential schedule risk for time required to evaluate additional factors as they arise. The probability is low based on the time frame between when the process begins and when construction starts.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 2	Risk ID	ENV 005

HAZMAT/Underground Storage Tanks

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.20 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

There is a risk of encountering hazardous materials and underground storage tanks during construction.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 2	Risk ID	ROW 001

Cactus Jack's

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Right-of-Way	
Cost ($M)	$0.05 M	$0.15 M	$0.25 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

Closing the right in-right out access within the clearance limits of the interchange will affect the property.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 2	Risk ID	ROW 002

Total Takes

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
80%				Active	Right-of-Way	
Cost ($M)	$1.00 M	$1.25 M	$1.50 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.00 M	0.00 Mo.

The estimate was developed for neat line of ROW required. There is a risk that total takes are required that will result in an increase of 50,00 sf of ROW to be purchased at $25/sf for the transition sections at the bridge ends.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 2	Risk ID	ROW 003

Condemnation and Administrative Settlement

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Right-of-Way	
Cost ($M)	$0.80 M	$0.90 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.68 M	0.00 Mo.

The risk adjusted ROW costs is approximately $2.75M. Typically a ROW contingency is held for 30 to 40% of ROW costs. This includes relocation and demolition.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 2	Risk ID	ROW 005

Substation Locations

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
100%				Active	Right-of-Way	
Cost ($M)	$0.10 M	$0.13 M	$0.16 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.13 M	0.00 Mo.

The elevated guideway will require substations outside of the roadway prism that does not define ROW areas at this time. Assume there will be at least one in this area, approximately 50' x 100' @ $25/sf.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Risk Data Sheets – Alternative 3

Project	I-17 & Camelback Alternative 3	Risk ID	CNS 001

ITS/FMS - I-17 Traffic Management

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.50 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.23 M	0.00 Mo.

There is a risk that would add ITS/FMS alternatives for the I-17 corridor. This may result in infrastructure upgrades that would add costs to the project to accommodate these additional facilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

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Project	I-17 & Camelback Alternative 3	Risk ID	CNS 002

72 Inch Storm Line

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.25 M	$0.50 M	$0.75 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.13 M	0.00 Mo.

The 72 inch line is running along the west side of I-17 and may conflict with bridge pier construction. The risk is to relocate the storm line or revise the bridge design to avoid the line or protect in place.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 2 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	CNS 005

Flyover Foundation Construction

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
90%				Active	Construction	
Cost ($M)	$0.30 M	$0.50 M	$0.70 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.45 M	0.00 Mo.

The flyover foundation will be built in the median where the existing structure foundation exists. Similar issues may be encountered at the abutments. Alignment adjustments will also be required along I-17 to accommodate the new median width.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 3 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	DES 001

Drainage

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.40 M	$0.50 M	$0.60 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.38 M	0.00 Mo.

There is a risk that the existing drainage basin will need to be replaced or modified to accommodate additional capacity. This alternative will have added cost for drainage conveyance and is filling in part of the flood control basin.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 4 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	DES 002

Grand Canyon University Development

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.15 M	$0.20 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

This alternative is providing right in-right out access from I-17 to 26th Ave. Design modifications may be required to accommodate their plans. These modifications could include pedestrian and vehicle access that will add costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 5 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	DES 003

Aesthetics and Context Sensitive Solutions

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.14 M	0.00 Mo.

Extensive stakeholder involvement may add costs for mitigation for design elements not yet captured in the base costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 6 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ENV 001

Environmental Documentation

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	12.00 Mo.	24.00 Mo.	36.00 Mo.	Yes	$0.00 M	2.40 Mo.

It is assumed that there will be 2 different environmental documents (one for I-17 and one for VM). These documents might conflict and need to be coordinated. Two federal agencies requiring different levels of documentation and different public outreach requirements. Light Rail needs a NEPA decision by September 2018. The base schedule has not been defined for the I-17 environmental work (the earliest start of this work is FY 2018, after the CMP is approved).

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 7 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ENV 002

Noise Concerns

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.30 M	$0.75 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.18 M	0.00 Mo.

Evaluation of noise and mitigation will depend on impacts to sensitive receptors and mitigation will be implemented as necessary. The traffic and light rail is elevated and an analysis will need to be performed to determine the impacts to the surrounding residences and businesses. Noise mitigation may be required that will add costs to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 8 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ENV 003

Historical/Cultural

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.

This location is previously disturbed and there are no known historical/cultural locations. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 3	Risk ID	ENV 004

Environmental Justice

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
5%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	3.00 Mo.	12.00 Mo.	18.00 Mo.	Yes	$0.00 M	0.58 Mo.

This a potential schedule risk for time required to evaluate additional factors as they arise. The probability is low based on the time frame between when the process begins and when construction starts.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 3	Risk ID	ENV 005

HAZMAT/Underground Storage Tanks

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.20 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

There is a risk of encountering hazardous materials and underground storage tanks during construction.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 11 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ROW 001

Cactus Jack's

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
99%				Active	Right-of-Way	
Cost ($M)	$3.00 M	$4.00 M	$5.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$3.96 M	0.00 Mo.

The roadway widening and access revisions may result in a total take of the dealership property. This location is the headquarters for all of their other dealerships in the region.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 12 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ROW 002

Total Takes

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
80%				Active	Right-of-Way	
Cost ($M)	$2.00 M	$3.75 M	$5.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$2.93 M	0.00 Mo.

The estimate was developed for neat line of ROW required. There is a risk that total takes are required that will result in an increase of 150,000 sf of ROW to be purchased at $25/sf.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 13 of 14

Project	I-17 & Camelback Alternative 3	Risk ID	ROW 003

Condemnation and Administrative Settlement

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Right-of-Way	
Cost ($M)	$2.10 M	$2.55 M	$3.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.91 M	0.00 Mo.

The risk adjusted ROW costs is approximately $7M. Typically a ROW contingency is held for 30 to 40% of ROW costs. This includes relocation and demolition.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 14 of 14

Risk Data Sheets – Alternative 4

Project	I-17 & Camelback Alternative 4	Risk ID	CNS 001

ITS/FMS - I-17 Traffic Management

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.50 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.23 M	0.00 Mo.

There is a risk that would add ITS/FMS alternatives for the I-17 corridor. This may result in infrastructure upgrades that would add costs to the project to accommodate these additional facilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 1 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	CNS 002

72 Inch Storm Line

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
15%				Active	Construction	
Cost ($M)	$0.25 M	$0.50 M	$0.75 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

The 72 inch line is running along the west side of I-17 and may conflict with bridge pier construction. The risk is to relocate the storm line or revise the bridge design to avoid the line or protect in place.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 2 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	DES 001

Drainage

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.40 M	$0.50 M	$0.60 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.13 M	0.00 Mo.

There is a risk that the existing drainage basin will need to be replaced or modified to accommodate additional capacity. This alternative will have added cost for drainage conveyance and is filling in part of the flood control basin.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 3 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	DES 002

Grand Canyon University Development

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.15 M	$0.20 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

This alternative is providing right in-right out access from I-17 to 26th Ave. Design modifications may be required to accommodate their plans. These modifications could include pedestrian and vehicle access that will add costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 4 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	DES 003

Aesthetics and Context Sensitive Solutions

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
50%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.14 M	0.00 Mo.

Extensive stakeholder involvement may add costs for mitigation for design elements not yet captured in the base costs.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 5 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ENV 001

Environmental Documentation

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	12.00 Mo.	24.00 Mo.	36.00 Mo.	Yes	$0.00 M	2.40 Mo.

It is assumed that there will be 2 different environmental documents (one for I-17 and one for VM). These documents might conflict and need to be coordinated. Two federal agencies requiring different levels of documentation and different public outreach requirements. Light Rail needs a NEPA decision by September 2018. The base schedule has not been defined for the I-17 environmental work (the earliest start of this work is FY 2018, after the CMP is approved).

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 6 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ENV 002

Noise Concerns

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
10%				Active	Construction	
Cost ($M)	$0.10 M	$0.30 M	$1.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.04 M	0.00 Mo.

Evaluation of noise and mitigation will depend on impacts to sensitive receptors and mitigation will be implemented as necessary. The light rail is elevated and an analysis will need to be performed to determine the impacts to the surrounding residences and businesses. Noise mitigation may be required that will add costs to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 7 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ENV 003

Historical/Cultural

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.

This location is previously disturbed and there are no known historical/cultural locations. This is a watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 8 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ENV 004

Environmental Justice

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
5%				Active	Design/Permitting	
Cost ($M)				Critical Path?	EV Cost	EV Sched
Schedule (Mo)	3.00 Mo.	12.00 Mo.	18.00 Mo.	Yes	$0.00 M	0.58 Mo.

This a potential schedule risk for time required to evaluate additional factors as they arise. The probability is low based on the time frame between when the process begins and when construction starts.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 4	Risk ID	ENV 005

HAZMAT/Underground Storage Tanks

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
25%				Active	Construction	
Cost ($M)	$0.20 M	$0.30 M	$0.40 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$0.08 M	0.00 Mo.

There is a risk of encountering hazardous materials and underground storage tanks during construction.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

Project	I-17 & Camelback Alternative 4	Risk ID	ROW 001

Cactus Jack's

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
40%				Active	Right-of-Way	
Cost ($M)	$3.00 M	$4.00 M	$5.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.60 M	0.00 Mo.

The roadway widening and access revisions may result in a total take of the dealership property. This location is the headquarters for all of their other dealerships in the region.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 11 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ROW 002

Total Takes

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
80%				Active	Right-of-Way	
Cost ($M)	$2.00 M	$2.50 M	$3.00 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$2.00 M	0.00 Mo.

The estimate was developed for neat line of ROW required. There is a risk that total takes are required that will result in an increase of 100,000 sf of ROW to be purchased at $25/sf.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 12 of 13

Project	I-17 & Camelback Alternative 4	Risk ID	ROW 003

Condemnation and Administrative Settlement

Pre-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Activity Impacted	
75%				Active	Right-of-Way	
Cost ($M)	$1.25 M	$1.50 M	$1.70 M	Critical Path?	EV Cost	EV Sched
Schedule (Mo)					$1.12 M	0.00 Mo.

The risk adjusted ROW costs is approximately $4.2M. Typically a ROW contingency is held for 30 to 40% of ROW costs. This includes relocation and demolition.

Post-Response Quantification

Probability	Low	Most Likely	High	Risk Status	Risk Owner	
Cost ($M)				Strategy	EV Cost	EV Sched
Schedule (Mo)					$0.00 M	0.00 Mo.
Cost to Mitigate						

July 8, 2016 Risk Register Page 13 of 13

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Value Planning Agenda

Cost Risk Assessment & Value Planning Workshop Agenda

I-17 / Camelback Road / Light Rail Crossing

June 27 – 30, 2016

Location: *MAG 302 N 1st Ave. Suite 200, Saguaro Conference Room*

Meeting Objectives:

1. Common understanding among participants of the Cost Risk Analysis and Value Planning Process.
2. Describe project characteristics, schedule, cost, and risk issues.
3. Review project schedule and cost estimate.
4. Develop Risk Response Strategies.

Participants: All Workshop Participants need to be present at 8:30 AM on Day 1 and then return at the designated time in the agenda.

Core Group: Bob Hazlett, Chaun Hill, Quinn Castro, Ken Smith, Jeremy Neuman, Brian Bombardier, Jason Nauman, Trent Eakin, Scott Gehrke, Jim Slaker, Jenn Pyne, Abhi Dayal, Audra Thomas, Omar Jaff, Jay Yenerich, Eric Prosnier, Eunice Chan, Maurice Goyette, Carla Kahn

Monday 6/27/2016	*Topic*	*Lead*	*Attendees*
8:30 – 8:45	**Welcome, sign-in, updates, introductions, & agenda review**	Ken Smith	All
8:45 – 9:15	**Overview of CRA & VP process** **Expectation and Goal Setting**	Ken Smith	All
	Information Phase		
9:15 – 9:45	**Project Briefing** Project presentation ▪ I-10/I-17 "Spine" ▪ Valley Metro Crossings ▪ City of Phoenix T2050	Project Team	All
9:45 – 10:15	**Flowchart Finalization & Concurrence** Review Flowchart, revise if necessary	Ken Smith	All
10:15 – 10:30	**Break**		
10:30 – 11:00	**Brainstorm Issues**	Ken Smith	All
11:00 – 11:15	**Environmental, Permitting & ROW** ▪ Environmental Documentation ▪ Required Permits ▪ ROW	Ken Smith	Core Group
11:15 – 12:00	**Valley Metro** ▪ Light Rail Crossing Alternatives / Constraints **Response Strategies**	Ken Smith	Core Group
12:00 – 1:00	**Lunch**		
1:00 – 2:00	**Valley Metro** ▪ Light Rail Crossing Alternatives /	Ken Smith	Core Group

1/3

	Constraints ▪ Response Strategies		
2:00 – 2:30	**Utilities** ▪ Utility Relocation Needs ▪ Response Strategies	Ken Smith	Core Group, Jamie Erickson
2:30 – 2:45	**Break**		
2:45 – 3:45	**Design** ▪ Drainage ▪ Structures ▪ MOT / Traffic ▪ Signals ▪ Response Strategies	Ken Smith	Core Group, Bruce Littleton, Dave Benton, Ken Akoh Arrey
3:45 – 4:30	**Management and Stakeholders** ▪ Define risks ▪ Response Strategies	Ken Smith	Core Group
4:30 – 5:00	**Construction / Maintenance Issues** ▪ Define risks ▪ Response Strategies	Ken Smith	Core Group, Madhu Reddy, David Locher, Raul Amavisca Dale Drost
5:00	**Adjourn**		

Tuesday 6/28/2016	*Topic*	*Lead*	*Attendees*
	Evaluation Phase		
8:30 – 10:00	▪ **Brainstorm on functions and large risk areas**	Ken Smith	Core Group
10:00 – 10:15	**Break**		
10:15 – 12:00	▪ **Evaluate ideas**	Ken Smith	Core Group
12:00 – 1:00	**Lunch**		
	Development Phase		
1:00 – 2:30	▪ **Development of recommendations**	Ken Smith	Core Group
2:30 – 2:45	**Break**		
2:45 – 5:00	▪ **Continue development of recommendations**	Ken Smith	Core Group
5:00	**Adjourn**		

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Wednesday 6/29/2016	Topic	Lead	Attendees
8:30 – 10:00	• Continue development of recommendations	Ken Smith	Core Group
10:00 – 10:15	Break		
10:15 – 12:00	• Continue development of recommendations	Ken Smith	Core Group
12:00 – 1:00	Lunch		
1:00 – 2:30	• Complete development of recommendations	Ken Smith	Core Group
2:30 – 2:45	Break		
2:45 – 5:00	• Performance evaluation and risk assessment of recommendations	Ken Smith	Core Group
5:00	Adjourn		

Thursday 6/30/2016	Topic	Lead	Attendees
8:30 – 10:00	• Review results and prepare presentation	Ken Smith	Core Group
10:00 – 10:15	Break		
10:15 – 12:00	• Review results and prepare presentation	Ken Smith	Core Group
12:00 – 1:00	Lunch		
1:00 – 2:30	• Rehearse Presentation	Ken Smith	Core Group
2:30 – 4:00	Present Results	CRA & VP Team	Invitees
4:00	Adjourn		

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Value Planning Attendees

MARICOPA ASSOCIATION of GOVERNMENTS

I-17 / Camelback Road / Light Rail Crossing Value Planning
June 27 – 30, 2016

DATE 6/27	6/28	6/29	6/30	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE OFFICE	CELL	EMAIL
✓	✓	✓	✓	Ken Smith	HDR	Risk Lead	360 570 4415	360 451 2527	Ken.l.smith@hdrinc.com
✓	✓	✓	✓	Trent Eakin	HDR	SME	360 570 7270		trent.eakin@hdrinc.com
✓	✓	✓	✓	Suresh Rajhandra ~~Jeremy Neuman~~	HDR	Workshop Assistant	602 778 7345		~~Jeremy.neuman@hdrinc.com~~
✓	✓	✓	✓	Brian Bombardier	HDR	SME	602 778 7324		Brian.bombardier@hdrinc.com
✓	✓	✓	✓	Jason Nauman	HDR	SME	602 522 7708	935-707-5002	Jason.nauman@hdrinc.com
~~✓~~	~~✓~~	~~✓~~	✓	Scott Gehrke	HDR	SME	602 792 8807		Scott.gehrke@hdrinc.com
~~✓~~	~~✓~~	~~✓~~	✓ RIP NOT ATTEND	Jim Slaker	HDR	SME	602 322 4432		James.slaker@hdrinc.com
X	X	X	✓	Bob Hazlett	MAG	Senior Engineering Manager	602 254 6300		bhazlett@azmag.gov
✓	X	✓	✓	Chaun Hill	MAG	Senior Transportation Engineer	602 254 6300		chill@azmag.gov
✓	✓	✓	✓	Quinn Castro	MAG	Transportation Engineer	602 254 6300		qcastro@azmag.gov

MARICOPA ASSOCIATION of GOVERNMENTS

I-17 / Camelback Road / Light Rail Crossing Value Planning
June 27 – 30, 2016

DATE 6/27	6/28	6/29	6/30	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE OFFICE	CELL	EMAIL
✓	✓	Ü	✓	Audra Thomas	MAG	Transit Planning Project Manager	602 452 5058		akthomas@azmag.gov
✓	✓	✓	✓	Raul Amavisca	ADOT IDO	District Engr - Admin	602-206-2543		ramavisca@azdot.gov
✓	✓	✓	✓	DAVE DROST	ADOT IDO	MAINTENANCE	602-712-8395	602-245-0241	ddrost@azdot.gov
✓	✓	✓		David Lohr	ADOT IDO	Project Development	602-712-2317	602-220-9431	dlohr@azdot.gov
✓	✓	✓	✓	Clemence Ligocki	ADOT MPD	Planning + Programming Mgr	602-712-8143	480-688-5852	cligocki@azdot.gov
✓				AUDRA	MAG				
✓	✓		✓	Abhi Dayal	Valley Metro	Planning Manager	602-744-5572		adayal@valleymetro.org
✓	✓	✓	X	MAURICE GOYETTE	COP	Lead Light Rail ENGINEER	602-256-4995		maurice.goyette@phoenix.gov
✓	X		✓	Jay Henerich	Valley Metro	Design Manager / Engineering	602-595-5209		jhenerich@valleymetro.org
✓	✓	✓		JIM SLAKER	HDR/VALLEY METRO	CONCEPTUAL DESIGN	602-792-8830	480-620-5239	JSLAKER@VALLEYMETRO.ORG

MARICOPA ASSOCIATION of GOVERNMENTS

I-17 / Camelback Road / Light Rail Crossing Value Planning
June 27 – 30, 2016

DATE 6/27	6/28	6/29	6/30	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE OFFICE	CELL	EMAIL
✓	✓	✓	✓	Jennifer Pyne	AECOM/ Valley Metro	Planning	602 648 2335	480 266 0645	~~jennifer~~ jpyne@valleymetro.org
✓	✓	✓	✓	OMAR JAFF	AECOM	Engineering	503 478 7664	503 329 4848	omar.jaff@AECOM.com
✓				Bruce L. Littleton	COP		602-262-4690	302-423-6599	bruce.littleton@phoenix.gov
✓			✓	Eunice Chan	FHWA	Area Engineer	602-382-9965		eunice.chan@dot.gov
✓			✓	Megan Casey	Valley Metro	Community Relations	602-495-5214	602-639-3677	mcasey@valleymetro.org
✓				Syed Alam	ADOT	Sr. Drainage Engineer	602-712-8701	602-319-6823	salam@azdot.gov
✓				Yolonda Moore	COP	Project Mgr	602-262-6644		yolonda.moore@phoenix.gov
✓				Jami Spear	COP	Real Estate	602-534-4793	602-501-2878	jami.spear@phoenix.gov
✓				Jami Erickson	COP	Water Services Dept Water/Sewer	602 261 8289		jami.erickson@phoenix.gov
✓	✓	✓	✓	ERIC PROSNIER	ADOT	VPM	602.712.8435		eprosnier@azdot.gov

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I-17 / Camelback Road / Light Rail Crossing Value Planning
June 27 – 30, 2016

DATE 6/27	6/28	6/29	6/30	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE OFFICE	CELL	EMAIL
X		X	X	Albert Sanders	COP	Asst to the City Mgr/ Light Rail			
X			X	Ray Dovalina	"	City of Phx Street TRANSP. Director			
X	X	X	X	David Moody	MAG	Assc			
~~X~~				~~[illegible]~~	~~[illegible]~~	~~[illegible]~~			
X			X	Carla Kahn	City of Phoenix	LR Coordinator			
	X			Annette Riley	ADOT				
		X	X	Madhu Reddy	ADOT	DISTRICT ENGINEER			
X			X	Steve Boschen	ADOT	DIVISION DIRECTOR IDD			
			X	Eric Anderson	MAG	TRANSPORTATION DIR.			

MARICOPA ASSOCIATION of GOVERNMENTS

I-17 / Camelback Road / Light Rail Crossing Value Planning
June 27 – 30, 2016

DATE				NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
6/27	6/28	6/29	6/30				OFFICE	CELL
							EMAIL	
			X	Debbie Albert	City of Glendale	Transportation	623/930-2939	623/293-0894
							dalbert@glendaleaz.com	
			X	Tom Deutring	FHWA	Project Delivery Team Leader	602-382-8971	
							thomas.deutring@dot.gov	

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Value Planning Report Out

Safety First

- *Emergency Exits*
  - *Muster point*
- *CPR*
- *The number for "911"*

2

2

MARICOPA ASSOCIATION of GOVERNMENTS

Plan the Work and Work the Plan

3

Introductions

- Who are you?
- What do you do?
- Have you been on a Cost Risk Assessment or Value Engineering workshop before?

4

Addressing Cost and Schedule Concerns

Usual Questions

- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

Analysis Needs

- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Value Engineering &Mitigation Strategies
- Risk Monitoring & Control

5

I-17 / Camelback TI Vicinity Map

6

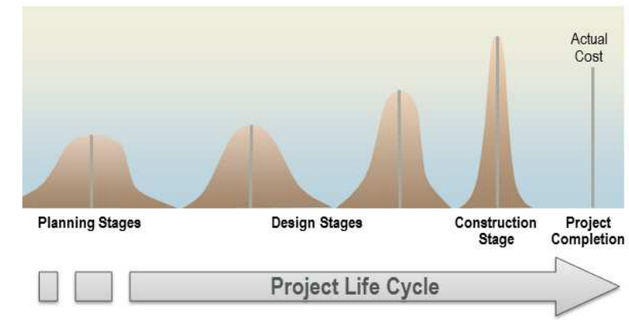
Overview of Project Cost

Base cost estimate serves as the basis against which cost risks and uncertainties are assessed

Estimating is not an exact science:

- Cost estimate is only an approximation of the probable costs
- Composed of many elements that may not be completely or equally defined at the time the estimate is prepared

A numerical value of uncertainty is an estimate of the error or tolerance within the quantity or unit price of an item. Level of uncertainty is directly related to its position in the project life cycle



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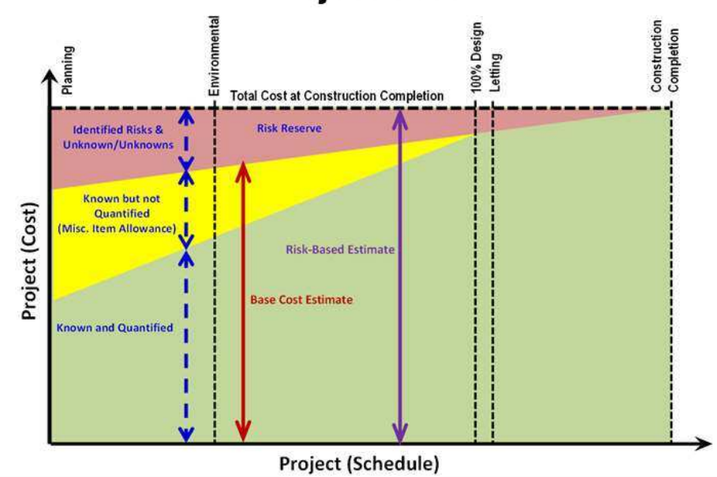
Project Cost



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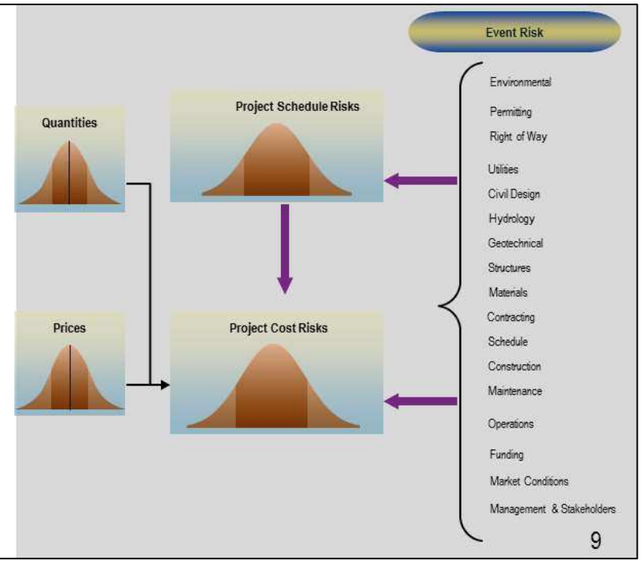
How the Modeling Works

- Monte Carlo Simulation
  - Base cost and uncertainties
  - Cost Event Risks
  - Schedule Event Risk

Making the "black box" transparent



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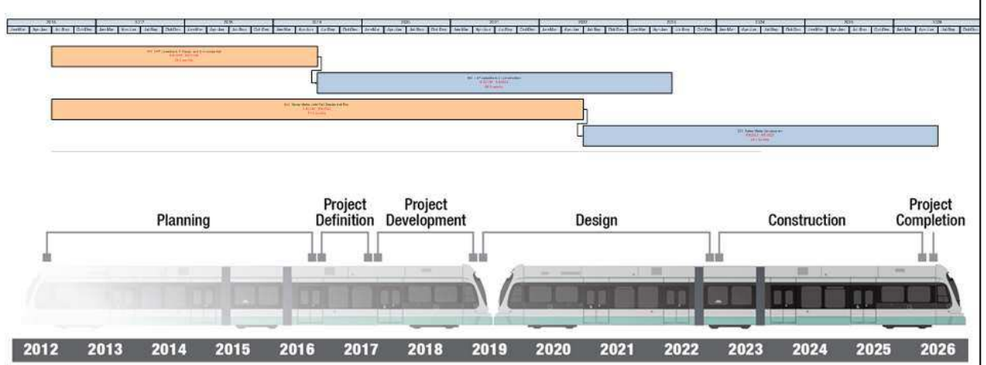
Schedule



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MARICOPA ASSOCIATION of GOVERNMENTS

Leading Preferred Alternative

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I-17 / Camelback TI East-West Demand Issues

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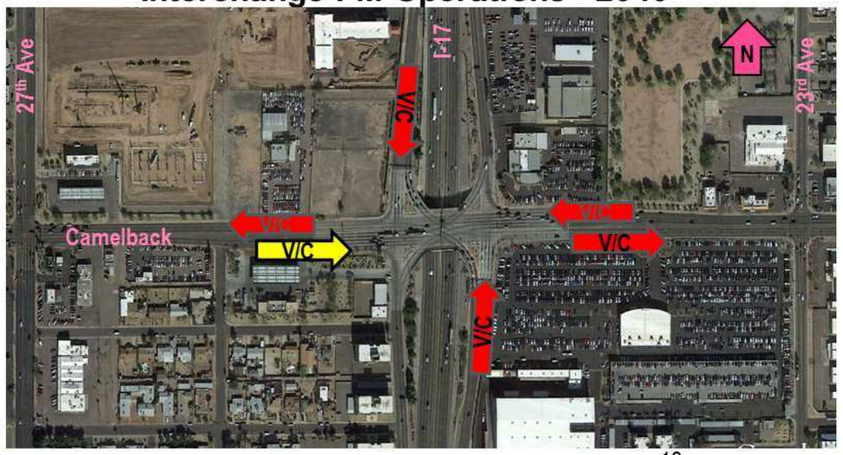
I-17 / Camelback TI Interchange PM Operations - 2040



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I-17 Light Rail Crossing Stakeholder Focus Group - Key Concerns

- Restricted left turn access on Camelback
- Potential for changes to property access
- Impacts and duration of construction
- Visibility of businesses
- ROW requirements
- Pedestrian safety

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LR Option A – At-grade crossing in Camelback median

15

LR Option B (1, 2, 3) – North side of Camelback

16

LR Option C – Colter Street crossing

17

LR Option D – Colter Street crossing

18

LR Option E – North of Interchange

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Performance Based Value Planning

Value Planning is not just about reducing project costs, but can also improve project performance

- Roadway Operations
- Transit Operations
- Maintainability
- Construction Impacts
- Environmental Impacts
- Promotes Economic Growth

$$\text{Value} = \frac{\text{Performance}}{\text{Cost}}$$

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Performance Weighting

Performance Attributes Criteria Matrix								
False Paired Comparison								
							Total points	% of Total
Roadway Operations	A	A/B	A	A	A	A/F	5.0	23.8%
Transit Operations		B	B	B	B	B/F	5.0	23.8%
Maintainability			C	C	C	F	3.0	14.4%
Construction Impacts				D	E	F	1.0	4.7%
Environmental Impacts					E	F	2.0	9.5%
Promotes Economic Growth						F	5.0	23.8%
						Total	21.0	100.0%

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Value Planning Process

- **Design competition** to evaluate the three roadway scenarios with the five transit scenarios
- Combined the best transit scenario for each of the three roadway alternatives
- Scored performance of each of the alternatives developed
- Performed a risk assessment of each of the alternatives developed
- Defined a value index for each of the alternatives.

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Rules of Design Competition

- Each team must include:
- Project limits 23rd to 27th 3275' LF of LR
- One station near 27th
- Interchange improvements
- ROM estimate
  - Construction costs (2016 $)
    - Mark ups of 60% for:
      - Miscellaneous Items 15%
      - MOT 10%
      - Mobilization 8%
      - Design Engineering 12%
      - Construction Administration 10%
      - Construction Change orders 5%
  - ROW costs
  - Utilities allowance

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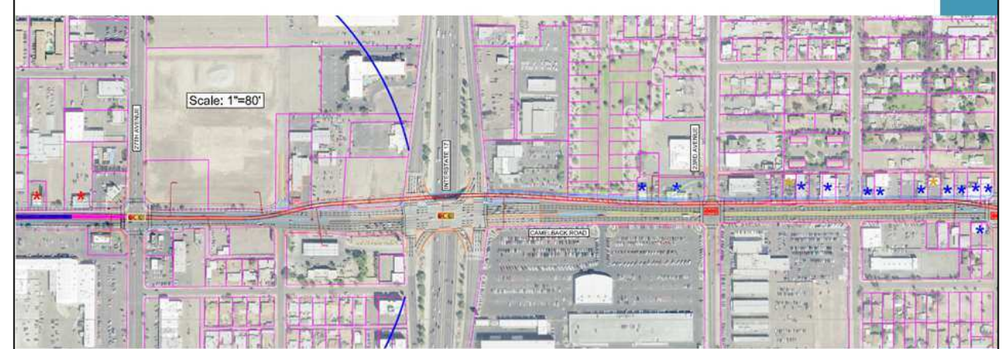
Alternative 1 SPUI Light Rail Elevated, North Side



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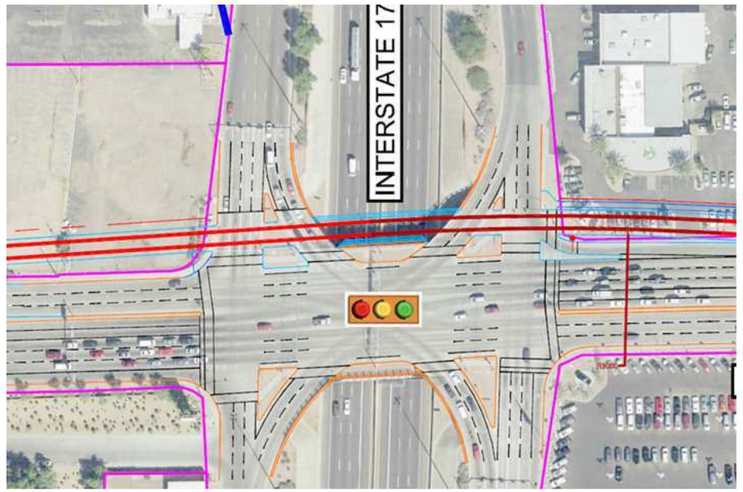
Alternative 1 SPUI Light Rail Elevated, North Side



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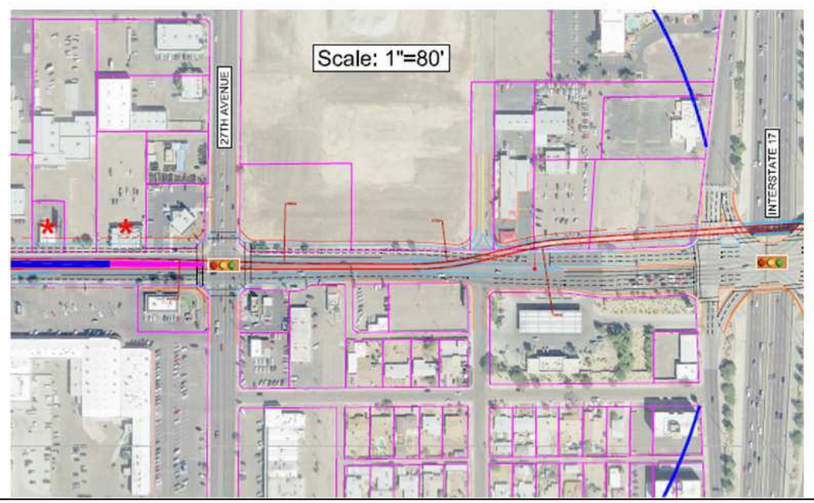
Alternative 1 SPUI Light Rail Elevated, North Side



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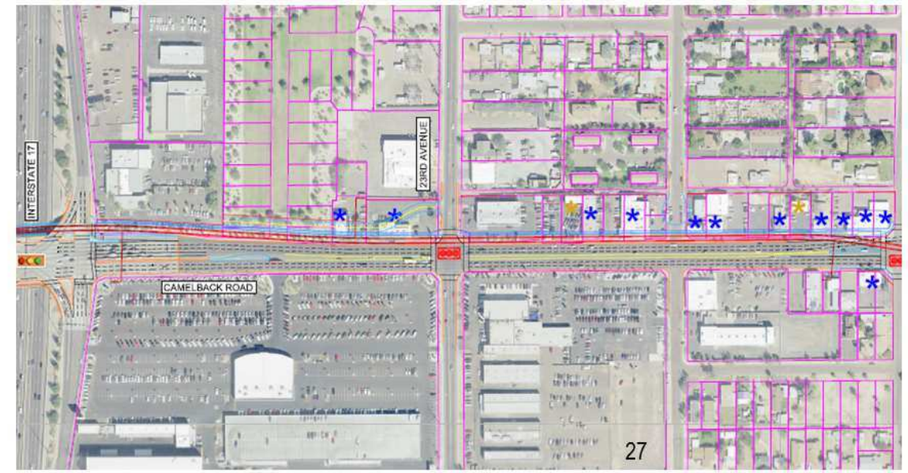
Alternative 1 SPUI Light Rail Elevated, North Side



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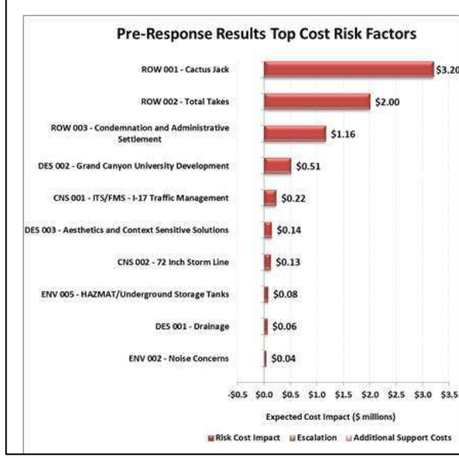
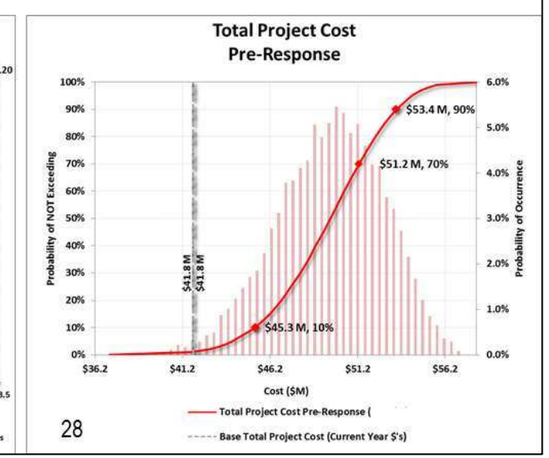
Alternative 1 SPUI Light Rail Elevated, North Side





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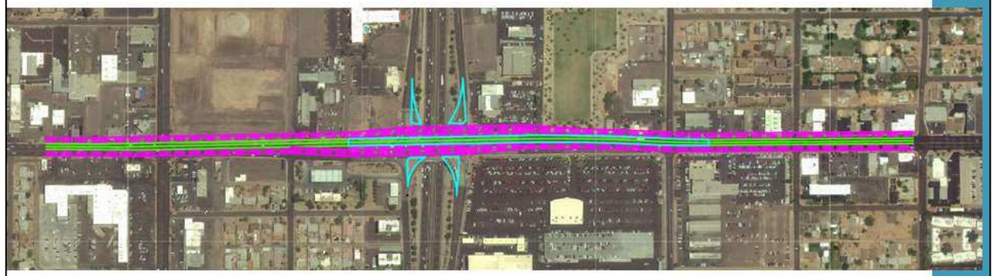
Alternative 2 Tight Diamond-Light Rail Median Running Grade Separated



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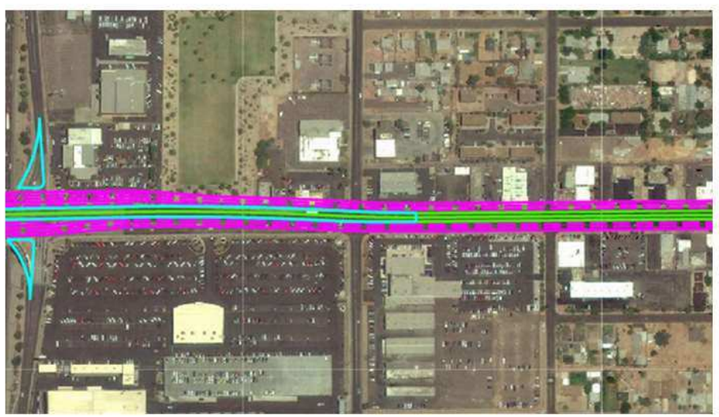

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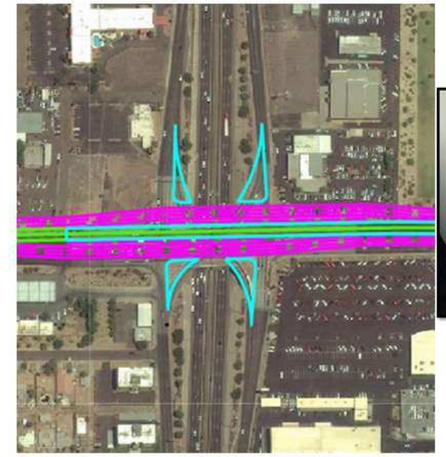
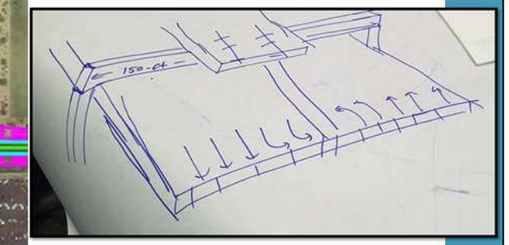
Alternative 2 Tight Diamond-Light Rail Median Running Grade Separated





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Alternative 2 Tight Diamond-Light Rail Median Running Grade Separated

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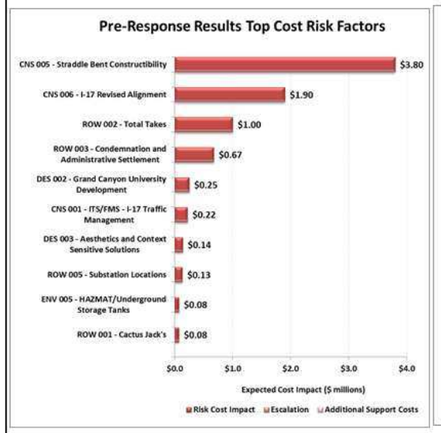
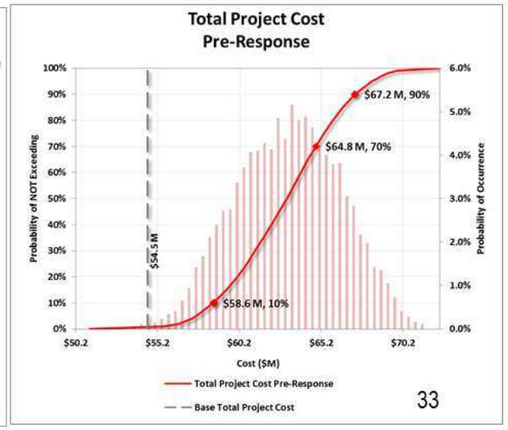
Alternative 2 Tight Diamond-Light Rail Median Running Grade Separated





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Alternative 3 Platform Diamond with Median LRT

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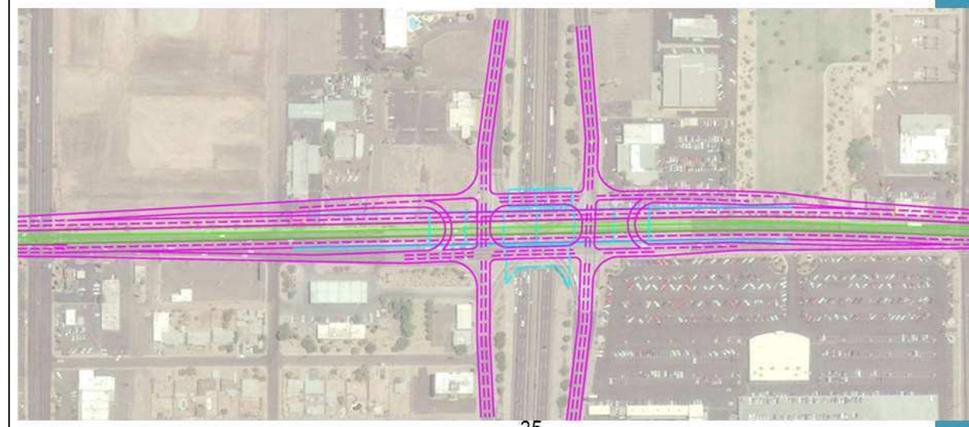
Alternative 3 Platform Diamond with Median LRT



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Alternative 3 Platform Diamond with Median LRT

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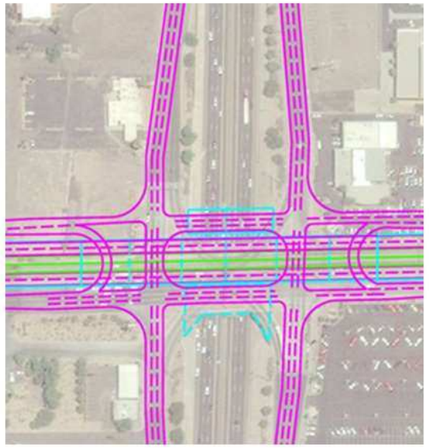
Alternative 3 Platform Diamond with Median LRT



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Alternative 3 Platform Diamond with Median LRT

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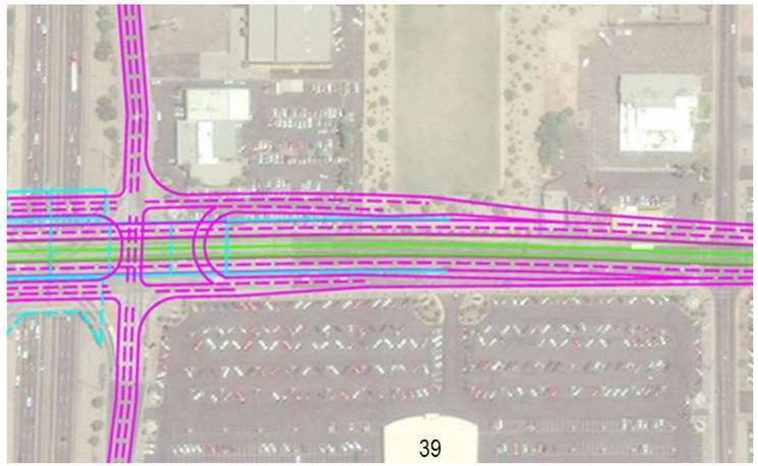
Alternative 3 Platform Diamond with Median LRT



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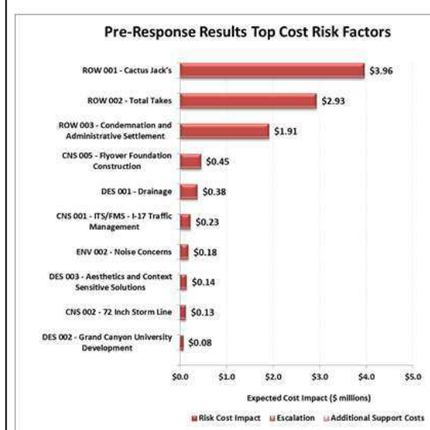
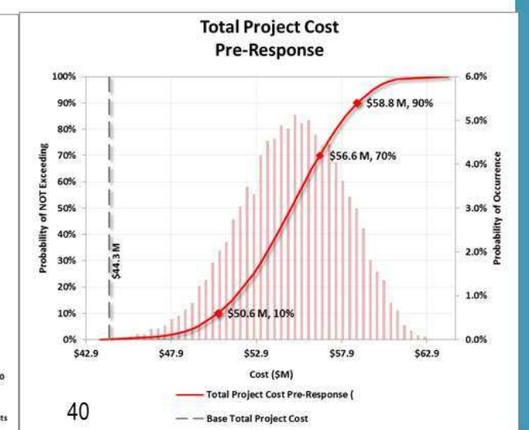
Alternative 3 Platform Diamond with Median LRT





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Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge

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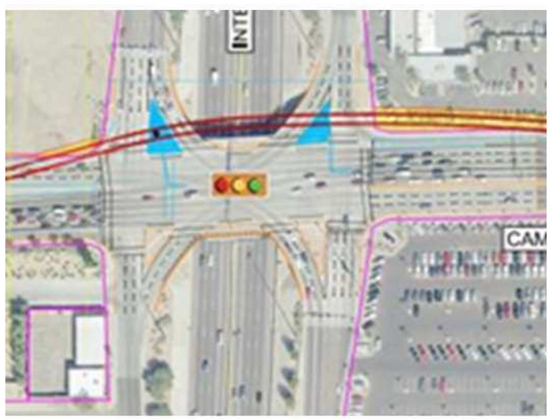
Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge



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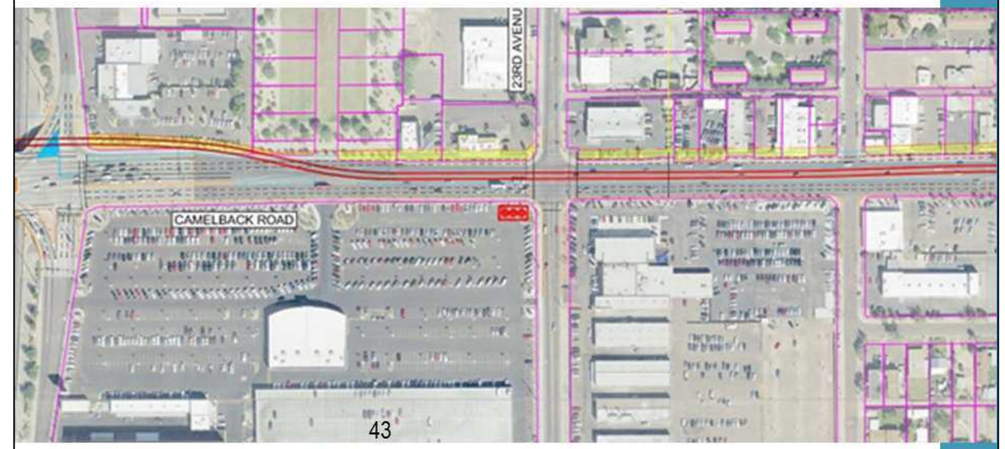
MARICOPA ASSOCIATION of GOVERNMENTS

Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge



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Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge

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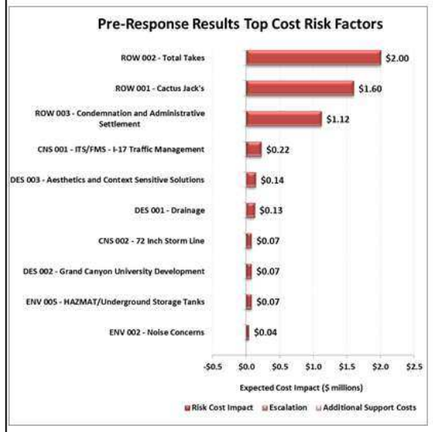
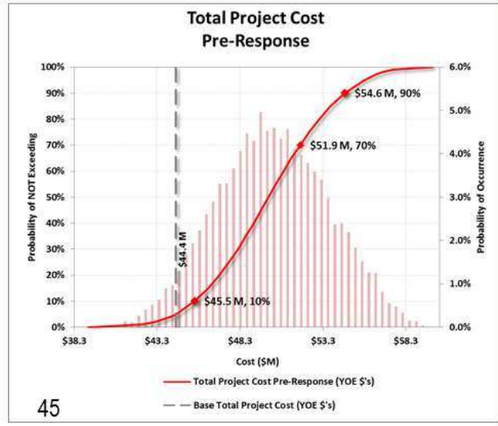
Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge





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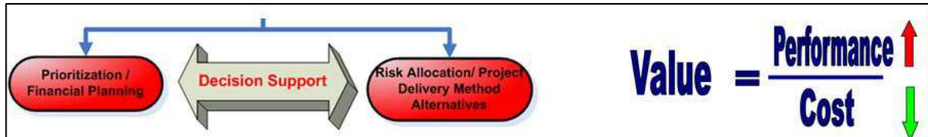

Recommendation Value Improvement				
Value Index				
Recommendations		Performance (P)	Cost (C) $ millions	Value Index
1	SPUI LRT elevated to North	571	$51.2	11.16
2	Tight Diamond LRT Fly Over	662	$64.8	10.22
3	Platform Diamond LRT Fly Over	752	$56.6	13.29
4	SPUI Elevated LRT and Fly Over	638	$51.9	12.29

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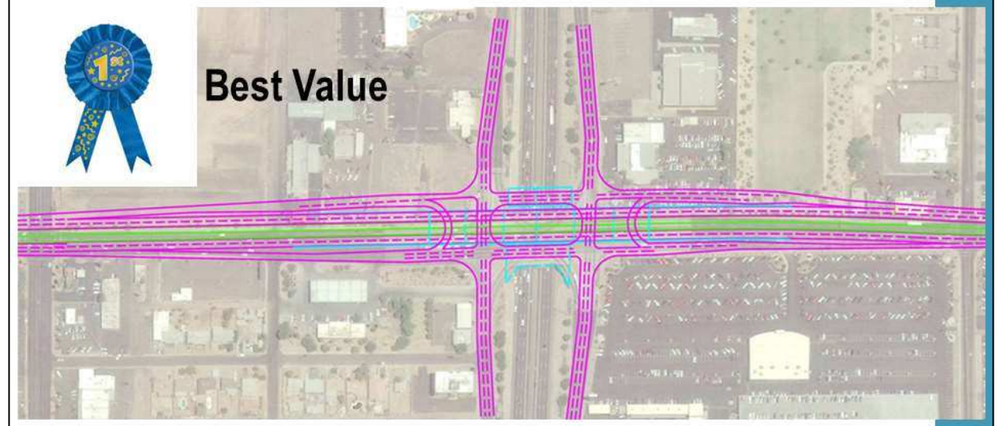
Alternative 3 Platform Diamond with Median LRT



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Alternative 4 - SPUI with Elevated Light Rail Median Running with I-17 Grade Separation north of the existing SPUI bridge

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Performance Based Results

Using performance attributes is an integral part of the value engineering process. Performance attributes provide the cornerstone of the VE process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the value study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

Value analysis has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VE can play with regard to improving project performance. Project costs are fairly easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The Value Planning Team Leader will lead the Team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops forms the basis for the Value Planning Teams' understanding of the performance requirements of the project, and to what degree the current design concept is meeting those requirements. From this baseline, the Value Planning Team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Performance based value engineering yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a baseline understanding of how the project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VE process
- Develops a better understanding of a VE recommendation's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions

Methodology

Performance based value engineering process consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project
2. Establish the hierarchy and impact of these attributes on the project
3. Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts
4. Identify the change in performance of alternative project concepts generated by the study
5. Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement

The primary goal of value engineering is to improve project value. A simple way to think of value in terms of an equation is as follows:

$$Value = \frac{Performance}{Cost}$$

Assumptions

Before embarking on the details of this methodology some assumptions need to be identified. The methodology described in the following steps assumes that the project functions are well established. Project functions are "what" the project delivers to its users and stakeholders; a good reference for the project functions can be found in the environmental document's purpose and need statement. Project functions are generally well defined prior to the start of the value study. In the event that project functions have been substantially modified, the methodology must begin anew from Step 1.

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components.

It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory. All performance requirements MUST be met by any idea being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be Project Schedule which means that a wide range of alternatives, which have different durations, could be acceptable.

The Value Planning Team Leader will initially request that representatives from project Team and external stakeholders identify performance attributes that they feel are essential to meeting

the overall need and purpose of the project. Usually four to seven attributes are selected. It is important that all potential attributes be thoroughly discussed.

The information that comes out of this discussion will be valuable to both the Value Planning Team and the Project Owner. It is important that the attribute be discretely defined, and they must be quantifiable in some form. The vast majority of performance attributes that typically appear in transportation value studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Step 2 – Determine the Relative Importance of the Attributes
Once the group has agreed upon the project's performance attributes, the next step is to determine their relative importance. This is accomplished through the use of an evaluative tool, termed in this report as the "Performance Attribute Matrix."

This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?" A letter code (e.g., "a") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of equal importance, both letters (e.g., "a/b") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed.

When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote", as it made the list in the first place and should be given some degree of importance.

Step 3 – Establish the Performance "Baseline" for the Original Design
The next step is to define the baseline as it pertains to each performance attribute. The baseline is then given a score of 5 on a scale of 0 to 10 for each attribute.

Step 4 – Evaluate the Performance of the CRAVE Recommendations
Once the performance of the baseline has been established for the original design concept, it can be used to help the Value Planning Team develop performance ratings for individual VE recommendations as they are developed during the course of the value study. The Performance Measures Form at the back of each recommendation is used to capture this information.

It is important to consider the recommendation's impact on the entire project, rather than on discrete components.

Step 5 – Compare the Performance Ratings of Recommendations to the "Baseline" Project

The last step in the process is to develop the performance ratings for the original design concept. The Value Planning Team groups the recommendation into a scenario (or scenarios) to provide the decision makers a clear picture of how the recommendations fit together into possible solutions. At least one scenario is developed to present the Value Planning Team's consensus of what should be implemented. Additional scenarios are developed as necessary to present other combinations to the decision makers that should be considered. The scenario(s) of VE recommendations are rated and compared against the original concept. The performance ratings developed for the VE Scenarios are entered into the matrix and the summary portion of is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations.

- % Performance Improvement = Δ Performance VE Strategy / Total Performance Original Concept
- Value Index = Total Performance / Total Cost (in Millions)
- % Value Improvement = Δ Value Index VE Strategy / Value Index Original Concept

I-10/West Sky Harbor Access Value Planning Workshop Results

February 13-17, 2017

I-10 West Sky Harbor Access
Value Planning Study

FINAL Report

Prepared for:
Maricopa Association of Governments

Lead Authors:
Ken Smith
Trent Eakin

Prepared By:
HDR Engineering, Inc.

Date:
February 2017

Disclaimer:

The information contained in this report is the professional opinions of the Team members during the Value Planning Study. These opinions were based on the information provided to the Team at the time of this workshop.

As the project continues to develop, new information will become available and this information will need to be evaluated on how it may affect the recommendations and findings in this report. All costs displayed in the report are also based on best available information at the time of the study and are in 2017 dollars unless otherwise noted.

This report was prepared by:

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Phoenix, AZ 85018

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Executive Summary

Introduction

This Value Planning report summarizes the events of the workshop conducted for the City of Phoenix Aviation Department, the Arizona Department of Transportation, and the Maricopa Association of Governments (MAG), facilitated by HDR Engineering, Inc.

The project under review was the I-10 West Sky Harbor Access project. The workshop was conducted on February 13-17, 2017. The presentation of the Value Planning design alternatives developed during the workshop was held February 17, 2017.

Value Planning Summary

Number of Alternatives: 3

Total Number of Team Members: 32

MAG: 3

City of Phoenix: 11

ADOT: 5

FHWA: 1

Consultants: 12

Facilitator: HDR Engineering, Inc.

The primary objectives of the Team through the application of Value Engineering and Risk Management tools were to:

- Conduct a thorough review and analysis of the key project issues using a multidisciplinary, cross-functional team
- Develop, various concepts for meeting the transportation and access needs in and out of Sky Harbor Airport
- Improve the value of each alternative through innovative measures aimed at improving the performance while reducing costs
- Perform a cost risk analysis on each alternative (access/roadway portion only)

Project Overview

The I-10 West Sky Harbor Access project, as it relates to the focus of this study, is a series of major projects planned to expand the capacity of the Sky Harbor Airport and enhance airport access from the I-10/I-17 corridor, the local roadway system, and the Rental Car Center (RCC); the RCC is now only accessible with the use of shuttles. A number of agencies are involved with the planning and development of these projects including the City of Phoenix, the Arizona Department of Transportation, and the Maricopa Association of Governments, to name a few.

The complexity of the type of projects involved, their impacts to one another, and the goal to limit the adverse impacts to the facility users and reduce as much temporary work as possible requires special planning and coordination between multiple agencies. To accommodate this initiative, a Value Planning/Cost Risk Assessment was commissioned to develop an initial roadmap, or management plan, that defines the goals of each party and documents the information currently available. During this workshop, the team developed preliminary design ideas that are aimed to create solutions and mitigate many of the risks and exploit opportunities found on the program.

The study focused on the following areas surrounding the expansion of the airport and the long term growth plan for the region. These focus areas included:

1. Sky Harbor Airport – Sky Train Expansion and Future Terminal
2. I-10/I-17 Corridor and Sky Harbor Airport access plan
3. Sky Harbor Boulevard/Local arterial route enhancements
4. Rental Car Center access
5. Future land development plans/restrictions
6. Cargo/freight access

The Sky Train project is scheduled to be advertised in late 2017 with construction scheduled to begin in early 2018. The Regional Transportation Plan also has plans for expansion of the freeway corridor, including plans that are aimed to improve airport and rental car facility access, reduce congestion, and enhance the social and economic goals of the region. Additional enhancements include the accommodations for future airport expansion including a new west terminal, a new ground transportation facility (West GTC), major modifications to Sky Harbor Boulevard, and the construction of new taxiways to name a few.

The outcome of the Value Planning workshop is to improve the overall value of the program by analyzing current plans using a cross functional approach, identify project risks, expand risk mitigation strategies, and develop design alternatives the team feels is the best approach to solve the known issues.

Value Planning Study

The workshop included a team of representatives from the agencies involved and was supported by a group of subject matter experts (SME's). The workshop participants, or 'Team' as it will be referred to throughout this report, developed a list of issues at the beginning of the study. This strategy provided the team an opportunity to weigh the issues and determine which issues required the most attention, a process that helped utilize the team's time most effectively. Following the capture of these issues, a brainstorm session was conducted with the team to brainstorm ideas that may reduce the adverse impacts of the issues or even eliminate them altogether. These ideas were then evaluated and a list of advantages and disadvantages were established for each. The team then rated these ideas on a scale of one to five, a process that excludes lower performing ideas the design team already has eliminated or inevitably will eliminate as design progresses. This rating process has the advantage to only move forward the ideas with the best probability of implementation.

With the total number of ideas limited and related ideas grouped into separate categories, the 'team' was divided into three separate teams and a design competition was held. This approach allowed three different teams to all evaluate the project separately and develop their own approach to solve many of the challenges and issues identified. As a result, three separate evaluations were created, each with its own unique approach to developing a preliminary plan the design team may refer to for decision support.

For additional decision support, each alternative went through a preliminary 'Cost Risk Assessment' exercise. This exercise not only included base costs in the analysis, it captured and quantified individual risks and opportunities that may impact each alternative. Both risks and opportunities for each alternative were captured these risks were modeled with the base costs and base schedule. The results of the analysis generated a 'S-curve' for each alternative, a tool that provides managers with a range of costs based on these inputs.

The costs results at the 70th percentile, a programming percentile as recommended by the FHWA, were ultimately used for the denominator of the value equation to help determine which alternative provided the best overall value. Please keep in mind that only the airport access, from both freeways and local roads, and the Rental Car Center (RCC) access portion of the project was considered for the cost analysis, ignoring the sky train, new west terminal, and other airport projects to simplify the analysis. The goal of the alternative development was to continue to focus on access accommodations for these projects, and how future development and programmatic goals may impact other projects planned on and near the airport.

Value Planning Alternatives

Three individual teams at the workshop each evaluated ideas that rated the highest and moved forward for further development. In summary, each team developed their own alternative that may be considered by the design team. While one individual design alternative itself may not be the final solution, the three alternatives will provide a roadmap for the design team to consider and may choose to incorporate elements of more than one alternative.

In addition to rating the ideas, the design alternatives were rated in a team environment using the Value Engineering performance rating criteria, a strategy that resulted in one alternative becoming the design 'winner'. The performance criteria was defined by the project team and used as part of the value equation. This helped determine which alternative provided the best overall value. The three alternatives, their performance score, their CRA modeled cost at the 70th percentile, and their 'Value Index' score (performance/cost) is provided in Table 1.

Table 1: List of Alternatives

Alternatives	Performance	Cost (70th Percentile)	Value Index (Performance/Cost)
Alternative 1	856	$166.7	5.13
Alternative 2	760	$134.0	5.67
Alternative 3	805	$104.5	7.71

Additional information related to each alternative and their write-ups as developed by each team at the workshop may be found in the 'Development Phase' section of this report.

The Value Planning Team wishes to express its appreciation to the project design Team and management for the excellent support they provided during the workshop. It is the Team's expectation that their evaluation of each alternative will assist management with decision support as the program moves forward.

Ken L. Smith, PE, CVS®
Value Planning Team Lead

Introduction

This Value Planning report summarizes the events of the workshop conducted with the City of Phoenix Aviation Department, the Arizona Department of Transportation, and the Maricopa Association of Governments (MAG), facilitated by HDR, Inc. The project under review was the I-10 West Sky Harbor Access project.

Project Description

The I-10 West Sky Harbor Access project is a series of major projects planned to expand the capacity of the Sky Harbor Airport and enhance airport access from the I-10/I-17 corridor, the local roadway system, and the Rental Car Center (RCC). A number of agencies are involved with the planning and development of these projects including but not limited to the City of Phoenix, the Arizona Department of Transportation, and the Maricopa Association of Governments, to name a few.

The study focused on the following areas surrounding the expansion of the airport and the long term growth strategy for the region. These focus areas include:

1. Sky Harbor Airport – Sky Train Expansion and Future Terminal
2. I-10/I-17 Corridor and I-10 West Sky Harbor access plan
3. Sky Harbor Boulevard/Local arterial route enhancements
4. Rental Car Center access
5. Future land development plans/restrictions
6. Cargo/base access accommodations

The Sky Train project is currently scheduled to be advertised later in 2017 with construction scheduled to begin in early 2018. The route for the Sky Train has been established based on the alignment developed by the design team and approved by the aviation department. The Regional Transportation Plan also has plans for expansion of the freeway corridor, including plans that are aimed to improve airport access, reduce congestion, and enhance the social and economic goals of the region. Additional enhancements include the accommodations for future airport expansion plans including a new west terminal, major modifications to Sky Harbor Boulevard, the construction of new taxiways, and enhancements to meet current design standards for safety and multi-modal transportation as much as possible

Scope of the Value Planning Study

The scope of the workshop was to develop alternative concepts for the I-10 West Sky Harbor Access program and develop creative solutions for the design team to consider based on the project's long term goals. The primary objectives of the Team through the application of Value Engineering and Risk Management tools were to:

- Conduct a thorough review and analysis of the key project issues using a multidisciplinary, cross-functional Team;
- Develop various concepts for meeting the transportation needs in and out of Sky Harbor Airport

- Improve the value of each alternative through innovative measures aimed at improving the performance while reducing costs; and,
- Perform a cost risk analysis for each alternative.

Value Planning Study Timing

The timing of the study was based on a conceptual layout for the project. The workshop was held at the City of Phoenix Aviation facilities from February 13-17, 2017. The presentation of the alternative and their preliminary cost risk analysis results was held the afternoon of February 17, 2017.

Value Planning Team Members

The list of Team members who participated in the Value Planning is provided in Table 2. Other attendees and their participation during the workshop are identified on the sign-in sheets provided in the Appendix.

Table 2: Value Planning Team Members

Name	Organization	Position/Discipline
Ken Smith	HDR	Risk/Value Planning Lead
Suresh Raghavendra	HDR	Workshop Assistant
Chaun Hill	MAG	Senior Transportation Engineer
Audra Koester Thomas	MAG	Transit Planning Project Manager
Quinn Castro	MAG	Transportation Engineer
Trent Eakin	HDR	Construction SME/Modeler
Brian Bombardier	HDR	Roadway SME
Jesse Gutierrez	ADOT	Deputy State Engineer
Madhu Reddy	ADOT	District Engineer
Todd Emery	ADOT	
Scott Beck	ADOT	
Trent Kelso	Teek Engineering	
Aryan Lirange	FHWA	Engineer
Eileen Yazzie	City of Phoenix	
Jordan Feld	City of Phoenix	
Sarah Carter	City of Phoenix	
Robyn Sahid	City of Phoenix	
Molly Monserud	City of Phoenix	Project Manager - Planning
Floyd Johnson	City of Phoenix	
Jazmine Hayes	City of Phoenix	
Nicole Swanson	City of Phoenix	
Randall Payne	City of Phoenix	
Carl Siebe	HDR	Senior Aviation Consultant
Scott Sikel	HDR	Aviation
Jessica Wyatt	HNTB	
Nate Walnum	Kimley Horn	

Table 2: Value Planning Team Members		
Name	**Organization**	**Position/Discipline**
Kim Carrol	Kimley Horn	Traffic
John Kissinger	Kimley Horn	Traffic/ITS
Mark Pilwallis	Gannett Fleming	
Reed Henry	ADOT	Roadway Engineer
Curtis Richardson	City of Phoenix	
Mark Milstone	City of Phoenix	CE III

Figure 1: Value Planning Teams

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Information Phase

The workshop began with a presentation of the planned and proposed projects from the planning managers and project representatives. Projects include the long term plan for the Sky Harbor Airport including terminal modernizations and a new ground transportation facility, Sky Train expansion, Rental Car Center access, I-10/I-17 corridor connections and enhancements, and local roadway accommodations. This allowed the team to capture the overall concept and utilize the value engineering methodology combined with risk management tools to evaluate the constraints and develop alternatives to accommodate future development and reduce throw away work.

Figure 2 below provides an illustration of the proposed West Ground Transportation facility just to the west of I-10 and directly adjacent to 24th Street. The team recognized the complexities of the improvements to the airport in addition to how access was going to be improved to the interstate system, local roadways, the rental car center, and cargo and freight operations currently located on adjacent to airport property.

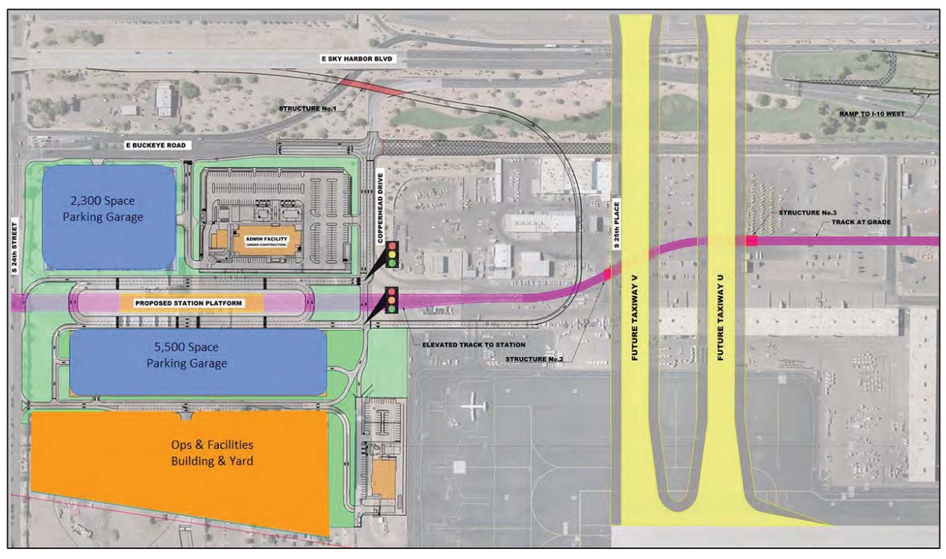


Figure 2: West GTC Long Term Concept

Summary of Analysis

The following analysis tools were used to study the project:

- Constraints and Controlling Decisions
- Investigation Observations - 'Project Issues List'
- Project Schedule Review
- Performance Attributes

- Performance Attribute Matrix
- Creative Idea Development
- Evaluation of Ideas
- Alternative Development
- Performance Based Results – Value Index
- Cost Risk Assessment

Constraints and Controlling Factors

As part of the project briefing, the Value Planning Team was given the following project constraints and controlling factors when considering alternatives:

- The Sky Train alignment from the terminals to the Rental Car Center has already been established and may not be altered
- The roadway crossover (traffic switch for vehicles entering from the west side of the airport) for Sky Harbor Boulevard will need to occur to the west of the new airport taxiways (Taxiways U & V)
- The FAA regulates both the zones above the airport but also on the ground at the ends of each runway, otherwise known as runway protection zones (RPZ's)

Investigation Observations

The first day of the workshop included a presentation from the Project Team. The following summarizes key project drivers, observations, and considerations identified during this session. Table 3 presents a list of project issues identified by the Value Planning Team and the number of participants who identified the issue.

Table 3: Project Issues

Description	No. of Participants Identifying the Issue
Interactions with highway DOT changes and west access	11
Circuitous route from west GTC	10
Cargo growth and accommodations	5
Access/egress to rental car center/terminals	5
Multi-modal - explore all aspects and types	5
Airport security changes - cut through traffic	3
Technological changes - autonomous vehicles/ride share	3
Phasing plan (financial)	3
Access to and from I-10	3
Growth on east and west may impact traffic	2
Changing security requirements during design	2
All modes of traffic (complete streets)	2
Changes to interchange (I-10/I-17) and conflicts with Airport layout	2

Table 3: Project Issues	
Description	**No. of Participants Identifying the Issue**
No I-10 backups eastbound	2
Construction phasing	2
Access prioritization	2
24th street goal conflicts	2
Cul-de-sac airport - one way in/out	1
24th street running through RPZ	1
Accommodating airport support facilities	1
Terminal 2 access and egress	1
Growth of employment at Sky Harbor Center	1
Airline growth	1
Parking to terminal access and accommodations	1
Directional signing/construction impacts	1
Entry/exit plazas	1
Airspace protection	1
Transit access and safety	1
Balance between airport accommodations and I-10	1
Potential development and growth in land use area west of 16th street	1
Conflicts between goals	1
ITS	1
Land use changes west of I-10 and traffic growth - new interchange?	1
West GTC access and impacts	1
Extension of Sky Train to Central Ave?	1

Project Schedule Review

A preliminary schedule was developed to provide a date range for known project activities and milestones including terminal modernizations, West Ground Transportation facility construction, the Sky Train, taxiways, and roadway construction. These activities are then cost loaded to allow the risks to impact a specific activity that will either lengthen or reduce the baseline schedule. This provides a more reasonable cost outcome based on risk impacts that also carry schedule impacts.

The preliminary schedule was reviewed by the entire Team and updated as necessary throughout the workshop. To simplify the analysis, only the roadway access portion of the project was used in the cost risk assessment model (highlighted in yellow in Table 4 below) as these activities are shaped by the scheduled major airport activities and are the activities with

the most risk but also hold the potential for the most opportunity; better timing for road projects that accommodate the opening of the west GTC for example.

Table 4 shows major activities for the program and their estimated start and end dates. Please see the Appendix for the flowchart activity diagram for an illustration of the project schedule and their relationship to succeeding activities, where applicable.

Table 4: Project Activity Ultimate Baseline Schedule			
Activity ID	**Activity Name**	**Start Date**	**End Date**
101	Sky Train/West GTC Design	1/1/2017	1/1/2018
105	Sky Train/West GTC Construction	1/1/2018	12/1/2021
108	Sky Trains Systems Const. & Testing	12/1/2020	12/1/2021
110	T2/T3 Modernization	3/1/2019	3/1/2020
120	West Terminal & Roadways	6/1/2024	6/1/2026
200	Taxiway Construction – U & V	1/1/2023	1/1/2024
210	Roadway – Sky Harbor Boulevard	1/1/2023	1/1/2024
220	Air Cargo	1/1/2023	1/1/2024
300	Roadway Design	4/1/2019	4/1/2022
305	Environmental	4/1/2021	4/1/2022
310	Right of Way	4/1/2021	4/1/2022
315	Ad-Bid-Award	4/1/2022	7/1/2022
320	Roadway/Highway Construction	7/1/2022	12/31/2024

Performance Attributes

Performance attributes are an integral part of the value analysis process. The performance of each project must be properly defined and agreed upon by the Project Team, Value Planning Team, and stakeholders at the beginning of the study. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

Performance attributes can generally be divided between project scope components (roadway operations, transit operations, etc.) and project delivery components (construction impacts, environmental impacts, etc.). It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory and binary in nature. All performance requirements **must** be met by any Value Planning alternative being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was to design and construct a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives that have different durations could be acceptable.

The Value Planning Team, along with the Project Team, identified and defined the performance attributes for this project. The performance attributes shown in Table 5 were used throughout the study to identify, evaluate, and develop ideas and alternatives.

Table 5: Performance Attributes		
Evaluative Criteria		
Performance Attribute	**Description**	**Comments**
Freeway Operations	An assessment of capacity, access, and safety on I-10, I-17, SR-143, and SR-202L. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance, and lane and shoulder widths.	Currently, I-10 half diamond to the south and direct access between the north and the east. 44th St, SR-202L and SR-143 current access point to the airport. Frontage road between Jefferson and Sky Harbor Circle.
Airport Operations	An assessment of airport airside and landside operations and safety. Operational metrics include airspace protection and landside movements.	Access to airport facilities. Ability to accommodate the growth of passengers (20 million more in 20 years); currently, 44 million. Current bus service into terminal 2; this will truncate at west GTC when Sky Train Phase 2 opens. Freight operations within the airport. Security within the Sky Harbor airport.
Maintainability	An assessment of the long-term maintainability of the facilities. Maintenance considerations include the overall durability, longevity, and maintainability of structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel, including sediment and debris removal.	Pavements, structures, storm drainage, access to ITS and utilities, landscaping
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access, visual effects, noise, vibration, dust, and construction traffic; environmental impacts.	Construction access of laydown areas for various projects.
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts; impacts to shore edge; impacts to cultural, recreational and historic resources.	Conditional environmental approvals on the airport projects. For airport-roadway projects, environmental process has not started. Separate environmental documents for airport and airport-roadway projects.

Table 5: Performance Attributes		
Evaluative Criteria		
Performance Attribute	**Description**	**Comments**
Promotes Economic Growth	An assessment how the alternative assists in promoting growth and airport oriented development.	Protecting the future plans for growth outside of the airport properties.
Security	Ability to screen the vehicles entering the airport core. Ability to quickly change with regulation change. Considerations of how to protect critical facilities such as sky train and control center.	Currently, there is no method in place to screen the vehicles. Temp plans are in place; enhancements could be permanent.
Local Roadway Operations	Sky Harbor Boulevard, Sky Harbor Circle, 44th Street, 24th Street, Old Town Road, and Buckeye Road	24th Street must stay open as an airport access. Light rail station at 44th St and Washington. Planned BRT and bike lanes on 24th St and existing bus service.

Performance Attribute Matrix

A matrix was used to determine the relative importance of the individual performance attributes for the project. The Project and Value Planning Teams evaluated the relative importance of the performance attributes that would be used to evaluate the creative ideas.

These attributes were compared in pairs, asking the question: "Which one is more important to the purpose and need of the project?" The letter code (e.g., "A") was entered into the matrix for each pair. After all pairs were discussed they were tallied (after normalizing the scores by adding a point to each attribute) and the percentages calculated.

Table 6: Performance Attributes Criteria Matrix

Paired Comparison

									Total Points	% of Total
Freeway Operations	A	A/B	A	A	A	A	A	A	7.5	20.8%
Airport Operations		B	B	B	B	B	G	B	6.5	18.0%
Maintainability			C	C/D	C	F	G	H	2.5	6.9%
Construction Impacts				D	D/E	F	G	H	2.0	5.5%
Environmental Impacts					E	F	G	H	1.5	4.1%
Promotes Economic Growth						F	G	F/H	4.5	12.5%
Security							G	G	7.0	19.8%
Local Roadway Operations								H	4.5	12.5%
								Total	**36.0**	**100%**

The performance attribute criteria matrix exercise resulted in the following order of precedence during the workshop.

1. Freeway Operations
2. Security
3. Airport Operations
4. Promote Economic Growth
5. Local Roadway Operations
6. Maintainability
7. Construction Impacts
8. Environmental Impacts

These results are then carried forward and are used in the establishment of a performance score for each of the alternatives. These were ranked to allow the team to rate the alternatives based on their impacts, either adversely or positively, to the performance attributes and how they compare with current concepts, how they accommodate future development, and how they compare to the other alternatives that were developed.

Creative Phase

The Value Planning Team held a brainstorm session following the development of the issue list as a method to develop ideas that may reduce the impacts or resolve many of these identified issues. The ideas were based on the available information given at the time of the study and do not necessarily solve all issues that may be encountered in the future.

The focus of the brainstorm session is not to evaluate any ideas during this process, but only to come up with a list of potential ideas that will be assessed in the next step of the workshop, the evaluation phase.

The list of ideas are categorized by options for I-10, Buckeye, 24th Street, Sky Harbor Circle, Sky Harbor Circle, Sky Harbor Boulevard (reduce cut through traffic), and 'Other'. Similarities may be evident with some ideas in separate categories and these ideas may be combined into one design alternative based on the results of the evaluation.

I-10 Options

1. Braid Sky Harbor Circle north ramps with Jefferson south side ramps
2. Reverse ramps between Sky Harbor Circle north and south
3. Rebuild I-10 and Buckeye interchange as 2-level diamond style interchange
4. Rebuild I-10 and Buckeye interchange as 3-level platform diamond or SPUI interchange
5. Rebuild I-10 and Buckeye interchange as 3-level DDI
6. CD roads along I-10 from SR-51 to I-17
7. Add ramp braids to reduce weaves on I-10 mainline
8. Use Copperhead Road to access I-10 WB
9. West GTC over 24th Street on ramp I-10 WB (Sketch 1)
10. Flyover ramps from I-10 to RCC
11. Add aux lanes on I-10 EB between SR-51 and Sky Harbor Circle
12. Realign I-10 along the 16th Street alignment

Buckeye Road Options

13. Grade separate 24th Street and Buckeye Road
14. Reconfigure Buckeye Road and Sky Harbor Circle intersection to favor west to south movement
15. Grade separate Buckeye Road and Sky Harbor Circle intersection
16. Roundabout at Buckeye Road and Sky Harbor Circle
17. Continuous Flow Interchange (CFI) at Buckeye Road and Sky Harbor Circle
18. Terminate Buckeye Road at Sky Harbor Circle
19. Make Buckeye Road and Sky Harbor Boulevard one-way (couplet terminating at a SPUI)
20. Realign Sky Train to Buckeye Road
21. Half DDI at Buckeye Road

24th Street Options

22. Move Sky Train to north of WGTC and combine the Sky Train trench with Sky Harbor Boulevard trench under U&V taxiways
23. Depress 24th Street within the proximity of Buckeye Road

24. 24th Street split south of Jefferson and run as I-10 Frontage Road (moves outside of RPZ's); Maintain the existing 24th Street for bike/pedestrians
25. Restrict use of 24th Street to bike/ped and transit (BRT), and limit direct airport access
26. Slip ramp from I-17 SB to I-10 WB directional ramp to 24th Street
27. Convert 24th into Sky Harbor Circle; add a grade separation at Buckeye; and restrict access on 24th Street to ped/bike between SHC north and south

Sky Harbor Circle Options

28. Complete the SHC loop on the east of I-10 (integrate with the reverse ramps concept and keep Sky Train on the outside of the loop) (integrate with the terminate Buckeye concept)

Deter Cut-Through Traffic Options

29. Tolling
30. Roundabouts
31. Signalized intersections
32. Photo Enforcement
33. East and west Cul-de-sac
34. Cul-de-sac the east end
35. Reduced speed limit (15 mph)
36. ITS (mandatory inspection)
37. Random inspections
38. Modify SR-202L access at Priest Drive

Other Options

39. ITS for travel times using different airport access
40. Managed Lanes through airport core

Evaluation Phase

Although each project is different, the evaluation process for each Value Planning effort can be thought of in its simplest form as a way of combining, evaluating, and narrowing ideas until the team agrees on the ideas to be forwarded to the development phase.

Taking into consideration the constraints and controlling decisions, the team discussed each idea and documented the advantages and disadvantages compared to the existing facility and the criteria to meet the needs of future development.

Each idea was then carefully evaluated with the Team reaching consensus on the overall rating of the idea (zero through five). High-rated ideas (four or higher) were developed further; those that were considered to be equivalent to the baseline (rated three) were documented as design considerations; and low-rated ones (two or lower) were dropped from further consideration; however, the team provided a short description and justification to support the low rating. The rating values are shown below:

5 = Great Opportunity
4 = Good Opportunity
3 = Design Consideration (comparable to project team's approach)
2 = Minor Value Degradation
1 = Major Value Degradation
0 = Fatal Flaw (unacceptable impact or doesn't meet the project purpose and need)

= Advanced as recommendation

= Forwarded as design consideration

= Dropped from future consideration

As the workshop evolved, three additional categories were added to the evaluation table to allow the team to also consider three major elements important to the program. These three categories are Airport Access, Rental Car Center Access, and Freight Access. The addition of these categories allowed the team to consider if the idea positively or adversely affected the function of important program goals. Evaluation of the ideas is categorized in the same manner as the creative list; I-10, Buckeye, 24th Street, Sky Harbor Circle, Sky Harbor Boulevard cut through reduction, and 'Other'.

I-10 Options

#	Description	Advantages	Disadvantages
1	Braid Sky Harbor Circle north ramps with Jefferson south side ramps	▪ Avoids RCC traffic going across the Light Rail ▪ Current ramps backup; this idea could improve freeway operations ▪ Could improve access to RCC	▪ Adding another set of ramps could impede freeway operations

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍👎							👍

Airport Access		RCC Access	👍	Freight Access	

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
2	Reverse ramps between Sky Harbor Circle north and south	▪ Simplifies RCC signing ▪ Could reduce east to west cut-through traffic ▪ Could reduce weaves on I-10 ▪ Improves private economic growth ▪ All access on Buckeye providing area for vehicle screening	▪ Eliminates the interchange at Buckeye ▪ Circuitous route to airport from I-10 ▪ Impacts to existing signal at Buckeye ▪ Hinders airport economic growth

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍👎	👎				👍👎	👍	👎

Airport Access	👎	RCC Access	👍	Freight Access	👍

Cost:	*Justification/Comments: Maybe combined with the CD road idea.*
Rating: 1	

#	Description	Advantages	Disadvantages
3	Rebuild I-10 and Buckeye interchange as 2-level diamond style interchange	▪ Full access interchange ▪ Single point of access to RCC for all directions ▪ Relatively easy modification without affecting the mainline ▪ Low cost	▪ Could slowdown RCC access – SHC/Buckeye intersection operations could breakdown ▪ Risk of potential backup on to mainline

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👎	👎						

Airport Access	👍	RCC Access	👍	Freight Access	👍

Cost:	*Justification/Comments: Could be improved with a third level S-E flyover. May require braiding of ramps. Consider variations of Buckeye and 24th St intersection.*
Rating: 3.5	

#	Description	Advantages	Disadvantages
4	Rebuild I-10 and Buckeye interchange as 3-level platform diamond or SPUI interchange	▪ Higher capacity ▪ Full access ▪ Promotes economic growth	▪ Additional signals on Buckeye ▪ Eliminates free flowing movements ▪ Encourage cut-through traffic ▪ Height and depth constraints ▪ Traffic control – close Buckeye

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍👎		👎	👎		👍		👍

Airport Access	👍	RCC Access	👍	Freight Access	

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
5	Rebuild I-10 and Buckeye interchange as 3-level DDI	▪ Higher capacity ▪ Full access ▪ Promotes economic growth ▪ Provides more free flow movements	▪ Encourage cut-through traffic ▪ Height and depth constraints ▪ Traffic control – close Buckeye ▪ Connection with 24th Street

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍		👎	👎		👍		👍

Airport Access	👍	RCC Access	👍	Freight Access	

Cost:	*Justification/Comments: Half DDI could accommodate the crossover required by the airport.*
Rating: 2	

#	Description	Advantages	Disadvantages
6	CD roads along I-10 from SR-51 to I-17	▪ Cleans up I-10 operations ▪ Eliminates high-speed weaves	▪ Could be costly ▪ Signing can be challenging

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍							

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
7	Add ramp braids to reduce weaves on I-10 mainline	▪ Eliminates weaves	▪ Cost ▪ Profiles ▪ ROW

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍				👎			

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other ideas.*
Rating: 3	

#	Description	Advantages	Disadvantages
8	Use Copperhead Road to access I-10 WB	▪ Utilizes old 24th Street separation	▪ Conflicting movement with Buckeye traffic

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍👎						👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other ideas.*
Rating: 3	

#	Description	Advantages	Disadvantages
9	West GTC over 24th Street on ramp I-10 WB (Sketch 1)	▪ One access to airport from I-10 ▪ Consistent with existing plans for airport improvements ▪ Eliminates weaves on I-10	▪ Cost ▪ Potential impacts to the SW corner of Buckeye and 24th Street ▪ Circuitous route from EB Buckeye to I-10 WB

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍	👍					👍	👍

Airport Access	👍	RCC Access	👍	Freight Access	👍

Cost:	*Justification/Comments: Moved forward to further development.*
Rating: 5	

#	Description	Advantages	Disadvantages
10	Flyover ramps from I-10 to RCC	▪ Easy access to/from RCC	▪ Potential vertical clearance issues with OEI's ▪ Cost ▪ Introduces additional weaves on I-10

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👎	👎						

Airport Access		RCC Access	👍	Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1	

#	Description	Advantages	Disadvantages
11	Add aux lanes on I-10 EB between SR-51 and Sky Harbor Circle	▪ Potentially improves operations on I-10	▪ May add additional weaves

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍👎							

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other ideas.*
Rating: 3	

#	Description	Advantages	Disadvantages
12	Realign I-10 along the 16th Street alignment	▪ Provides more space for the airport	▪ Cost ▪ Community impacts ▪ Delays the projects

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍			👎			

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 0.5	

Buckeye Road Options

#	Description	Advantages	Disadvantages
13	Grade separate 24th Street and Buckeye Road	▪ Eliminates at-grade intersection ▪ May eliminate potential conflicts of signal adjacent to I-10	▪ Eliminates turning movements from Buckeye and 24th Street and vice versa ▪ May have considerable utility impacts

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍	👎						👍👎

Airport Access		RCC Access		Freight Access	
	👎				

Cost:	Justification/Comments: Must be combined with other options for airport access from 24th Street.
Rating: 3	

#	Description	Advantages	Disadvantages
14	Reconfigure Buckeye Road and Sky Harbor Circle intersection to favor west to south movement	▪ Improves access from Sky Harbor Circle ▪ Could discourage Buckeye through traffic through airport	▪ Buckeye continuity is disrupted ▪ May disrupt future airport and land use plans

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍				👎		👎

Airport Access		RCC Access		Freight Access	

Cost:	Justification/Comments: Dropped from further consideration.
Rating: 2	

#	Description	Advantages	Disadvantages
15	Grade separate Buckeye Road and Sky Harbor Circle intersection	▪ Reduces signal phases; increase intersection capacity; reduces delay; improves operations	▪ Cost ▪ Adjacent land access could be impacted

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
					👎		👍

Airport Access		RCC Access		Freight Access	

Cost:	Justification/Comments: Could be combined with other options. Could also make the intersection a roundabout under the bridge.
Rating: 3	

#	Description	Advantages	Disadvantages
16	Roundabout at Buckeye Road and Sky Harbor Circle	▪ Eliminates left turns	▪ Driver unfamiliarity with multilane roundabouts ▪ High volume multilane

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						👍👎

Airport Access		RCC Access		Freight Access	

Cost:	Justification/Comments: Dropped from further consideration.
Rating: 1.5	

#	Description	Advantages	Disadvantages
17	CFI at Buckeye Road and Sky Harbor Circle	▪ Reduces delay ▪ Increases capacity	▪ Drive expectancy ▪ Additional ROW ▪ Reduces access to adjacent land

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
				👎	👎		👍👎

Airport Access		RCC Access		Freight Access	

Cost:	Justification/Comments: Dropped from further consideration.
Rating: 1	

#	Description	Advantages	Disadvantages
18	Terminate Buckeye Road at Sky Harbor Circle	▪ Minimizes cut-through traffic ▪ Eliminates traffic in the vicinity of I-10 interchange	▪ Eliminates direct access to airport from Buckeye ▪ Complicates local business access between I-10 and Sky Harbor Circle

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍					👎		👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 0.5	

#	Description	Advantages	Disadvantages
19	Make Buckeye Road and Sky Harbor Boulevard one-way (couplet terminating at a SPUI)	▪ Lines up with the airport's plan for Sky Harbor Boulevard	▪ Need to address 24th Street ▪ Crossings under the cross taxiways

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍👎						

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other options.*
Rating: 3	

#	Description	Advantages	Disadvantages
20	Realign Sky Train to Buckeye Road		▪ Constrains access to I-10 from Buckeye ▪ Eliminates access to properties on the south side of Buckeye ▪ May add another level to the interchange ▪ Drainage conflicts ▪ Inconsistent with the interchange at Buckeye

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍	👎		👎		👎		👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other options.*
Rating: 1	

#	Description	Advantages	Disadvantages
21	Half DDI at Buckeye Road	▪ Eliminates the crossover on airport property	▪ Requires additional road network to access WGTC

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other ideas. Requires modifications to 24th Street, Sky Harbor Boulevard, and the I-10 interchange.*
Rating: 3	

24th Street Options

#	Description	Advantages	Disadvantages
22	Move Sky Train to north of WGTC and combine the Sky Train trench or Sky Harbor Boulevard roadway trenches under U&V taxiways to minimize bridge area	▪ Reduces structure required over roadways when the taxiways are built	▪ Constructability

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
			👍👎				

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Must be combined with other ideas.*
Rating: 2.5	

#	Description	Advantages	Disadvantages
23	Depress 24th Street within the proximity of Buckeye Road	▪ Eliminates at-grade intersection ▪ May eliminate potential conflicts of signal adjacent to I-10 ▪ Reduces the fill heights of Sky Harbor Boulevard crossing 24th Street	▪ Eliminates turning movements from Buckeye and 24th Street and vice versa ▪ May have considerable utility impacts

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
👍			👍👎				👍👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
24	24th Street split south of Jefferson and run as I-10 Frontage Road (moves outside of RPZ's); Maintain the existing 24th Street for bike/ped		▪ May require a railway crossing ▪ Requires an additional roadway bridge ▪ Cost ▪ Significant property impacts ▪ Could impact freight operations on the south side

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
					👎		

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1	

#	Description	Advantages	Disadvantages
25	Restrict use of 24th Street to bike/ped and transit (BRT), and limit direct airport access		▪ Discontinuity of a major north-south movement ▪ Freight access

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
							👍

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Maybe combined with other options that provide continuity north-south.*
Rating: 1.5	

#	Description	Advantages	Disadvantages
26	Slip ramp from I-17 SB to I-10 WB directional ramp to 24th Street		▪ RPZ challenges ▪ Geometry

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👎					👎	

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1	

#	Description	Advantages	Disadvantages
27	Convert 24th Street into Sky Harbor Circle; add a grade separation at Buckeye; and restrict access on 24th Street to ped/bike between Sky Harbor Circle north and south	▪ Reduced travel time on 24th Street due to reduced signals ▪ Encourages economic development west of I-10 ▪ Improves RPZ condition ▪ Eliminates the at-grade intersection of Buckeye and 24th Street ▪ Eliminates the grade separation required for 24th Street and Sky Harbor Boulevard ▪ Improves intersection of Buckeye and Sky Harbor Circle	▪ May change access in the vicinity of Buckeye and Sky Harbor Circle

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
					👍	👍	👍👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Could be combined with other interchange solutions.*
Rating: 4	

Sky Harbor Circle Options

#	Description	Advantages	Disadvantages
28	Complete the Sky Harbor Circle loop on the east of I-10 (integrate with the reverse ramps concept and keep Sky Train on the outside of the loop) (integrate with the terminate Buckeye Road concept)	▪ Discourage cut-through traffic	▪ Circuitous airport access ▪ Forces some freight traffic with airport-destination traffic

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👎				👍👎		

Airport Access		RCC Access		Freight Access	
	👎		👍		👎

Cost:	*Justification/Comments: Must be integrated with the reverse ramps concept.*
Rating: 1.5	

Deter Cut-Through Traffic Options

#	Description	Advantages	Disadvantages
29	Tolling	▪ Reduces cut-through traffic	▪ Perception issues ▪ Implementation

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Could be considered as a peak hour solution.*
Rating: 4	

#	Description	Advantages	Disadvantages
30	Roundabouts	▪ Reduces cut-through traffic	▪ Driver expectancy ▪ Reverse flow fatal flaws this idea

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👎						👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 0	

#	Description	Advantages	Disadvantages
31	Signalized intersections		

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: No intersection available to signalize.*
Rating: 0	

#	Description	Advantages	Disadvantages
32	Photo Enforcement	▪ Reduces speed	▪ May require a law to support this

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 1.5	

#	Description	Advantages	Disadvantages
33	East and west Cul-de-sac of Sky Harbor Boulevard	▪ Eliminates pass-through traffic	▪ Requires redundant roadways

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 0.5	

#	Description	Advantages	Disadvantages
34	Cul-de-sac the east end only	▪ Reduces pass-through traffic	▪ Requires redundant roadways

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍						👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 0.5	

#	Description	Advantages	Disadvantages
35	Reduced speed limit (15 mph)	▪ Ease of implementation	▪ Requires enforcement ▪ May reduce airport operation

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👎						

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Combine with photo enforcement. Consider variable speed limit.*
Rating: 3	

#	Description	Advantages	Disadvantages
36.	ITS (mandatory inspection)	▪ Could enhance security	▪ Enforcement

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
						👍	

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Dropped from further consideration.*
Rating: 2.5	

#	Description	Advantages	Disadvantages
37	Random inspections	▪ May deter pass-through traffic	▪ Cost

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍					👍	👎

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
38	Modify SR-202L access at Priest Drive		▪ Addresses only a small amount of EB pass-through

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Does not address all pass-through traffic and outside of the purview of this study.*
Rating: 1	

Other Options

#	Description	Advantages	Disadvantages
39	ITS for travel times using different airport access	▪ Informs drivers	▪ Could increase pass-through

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👎						

Airport Access	👍	RCC Access		Freight Access	

Cost:	*Justification/Comments: This is ADOT's current practice for the interstates.*
Rating: 2.5	

#	Description	Advantages	Disadvantages
40	Managed Lanes through airport core (lane control)	▪ Allows reconfiguring lanes ▪ May reduce cut-through traffic	▪ Can create congestion ▪ Airport operations

Freeway Operations	Airport Operations	Maintainability	Construction Impacts	Environmental Impacts	Promotes Economic Growth	Security	Local Roadway Operations
	👍👎						

Airport Access		RCC Access		Freight Access	

Cost:	*Justification/Comments: Maybe better served with variable speed limit or other concepts.*
Rating: 2	

Development Phase

In order to develop combined solutions, a design competition was organized to create a competitive environment where the best ideas with the greatest value were moved forward.

The Value Planning Team was divided into three separate groups with the goal to include a design expert from each division; aviation, roadway, structures, construction, etc. Each group was tasked with identifying the best ideas from the evaluation phase and incorporating these ideas into their alternative write-ups. Design considerations, those ideas rated a three or above, were also incorporated where appropriate.

The end result was the development of three separate write-ups with their own unique approach to solve many of the issues the program faces. Each write up from the teams, a preliminary estimate, and a preliminary design concept with graphics and assumptions is provided in the 'Development Phase' section of this report.

To help achieve consistency in the design competition, the groups were given the following directions and assumptions:

1. The Sky Train alignment from the terminals to the Rental Car Center has already been established and may not be altered
2. The roadway crossover (traffic switch for vehicles entering from the west side of the airport) for Sky Harbor Boulevard will need to occur to the west of the new airport taxiways (Taxiways U & V)
3. The FAA regulates both the zones above the airport but also on the ground at the ends of each runway, otherwise known as runway protection zones (RPZ's)
4. Focus on the ideas that will bring a solution to the highest rated performance attributes established at the beginning of the workshop

A unique solution was developed by each of the three teams and is documented in the following section. Surprisingly, you will find that each team had a different approach to accommodate program objectives. The result was a value rating process that opened up a constructive dialogue to determine which alternative would become the design 'winner'. Even though one alternative ranked higher using the value performance rating system than the other two alternatives, it does not mean the design team will choose to implement only one alternative. They may wish to incorporate ideas from multiple alternatives into the design as the program advances. Please refer to the 'Value Planning Approach' and 'Performance Based Results' section in the appendix for additional detail related to the value planning performance rating system and how it was applied in this workshop.

Each alternative consists of a description of the alternative, a listing of its advantages and disadvantages, and a brief narrative that includes justification, sketches, photos, assumptions and calculations (where applicable) as developed by the Team. It is to be noted that the cost of the alternative is only the blended cost of the access or roadway portion of the project where the cutoff or hold point was to the west of Copperhead Drive. Terminal modernization costs, Sky

Train, taxiway, Sky Harbor Boulevard (east of Copperhead Drive), and other airport improvements are not included in the cost of the analysis.

The Value Planning Alternatives are presented as written by the groups during the workshop. While they have been edited in the report to correct errors or better clarify the alternative, they represent the each team's recommendation as developed and reviewed by the teams during the study.

	Alternative No. 1 Diamond TI with SE Fly Over	Idea #'s 1, 4, 7, 11, 13, 19, 23, 20, 32, 36, 37, 40

Recommendation:

Provides full access TI at I-10 and Buckeye, provides simple east/west Buckeye operations in/out of the airport, provide security check point, provides direct access to WGTC from I-10, provides full access to RCC to/from I-10 and I-17 via Buckeye TI, and eliminated weave sections on all four quadrants of I-10/Buckeye Road TI.

Advantages:

- Full access to/from Sky Harbor and RCC at the Buckeye Road TI
- Fully driver expectant, and easy to sign/wayfind.
- Operationally provides continuous east/west flow on Buckeye Road between downtown and airport
- Long Term solution for I-10 access to Sky Harbor and WGTC
- Additional access for Freight from I-10 and Buckeye to Sky Harbor Cir to 24th St.
- Security Check Point to screen prior to crossing under the taxiways.
- Fix weave on I-10 between Jefferson and Buckeye
- Fix weave on I-10 between I-17 and Buckeye
- Consistent with airport plans for Sky Train to/from RCC
- Removes at grade crossing of light rail for all airport users.

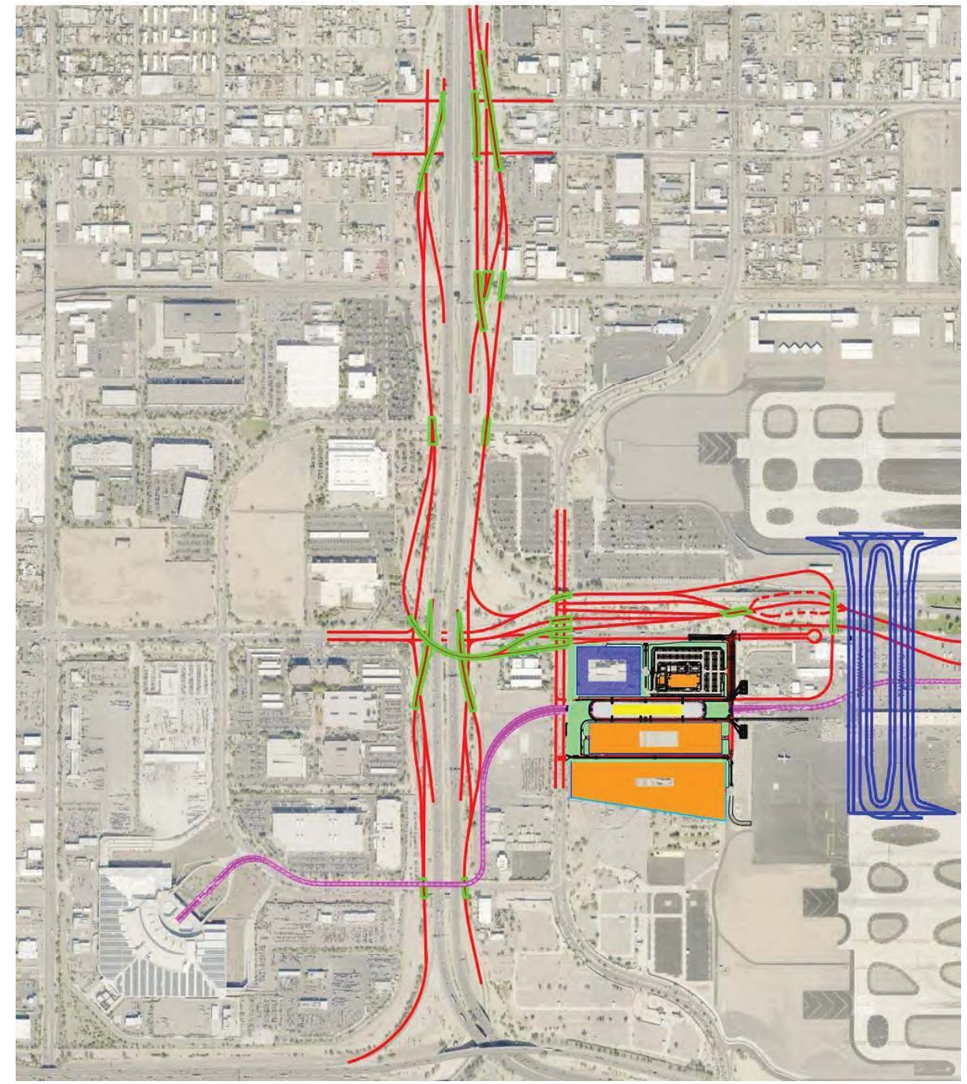
Disadvantages

- Does not deter cut through traffic, and could make it worse.
- Cost
- Constructability/Maintenance of Traffic
- Creates a new weave on I-10 between the Jefferson south side ramps and the I-17 system ramps, but resulting weave section is in excess of 2000 feet.
- Relocate Community Tire Center
- Relocate Gray Hound Bus Depot
- Lose the direct connection between 24th Street and Buckeye Road.

BASE COST SUMMARY	COST
Recommendation	**$132,100,000**

	Alternative No. 1 Diamond TI with SE Fly Over	Idea #'s 1, 4, 7, 11, 13, 19, 23, 20, 32, 36, 37, 40

Discussion/Justification/Sketches/Photos:



	Alternative No. 1 Diamond TI with SE Fly Over	Idea #'s 1, 4, 7, 11, 13, 19, 23, 20, 32, 36, 37, 40

Assumptions and Calculations:

1. Bridges are single lane along I-10 all 25 feet wide with 12 ft lane, 8' shoulder, 5' shoulder (90,000 SF)
   a. Southbound I-10 Ramp Bridges
      i. L1= 800 x 25 = 20K
      ii. L2=200 x 25 = 5K
      iii. L3=800 x 25 = 20K
      iv. L4=200 x 25 = 5K
   b. Northbound I-10 Ramp Bridge
      i. L1 = 600 x25 = 15K
      ii. L2= 200 x 25 = 5K
      iii. L3 = 800 x 25 = 20K
   c. Northbound I-10 Widening bridge at Sky Harbor Cir N. (1200 SF)
      i. L= 200 x 6
2. I-10 Ramp Roadway Lengths
   a. Southbound Side = 9,000 LF x 25 = 25,000 SY
   b. Northbound Side = 7,100 LF x 25 = 19,725 SY
3. I-10 to EB Buckeye Flyover:
   a. Assume two lane (2-EB 12' lanes, 8' shoulder, 8' shoulder)(40')
   b. L – 1,500 x 40 = 61,000 SF
4. Traffic Signalized Intersection at Buckeye
   a. 2 ramp termini = 2 signals one at each ramp termini
   b. 24th Street and Sky Harbor
   c. 24th Street and south side WGTC (??)
5. Pavement Marking and Signing
   a. I-10 = 3 miles (total for both directions)
   b. Buckeye = 1.0 mile (total for both directions)
6. Lighting
   a. I-10 Lighting = 3 Miles (both directions)
   b. Buckeye Lighting = 1 Mile (both directions)
7. Earthwork
   a. Buckeye Earthwork: Assume 500K CY
   b. I-10 Ramps Assume 500K CY
8. Removals
   a. I-10 Ramp Pavement Removal (
      i. SB Removal 7,000 SY
      ii. NB Removal 2,000 SY
9. Buckeye Road Bridges
   a. Buckeye Eastbound
      i. Buckeye Over 24th Street Bridge (2 lane) = 6600 SF
      ii. Buckeye to WGTC Bridge over 24th Street (2-lane) = 4900 sf
      iii. Buckeye cross over bridge = 7800 SF
   b. Buckeye Westbound
      i. WGTC to Westbound crossing of Sky Harbor Blvd = 9900 SF
      ii. Westbound Sky Harbor Blvd over 24th St = 5000 SF
10. Buckeye Road

	Alternative No. 1 Diamond TI with SE Fly Over	Idea #'s 1, 4, 7, 11, 13, 19, 23, 20, 32, 36, 37, 40

   a. PCCP (from crossing to reconstruction) 2900 LF x 80 foot = 25000 SY
   b. Asphalt (at grade) 30 feet (wide) x 380 = 11,500 SY
11. Security Plaza Pavement
   a. Asphalt = 8500 SY
12. 24th Street
   a. Asphalt 1,500 lf x = 13,000 SF

Team 1 Recommendation Cost Estimate

Item Description	Unit	Freeway QTY	Local QTY	Unit Cost	Freeway Total	Local Total	Total (Most Likely)	% Under	% Over	$ Under	$ Over
Removals											
Pavement Removal	SY	13,000	15,000	$ 5.00	$ 65,000	$ 75,000	$ 140,000	-25%	25%	$ 105,000	$ 175,000
Earthwork											
General Earthwork	CY	500,000	500,000	$ 7.00	$ 3,500,000	$ 3,500,000	$ 7,000,000	-25%	25%	$ 5,250,000	$ 8,750,000
Base and Surface Treatment											
Concrete Pavement	SY	75,000		$ 45.00	$ 3,375,000	$ -	$ 3,375,000	-15%	15%	$ 2,868,750	$ 3,881,250
Asphalt Pavement	SY		33,000	$ 35.00		$ 1,155,000	$ 1,155,000	-10%	10%	$ 1,039,500	$ 1,270,500
Drainage											
On-Site	MILE	1.5	0.5	$500,000	$ 750,000	$ 250,000	$ 1,000,000	-10%	30%	$ 900,000	$ 1,300,000
Off-Site	LS	1000000	500000	$1	$ 1,000,000	$ 500,000	$ 1,500,000	-25%	20%	$ 1,125,000	$ 1,800,000
Pump Station	EACH	0	1	$2,000,000	$ -	$ 2,000,000	$ 2,000,000	-10%	10%	$ 1,800,000	$ 2,200,000
Structures											
Walls	SF	215,000	100,000	$ 65.00	$ 13,975,000	$ 6,500,000	$ 20,475,000	-30%	10%	$ 14,332,500	$ 22,522,500
Flyover	SF	61,000		$ 165.00	$ 10,065,000		$ 10,065,000	-10%	10%	$ 9,058,500	$ 11,071,500
Single Level (AASHTO)	SF	122,000	34,000	$ 125.00	$ 15,250,000	$ 4,250,000	$ 19,500,000	-15%	15%	$ 16,575,000	$ 22,425,000
Widening Bridge	SF	1,200		$ 185.00	$ 222,000		$ 222,000	-10%	10%	$ 199,800	$ 244,200
Traffic Engineering											
Ramp TI Signals	EA	3	1	$ 200,000.00	$ 600,000	$ 200,000	$ 800,000	-10%	10%	$ 720,000	$ 880,000
Pavement Marking & Signing	MILE	3	1	$ 150,000.00	$ 450,000	$ 150,000	$ 600,000	-10%	10%	$ 540,000	$ 660,000
Lighting	MILE	3	1	$ 350,000.00	$ 1,050,000	$ 350,000	$ 1,400,000	-10%	10%	$ 1,260,000	$ 1,540,000
ITS (Reconstruction & New)	LS	70%	30%	$ 1,000,000.00	$ 700,000	$ 300,000	$ 1,000,000	-10%	10%	$ 900,000	$ 1,100,000
Item Subtotal					$ 51,002,000	$ 19,230,000	$ 70,232,000	-19%	14%	$ 56,674,050	$ 79,819,950
Misc Item Allowance (10%)				10%	$ 5,100,200	$ 1,923,000	$ 7,023,200	-19%	14%	$ 5,667,405	$ 7,981,995
Traffic Control (10%)				10%	$ 5,100,200	$ 1,923,000	$ 7,023,200	-19%	14%	$ 5,667,405	$ 7,981,995
Mobilization				8%	$ 4,080,160	$ 1,538,400	$ 5,618,560	-19%	14%	$ 4,533,924	$ 6,385,596
Dust and Water Palliative	0.75%			0.75%	$ 382,515	$ 144,225	$ 526,740	-19%	14%	$ 425,055	$ 598,650
Contractor Quality Control	2.00%			2%	$ 1,020,040	$ 384,600	$ 1,404,640	-19%	14%	$ 1,133,481	$ 1,596,399
Contractor Surveying	2.00%			2%	$ 1,020,040	$ 384,600	$ 1,404,640	-19%	14%	$ 1,133,481	$ 1,596,399
Erosion Control	0.30%			0.30%	$ 153,006	$ 57,690	$ 210,696	-19%	14%	$ 170,022	$ 239,460
Construction Total					$ 67,858,161	$ 25,585,515	$ 93,443,676	-19%	14%	$ 75,404,824	$ 106,200,443
Engineering Items											
Construction Engineering				9%	$ 6,107,234	$ 2,302,696	$ 8,409,931	-19%	14%	$ 6,786,434	$ 9,558,040
Design Costs - Consultant				10%	$ 6,785,816	$ 2,558,552	$ 9,344,368	-19%	14%	$ 7,540,482	$ 10,620,044
Construction Contingency				5%	$ 3,392,908	$ 1,279,276	$ 4,672,184	-19%	14%	$ 3,770,241	$ 5,310,022
Right of Way											
Misc Right-of-Way					$ 500,000		$ 500,000	-25%	50%	$ 375,000	$ 750,000
Business 1					$ 2,000,000		$ 2,000,000	-10%	10%	$ 1,800,000	$ 2,200,000
Business 2					$ 4,000,000		$ 4,000,000	-10%	10%	$ 3,600,000	$ 4,400,000
Warehouse Take North of UPRR and East of I-10					$ 2,000,000		$ 2,000,000	-10%	20%	$ 1,800,000	$ 2,400,000
Project Subtotal					$ 92,644,120	$ 31,726,039	$ 124,370,158	-19%	14%	$ 101,076,981	$ 141,438,550
ICAP ADOT				6.36%	$ 7,745,048		$ 7,745,048				
Airport Indirect				4.50%		$ 1,427,672	$ 1,427,672				
PROJECT TOTAL					**$ 100,400,000**	**$31,700,000**	**$ 132,100,000**	**-23%**	**7%**	**$101,100,000**	**$141,400,000**

Recommendation Total Base Cost	$132,100,000

Alternative 1 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Freeway Operations Fix weave on I-10 between Jefferson and Buckeye Fix weave on I-10 between I-17 and Buckeye Full access to/from Sky Harbor and RCC at Buckeye Simple and Conventional Diamond interchange for driver expectancy for unfamiliar users Single interchange to access airport and RCC from every freeway direction Long Term solution for I-10 access to Sky Harbor and WGTC Removed at grade crossing for airport traffic at light rail crossings	***Rating***	**10**
	Weight	**20.8**
	Contribution	**208**
Airport Operations Operationally provides free-flow east/west on Buckeye Road east of I-10 Long Term solution for I-10 access to Sky Harbor and WGTC Additional access for Freight from I-10 and Buckeye to Sky Harbor Cir to 24th St. Security Check Point to screen Provides full access to/from RCC Meets airport plans for Sky Train to/from RCC Removed at grade crossing for RCC traffic at light rail crossings With RCC bus operations being removed, the need for improving Buckeye/Sky Harbor Cir was not necessary. Direct freeway access to/from the WGTC, indirect access to/from WGTC to airport core May encourage cut through traffic Freight operations on south side will have to use Sky Harbor Circle and Buckeye	***Rating***	**9**
	Weight	**18.0**
	Contribution	**162**
Maintainability Requires additional infrastructure Room to maintain infrastructure	***Rating***	**5**
	Weight	**6.9**
	Contribution	**34.5**
Construction Impacts Phasing and maintenance of traffic Utility Impacts, possibly at 24th Street, but also along the old 24th Street corridor	***Rating***	**5**
	Weight	**5.5**
	Contribution	**27.5**
Environmental Impacts Not residential area	***Rating***	**8**

Alternative 1 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Greyhound station and community tire displacement Change of Access Report, but solution should only improve interstate operations Removed signals - Air quality	***Weight***	**4.1**
	Contribution	**32.8**
Promotes Economic Growth Maintain Washington and Jefferson Access Fully compatible with Spine recommendations Promotes economic and access opportunities on Buckeye and on Sky Harbor Cir. To I-10 Maintain majority of Greyhound Parcel for redevelopment - potentially for WGTC parking expansion over 24th Street. Could hinder future use for existing Gray Hound site Ped/Bike opportunities on 24th Street	***Rating***	**9**
	Weight	**12.5**
	Contribution	**112.5**
Security Security Plaza dual purpose for tolling ITS Camera and communication Room for Photo Enforcement	***Rating***	**9**
	Weight	**19.8**
	Contribution	**178.2**
Local Roadway Operations Maintaining all existing access points except 24th Street access to I-10 via Buckeye Improves Freight access from Buckeye via Sky Harbor Cir/24th St. Indirect access for west Buckeye to 24th Street Provides direct I-10 access to/from WGTC Promotes direct BRT/Bikes/Ped intermodal connection to WGTC With RCC bus operations being removed, the need for improving Buckeye/Sky Harbor Cir was not necessary, but could be improved as needed in the future.	***Rating***	**8**
	Weight	**12.5**
	Contribution	**100**
	Total Performance Score	**855.5**

	Alternative No. 2 Re-route 24th Street to Sky Harbor Circle	Idea #'s 9, 13/15, 27

Recommendation:

The concept provides new access rental car access to I-10 from the terminals, West GTC and rental car center by the realignment of 24th Street with removal of the north-south 24th Street alignment between the Sky Harbor Circle intersections eliminates an at-grade intersection with Buckeye in close proximity to the I-10 ramps. The existing 24th Street alignment would merge onto Sky Harbor Circle on both north and south termini and traffic would continue/reroute on the west side of I-10. In conjunction with higher volumes on Sky Harbor Circle, the intersection with Buckeye will be grade-separated. Local access will be maintained through a "quadrant" or partial clover-leaf intersection with potential access and land development options within the NE and NW quadrants, including new fueling station.

Figure 3: Alternative 2 Concept

Ramps to/from Eastbound I-10 will largely remain in their existing configuration with the EB I-10 off-ramp providing a directional ramp into the airport north of Buckeye Road. A significant improvement will be providing a spur ramp from the existing off-ramp for Westbound Buckeye. This will provide access to the Rental Car center and Buckeye but will be free-flow and not signalized as EB Buckeye is not served. The EB I-10 on-ramp will remain as existing. See Figure 4 below for additional details.

Ramps to/from Westbound I-10 will be significantly improved to better serve airport and local traffic with the addition of a WB I-10 on-ramp for local and Rental Car traffic. The SE quadrant of the interchange will provide a quadrant ramp for WB I-10 off-ramp and WB I-10 on-ramp serving both

	Alternative No. 2 Re-route 24th Street to Sky Harbor Circle	Idea #'s 9, 13/15, 27

airport and Buckeye traffic. The existing directional WB I-10 on-ramp serving the main airport exit will largely remain in the existing configuration. The Westbound I-10 on-ramp at Buckeye and Sky Harbor Blvd will join prior to merging onto WB I-10. Refer to Figures 4 and 5 below.

Buckeye Road will be terminated at the current (but planned to be abandoned) 24th Street alignment. The termination intersection will be signalized and accommodate most turning movements with the intent of moving all traffic to Sky Harbor Boulevard. Please see Figure 5 below for the new Buckeye Road/I-10 access configuration.

Access to/from the West GTC will be managed on the eastside of the facility through a combination of at-grade and grade-separated access points. Inbound traffic will not be stopped and a free-flow ramp will cross over the outbound Sky Harbor Boulevard. Outbound traffic from the WGTC will generally turn left and have access to both directions of I-10, WB Buckeye, or turn back to the airport through the ramp signal. Please see Figure 6 for an illustration of access to/from the West GTC facility.

Total Recommendation Base Cost (see Appendix for cost assumptions and backup) = **$77,513,000**

	Alternative No. 2 Re-route 24th Street to Sky Harbor Circle	Idea #'s 9, 13/15, 27

Advantages:

- Improve I-10 interchanges at Washington and Jefferson St by improving rental car access at Buckeye interchange
- Ramps to/from I-10 maintain existing footprint and location on mainline
- PHX Sky Train alignment remains as planned
- Remove 24th traffic out of a portion of the RPZ; eliminates 24th/Buckeye intersection and related movements
- Develops/creates directional switch of Sky Harbor Boulevard close to I-10 and outside of airport
- Maintains space for future security plaza screening outside of RPZ and Sky Harbor Boulevard, compatible with designed solution for in-flow traffic
- Simplified way finding for vehicles accessing the airport (limited and direct decision points)
- Simplifies rental car customer way finding to/from the rental car facility (all access is from Buckeye Rd)
- Increases development potential for fueling station on NE or NW corner of Sky Harbor Circle and Buckeye Rd (enroute for RCC traffic)
- Limited signals for realigned 24th Street with grade separation at Buckeye (lengthens route but shortens travel time)
- Eliminates weave movements for I-10 RCC traffic with grade separated Sky Harbor Circle
- Removal of 24th Street between Sky Harbor Circle intersections allows expansion of the south portion of the West GTC development
- BRT enhanced from realignment of 24th to Sky Harbor Cir to allow access to RCC/Sky Train
- Includes enhanced bike lane to ensure continuous regional bike flow (via 24th Street/I-10 crossing per Phoenix Bike Plan, Spine Corridor Master Plan Recommendations

Disadvantages:

- Short section of "British" roadway on east side of West GTC (traditional travel directions switched); can be mitigated with curbing
- Longer route for vehicles along 24th Street (mitigated with shorter travel time) for local traffic must use Buckeye to access airport
- No major change to proximity of I-10 Buckeye ramps to the I-17/I-10 Split

Constrains Greyhound property reuse

	Alternative No. 2 Re-route 24th Street to Sky Harbor Circle	Idea #'s 9, 13/15, 27

Discussion/Justification/Sketches/Photos:

Slip ramp from I-10 EB will allow rental car traffic to exit directly to WB Buckeye Road. Customers will stay in the right lane to Sky Harbor Circle (New 24th Street) to access the partial cloverleaf to 24th Street. Vehicles can remain in the right lane all the way to the rental car center eliminating any lane changes or weaving which simplifies decision making. Potential for quadrant intersection instead of cloverleaf.

Figure 4: I-10 EB off-ramp and rental car access

Rental cars accessing I-10 Westbound will be served by a new loop off of Buckeye Road east of I-10. This improves current rental car operations by allowing vehicles to exit the facility along Sky Harbor Blvd. making a right onto Buckeye and a right onto the 1-10 on-ramp (west of I-10 for EB and east of 1-10 for WB).

	Alternative No. 2 Re-route 24th Street to Sky Harbor Circle	Idea #'s 9, 13/15, 27

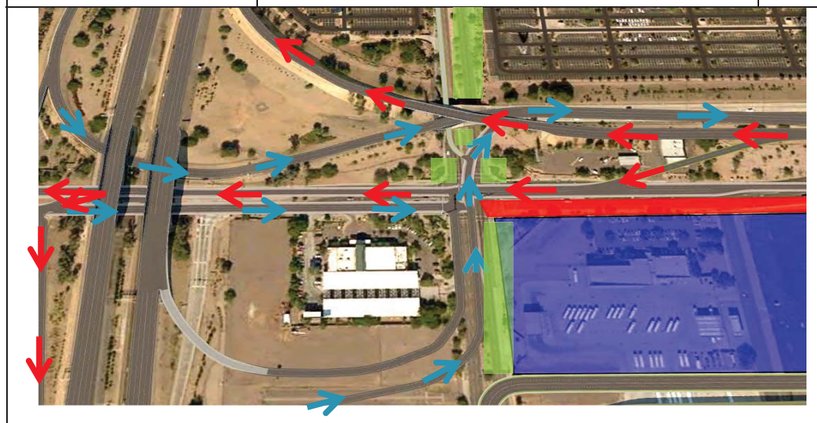


Figure 5: I-10 Access

Simplified way finding with one decision point off I-10 in each direction. Additional decisions are made as drivers access the terminal – first to the West GTC and then to the terminal.

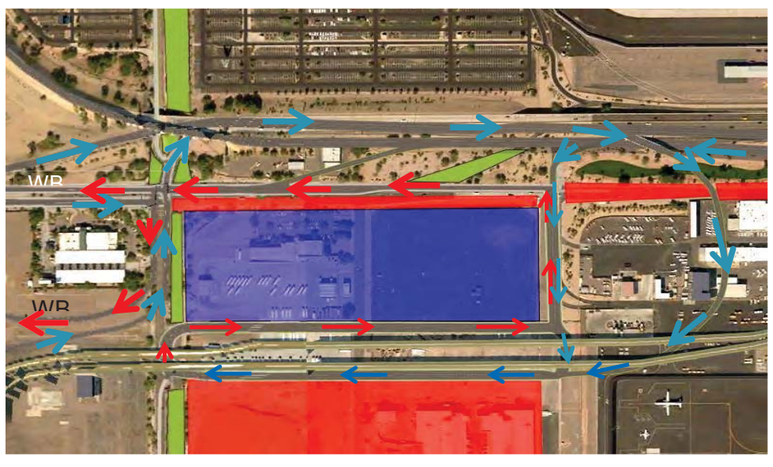


Figure 6: West GTC Access

The GTC access plan as described above.

Alternative 2 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Freeway Operations Relieving traffic at Washington and Jefferson by adding a free flow ramp at Buckeye Remove some of the traffic from Washington and Jefferson Single interchange to access airport and RCC from every freeway direction Maximum utilization of existing infrastructure for I-10 access to Sky Harbor and WGTC By shifting north/south traffic from 24th street to Sky Harbor Circle allows Buckeye to better serve the airport	***Rating***	**6**
	Weight	**20.8**
	Contribution	**124.8**
Airport Operations Provides single decision point east/west on Buckeye Road east of I-10 Long Term solution for I-10 access to Sky Harbor and WGTC Additional access for Freight from I-10 and Buckeye to Sky Harbor Cir to 24th St. Plaza Check Point to screen for security or toll for controlling cut through Provides intuitive access to/from RCC via Sky Harbor Circle Meets airport plans for Sky Train to/from RCC Single decision Point access to/from the WGTC with all right hand turns Freight operations on south side will have to use Sky Harbor Circle removes 24th from RPZ	***Rating***	**9**
	Weight	**18.0**
	Contribution	**162**
Maintainability Minimal additional features to maintain Room to maintain infrastructure with focus on fills and slopes vs. retaining walls	***Rating***	**7**
	Weight	**6.9**
	Contribution	**48.3**
Construction Impacts Phasing for grade separation at Buckeye and Sky Harbor Circle is on critical path Most of new can be built off line	***Rating***	**7**
	Weight	**5.5**
	Contribution	**38.5**
Environmental Impacts No residential area impacts Greyhound station and community tire will be purchased and displaced Should be accomplished with an EA	***Rating***	**8**
	Weight	**4.1**

Alternative 2 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Removed signals which will improve air quality by limiting queue times at signals	***Contribution***	**32.8**
Promotes Economic Growth Limited access Sky Harbor Circle and Buckeye my deter economic growth in the north quadrants Promotes economic and access opportunities on Buckeye and on Sky Harbor Cir Area south of existing Gray Hound site is available for future development	***Rating***	**8**
	Weight	**12.5**
	Contribution	**100**
Security Security Plaza dual purpose for tolling ITS Camera and communication Room for Photo Enforcement	***Rating***	**9**
	Weight	**19.8**
	Contribution	**178.2**
Local Roadway Operations Rerouting 24th Street to Sky Harbor Cir will reduce travel time on 24th by eliminating signals Freight access from continues via Sky Harbor Cir/24th St. Promotes direct BRT/Bikes/Ped intermodal connection to WGTC Rerouting 24th Street to Sky Harbor Cir increase time if destination is Sky train Stakeholder acceptance of rerouting 24th	***Rating***	**6**
	Weight	**12.5**
	Contribution	**75**
	Total Performance Score	**759.6**

Alternative No. 3
Connection and Access Modifications

Recommendation:

Modify I-10 Connections:

1. Eliminate the lane drop (4 lanes to 3 lanes) north of Washington.
2. Add south connector road from Jefferson to Sky Harbor Circle North, continue to new on-ramp to I-10 EB. Eliminate existing Jefferson to I-10 EB on-ramp.
3. Relocate I-10 EB off-ramp to Sky Harbor Boulevard to the north to set up two-lane exit that splits to a new Rental Car Center (RCC) access to Buckeye Road.
4. Eliminate I-10 ramps (entry and exit) at Buckeye Road to the south.
5. Maintain I-17 EB to I-10 WB and maintain connection to Buckeye Road to accommodate airport bound passengers from I-17.
6. Add new off-ramp from I-10 WB to Sky Harbor Circle North and maintain frontage road connector from Sky Harbor Circle North to Jefferson.
7. Remove off-ramp to Jefferson.
8. Maintain existing I-10 EB exit ramp to Sky Harbor Boulevard – split for direct access to West GTC and terminals (with large area reserved for security/toll plaza).
9. Add new direct on-ramps to I-10 WB from Sky Harbor Boulevard WB and West GTC.
10. Change RCC egress to I-10 EB so that it is now direct from 24th St and Sky Harbor Circle.

Add airport West GTC connections/features:

1. Add new direct ramp from Sky Harbor Boulevard WB to I-10 WB.
2. Add new direct ramp from West GTC to I-10 WB that also accommodates RCC traffic.
3. Moved Sky Harbor Boulevard “cross-over” as far west as possible.
4. Created large area for airport security/toll plaza.

Alternative No. 3
Connection and Access Modifications

Advantages:

- Improved RCC ingress and egress
- Direct freeway access to Terminals and West GTC
- Direct freeway access from Terminal to I-10 WB and West GTC
- Realistic phasing that is independent from other airport program items
- Consolidate airport and RCC access (4 ramps into 2)
- Mainline I-10 weaving removed: I-17 to I-10 west weave; SR-51 to airport exit; airport exit to I-10 WB removed weave with Jefferson
- Aux lane from SR-51 to airport (removed pinch point approaching airport exit)
- I-17 access to airport maintained to Buckeye Road via frontage road, to preserve airport access from that important route (I-17)
- I-17 access to WB I-10 maintained
- Local street access to and from airport maintained
- System can be further enhanced with ITS additions both on freeway and within airport
- Large area created on airport for security and toll plaza to address cut-through traffic
- Sky Harbor Boulevard “cross over” moved far west (4,500 feet), freeing up valuable terminal expansion space
- Local street development opportunities and access maintained and enhanced
- Construction impacts are minimal – no I-10 mainline impacts, no Sky Train impacts, no West GTC impacts, new ramps are low impact /offline construction
- Compatible with current program for Taxiways U/V, Sky Train and West Terminal

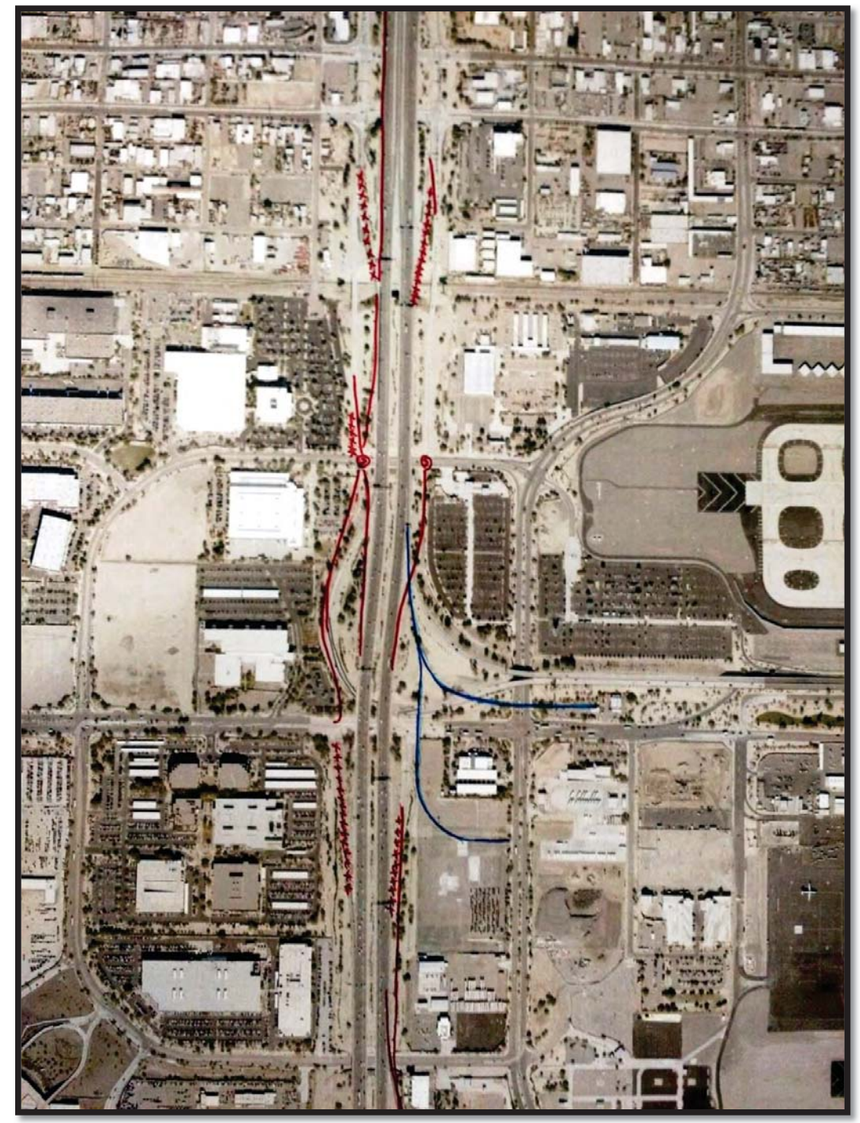
Disadvantages:

- Terminal exit to EB I-10 is slightly longer than current connection; although, this is a low volume movement and the proposed solution will eliminate the current unprotected left turn movement off of Buckeye Road to I-10

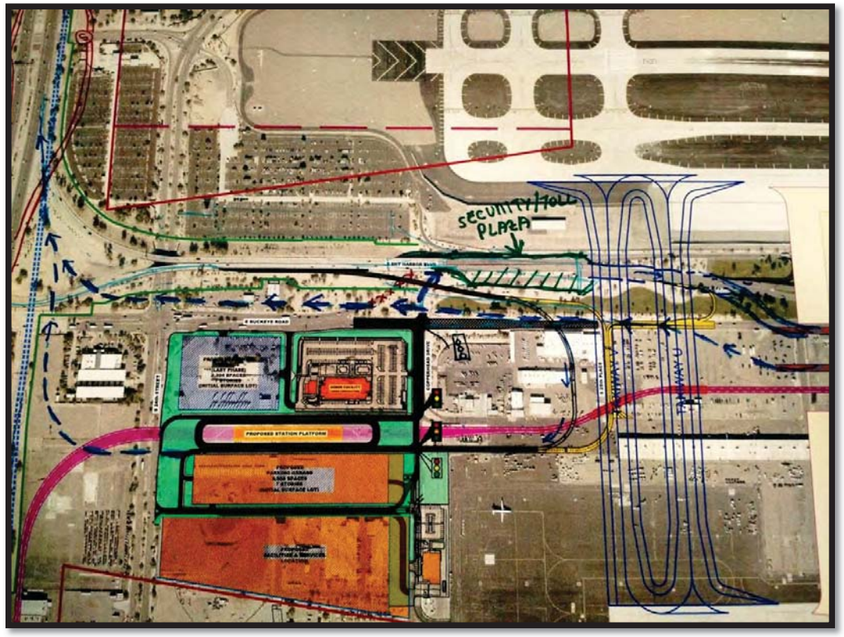
BASE COST SUMMARY	COST
Recommendation	**$66,264,978**

Alternative No. 3
Connection and Access Modifications

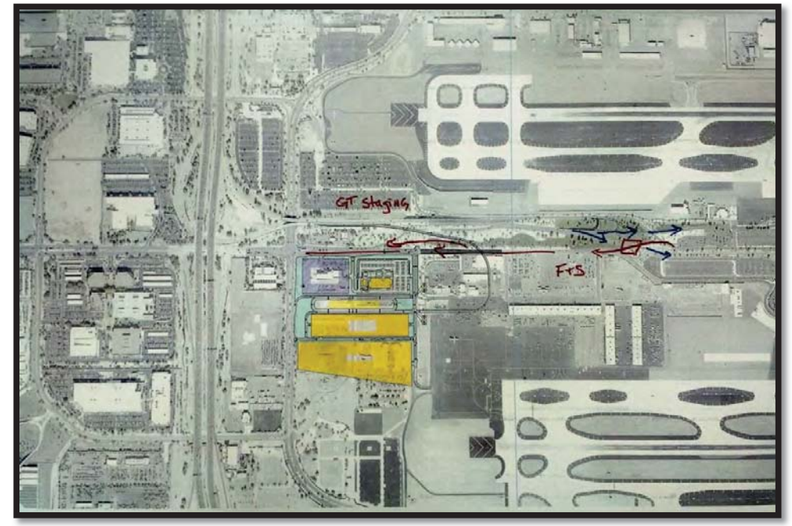
Discussion/Justification/Sketches/Photos:



Alternative No. 3
Connection and Access Modifications



Alternative No. 3
Connection and Access Modifications



Alternative 3 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Freeway Operations Consolidated access may over tax the volumes Improved weaving Maintained important connection to the airport Reduced demand on Washington/Jefferson Off Ramp Eliminated pinch points between SR-51 and Airport Exit Increased capacity by adding an Aux lane Increased transit reliability through improved I-10 EB operations	***Rating***	**7**
	Weight	**20.8**
	Contribution	**145.6**
Airport Operations Increase access to and from the RCC Phasing of the improvements can be independent of the airport projects Direct freeway access to and from the terminals and the GTC (except terminal exit to I-10 EB) Allocated space for toll plaza and security screening area without creating backups to deter cut-through traffic Enhanced development potential along city streets Maintained all local street access to the terminals and the GTC Maintained cargo access Identified GT staging area with improved access to and from terminals Includes one intersections Identified electronic monitoring and tolling to deter cut-through traffic	***Rating***	**9**
	Weight	**18.0**
	Contribution	**162**
Maintainability Improved the ease of access to maintenance vehicles Limited disruptions to airport operations during maintenance activities	***Rating***	**7**
	Weight	**6.9**
	Contribution	**48.3**
Construction Impacts Freeway improvements can be completed independent of airport operations Maintained freeway operations during construction Airport improvements can be completed independent of other airport programs Maintained airport operations during construction	***Rating***	**7**
	Weight	**5.5**
	Contribution	**38.5**

Alternative 3 Performance Evaluation		
PERFORMANCE MEASURES **Attributes and Rating Rationale for Recommendation**	***Performance***	***Alternative***
Environmental Impacts Eliminated the frontage road stop sign approaching Jefferson Avoided the I-10 storm drain tunnel Eliminated circuitous routes in and out of the RCC Minimized ROW requirements	***Rating***	**8**
	Weight	**4.1**
	Contribution	**32.8**
Promotes Economic Growth Local street network optimizes the potential for future development Maintained access to cargo locations Improved access to and from Sky Harbor Circle Accommodated future airport growth Improved access to and from the RCC provides higher customer satisfaction Improved access to existing and future commercial developments	***Rating***	**8**
	Weight	**12.5**
	Contribution	**100**
Security Allocated space for security screening area without creating backups and to deter cut-through traffic Identified electronic monitoring and tolling to deter cut-through traffic Identified security screening location prior to the taxiways Created alternative passenger drop-off and pickup route for heightened security situations Provided flexibility to accommodate changing security mandates	***Rating***	**9**
	Weight	**19.8**
	Contribution	**178.2**
Local Roadway Operations Provided ample opportunities to connect transit to the west GTC Separated airport traffic from local traffic on Sky Harbor Circle at 16th Street Improved access to existing and future commercial developments Better directional access to and from the RCC Keeps 24th at grade through the airport	***Rating***	**8**
	Weight	**12.5**
	Contribution	**100**
	Total Performance Score	**805.4**

Alternative Performance Assessment Summary

After the Value Planning Team developed the alternatives, the performance of each alternative was rated against the others. Changes in performance are always based upon the overall impact to the total project. Once performance and cost data have been developed by the Team, the net change in value of the alternatives can be compared.

The resulting value improvement scores provide a way to assess the potential impact of each alternative on total project value. There is no base concept to compare to as the program is in the planning stages and no initial overall concept has been established. Each attribute was weighted on a scale of 1 to 10 for each alternative with a 1 being poor performance and ten being high performance. These attributes were compared to the current condition, the conditions that will exist after airport projects are complete, and compared to the other alternatives during the assessment.

Table 7: Performance Attribute Ratings

Performance Attribute Ratings				
Attribute	**Attribute Weight**	**Alternative**	**Performance Rating**	**Total Performance**
Freeway Operations	20.8	1	10	208.0
		2	6	124.8
		3	7	145.6
Airport Operations	18.0	1	9	162.0
		2	9	162.0
		3	9	162.0
Maintainability	6.9	1	5	34.5
		2	7	48.3
		3	7	48.3
Construction Impacts	5.5	1	5	27.5
		2	7	38.5
		3	7	38.5
Environmental Impacts	4.1	1	8	32.8
		2	8	32.8
		3	8	32.8
Promotes Economic Growth	12.5	1	9	112.5
		2	8	100.0
		3	8	100.0
Security	19.8	1	9	178.2
		2	9	178.2
		3	9	178.2
Local Roadway Operations	12.5	1	8	100.0
		2	6	75.0
		3	8	100.0

The total performance score for each alternative is divided by the risk adjusted total project cost (Performance ÷ Cost) to compute the value index of each alternative. Table 8 provides a summary of the alternatives generated and their performance, cost, and value index. It can be seen from Table 8 that Alternative 3, the highest value index is the 'winner' of the design competition and provides the best overall value based on the team's performance rating criteria established during the workshop. Please refer to the 'Performance Attribute Criteria Matrix' shown in Table 6 for additional information regarding the ratings of each attribute.

Table 8: List of Alternatives

Alternatives		Performance	Cost (YOE)	Value Index (Performance/Cost)
1	Alternative 1	875	$166.7	5.13
2	Alternative 2	760	$134.0	5.67
3	**Alternative 3**	**805**	**$104.5**	**7.71**

Cost Risk Assessment Results

The results in the table below summarize the 'Cost Risk Assessment' (CRA) analysis of each alternative modeled with their own risks separately. These results were evaluated and the risk adjusted amount at the 70th percentile was used for the cost in the value equation. This approach ultimately determined a 'winner' of the design competition and allowed the team to focus on specific risks that affect each alternative. Table 9 and Table 10 show the modeled cost results and schedule results for each alternative, respectively including escalation and extended overhead costs.

Table 9: Risk Analysis Cost Results

Category	Base Cost (Million $ 2017)	Risk-Adjusted Cost Results
		70th Percentile (Million $ YOE)
Alternative 1	$134.77	$166.7
Alternative 2	$77.51	$134.0
Alternative 3	$66.26	**$104.5**

Table 10: Risk-Adjusted Schedule Results

Category	Base Schedule Date	Project Completion Schedule Date		
		10th Percentile	70th Percentile	90th Percentile
Alternative 1	December 2024	May-2025	Mar-2026	Aug-2026
Alternative 2	July 2024	Jul-2024	Mar-2025	Jul-2025
Alternative 3	January 2024	Jan-2024	Jan-2025	Jul-2025

The risks captured and quantified for each alternative, or the 'Risk Management Plan' is provided in the appendix. Additional information including tornado diagrams and schedule and cost 'S-curves' are provided for decision support, also provided in the appendix.

The management team will refer to this document as design progresses and make continuous updates to the plan based on risk status; either active, inactive or retired. Risks may be added to the plan based on recent developments that occur throughout design. The most important aspect of risk management is to monitor and control the identified risks to ensure the project maintains the proper risk reserve as design progresses. Too much risk reserve may prevent other important projects from moving forward, just as not enough reserve will severely impact the project and may require potential costly or unnecessary steps to secure funding in the future if risks are not managed appropriately.

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Appendix

- Base Cost Preliminary Development
- Program Base Schedule Review
- Alternative Cost Risk Assessment Results
  - Alternative 1 Cost and Schedule 'S-Curves
  - Alternative 1 Cost and Schedule Tornado Diagrams
  - Alternative 2 Cost and Schedule 'S-Curves
  - Alternative 2 Cost and Schedule Tornado Diagrams
  - Alternative 3 Cost and Schedule 'S-Curves
  - Alternative 3 Cost and Schedule Tornado Diagrams
- Alternative Risk Data Sheets
  - Alternative 1 Risk Data Sheets
  - Alternative 2 Risk Data Sheets
  - Alternative 3 Risk Data Sheets
- Value Planning Agenda
- Value Planning Attendees
- Value Planning Report Out
- Value Planning Approach
- Performance Based Results

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MARICOPA ASSOCIATION of GOVERNMENTS

Base Cost Preliminary Development

Item Description	Unit	Recommended I-10 QTY	Buckeye QTY	Unit Cost	I-10 Total	Buckeye Total	Total (Most Likely)	% Under	% Over	$ Under	$ Over
Removals											
Pavement Removal	SY	13,000	15,000	$ 5.00	$ 65,000.00	$ 75,000.00	$ 140,000.00	-25%	25%	$ 105,000	$ 175,000
Earthwork											
General Earthwork	CY	500,000	500,000	$ 7.00	$ 3,500,000.00	$ 3,500,000.00	$ 7,000,000.00	-25%	25%	$ 5,250,000	$ 8,750,000
Base and Surface Treatment											
Concrete Pavement	SY	75,000		$ 45.00	$ 3,375,000.00	$ -	$ 3,375,000.00	-15%	15%	$ 2,868,750	$ 3,881,250
Asphalt Pavement	SY		33,000	$ 35.00		$ 1,155,000.00	$ 1,155,000.00	-10%	10%	$ 1,039,500	$ 1,270,500
Drainage											
On-Site	MILE	1.5	0.5	$500,000	$ 750,000.00	$ 250,000.00	$ 1,000,000.00	-10%	30%	$ 900,000	$ 1,300,000
Off-Site	LS	1000000	500000	$1	$ 1,000,000.00	$ 500,000.00	$ 1,500,000.00	-25%	20%	$ 1,125,000	$ 1,800,000
Pump Station	EACH	0	1	$2,000,000	$ -	$ 2,000,000.00	$ 2,000,000.00	-10%	10%	$ 1,800,000	$ 2,200,000
Structures											
Walls	SF	215,000	100,000	$ 65.00	$ 13,975,000.00	$ 6,500,000.00	$ 20,475,000.00	-30%	10%	$ 14,332,500	$ 22,522,500
Flyover	SF	61,000		$ 165.00	$ 10,065,000.00		$ 10,065,000.00	-10%	10%	$ 9,058,500	$ 11,071,500
Single Level (AASHTO)	SF	122,000	34,000	$ 125.00	$ 15,250,000.00	$ 4,250,000.00	$ 19,500,000.00	-15%	15%	$ 16,575,000	$ 22,425,000
Widening Bridge	SF	1,200		$ 185.00	$ 222,000.00		$ 222,000.00	-10%	10%	$ 199,800	$ 244,200
Traffic Engineering											
Ramp TI Signals	EA	3	1	$ 200,000.00	$ 600,000.00	$ 200,000.00	$ 800,000.00	-10%	10%	$ 720,000	$ 880,000
Pavement Marking & Signing	MILE	3	1	$ 150,000.00	$ 450,000.00	$ 150,000.00	$ 600,000.00	-10%	10%	$ 540,000	$ 660,000
Lighting	MILE	3	1	$ 350,000.00	$ 1,050,000.00	$ 350,000.00	$ 1,400,000.00	-10%	10%	$ 1,260,000	$ 1,540,000
ITS (Reconstruction & New)	LS	70%	30%	$ 1,000,000.00	$ 700,000.00	$ 300,000.00	$ 1,000,000.00	-10%	10%	$ 900,000	$ 1,100,000
Item Subtotal					$ 51,002,000.00	$ 19,230,000.00	$ 70,232,000.00	-19%	14%	$ 56,674,050	$ 79,919,950
Misc Item Allowance (10%)				10%	$ 5,100,200.00	$ 1,923,000.00	$ 7,023,200.00	-19%	14%	$ 5,667,405	$ 7,991,995
Traffic Control (10%)				10%	$ 5,100,200.00	$ 1,923,000.00	$ 7,023,200.00	-19%	14%	$ 5,667,405	$ 7,991,995
Mobilization				8%	$ 4,080,160.00	$ 1,538,400.00	$ 5,618,560.00	-19%	14%	$ 4,533,924	$ 6,385,596
Dust and Water Palliative	0.75%			0.75%	$ 382,515.00	$ 144,225.00	$ 526,740.00	-19%	14%	$ 425,055	$ 598,650
Contractor Quality Control	2.00%			2%	$ 1,020,040.00	$ 384,600.00	$ 1,404,640.00	-19%	14%	$ 1,133,481	$ 1,596,399
Contractor Surveying	2.00%			2%	$ 1,020,040.00	$ 384,600.00	$ 1,404,640.00	-19%	14%	$ 1,133,481	$ 1,596,399
Erosion Control	0.30%			0.30%	$ 153,006.00	$ 57,690.00	$ 210,696.00	-19%	14%	$ 170,022	$ 239,460
Construction Total					$ 67,858,161.00	$ 25,585,515.00	$ 93,443,676.00	-19%	14%	$ 75,404,824	$ 106,200,443
Engineering Items											
Construction Engineering				9%	$ 6,107,234.49	$ 2,302,696.35	$ 8,409,930.84	-19%	14%	$ 6,786,434	$ 9,558,040
Design Costs - Consultant				10%	$ 6,785,816.10	$ 2,558,551.50	$ 9,344,367.60	-19%	14%	$ 7,540,482	$ 10,620,044
Construction Contingency				5%	$ 3,392,908.05	$ 1,279,275.75	$ 4,672,183.80	-19%	14%	$ 3,770,241	$ 5,310,022
Right of Way											
Misc Right-of-Way					$ 500,000.00		$ 500,000.00	-25%	50%	$ 375,000	$ 750,000
Community Tire Relocate					$ 2,000,000.00		$ 2,000,000.00	-10%	10%	$ 1,800,000	$ 2,200,000
Greyhound Relocate					$ 4,000,000.00		$ 4,000,000.00	-10%	10%	$ 3,600,000	$ 4,400,000
Warehouse Take North of UPRR and East of I-10					$ 2,000,000.00		$ 2,000,000.00	-10%	20%	$ 1,800,000	$ 2,400,000
Project Subtotal					$ 92,644,119.64	$ 31,726,038.60	$ 124,370,158.24	-19%	14%	$ 101,076,981	$ 141,438,550
ICAP ADOT				8.36%	$ 7,745,048.40		$ 7,745,048.40				
Airport Indirect				4.50%		$ 1,427,671.74	$ 1,427,671.74				
PROJECT TOTAL					**$ 100,389,168.04**	**$ 31,726,038.60**	**$ 133,542,878.38**	-24%	6%	**$ 101,076,981.17**	**$ 141,438,549.91**

Figure 7: Alternative 1 Base Estimate

MARICOPA ASSOCIATION of GOVERNMENTS

Item	Unit	USE	West of I-10	Cost		East of I-10	Base Cost			
Earthwork					$633,348.00					$3,391,288.00
Clearing and Removals	LS	$30,000			Minor pavement removal	LS	$80,000			Demo Greyhound
Roadway Excavation	CY	$7.00	2700	$18,900.00		CY	$7.00	223000	$1,561,000.00	
Drainage Excavation	CY			$0.00		CY			$0.00	
Borrow	CY	$8.00	75300	$602,400.00		CY	$8.00	224300	$1,794,400.00	
Furnish Water	2%		$12,048.00	$12,048.00		2%		$35,888.00	$35,888.00	
Base and Surface Treatment					$630,000.00					$1,736,000.00
Concrete Pavement	SY	$45		$0.00		SY	$45		$0.00	
Asphalt Pavement	SY	$35	18000	$630,000.00		SY	$35	49600	$1,736,000.00	
				$0.00					$0.00	
Drainage					$500,000.00					$650,000.00
On-Site	MILE	$500,000	1	$500,000.00		MILE	$500,000	1.3	$650,000.00	
Off-Site	LS			$0.00		LS			$0.00	
Pump Station	EACH	$1,000,000		$0.00		EACH	$1,000,000		$0.00	
Other	LS			$0.00		LS			$0.00	
Structures					$1,375,000.00					$5,683,800.00
Single level AASHOT	SF	$125	11000	$1,375,000.00		SF	$125	1500	$187,500.00	
Flyover	SF	$165		$0.00		SF	$165		$0.00	
Widening	SF	$185		$0.00		SF	$185	7680	$1,420,800.00	
Retaining Walls	SF	$65		$0.00		SF	$65	62700	$4,075,500.00	
Sound Walls	SF	$35		$0.00		SF	$35		$0.00	
Traffic Engineering					$386,493.64					$2,018,704.39
Traffic Control	10%		$1,251,300.00	$125,130.00		10%		$5,091,400.00	$509,140.00	
Signing and Pavement Marking	MILE	$150,000	0.435606061	$65,340.91		MILE	$150,000	2.819128788	$422,869.32	
Lighting	MILE	$350,000	0.435606061	$152,462.12		MILE	$350,000	2.819128788	$986,695.08	
Signal (per interchange or intersection)	EACH	$100,000		$0.00		EACH	$100,000	1	$100,000.00	
FMS	MILE	$100,000	0.435606061	$43,560.61		MILE	$100,000	0	$0.00	
Roadside Development					$63,190.65					$0.00
Topsoil	MILE			$0.00		MILE			$0.00	
Landscaping	MILE			$0.00		MILE			$0.00	
Utilities local street	MILE			$0.00		MILE			$0.00	
	MILE			$0.00		MILE			$0.00	
Dust and Water Palliative	0.75%		$1,251,300.00	$9,384.75		0.75%		$5,091,400.00	$38,185.50	
Contractor Quality Control	2.00%		$1,251,300.00	$25,026.00		2.00%		$5,091,400.00	$101,828.00	
Contractor Surveying	2.00%		$1,251,300.00	$25,026.00		2.00%		$5,091,400.00	$101,828.00	
Erosion Control	0.30%		$1,251,300.00	$3,753.90		0.30%		$5,091,400.00	$15,274.20	
Subtotal A					$3,588,032.29					$13,479,792.39
Miscellaneous Item Allowance	10.0%			$358,803.23		10.0%			$1,347,979.24	
Subtotal B					$3,946,835.52					$14,827,771.63
Mobilization	8%			$315,746.84		8%			$1,186,221.73	
Contract Total					$11,122,900.09					$41,787,356.42
Engineering & Contingency										
Construction Engineering	9%			$1,001,061.01		9%			$3,760,862.08	
Design Costs - Consultant	10.0%			$1,112,290.01		10.0%			$4,178,735.64	$5,291,025.65 Design
Construction Contingency	5%			$0.00		5%			$0.00	
Subtotal					$2,113,351.02					$7,939,597.72
Non-Bid Project Costs										
DPS Traffic Control				$0.00					$0.00	
Prior Right Utility Relocations & Service				$0.00		Tire shop and Greyhound			$6,000,000.00	
PCCP Quality Incentive	SY	$1.5	1500	$2,250.00		SY	$1.5	1500	$2,250.00	
AR-ACFC Smoothness Incentive	MILE	$11,000	0.12109091	$1,354.17		MILE	$11,000	0.12109091	$1,354.17	
Right-of-Way other	SF	$4	21300	$85,200.00		SF	$4	342000	$1,368,000.00	$7,453,200.00 ROW Grey Hound relo, tire center
Subtotal					$88,804.17					$7,371,604.17
Indirect Cost Allocation (ICAP)	8.36%			$1,113,974.62	$1,113,974.62	8.36%			$4,773,439.47	$4,773,439.47
Roadway Project Total					$14,439,029.89					$61,871,997.78
Add or credit for Sky Harbor BVD east of 27th										$63,566,802.02 Construction
Grand Total										$76,311,027.67 $76,311,027.67 TRUE

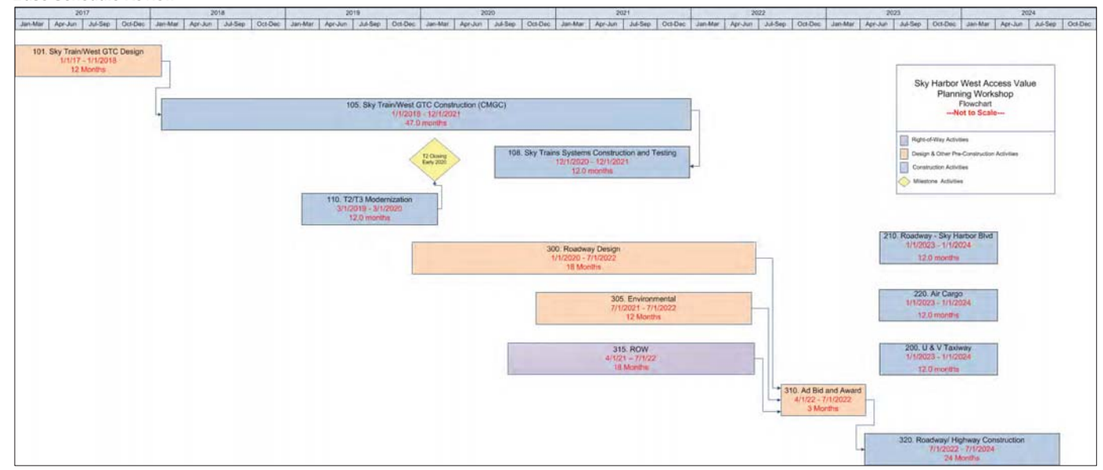
	Low	Most Likely	High
Roadway Design	$ 4,727,151.52	$ 5,561,354.73	$ 6,395,557.94
Environmental	$ 134,921.23	$ 158,730.85	$ 182,540.48
Right of Way	$ 6,864,844.39	$ 8,076,287.52	$ 9,287,730.65
Ad-Bid-Award	$ 125,000.00	$ 150,000.00	$ 175,000.00
Roadway/Highway Construction	$ 53,906,781.72	$ 63,566,802.02	$ 73,101,522.33

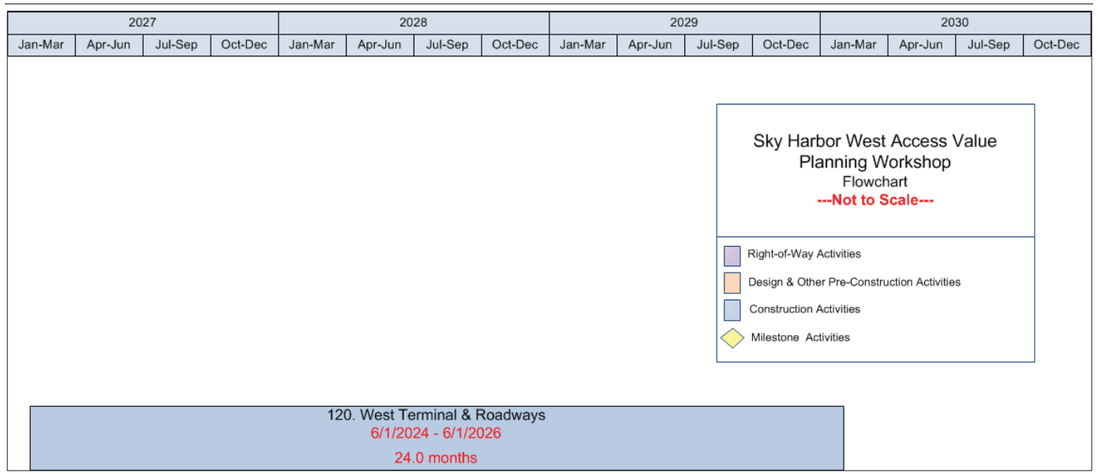
Figure 8: Alternative 2 Base Estimate

			Freeway		Airport Cost			
Item	Unit	Unit	Quantity	Estimate	Quantity	Estimate		Airport Notes
Earthwork								
Clearing and Removals (include 4 ramps removal)	LS	$1,500,000	1	$1,500,000	1	$500,000		Remove EB ramp into airport
Roadway Excavation	CY	$7.00	2051.9	$14,363				
Drainage Excavation	CY			$0				
Borrow	CY	$8.00	43766.7	$350,133	150,000	$1,200,000		Fill for new GTC and terminal ramps to I-10
Furnish Water	2%			$200,000		$34,000		
Base and Surface Treatment								
Concrete Pavement	SY	$45	19,567	$880,500	53,333	$2,400,000		12,000 ft new ramps by 40 ft avg width
Asphalt Pavement	SY	$35						
Drainage								
On-Site	MILE	$500,000	1.5	$750,000	2.5	$1,250,000		2.5 miles new roads
Off-Site	LS							
Pump Station	EACH	$2,000,000	1	$2,000,000				
Other	LS							
Structures								
Single level AASHOT	SF	$125	16800	$2,100,000	48000	$6,000,000		1,200 LF new bridge, 40 feet wide (over buckeye, 24th and Copperhead
Flyover	SF	$165		$0				
Widening	SF	$185	10960	$1,963,400				
Retaining Walls	SF	$65	15000	$975,000	40000	$2,600,000		At bridges and new ramps, say 2000 LF by 20 ft avg height
Sound Walls	SF	$35		$0				
Traffic Engineering								
Traffic Control	10%			$900,000		$1,398,400		
Signing and Pavement Marking	MILE	$150,000	1.5	$225,000	2.5	$375,000		
Lighting	MILE	$350,000	1.5	$525,000	2.5	$875,000		
Signal (per interchange or intersection)	EACH	$200,000	2	$400,000	2	$400,000		
TMS	MILE	$100,000	1.5	$150,000	2.5	$250,000		
Roadside Development								
Topsoil	MILE			$0				
Landscaping	MILE	$200,000	1.5	$300,000	2.5	$500,000		
Utilities local street	MILE	$500,000		$0	2	$1,000,000		Misc Improvements
Security plaza	MILE					$2,000,000		
				$13,273,596		**$20,782,400**		
Dust and Water Palliative	0.75%			$99,55		$155,868		
Contractor Quality Control	2.00%			$265,47		$375,646		
Contractor Surveying	2.00%			$265,47		$375,646		
Erosion Control	0.30%			$39,82		$56,347		
Subtotal A				**$13,943,912**		**$21,745,911**		
Miscellaneous Item Allowance	20.0%			$2,788,780		$4,349,182.24		
Subtotal B				**$16,732,695**		**$26,095,093**		
Mobilization	8%			$1,338,615.64		$2,087,607.48		
Contract Total				**$18,071,311**		**$28,182,701**		
Engineering & Contingency								
Construction Engineering	9%			$1,626,418.08		$2,536,443.09		
Design Costs - Consultant	10.0%			$1,807,131		$2,818,270.08	$4,625,401.20	
Construction Contingency	5%			$903,565.54		$1,409,135.05		
Subtotal				**$22,408,426**		**$34,946,549**		
Non-Bid Project Costs								
DPS Traffic Control								
Prior Right Utility Relocations & Service	L Sum	$1,000,000	1	$1,000,000				
PCCP Quality Incentive	SY	$1.5	19566.7	$29,350				
AR ACFC Smoothness Incentive	MILE	$11,000	1	$11,000				
Right-of-Way	SF	$4	25000	$100,000			$2,100,000	
ROW Tax	LS			$2,000,000				
				$26,548,776.86		**$34,946,549**		
Indirect Cost Allocation (ICAP)	8.36%			$2,195,877.68		$2,921,331.51		
Roadway Project Total				**$27,684,653.48**		**$37,868,080.64**	**$58,827,332.90**	
					Grand Total =	**$65,552,734.10**	**$65,552,734.10**	
							TRUE	
					-10%		10%	
				Roadway Design	$ 4,375,549.98	$ 4,861,722.20	$ 5,590,980.33	
				Environmental	$ 135,328.29	$ 150,362.54	$ 172,916.92	
				Right of Way	$ 2,045,004.00	$ 2,273,560.00	$ 2,616,594.00	
				Ad Bid Award	$ 135,000.00	$ 150,000.00	$ 175,000.00	
				Roadway/Highway Construction	$ 52,984,599.63	$ 58,827,332.90	$ 67,651,432.83	

Figure 9: Alternative 3 Base Estimate

Base Schedule Review





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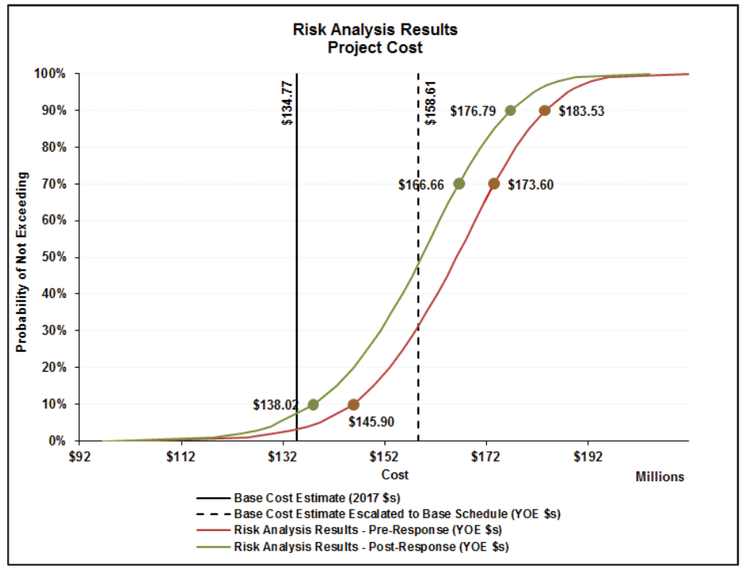
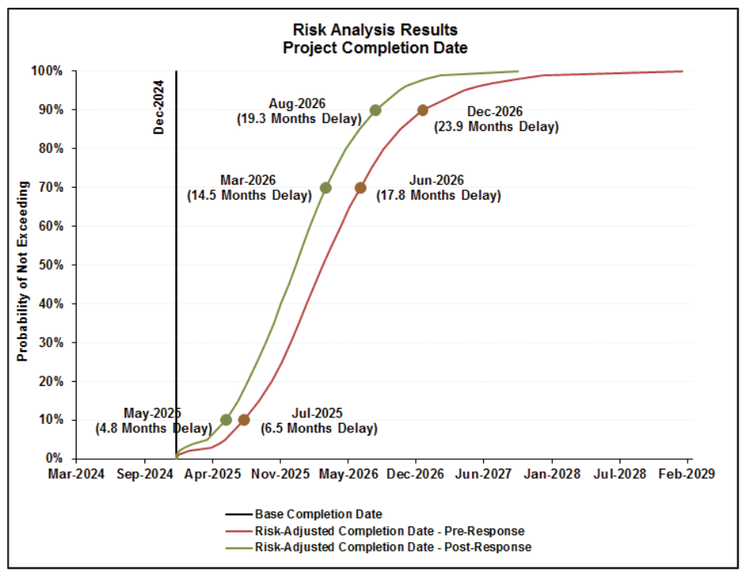
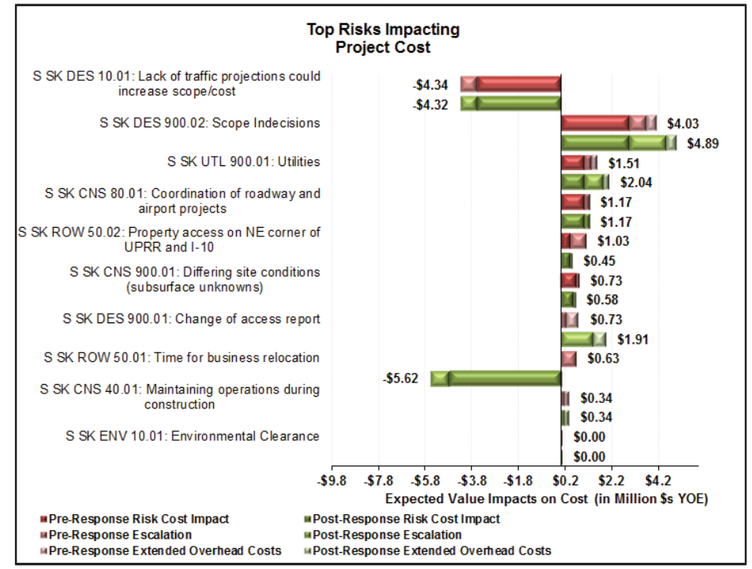
Alternative Cost Risk Assessment Results

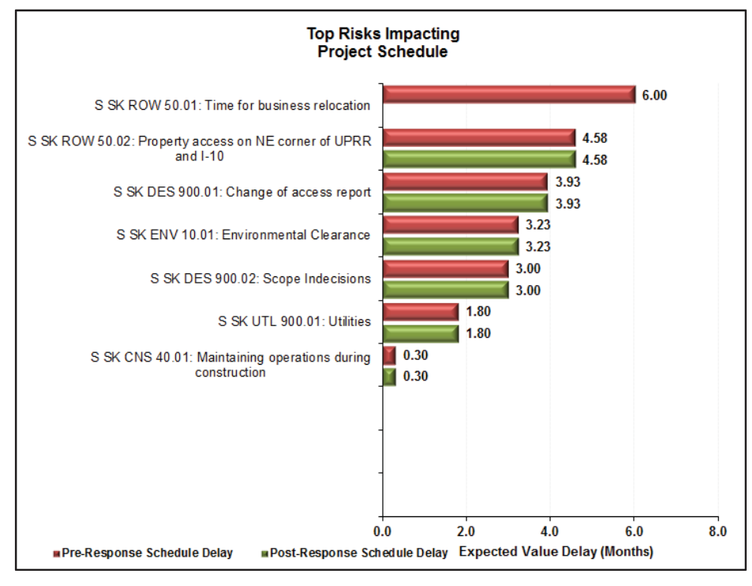
Alternative 1 – Cost & Schedule 'S-Curve'



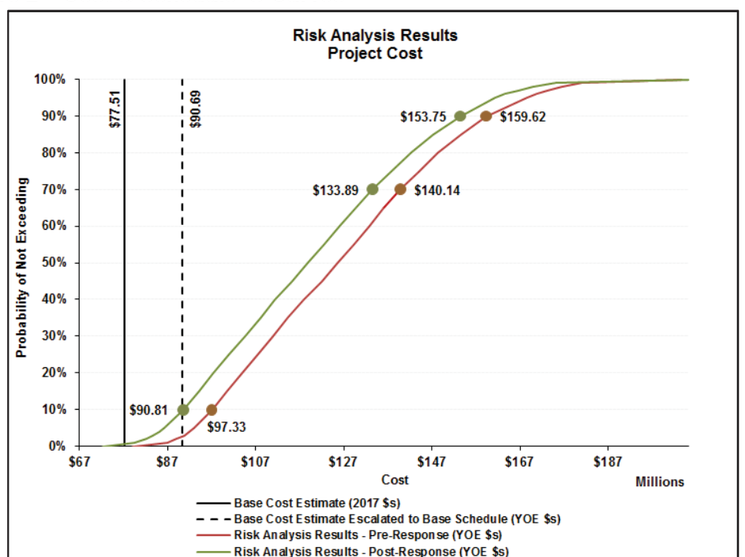


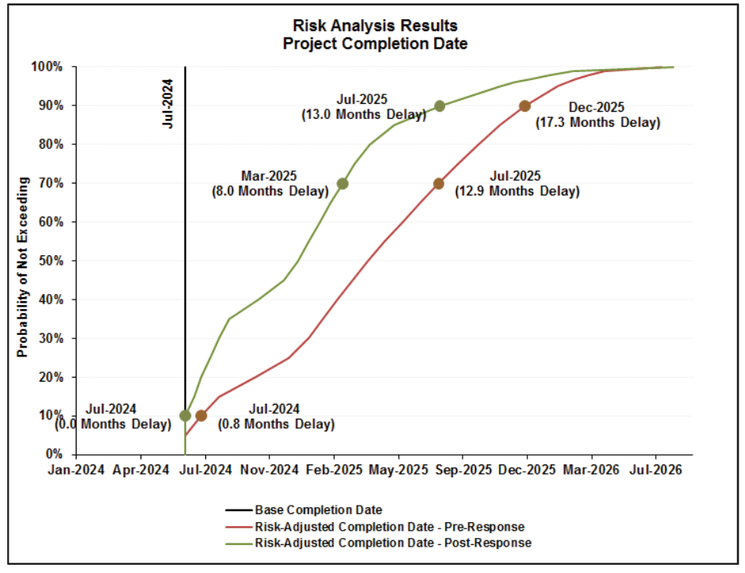
Alternative 1 – Cost & Schedule Tornado Diagrams



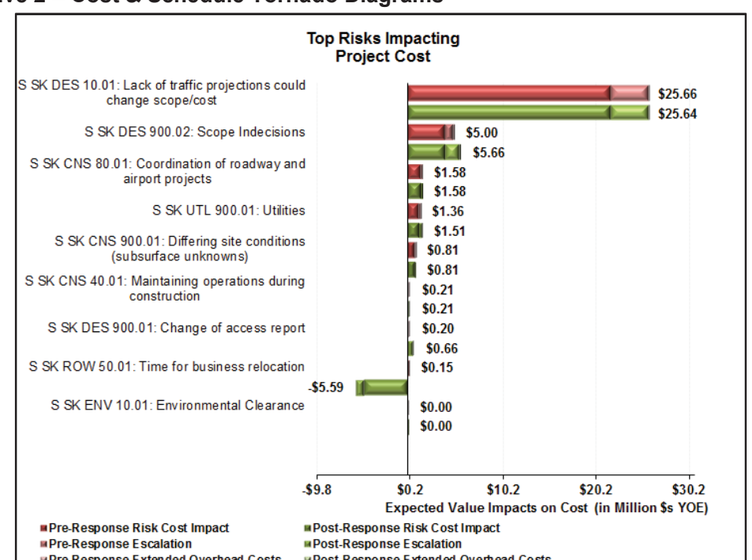


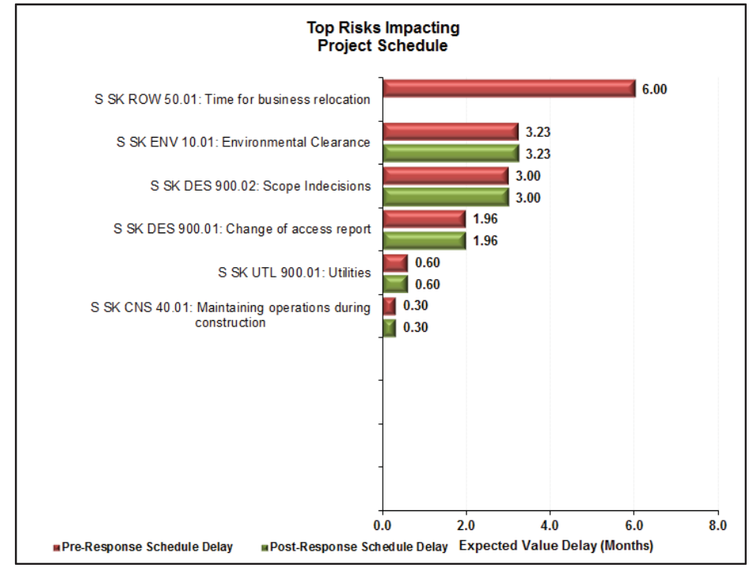
Alternative 2 – Cost & Schedule 'S-Curves'



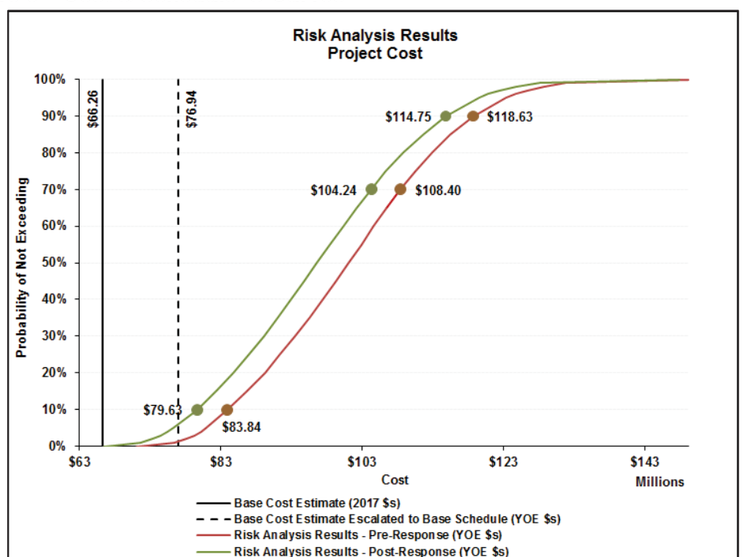


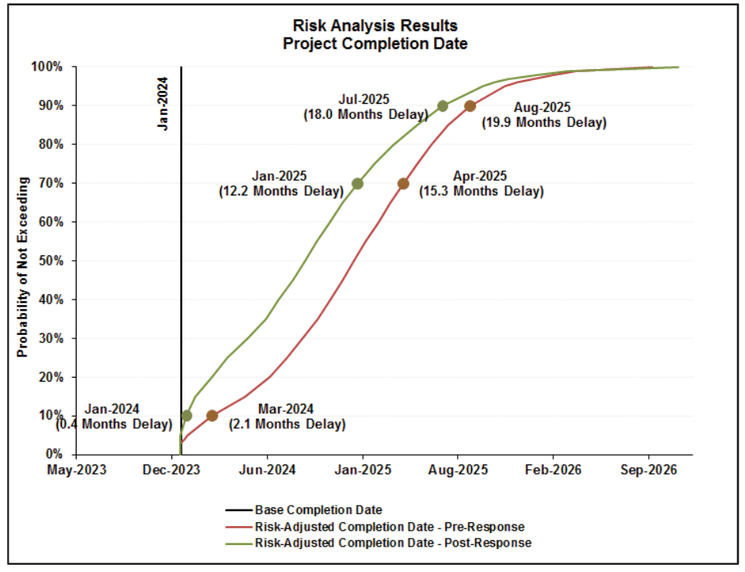
Alternative 2 – Cost & Schedule Tornado Diagrams



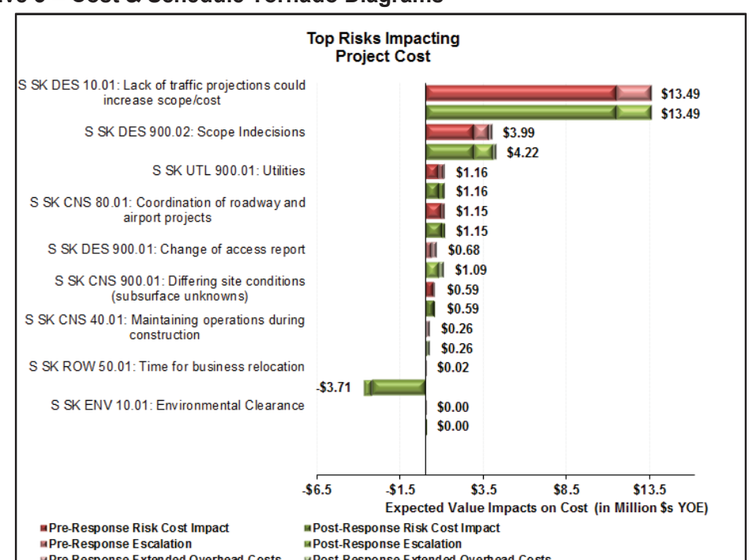


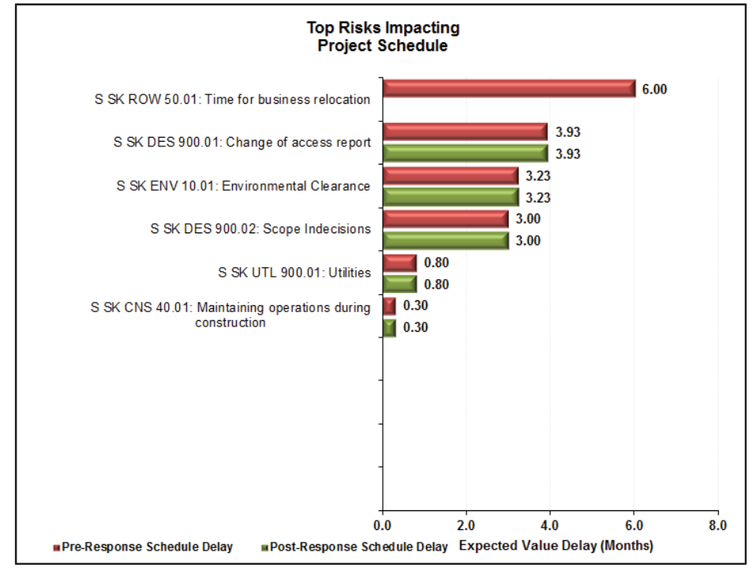
Alternative 3 – Cost & Schedule 'S-Curves'





Alternative 3 – Cost & Schedule Tornado Diagrams





Risk Data Sheets

Alternative 1 Risk Data Sheets

Project	Sky Harbor Airport	Risk ID	S SK ROW 50.01
Sub-Project	Sky Harbor	Status	Active

Time for business relocation

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	6.00	12.00	18.00	6.00			

Greyhound and Community Tire have to be relocated. They are both on airport property. However, the acquisition could be longer than the allocated time delaying the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$6.00	-$6.00	-$6.00	-$4.80	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

In the lease agreements, specify the time the businesses need to be relocated. Base schedule has advertisement date of 4/1/2022. This will avoid the schedule delay and could save the project $6 million.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

July 5, 2017 Risk Register Page 1 of 10

Project	Sky Harbor Airport	Risk ID	S SK DES 10.01
Sub-Project	Sky Harbor	Status	Active

Lack of traffic projections could increase scope/cost

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	-$25.00	-$10.00	-$5.00	-$2.92	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

At the planning level, traffic analysis has not been started. Upon further analysis, additional infrastructure may be required to mitigate this issue. This could be an opportunity for Alt-1. One example is revising access or not requiring all the braided ramps

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	-$25.00	-$10.00	-$5.00	-$2.92	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Advance the project and make necessary decisions.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

July 5, 2017 Risk Register Page 2 of 10

Project	Sky Harbor Airport	**Risk ID**	S SK ENV 10.01
Sub-Project	Sky Harbor	**Status**	Active

Environmental Clearance

Risk Trigger		**Flowchart Activity**	305
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00			

Obtaining environmental clearance and who is the lead fed agency. Base schedule assumes 12 months. Savings could be a lower level clearance document will be required. Delay could be a higher level document will be required.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00	Accept	

Advance the design and update the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	**Risk ID**	S SK DES 900.01
Sub-Project	Sky Harbor	**Status**	Active

Change of access report

Risk Trigger		**Flowchart Activity**	300
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	3.00	9.00	12.00	4.25			

Change of Access report for I-10 would require FHWA HQ approval. There is only 9 months for the approval process in the 18-month design schedule. FHWA requires 3 months for review and approval. The risk is submitting at 50% design.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	3.00	9.00	12.00	4.25	Mitigate	

FHWA can give DEOA (determination of engineering operational acceptability) prior to NEPA approval.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK CNS 900.01
Sub-Project	Sky Harbor	Status	Active

Differing site conditions (subsurface unknowns)

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$2.00	$0.54	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

5% for change order contingency has remained in the base cost. This risk is on and above that due to no geotechnical information and potential hazardous materials / contaminated soils.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
40%						
Cost ($M)	$0.50	$1.00	$2.00	$0.43	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Conduct geotechnical investigations and site studies.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

MARICOPA ASSOCIATION of GOVERNMENTS

Project	Sky Harbor Airport	Risk ID	S SK UTL 900.01
Sub-Project	Sky Harbor	Status	Active

Utilities

Risk Trigger		Flowchart Activity	cost to 320; schedule to 300

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
40%							
Cost ($M)	$1.00	$2.00	$4.00	$0.87	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	3.00	4.50	6.00	1.80			

No utility investigations have been made and there is no allowance in the current base cost for utilities. Roadway relocation and excavation can have utility impacts. This risk includes building bridges over railroad.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
40%						
Cost ($M)	$1.00	$2.00	$4.00	$0.87	Strategy	6/29/2017
Schedule (Mo)	3.00	4.50	6.00	1.80	Mitigate	

Conduct SUE and update the estimate.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	**Risk ID**	S SK CNS 80.01
Sub-Project	Sky Harbor	**Status**	Active

Coordination of roadway and airport projects

Risk Trigger		**Flowchart Activity**	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.50	$1.00	$2.00	$0.87	**Project Rank Cost**	**Project Rank Schedule**	2/16/2017
Schedule (Mo)				0.00			

In order to make temporary connections with other planned projects, there maybe requirements for temporary infrastructure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.50	$1.00	$2.00	$0.87	**Strategy**	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate roadway and airport projects; consider phasing of projects to minimize impacts.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	**Risk ID**	S SK DES 900.02
Sub-Project	Sky Harbor	**Status**	Active

Scope Indecisions

Risk Trigger		**Flowchart Activity**	Schedule 300; cost 320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$1.00	$5.00	$10.00	$2.58	**Project Rank Cost**	**Project Rank Schedule**	2/16/2017
Schedule (Mo)	4.00	6.00	8.00	3.00			

Separating needs and wants, and building consensus on the scope could result in delays to design and added infrastructure. Some scope creep items such as pavement overlay, structure rehabs, sign rehabs, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$1.00	$5.00	$10.00	$2.58	**Strategy**	6/29/2017
Schedule (Mo)	4.00	6.00	8.00	3.00	Mitigate	

Early and continued coordination with stakeholders.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK CNS 40.01
Sub-Project	Sky Harbor	Status	Active

Maintaining operations during construction

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	0.25	0.50	1.00	0.27			

There maybe temporary moratoriums on impacts on traffic during holidays that could delay the construction activities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	0.25	0.50	1.00	0.27	Mitigate	

Develop MOT plans and update the schedule.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

MARICOPA ASSOCIATION of GOVERNMENTS

Project	Sky Harbor Airport	Risk ID	S SK ROW 50.02
Sub-Project	Sky Harbor	Status	Active

Property access on NE corner of UPRR and I-10

Risk Trigger		Flowchart Activity	310

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.40	$0.80	$1.00	$0.38	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	1.00	4.00	18.00	2.92			

Scenario 1 has an impact to a trucking warehouse (the property on the NE corner of UPRR and I-10). Base assumes $2 million. This could have a cost and schedule delay for relocation. Hold a 40% contingency for administrative settlement and relocation.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.40	$0.80	$1.00	$0.38	Strategy	6/29/2017
Schedule (Mo)	1.00	4.00	18.00	2.92	Mitigate	

Start early coordination; update estimate accordingly.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Alternative 2 Risk Data Sheets

Project	Sky Harbor Airport	Risk ID	S SK ROW 50.01
Sub-Project	Sky Harbor	Status	Active

Time for business relocation

Risk Trigger		Flowchart Activity	310
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	6.00	12.00	18.00	6.00			

Greyhound and Community Tire have to be relocated. They are both on airport property. However, the acquisition could be longer than the allocated time delaying the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$6.00	-$6.00	-$6.00	-$4.80	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

In the lease agreements, specify the time the businesses need to be relocated. Base schedule has advertisement date of 4/1/2022. This will avoid the schedule delay and could save the project $6 million.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

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Project	Sky Harbor Airport	Risk ID	S SK DES 10.01
Sub-Project	Sky Harbor	Status	Active

Lack of traffic projections could change scope/cost

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$5.00	$25.00	$50.00	$19.38	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

At the planning level, traffic analysis has not been started. Upon further analysis, additional infrastructure may be required to mitigate this issue. One example is revising access or requiring braided ramps.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$5.00	$25.00	$50.00	$19.38	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Advance the project and make necessary decisions.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

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Project	Sky Harbor Airport	Risk ID	S SK ENV 10.01
Sub-Project	Sky Harbor	Status	Active

Environmental Clearance

Risk Trigger		Flowchart Activity	305

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00			

Obtaining environmental clearance and who is the lead fed agency. Base schedule assumes 12 months. Savings could be a lower level clearance document will be required. Delay could be a higher level document will be required.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00	Accept	

Advance the design and update the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK DES 900.01
Sub-Project	Sky Harbor	Status	Active

Change of access report

Risk Trigger		Flowchart Activity	300

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	3.00	9.00	12.00	2.13			

Change of Access report for I-10 would require FHWA HQ approval. There is only 9 months for the approval process in the 18-month design schedule. FHWA requires 3 months for review and approval. The risk is submitting at 50% design.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	3.00	9.00	12.00	2.13	Mitigate	

FHWA can give DEOA (determination of engineering operational acceptability) prior to NEPA approval.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK CNS 900.01
Sub-Project	Sky Harbor	Status	Active

Differing site conditions (subsurface unknowns)

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

5% for change order contingency has remained in the base cost. This risk is on and above that due to no geotechnical information and potential hazardous materials / contaminated soils.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Conduct geotechnical investigations and site studies.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK UTL 900.01
Sub-Project	Sky Harbor	Status	Active

Utilities

Risk Trigger		Flowchart Activity	cost to 320; schedule to 300

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
40%							
Cost ($M)	$1.00	$2.00	$3.00	$0.80	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	1.00	1.50	2.00	0.60			

No utility investigations have been made and there is no allowance in the current base cost for utilities. Roadway relocation and excavation can have utility impacts.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
40%						
Cost ($M)	$1.00	$2.00	$3.00	$0.80	Strategy	6/29/2017
Schedule (Mo)	1.00	1.50	2.00	0.60	Mitigate	

Conduct SUE and update the estimate.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	**Risk ID**	S SK CNS 80.01
Sub-Project	Sky Harbor	**Status**	Active

Coordination of roadway and airport projects

Risk Trigger		**Flowchart Activity**	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.50	$1.00	$2.00	$0.87	**Project Rank Cost**	**Project Rank Schedule**	2/16/2017
Schedule (Mo)				0.00			

In order to make temporary connections with other planned projects, there maybe requirements for temporary infrastructure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.50	$1.00	$2.00	$0.87	**Strategy**	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate roadway and airport projects; consider phasing of projects to minimize impacts.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	**Risk ID**	S SK DES 900.02
Sub-Project	Sky Harbor	**Status**	Active

Scope Indecisions

Risk Trigger		**Flowchart Activity**	Schedule 300; cost 320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$1.00	$5.00	$10.00	$2.58	**Project Rank Cost**	**Project Rank Schedule**	2/16/2017
Schedule (Mo)	4.00	6.00	8.00	3.00			

Separating needs and wants, and building consensus on the scope could result in delays to design and added infrastructure. Some scope creep items such as pavement overlay, structure rehabs, sign rehabs, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$1.00	$5.00	$10.00	$2.58	**Strategy**	6/29/2017
Schedule (Mo)	4.00	6.00	8.00	3.00	Mitigate	

Early and continued coordination with stakeholders.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK CNS 40.01
Sub-Project	Sky Harbor	Status	Active

Maintaining operations during construction

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	0.25	0.50	1.00	0.27			

There maybe temporary moratoriums on impacts on traffic during holidays that could delay the construction activities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	0.25	0.50	1.00	0.27	Mitigate	

Develop MOT plans and update the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Alternative 3 Risk Data Sheets

Project	Sky Harbor Airport	Risk ID	S SK ROW 50.01
Sub-Project	Sky Harbor	Status	Active

Time for business relocation

Risk Trigger		Flowchart Activity	310

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	6.00	12.00	18.00	6.00			

Community Tire has to be relocated. This is on airport property. However, the acquisition could be longer than the allocated time delaying the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$4.00	-$4.00	-$4.00	-$3.20	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

In the lease agreements, specify the time the businesses need to be relocated. Base schedule has advertisement date of 4/1/2022. This will avoid the schedule delay and could save the project $6 million.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Project	Sky Harbor Airport	Risk ID	S SK DES 10.01
Sub-Project	Sky Harbor	Status	Active

Lack of traffic projections could increase scope/cost

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$5.00	$15.00	$25.00	$11.25	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

At the planning level, traffic analysis has not been started. Upon further analysis, additional infrastructure may be required to mitigate this issue. One example is revising access or requiring all the braided ramps

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$5.00	$15.00	$25.00	$11.25	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Advance the project and make necessary decisions.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK ENV 10.01
Sub-Project	Sky Harbor	Status	Active

Environmental Clearance

Risk Trigger		Flowchart Activity	305

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00			

Obtaining environmental clearance and who is the lead fed agency. Base schedule assumes 12 months. Savings could be a lower level clearance document will be required. Delay could be a higher level document will be required.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	-4.00	6.00	12.00	4.00	Accept	

Advance the design and update the schedule.

Monitoring and Control

Risk Owner		Risk Aging	From		Status Interval
			To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Sky Harbor Airport	Risk ID	S SK DES 900.01
Sub-Project	Sky Harbor	Status	Active

Change of access report

Risk Trigger		Flowchart Activity	300
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	3.00	9.00	12.00	4.25			

Change of Access report for I-10 would require FHWA HQ approval. There is only 9 months for the approval process in the 18-month design schedule. FHWA requires 3 months for review and approval. The risk is submitting at 50% design.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	3.00	9.00	12.00	4.25	Mitigate	

FHWA can give DEOA (determination of engineering operational acceptability) prior to NEPA approval.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

Project	Sky Harbor Airport	Risk ID	S SK CNS 900.01
Sub-Project	Sky Harbor	Status	Active

Differing site conditions (subsurface unknowns)

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

5% for change order contingency has remained in the base cost. This risk is on and above that due to no geotechnical information and potential hazardous materials / contaminated soils.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Conduct geotechnical investigations and site studies.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	Risk Assignment

Project	Sky Harbor Airport	Risk ID	S SK UTL 900.01
Sub-Project	Sky Harbor	Status	Active

Utilities

Risk Trigger		Flowchart Activity	cost to 320; schedule to 300

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
40%							
Cost ($M)	$1.00	$2.00	$3.00	$0.80	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	1.00	2.00	3.00	0.80			

No utility investigations have been made and there is no allowance in the current base cost for utilities. Roadway relocation and excavation can have utility impacts.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
40%						
Cost ($M)	$1.00	$2.00	$3.00	$0.80	Strategy	6/29/2017
Schedule (Mo)	1.00	2.00	3.00	0.80	Mitigate	

Conduct SUE and update the estimate.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Project	Sky Harbor Airport	Risk ID	S SK CNS 80.01
Sub-Project	Sky Harbor	Status	Active

Coordination of roadway and airport projects

Risk Trigger		Flowchart Activity	320

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.50	$1.00	$2.00	$0.87	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)				0.00			

In order to make temporary connections with other planned projects, there maybe requirements for temporary infrastructure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.50	$1.00	$2.00	$0.87	Strategy	6/29/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate roadway and airport projects; consider phasing of projects to minimize impacts.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

July 5, 2017 Risk Register Page 7 of 9

Project	Sky Harbor Airport	Risk ID	S SK DES 900.02
Sub-Project	Sky Harbor	Status	Active

Scope Indecisions

Risk Trigger		Flowchart Activity	Schedule 300; cost 320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$1.00	$5.00	$10.00	$2.58	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	4.00	6.00	8.00	3.00			

Separating needs and wants, and building consensus on the scope could result in delays to design and added infrastructure. Some scope creep items such as pavement overlay, structure rehabs, sign rehabs, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$1.00	$5.00	$10.00	$2.58	Strategy	6/29/2017
Schedule (Mo)	4.00	6.00	8.00	3.00	Mitigate	

Early and continued coordination with stakeholders.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

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Project	Sky Harbor Airport	Risk ID	S SK CNS 40.01
Sub-Project	Sky Harbor	Status	Active

Maintaining operations during construction

Risk Trigger		Flowchart Activity	320
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	2/16/2017
Schedule (Mo)	0.25	0.50	1.00	0.27			

There maybe temporary moratoriums on impacts on traffic during holidays that could delay the construction activities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	6/29/2017
Schedule (Mo)	0.25	0.50	1.00	0.27	Mitigate	

Develop MOT plans and update the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Value Planning Agenda

I-10 West T. I. Access with Phoenix Sky Harbor Projects
CRA / Value Planning / Agenda

February 13 – 17, 2017

Location: 2485 E. Buckeye Road, Phoenix AZ.

Core Group: Chaun Hill, Quinn Castro, Sarah Carter, Molly Monserud, Jordan Feld, Ken Smith, Suresh Raghavendra, Brian Bombardier

Monday 8:00 AM	• Introduction / Background
	• Presentation of Design Elements and Constraints & Controlling Decisions
	  ○ West Access TI at I-10
	  ○ T2 / T3
	  ○ Sky Train
	  ○ U & V Taxiways
	  ○ Roadway
	  ○ West GTC
	  ○ Air Cargo/Freight
	  ○ West Terminal
	  ○ Other

Monday 12:30 PM	• Airport Needs / Wants • COP Needs / Wants • ADOT Needs / Wants • Evaluation Criteria • Paired Comparison
Tuesday 8:00 AM	• Footprint Map ○ Identify elements that are set in space (layout) and time (schedule) • Brainstorm Ideas (Creative Phase)
Tuesday 12:30 PM	• Group Scoring of Ideas • Shortlist 2 or 3 Themes (family of ideas)
Wednesday 8:00 AM	• Design Competition to Develop Solutions
Thursday 8:00 AM	• Conduct CRA on the Alternatives • Evaluation to Select the Best Value Solution
Friday 8:00 AM	• Develop Master Schedule (to include all the design elements) and Cash Flow • Presentation Preparation
Friday 1:00 PM	• Presentation
Friday 2:30 PM	• Adjourn

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Value Planning Attendees

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I-10 West T. I. Access with Phoenix Sky Harbor Projects – Design Charrette
Feb 13 – 17, 2017

HDR

DATE					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
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								Suresh.raghavendra@hdrinc.com	
X	X	X	X	X	Trent Eakin	HDR	Modeler	360 570 7270	
								Trent.eakin@hdrinc.com	
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								eanderson@azmag.gov	
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								sboschen@azdot.gov	

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Feb 13 – 17, 2017

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DATE					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
Feb 13	Feb 14	Feb 15	Feb 16	Feb 17				OFFICE	CELL
								EMAIL	
AR				X	Annette Riley	ADOT	Asst. State Engineer		
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Feb 13 – 17, 2017

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Feb 13 – 17, 2017

HDR

DATE					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
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Feb 13 – 17, 2017

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X	X	X	X	X	NATE WALNUM	KIMLEY-HORN	SKYTRAIN CIVIL ENG.	602-906-1111	602-478-7740
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X				X	Kyle Ethel	FAA	Planner		
								kyle.ethel@faa.gov	
X	X			X	Jason Bagnard	B & N			
X					Courtney Carter	COP	Planner II	602-683-2633	
								courtney.carter@phoenix.gov	
~~[illegible]~~	X	~~[illegible]~~			Curtis Richardson	COP	Aux. Pv II	602 273-4310	
	X	X		X	Rimpal Shah	ADOT	ADOT, PMG	Curtis.richardson@phoenix.gov 602-712-2167	

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X	X	X	X	X	FLOYD JOHNSON	CITY OF PHOENIX AVN OPS	LANDSIDE SUPERVISOR TRANSIT OPERATIONS	602-273-2165	
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Value Planning Report Out

Safety First

- *Emergency Exits*
  - *Muster point*
- *CPR*
- *The number for "911"*

2

Introductions

- Who are you?
- Who are you representing?
- Were you on the Value Planning / Cost Risk Assessment Team?

3

3

Plan the Work and Work the Plan

4

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Addressing Cost and Schedule Concerns

Usual Questions

- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

Analysis Needs

- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Value Engineering &Mitigation Strategies
- Risk Monitoring & Control

5

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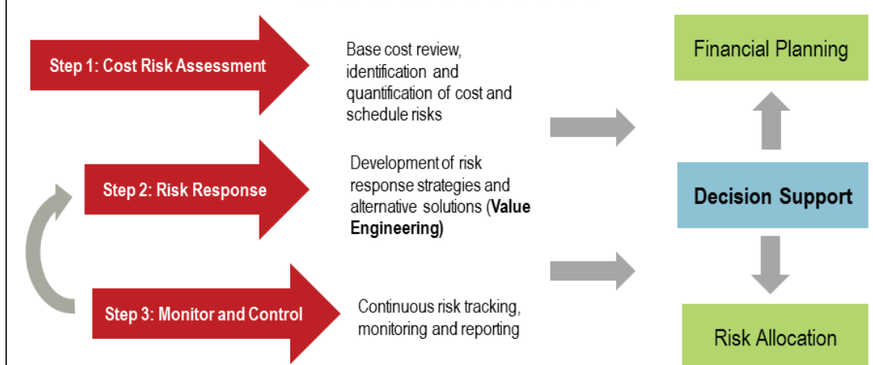
CRAVE Process



7

Value Planning / CRA Process

- Brainstorm and evaluate ideas
- Design competition
  - Combining ideas and planned projects
  - Defining access to and from the airport facilities
  - Assessing Risks
  - Mitigating risks

Performance Based Value Planning

Value Planning is not just about reducing project costs, but can also improve project performance

- Roadway Operations
- Airport Operations
- Maintainability
- Construction Impacts
- Environmental Impacts
- Promotes Economic Growth

$$\text{Value} = \frac{\text{Performance} \uparrow}{\text{Cost} \downarrow}$$

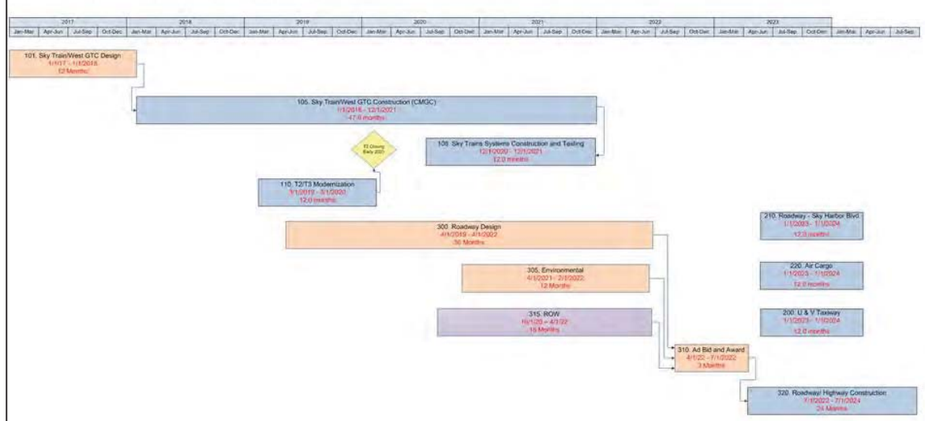
8

Weighting of Performance Attributes

Performance Attributes Criteria Matrix										
Paired Comparison										
									Total points	% of Total
Freeway Operations	A	A/B	A	A	A	A	A	A	7.5	20.8%
Airport Operations		B	B	B	B	B	G	B	6.5	18.0%
Maintainability			C	C/D	C	F	G	H	2.5	6.9%
Construction Impacts				D	D/E	F	G	H	2.0	5.5%
Environmental Impacts					E	F	G	H	1.5	4.1%
Promotes Economic Growth						F	G	F/H	4.5	12.5%
Security							G	G	7.0	19.8%
Local Roadway Operations								H	4.5	12.5%
								Total	36.0	100%

9

Assumed Schedule



10

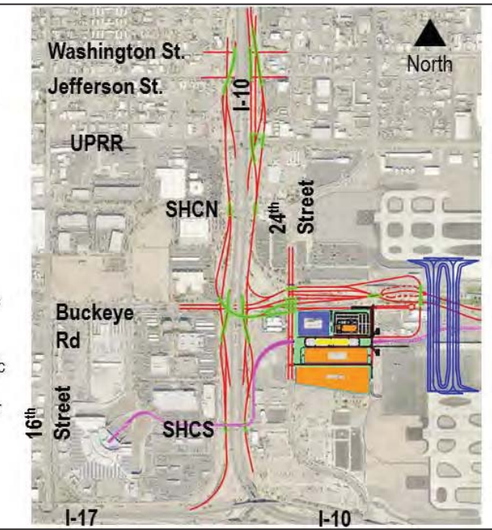
Design Competition Goals

- Each team was challenged with improving the regional transportation facilities:
  - Overall concept
  - Access to and from the airport
  - *Access* to and from RCC
  - Access to and from GTC
  - Access for cargo

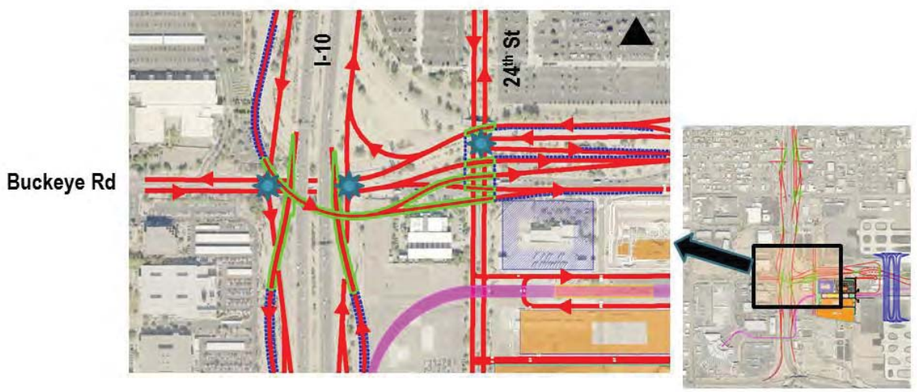
11

Team 1 Concept Overview

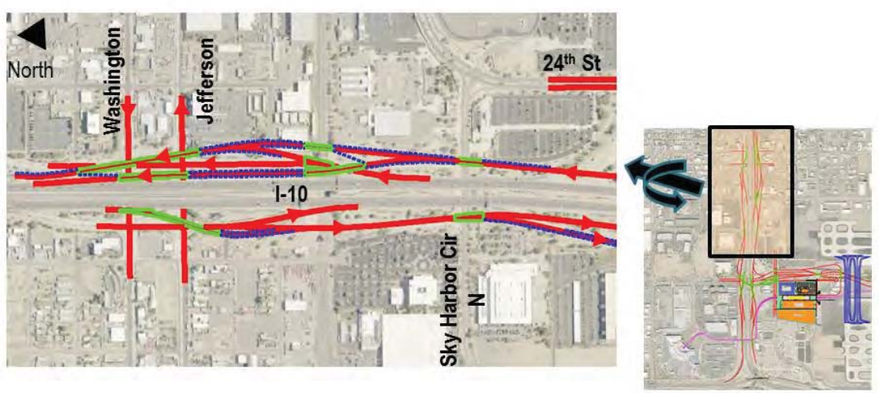
- Full Access Traffic Interchange on I-10 serving both sides of freeway
  - Encourage south to east and west to north movements
- Fix I-10 weaving issues surrounding airport interchange
- Direct non-stop access between I-10/I-17 freeways and airport core
- Direct non-stop access between I-10/I-17 freeways and WGTC
- Simple and non-circuitous routing of RCC traffic from I-10/I-17 freeways
- Maintain WGTC clockwise access
- Ability to perform security inspection for all traffic entering core
- Cross over traffic for reverse flow on Sky Harbor Blvd west of taxiway
- 24th Street BRT/Bike/Pedestrian intermodal connection to WGTC



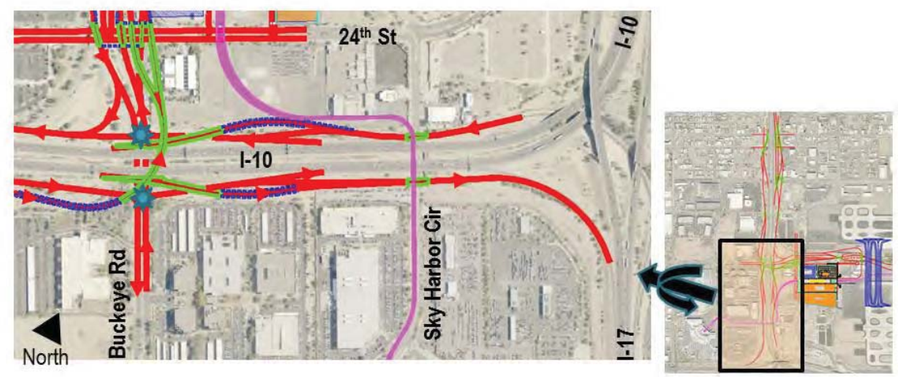
I-17 Interchange at Buckeye Road/Sky Harbor Blvd.



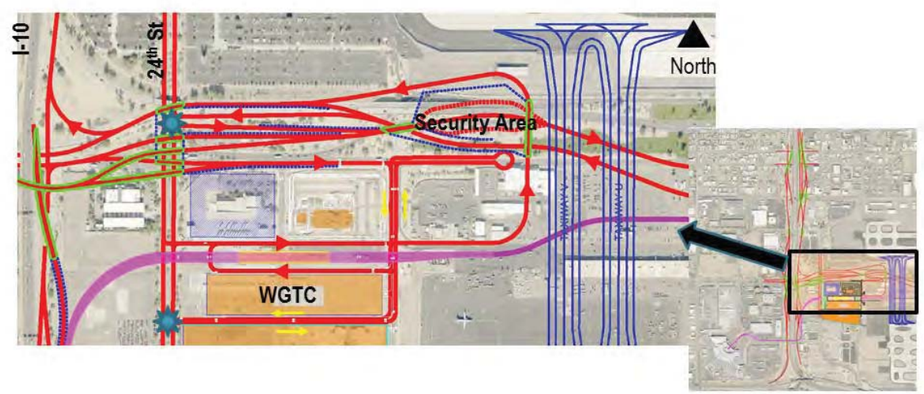
I-10 between Washington and Buckeye Road



I-10 between Buckeye Road and I-17



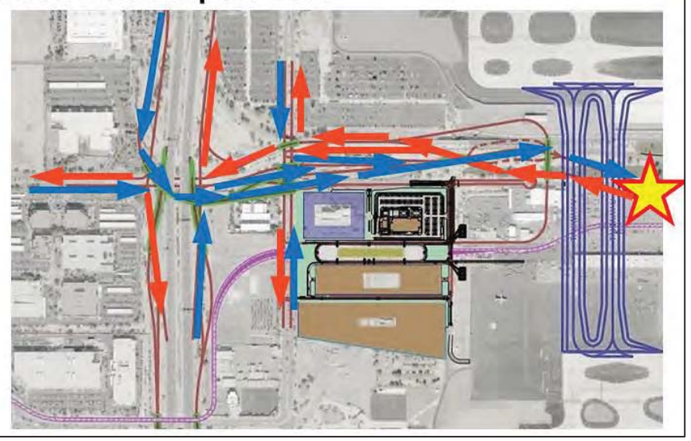
Sky Harbor Boulevard



Primary Access to/from Airport Core

To Core

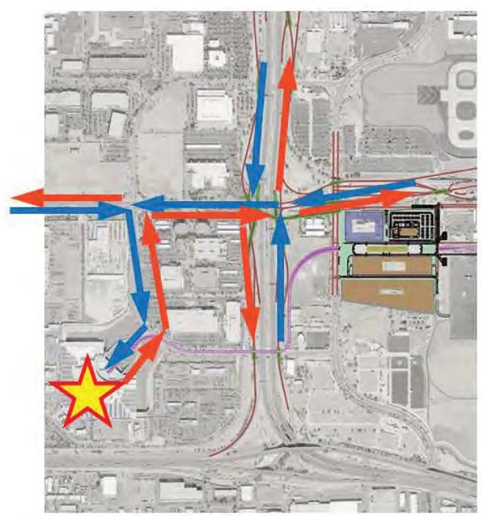
From Core



Primary Access to/from RCC

To RCC

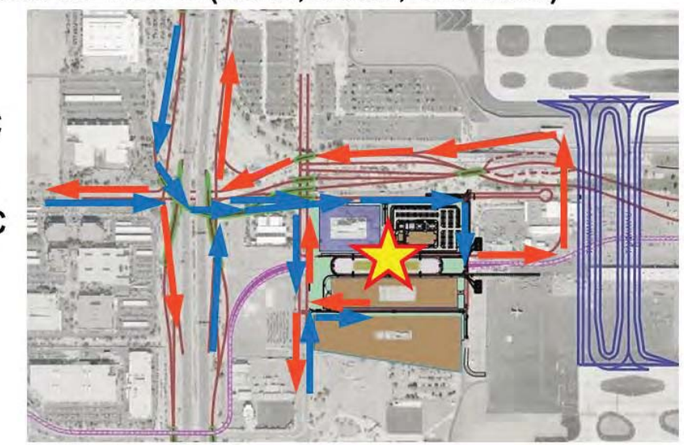
From RCC



Primary Access for WGTC (north, south, and west)

To WGTC

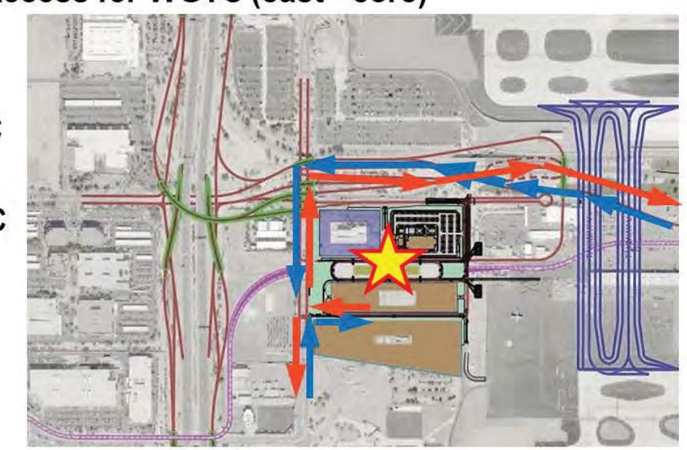
From WGTC



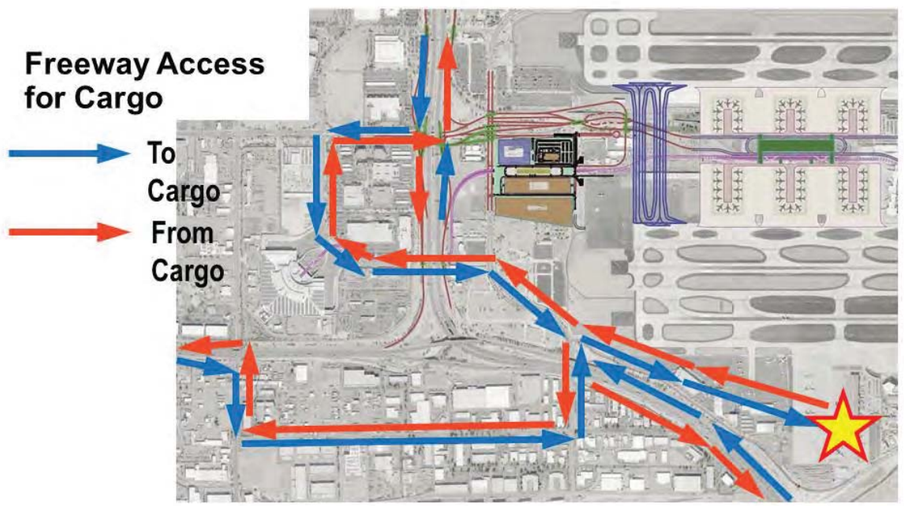
Secondary Access for WGTC (east - core)

To WGTC

From WGTC

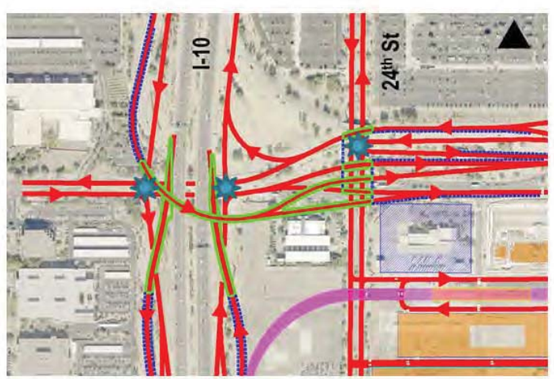


Freeway Access for Cargo

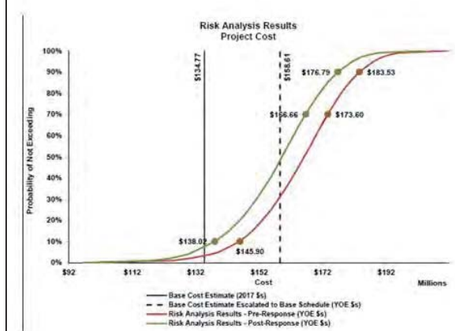


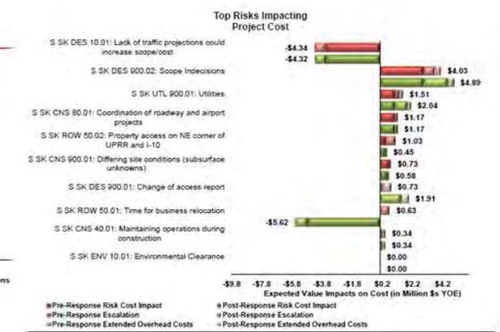
Group 1 Takeaways

- A single access point on I-10 that serves the airport to the east and the future planned land use to the west is critical.
- The interchange design should be simple, driver expectant, and easy to sign destinations.
- Improving I-10 between I-17 and SR-51 is complex and expensive, but essential to serving the economic hub (airport and downtown Phoenix) of the region for the long term.



Team 1 Modeled Results





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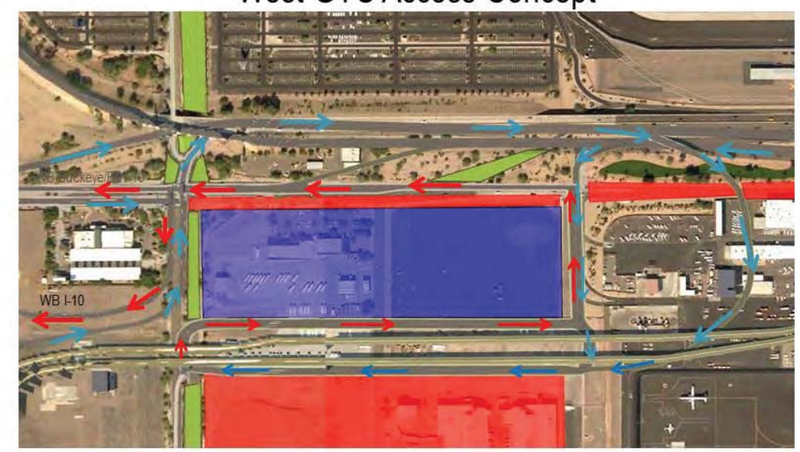
Team 2 Design Overview

Airport Access Concept

RCC Access Concept

MARICOPA ASSOCIATION of GOVERNMENTS

West GTC Access Concept



Cargo Access Concept

Sky Harbor Circle – Buckeye Interchange

Sky Harbor Circle – Buckeye Interchange Alternative

Sky Harbor Circle to 24th Street – North Side

24th Street to Sky Harbor Circle – South Side

Takeaways

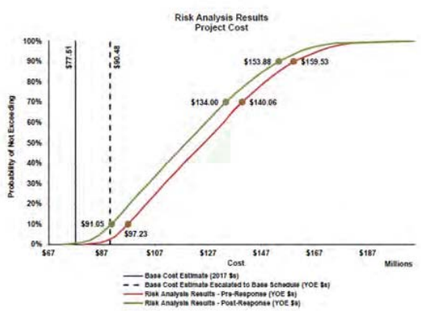
Rental Car Center Focus

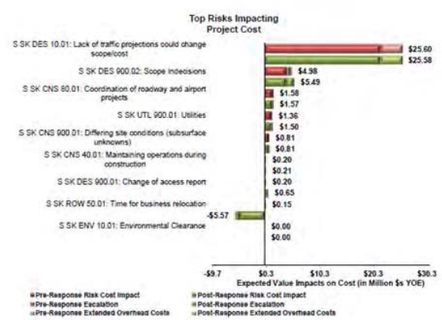
- Free-flow from EB Buckeye to I-10 WB (North)
- Enhanced right-only access from EB I-10 to RCC; right-only exit from RCC to I-10

Creative Options

- Doesn't limit freeway enhancements
- Minimizes existing RPZ conflicts
- Offers ways to optimize existing investments and phasing (e.g., expanded RCC opportunity, multimodal considerations)

Team 2 Modeled Results





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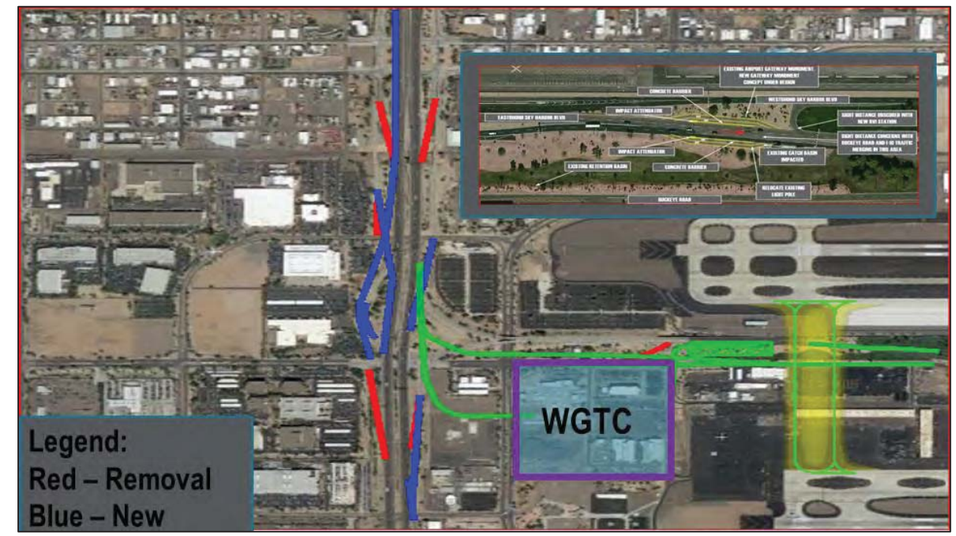
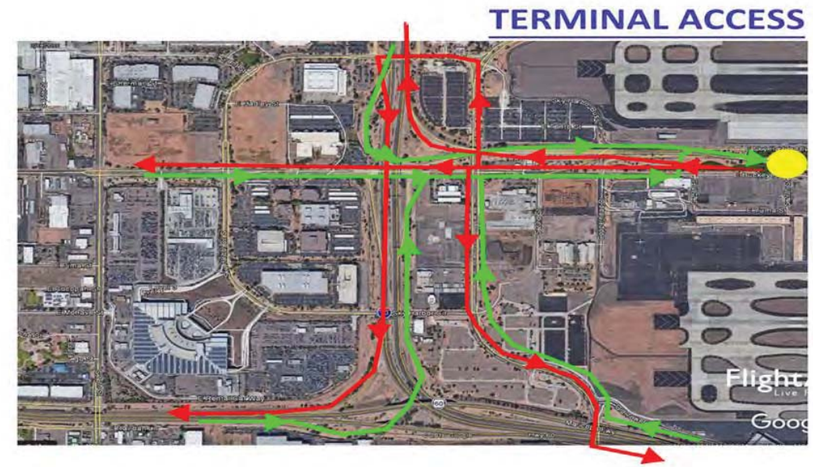
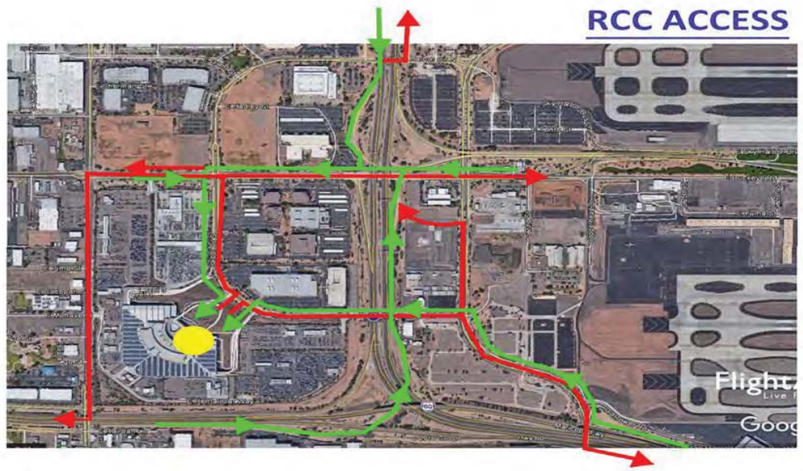


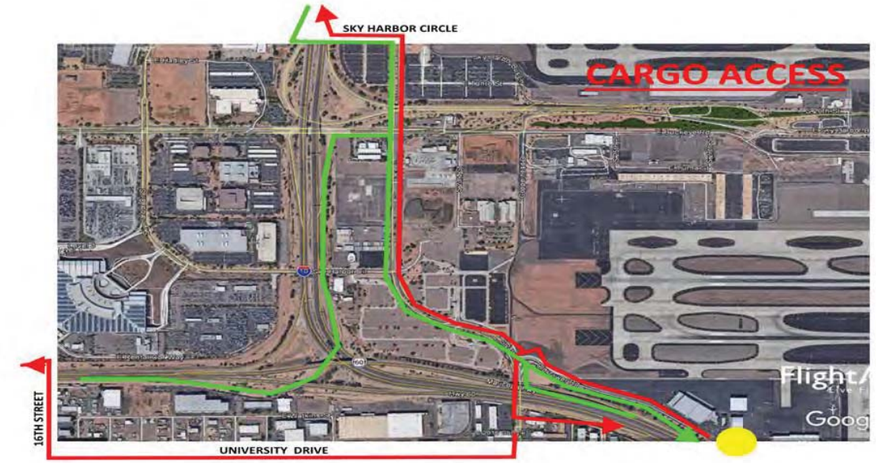


RCC ACCESS

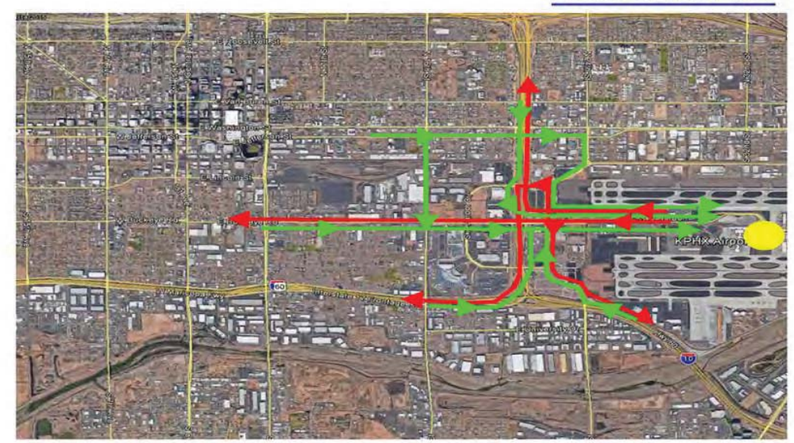


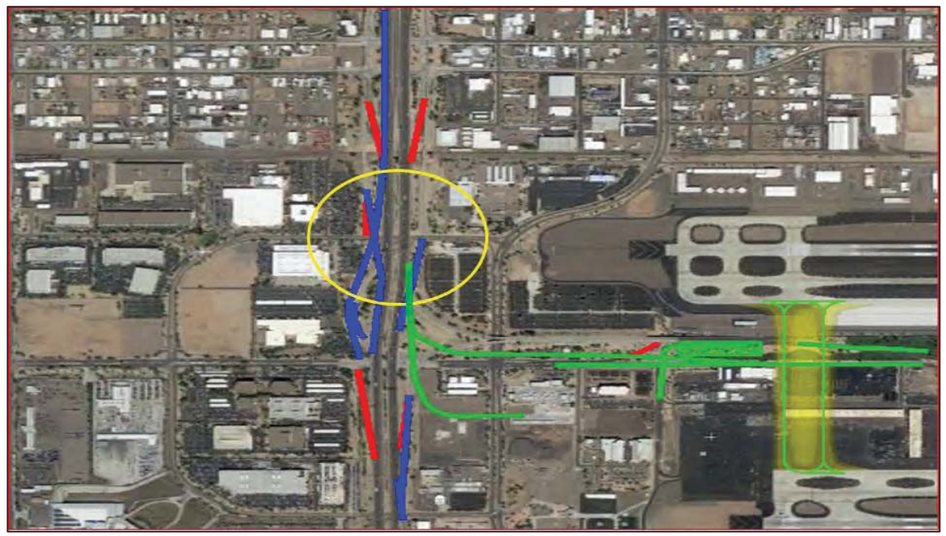
WGTC ACCESS

CARGO ACCESS

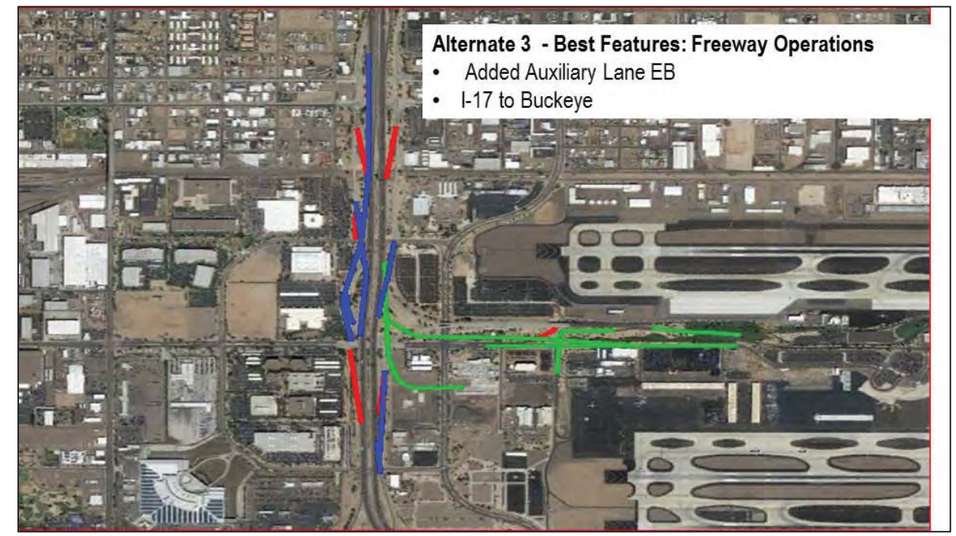


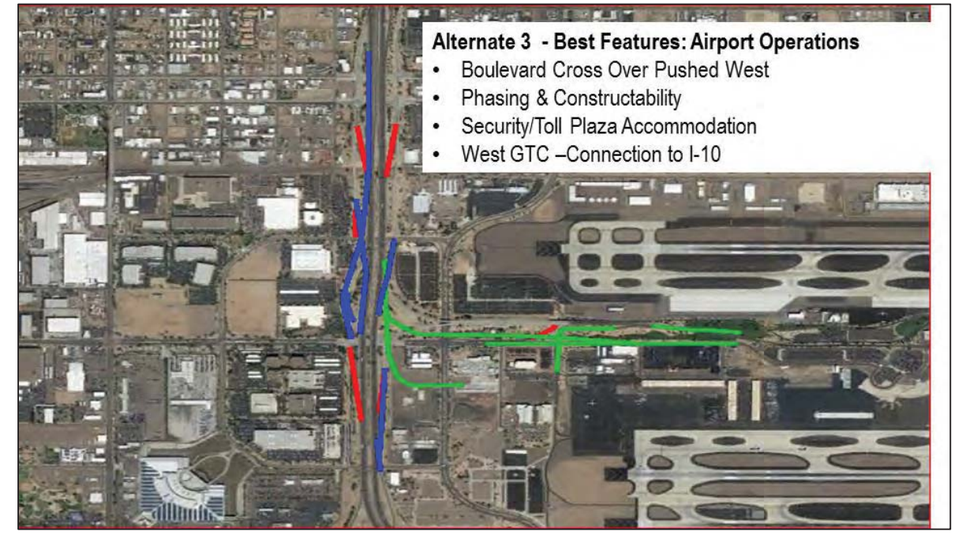
Local ACCESS



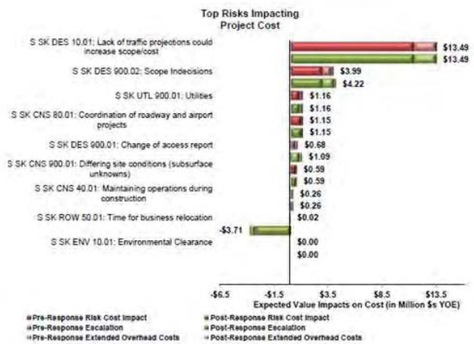


MARICOPA ASSOCIATION of GOVERNMENTS





Team 3 Modeled Results



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Performance

Performance Attribute Ratings				
Attribute	Attribute Weight	Concept	Performance Rating	Total Performance
Freeway Operations	20.8	1	10	208.0
		2	6	124.8
		3	7	145.6
Airport Operations	18.0	1	8	144.0
		2	9	162.0
		3	9	162.0
Maintainability	6.9	1	5	34.5
		2	7	48.3
		3	7	48.3
Construction Impacts	5.5	1	5	27.5
		2	7	38.5
		3	7	38.5

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Performance

Performance Attribute Ratings				
Attribute	Attribute Weight	Concept	Performance Rating	Total Performance
Environmental Impacts	4.1	1	8	32.8
		2	8	32.8
		3	8	32.8
Promotes Economic Growth	12.5	1	9	112.5
		2	8	100.0
		3	8	100.0
Security	19.8	1	8	198.0
		2	8	198.0
		3	8	198.0
Local Roadway Operations	12.5	1	8	100.0
		2	6	75.0
		3	8	100.0

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Best Value

Concept Value Improvement				
Value Index				
Concept		Performance (P)	Cost (C) $ millions	Value Index
1	Alternative 1	856	$166.7	5.13
2	Alternative 2	760	$134.0	5.67
3	Alternative 3	805	$104.5	7.71

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Value Planning Approach

Understanding the relationship of cost, performance, and value is essential in evaluating different alternatives. Comparing the performance and cost suggests which recommendations are potentially as good as or better than the current condition in terms of overall value.

Value Engineering, Analysis, or Planning has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that value analysis can play to improve project performance. To address this issue, a performance-based approach was used.

The primary objective of any workshop is to improve the value of the project. A simple way to think of value in terms of an equation is shown at right. While project costs are fairly easy to quantify and compare through traditional estimating techniques, performance is not so easily quantifiable.

$$Value = \frac{Performance}{Cost}$$

The use of performance attributes acts the cornerstone of this performance-based process by giving a systematic and structured way of considering the relationship of a project's performance and cost as it relates to value. Project performance must be properly defined and agreed on by the stakeholders at the beginning of the workshop. The performance attributes and requirements that are developed are then used throughout the study to identify, evaluate and document alternatives.

The application of performance-based value planning consists of the following steps:

1) Identify key project (scope and delivery) performance attributes and requirements for the project.
2) Establish the hierarchy and impact of these attributes on the project.
3) Identify the change in performance of alternative project concepts generated by the study.
4) Measure the aggregate effect of alternative concepts relative to the current condition and how it affects future development plans as a measure of overall value improvement.

The following are the key project performance attributes that were used in this Value Planning Study:

- Roadway Operations
- Transit Operations
- Maintainability
- Construction Impacts
- Environmental Impacts
- Promotes Economic Growth
- Security
- Local Roadway Operations

Performance Based Results

Using performance attributes is an integral part of the value engineering process. Performance attributes provide the cornerstone of the VE process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the value study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

The Value Planning Team Leader will lead the Team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops forms the basis for the Value Planning Teams' understanding of the performance requirements of the project, and to what degree the current concept is meeting those requirements. From this approach, the Value Planning Team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Performance based value planning yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a common understanding of how the project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VE process
- Develops a better understanding of a VE recommendation's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions

Methodology

Performance based value planning process consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project
2. Establish the hierarchy and impact of these attributes on the project

3. Establish the current concept and future development performance by evaluating and rating the effectiveness of the proposed design concepts
4. Identify the change in performance of alternative project concepts generated by the study
5. Measure the aggregate effect of alternative concepts relative to the current condition as a measure of overall value improvement

The primary goal of value planning is to improve project value. A simple way to think of value in terms of an equation is as follows:

$$Value = \frac{Performance}{Cost}$$

Assumptions

Before embarking on the details of this methodology some assumptions need to be identified. The methodology described in the following steps assumes that the project functions are well established. Project functions are "what" the project delivers to its users and stakeholders; a good reference for the project functions can be found in the environmental document's purpose and need statement. Project functions are generally well defined prior to the start of the value study. In the event that project functions have been substantially modified, the methodology must begin anew from Step 1.

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components.

It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory. All performance requirements MUST be met by any idea being considered.

Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be Project Schedule which means that a wide range of alternatives, which have different durations, could be acceptable.

The Value Planning Team Leader will initially request that representatives from project Team and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually four to seven attributes are selected. It is important that all potential attributes be thoroughly discussed.

The information that comes out of this discussion will be valuable to both the Value Planning Team and the Project Owner. It is important that the attribute be discretely defined, and they must be quantifiable in some form. The vast majority of performance attributes that typically

appear in transportation value studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Step 2 – Determine the Relative Importance of the Attributes
Once the group has agreed upon the project's performance attributes, the next step is to determine their relative importance. This is accomplished through the use of an evaluative tool, termed in this report as the "Performance Attribute Matrix."

This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?" A letter code (e.g., "a") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of equal importance, both letters (e.g., "a/b") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed.

When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote", as it made the list in the first place and should be given some degree of importance.

Step 3 – Evaluate the Performance of the Value Planning Alternatives
Once the performance of the current concept and future plans have been established, it can be used to help the Value Planning Team develop performance ratings for individual Value Planning alternatives as they are developed during the course of the value study. The Performance Measures Form at the back of each recommendation is used to capture this information.

It is important to consider the recommendation's impact on the entire project, rather than on discrete components.

Step 4 – Compare the Performance Ratings of Recommendations to the Current Concepts and Future Development Plans
The last step in the process is to develop the performance ratings for the current concept and future development plans. The Value Planning Team groups the recommendation into an alternative (or alternatives) to provide the decision makers a clear picture of how the recommendations fit together into possible solutions. At least one alternative is developed to present the Value Planning Team's consensus of what should be implemented. Additional scenarios are developed as necessary to present other combinations to the decision makers that should be considered. The scenario(s) of Value Planning recommendations are rated and compared against the current concept and how they accommodate future development. The performance ratings developed for the Value Planning alternatives are entered into the matrix and the summary portion is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations.

- % Performance Improvement = Δ Performance VP Strategy / Total Performance Original Concept
- Value Index = Total Performance / Total Cost (in Millions)

I-17/Central Avenue Bridge Replacement CRA Workshop Results

(in coordination with Valley Metro South Central LRT)

May 2, 2017

Decision Support Document
Advance I-17 / Central Avenue Overpass
Ultimate Construction

Baseline: To purchase ROW in all 4 corners and spread the frontage rods to provide vertical clearance for the overhead contact wires.

Recommendation: Build the ultimate I-17 over Central Avenue structure as a separate project prior to the need for VM's Central LRT project. The highway construction is anticipated to be completed by Dec 2020; VM needs the highway construction to be completed by Dec 2021.

Advantages:

- Bridge is not built in phases which eliminates potential operational impacts of constructing over live LRT traffic
- Reduces cost of ROW for VM project; eliminates ROW and roadway work to the north of I-17; $1.5 – 2.5 million
- Reduces throwaway or reconstruction
- Eliminates the need for bus bridge during ADOT I-17 construction
- Demonstrates a coordinated effort between agencies
- Provides an opportunity to reduce MOT cost and phases during ADOT I-17 construction

Disadvantages

- ROW on the south of I-17 could be perceived as acquired for a different need
- May require long term temporary barrier on I-17
- A portion of the new bridge would not be used for a long duration

Decision Support Document
Advance I-17 / Central Avenue Overpass
Ultimate Construction

Discussion/Justification/Sketches/Photos:

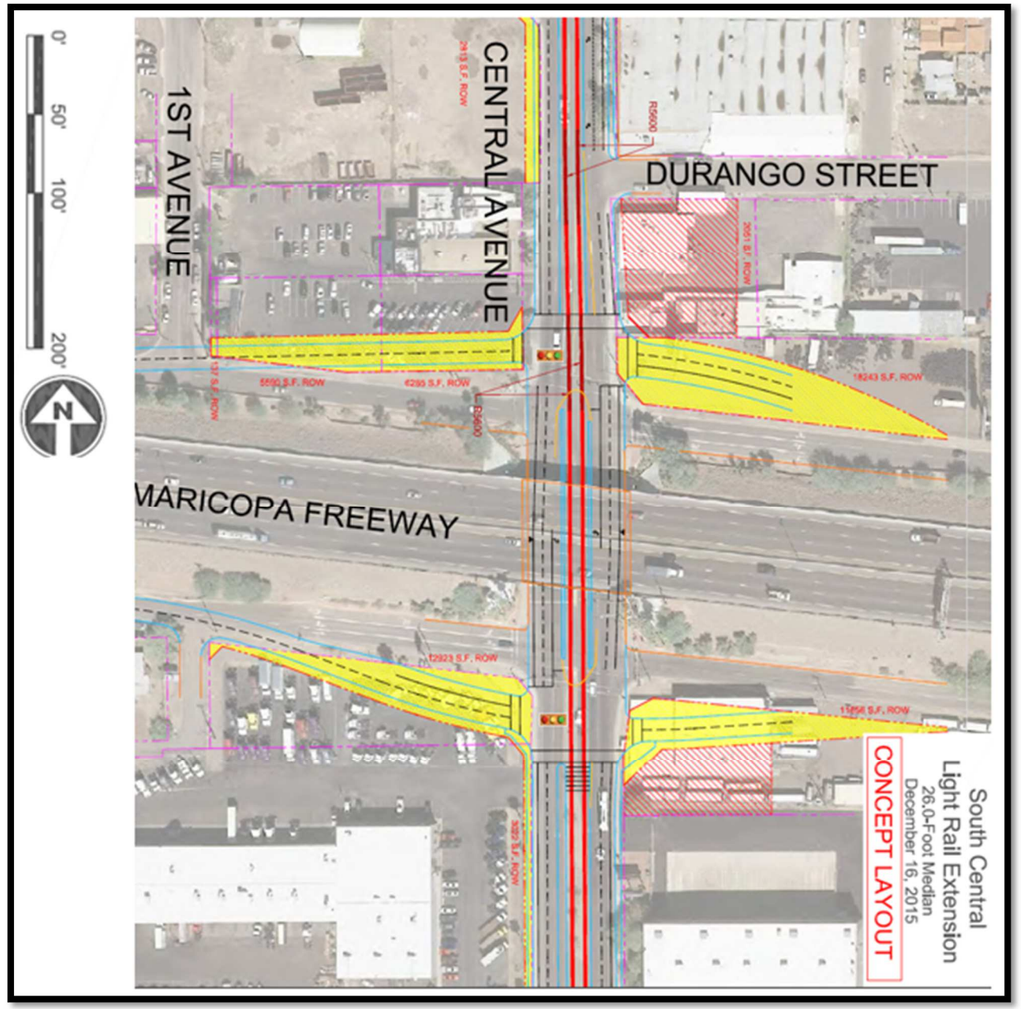


Figure 1: Existing Plan for Valley Metro

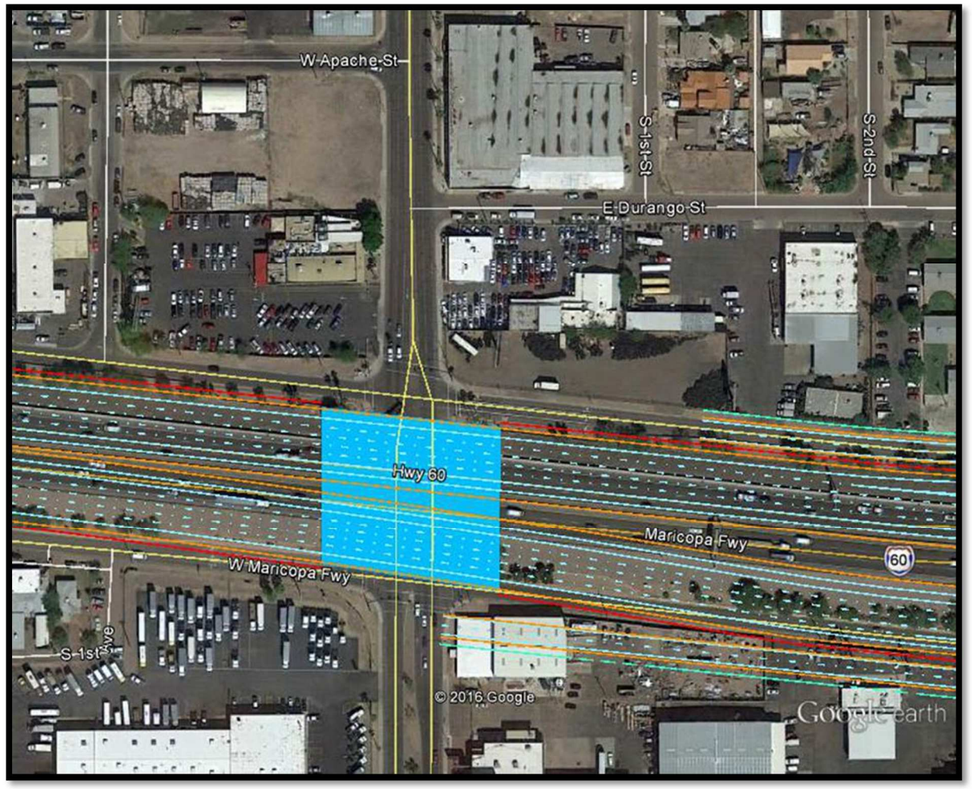


Figure 2: Ultimate Plan for I-17 at Central Avenue

Justification:

The operational shutdown window is 3 to 4 hours per day. The options are to have a bus bridge, which could reduce ridership resulting in a long term impact to VM or to incur a 25% premium on the ADOT project for demo and construction over live LRT.

The new bridge could be built in 3 phases to the south.

The VM project is a CMAR and there may be a possibility of adding the ADOT I-17 bridge construction to the VM CMAR scope if it would be an advantage to the project delivery.

Project	South Central CR	Risk ID	VM VMSC PRO 80.03_01
Sub-Project	VM South Central	Status	Active

Consistent communication by stakeholders to public

Risk Trigger		Flowchart Activity	30% Design Milestone

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.00			

Potentially there will be multiple PI teams - ADOT, VM, COP, and contractors. The risk is there might be different messages from the agencies and might be confusing to public. The public could lose confidence if they get misinformation from different sources. Might cause rework, additional work, and delays. I-17 will be covered by a PI through ADOT PI on-call; VM will be covered by VM PI.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.50	Mitigate	

Develop a communication plan and hierarchy with a single point of contact to the public for each agency as it relates to the I-17 / Central Avenue crossing. Consider a PI summit that analyzes the comprehensive impacts of valley projects.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Howard Steere		To		Weekly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.03_02
Sub-Project	VM South Central	Status	Active

Stakeholder consensus and communication

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$2.00	$3.00	$5.00	$2.38	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.50			

Early agreement and ongoing communication of design criteria between ADOT and VM as it relates to I-17 crossing on 7th Ave, Central Ave, and 7th St. The risk is that the decisions made may change causing redesign, rework, and delays, including during construction. Assume 25% of the $20 M for the high.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$1.00	$1.50	$2.50	$0.79	Strategy	5/2/2017
Schedule (Mo)	0.00	1.00	2.00	0.50	Mitigate	

Develop a MOA and JPA for design criteria between ADOT, VM, MAG, and COP by the end of 2017.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC SIT 40.09_01
Sub-Project	VM South Central	Status	Active

Geometric Compatibility between interim and ultimate configurations

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	-$10.00	-$2.00	$5.00	-$1.08	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	2.00	4.00	6.00	2.00			

The current design has the overhead contact system dipping down under the existing structure at I-17. To attain vertical clearance at the frontage rods, the frontage roads are being flared out. The risk is the uncertainty around the I-17 / Central Ave structure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	-$10.00	-$2.00	$5.00	-$1.08	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.00	Mitigate	

Potential strategies are 1.investigate lowering Central and the associated utility and reainage impacts, 2. raise I-17 profile, 3. structure types to reduce structure depth. Hold a alternative analysis workshop with VM and ADOT to evaluate alternatives and include the decision in the MOU.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM, ADOT PM		To		Monthly

Review Comments	Last Review	Date MC Last Updated
		5/2/2017
	Next Review	Risk Assignment

Project	South Central CR	Risk ID	VM VMSC PRO 80.01_01
Sub-Project	VM South Central	Status	Active

IGA - agreements between stakeholders

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
10%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.20			

The agreements are not currently in place. The risk is that the agreements might take a long time to be executed. The delays could be due to legal reviews and the decisions to be drafted into agreements not being made. The FFGA submittal is around Jan 2019.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.20		

Begin working on the framework of the MOA. Continue to discuss the MOA iusses and requirements at upcoming monthly coordination meeting. Get legal staff from both agencies involved earlier on.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		Monthly

Review Comments	Last Review	Date MC Last Updated
		5/2/2017
	Next Review	Risk Assignment

Project	South Central CR	Risk ID	VM VMSC SIT 40.05_01
Sub-Project	VM South Central	Status	Active

Coordination between ADOT and VM contractors - Specifications

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.00			

The risk is that the I-17 project overlaps with the VM project. There could be conflicts between contractors resulting in delay claims. Assume $500,000 per month in delay cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.50	$1.00	$1.50	$0.25	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.50	Mitigate	

Coordination with ADOT to specify windows within the contract for contractor to work within the I-17 / Central Ave area. Include a buffer within the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM Design Manager		To		Quarterly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC SIT 40.02_01
Sub-Project	VM South Central	Status	Active

Utility coordination

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

There is a large COP water infrastructure project along Central Avenue. Other significant utilities are sanitary sewer and communication. These utilities can conflict not only with the track work but also with the I-17 structure. This is a not quantifiable watchlist risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00	Mitigate	

Valley Metro is beginning a SUE contract; consider early order of work in the vicinity of I-17 to prepare for alternative analysis workshop in August 2017.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC ROW 60.01_01
Sub-Project	VM South Central	Status	Active

ROW

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Current plan requires properties in all 4 corners of I-17 and Central and one small portion at 7th Avenue. Decisions yet to be made on the scope of work could have positive or negative impacts to the ROW.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Define the ROW footprint in the vicinity of I-17 in the alternatives workshop.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
ADOT PM, VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.09_01
Sub-Project	VM South Central	Status	Active

Light rail operations if freeway construction happens after VM

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

The risk is that if VM builds their project per EIS design, there is a risk to the ADOT I-17 work of building in close proximity to live LRT. This may require a bus-bridge through the construciton site. This may have a cost to VM; the cost might have to be borne by ADOT. This might also impact ridership. ADOT would have to pay a premium for bridge demo over live track; there could be 25% premium on ADOT work. There is an operational shutdown window of 3 hours per day at night.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Build the ultimate bridge before the LRT; at a minimum complete the foundation work prior to the LRT work.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.03_03
Sub-Project	VM South Central	Status	Active

ADOT Resources

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Permanent PM is not yet assigned to the ADOT I-17 project. The risk is if there is inexperience in this area, with the complexitites involved, it could affect coordination and agreements of the VM project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Develop mentorship and escalation plans for key resouces. Consider augmenting with contract PM staff, as required.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.04_01
Sub-Project	VM South Central	Status	Active

Procurement - technical issues

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$1.00	$2.00	$3.00	$1.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Procurement documents for the projects need to be coordinated between VM and ADOT. Clearly defining the technical requirements with the ADOT project is the risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$1.00	$2.00	$3.00	$0.50	Strategy	5/2/2017
Schedule (Mo)				0.00	Mitigate	

Conitnuous coordination with ADOT to prioritize and define requirements and include them in the procurement documents.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC SIT 40.09_01
Sub-Project	VM South Central	Status	Active

Geometric Compatibility between interim and ultimate configurations

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	-$10.00	-$2.00	$5.00	-$1.08	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	2.00	4.00	6.00	2.00			

The current design has the overhead contact system dipping down under the existing structure at I-17. To attain vertical clearance at the frontage rods, the frontage roads are being flared out. The risk is the uncertainty around the I-17 / Central Ave structure.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	-$10.00	-$2.00	$5.00	-$1.08	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.00	Mitigate	

Potential strategies are 1.investigate lowering Central and the associated utility and drainage impacts, 2. raise I-17 profile, 3. structure types to reduce structure depth. Hold a alternative analysis workshop with VM and ADOT to evaluate alternatives and include the decision in the MOU.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM, ADOT PM		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.01_01
Sub-Project	VM South Central	Status	Active

IGA - agreements between stakeholders

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
10%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.20			

The agreements are not currently in place. The risk is that the agreements might take a long time to be executed. The delays could be due to legal reviews and the decisions to be drafted into agreements not being made. The FFGA submittal is around Jan 2019.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.20		

Begin working on the framework of the MOA. Continue to discuss the MOA issues and requirements at upcoming monthly coordination meeting. Get legal staff from both agencies involved earlier on.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC SIT 40.05_01
Sub-Project	VM South Central	Status	Active

Coordination between ADOT and VM contractors - Specifications

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	1.00			

The risk is that the I-17 project overlaps with the VM project. There could be conflicts between contractors resulting in delay claims. Assume $500,000 per month in delay cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.50	$1.00	$1.50	$0.25	Strategy	5/2/2017
Schedule (Mo)	1.00	2.00	3.00	0.50	Mitigate	

Coordination with ADOT to specify windows within the contract for contractor to work within the I-17 / Central Ave area. Include a buffer within the schedule.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM Design Manager		To		Quarterly

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC SIT 40.02_01
Sub-Project	VM South Central	Status	Active

Utility coordination

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

There is a large COP water infrastructure project along Central Avenue. Other significant utilities are sanitary sewer and communication. These utilities can conflict not only with the track work but also with the I-17 structure. This is a not quantifiable watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00	Mitigate	

Valley Metro is beginning a SUE contract; consider early order of work in the vicinity of I-17 to prepare for alternative analysis workshop in August 2017.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC ROW 60.01_01
Sub-Project	VM South Central	Status	Active

ROW

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Current plan requires properties in all 4 corners of I-17 and Central and one small portion at 7th Avenue. Decisions yet to be made on the scope of work could have positive or negative impacts to the ROW.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Define the ROW footprint in the vicinity of I-17 in the alternatives workshop.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
ADOT PM, VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.09_01
Sub-Project	VM South Central	Status	Active

Light rail operations if freeway construction happens after VM

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

The risk is that if VM builds their project per EIS design, there is a risk to the ADOT I-17 work of building in close proximity to live LRT. This may require a bus-bridge through the construction site. This may have a cost to VM; the cost might have to be borne by ADOT. This might also impact ridership. ADOT would have to pay a premium for bridge demo over live track; there could be 25% premium on ADOT work. There is an operational shutdown window of 3 hours per day at night.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Build the ultimate bridge before the LRT; at a minimum complete the foundation work prior to the LRT work.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.03_03
Sub-Project	VM South Central	Status	Active

ADOT Resources

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Permanent PM is not yet assigned to the ADOT I-17 project. The risk is if there is inexperience in this area, with the complexities involved, it could affect coordination and agreements of the VM project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/2/2017
Schedule (Mo)				0.00		

Develop mentorship and escalation plans for key resources. Consider augmenting with contract PM staff, as required.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	South Central CR	Risk ID	VM VMSC PRO 80.04_01
Sub-Project	VM South Central	Status	Active

Procurement - technical issues

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$1.00	$2.00	$3.00	$1.00	Project Rank Cost	Project Rank Schedule	5/2/2017
Schedule (Mo)				0.00			

Procurement documents for the projects need to be coordinated between VM and ADOT. Clearly defining the technical requirements with the ADOT project is the risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$1.00	$2.00	$3.00	$0.50	Strategy	5/2/2017
Schedule (Mo)				0.00	Mitigate	

Continuous coordination with ADOT to prioritize and define requirements and include them in the procurement documents.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/2/2017
Next Review	**Risk Assignment**

I-17/Mountain View CRA Workshop Results

(in coordination with Valley Metro Northwest Extension LRT)

May 3, 2017

Project	Valley Metro North West II CR	Risk ID	VM VMNW GUI 10.04_01
Sub-Project	VM North West II	Status	Active

Bridge over I-17 (clearance)

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
	25%	50%	1%				
Cost ($M)	$0.50	$2.00	$5.00	$1.18	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

There have been discussions on vertical clearance over I-17. The risk is that a vehicle with non-standard height could hit the structure. Since this will be a LRT only bridge, there is a higher risk of damage and LRT operations being impacted. ADOT design standard for clearance is 16'6". Increasing the clearance will impact the slopes, station height, and 25th Ave crossing. There is a risk cost associated with adding mitigation for potential over-height load. prob 3 - raising structure and stations; prob 2 - sacrificial structure; prob 1 - warning signs

Post-Response Quantification

Discrete Risk	Prob 1	Prob 2	Prob 3	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
	25%	50%	1%			
Cost ($M)	$0.50	$2.00	$5.00	$1.18	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

Assume 16'6" clearance and investigate structures to mitigate impacts that affect operations. This may include sacrificial beams (additional girders). Internal discussions at VM to determine the risk appetite due to over-height damage that could affect LRT operations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.02_01
Sub-Project	VM North West II	Status	Active

Spine compatibility, drainage

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

Current plan is a 72" drainage pipe under the frontage road, directly under the LRT station. The risk is that there has not been any coordination with the VM design. This is a non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

The drainage design should be accommodative of the VM preliminary concept design. Coordination with ADOT drainage design to get the drainage in the optimal location.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM Design Manager, ADOT Design Manager		To		Weekly

Review Comments

Risk workshop planned for the ADOT drainage project on 5/17/17.

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.02_02
Sub-Project	VM North West II	Status	Active

Drainage construction coordination

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)	1.00	2.00	3.00	1.00			

The risk is that a 72" at 25-feet down will more than likely close the frontage road during construction. This is in the vicinity of the LRT station, which might also require frontage road closure during construction. There could be holiday moratoriums in the vicinity of the mall, which might constrain the construction. Depending on the timing of the work, this could delay one or both projects.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)	1.00	2.00	3.00	1.00	Mitigate	

Specify an order of work in the contracts for both projects that stipulates any moratorium dates and that the ADOT drainage work should precede the VM work. Consider putting the station drilled shafts in first then trenching the pipe in between the drilled shafts. Consider the frontage road closure to be continuous for VM and ADOT projects.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM, ADOT PM		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.09_01
Sub-Project	VM North West II	Status	Active

Spine compatibility, freeway

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The Spine conceptual drawings show a 4-foot buffer b/w the freeway and the frontage road. This could be utilized to reduce the impacts to APS transmission lines. This is a non-quantifiable watch list item list.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Continue to communicate with ADOT if as design progresses the buffer is being utilized.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM; ADOT PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.07_01
Sub-Project	VM North West II	Status	Active

Spine compatibility, frontage roads

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that underneath the station, SB frontage road is reduced to one lane. This is a non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

Share VM traffic modeling with ADOT and get concurrence to reduce the frontage road to one through lane underneath the station. Document the decision in an MOA.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW PRO 80.03_01
Sub-Project	VM North West II	Status	Active

Locking down design decisions early - MOU/JPA/IGA

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.25	$0.35	$0.50	$0.29	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)	1.00	2.00	3.00	1.60			

The risk is that ADOT is not interested in agreements until after 30% design. It will be a challenge that the assumptions in the 15 to 30% design might change causing a delay to the VM project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.25	$0.35	$0.50	$0.29	Strategy	5/3/2017
Schedule (Mo)	1.00	2.00	3.00	1.60		

Lockdown key decisions such as number of lanes, and roadway and shoulder widths on frontage road, constructability requirements, pier locations, and vertical clearance prior to 30% design. Elevate the agreement discussions, if necessary. Assign a single point contact for each agency.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW PRO 80.03_02
Sub-Project	VM North West II	Status	Active

Consistent communication from stakeholders to public

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The ADOT drainage project and the VM station and guideway project will have the public appearance as one project. The risk is that there might be inconsistent communication, if not coordinated between agencies. This is a non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

Develop a communication plan and hierarchy with a single point of contact to the public for each agency as it relates to the 2 projects. Consider a PI summit that analyzes the comprehensive impacts to the valley projects. Develop a fact-sheet for each project.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM; ADOT PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.08_01
Sub-Project	VM North West II	Status	Active

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	
Schedule (Mo)				0.00			

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.08_02
Sub-Project	VM North West II	Status	Active

MOT - Plans and approvals

Risk Trigger		Flowchart Activity	
Modeling Notes			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

Temporary shift for median pier work. Short duration (weekend) closures for setting girders and deck pours will all place constraints on the VM project. This may require 3 or 4 weekend closures over the entire construction duration. Potentially there will be other ADOT work on I-17 that may conflict and should be coordinated with. This is a non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Get information from ADOT about planned I-17 closures. Consider using the mall ring road as detour for total closure of SB frontage road during construction.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.02_03
Sub-Project	VM North West II	Status	Active

APS clearance

Risk Trigger		Flowchart Activity	
Modeling Notes			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that raising the guideway gets into the clearance issues with APS. The base design assumes raising the poles. The risk is the delta based on the difference in height required due to vertical clearance decision over the freeway. It is a long lead design and procurement for this type of construction. This is a nonquantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

Get an agreement on the bridge height and depth, and communicate that with APS.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.07_02
Sub-Project	VM North West II	Status	Active

Construction sequencing / ADOT and VM contractor coordination

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that of having multiple projects/contractors working in the same area.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Insert key milestone dates in each contract and specify access and order of work as it relates to the work in the vicinity of the frontage road. Leverage the expertise of CMAR to provide input into construction sequencing. Suggest ADOT to consider a CMAR for their project.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.05_01
Sub-Project	VM North West II	Status	Active

Visual impacts and aesthetics

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.10	$0.50	$1.50	$0.30	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The retained fill along Mountain View may be viewed as a visual impact. There is a risk that the fill might be replaced with a clear span, adding cost to the project. Exotic aesthetic treatment for walls could exceed allowance (1%) in the base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.10	$0.50	$1.50	$0.30	Strategy	5/3/2017
Schedule (Mo)				0.00	Mitigate	

Conduct stakeholder outreach and engage the PI group to convey consistent message. Consider investing in graphics to convey the correct message. (avoid homeless camps and conduct threat and vulnerability risk analysis).

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW SIT 40.02_04
Sub-Project	VM North West II	Status	Active

Utilities over drainage

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

Risk is that the drainage project will be relocating utilities, which could be in conflict with the VM project. This is a nonquantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Collaboration between VM and ADOT project to coordinate utility relocations. Along the frontage road, coordinate SUE efforts between ADOT and VM projects.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM, ADOT PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW PRO 80.09_01
Sub-Project	VM North West II	Status	Active

Project Cost and schedule

Risk Trigger		Flowchart Activity	

Modeling Notes	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that typical projects experience cost growth from startup to completion.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Planning a couple of risk assessment workshops and a value engineering workshop prior to Spring 2018. Consider focusing the VE on the risk as well as the scope.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW PRO 80.03_03
Sub-Project	VM North West II	Status	Active

Collaboration with ADOT; ADOT permitting

Risk Trigger		Flowchart Activity	
Modeling Notes			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that knowing ADOT's expectations and requirements.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Meet with ADOT to understand ADOT's expectations and requirements.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

Project	Valley Metro North West II CR	Risk ID	VM VMNW PRO 80.01_01
Sub-Project	VM North West II	Status	Active

Access to Business north of Mountain View

Risk Trigger		Flowchart Activity	
Modeling Notes			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/3/2017
Schedule (Mo)				0.00			

The risk is that the stakeholders may request revisions to access that could affect the design of the project. This can affect the cost and schedule of the project. This is a nonquantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/3/2017
Schedule (Mo)				0.00		

Conduct stakeholder outreach to get the input. Mitigate the risk with design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
VM PM		To		

Review Comments

Last Review	Date MC Last Updated
	5/3/2017
Next Review	**Risk Assignment**

I-17/Indian School TI,
I-17/Northern TI,
I-17/Glendale TI,
I-17/Thunderbird TI, and
I-17/Bell TI CRA Workshop Results

May 16 & 18, 2017

Cost Risk Assessment (CRA)

Results

Project Name: I-17 & Indian School Platform TI

TRACS Number: U0006

Project Description: Upgrade the I-17 and Indian School interchange to a three level platform diamond, by adding a new east-west flyover over the interchange along Indian School Road.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$41.0	$39.4	$44.2	$46.3
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Jul 2022	Jul 2022	Sep 2022	Jan 2023

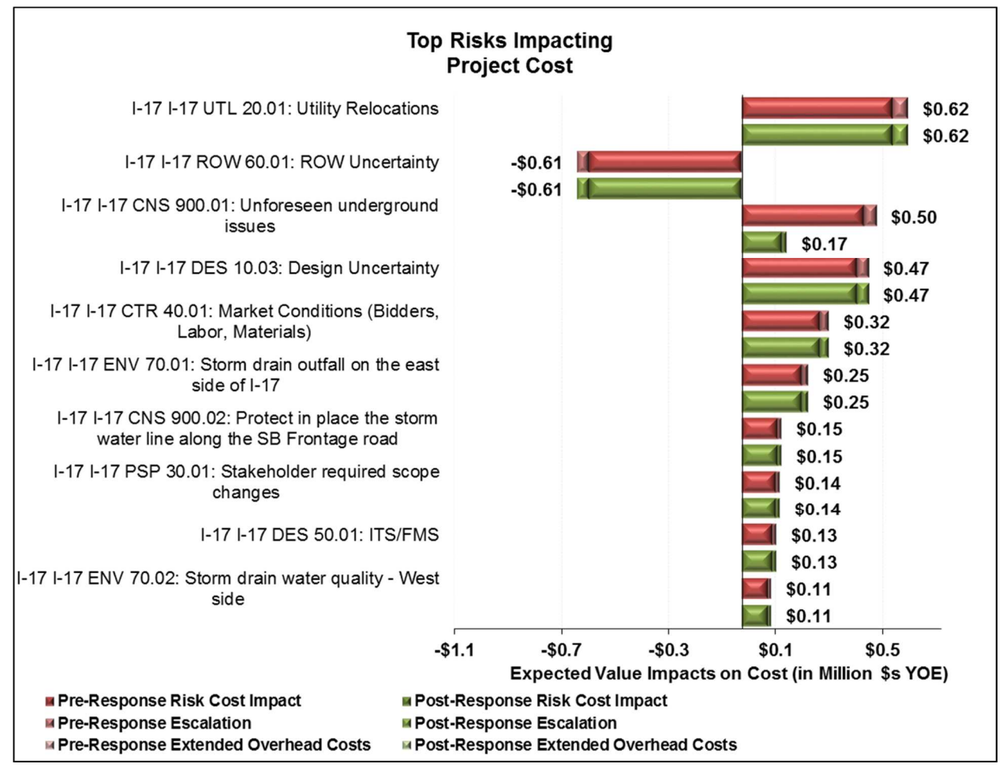
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$2,051,585	$2,253,575	$2,496,259
200	Right-of-Way / Utilities	$7,159,100	$7,159,100	$7,159,100
300	Construction	$26,767,829	$29,394,491	$32,560,322
310	Construction Engineering	$2,021,437	$2,204,656	$2,442,762
400	Project Completion	$0	$0	$0
Total		**$37,999,952**	**$41,011,822**	**$44,658,443**

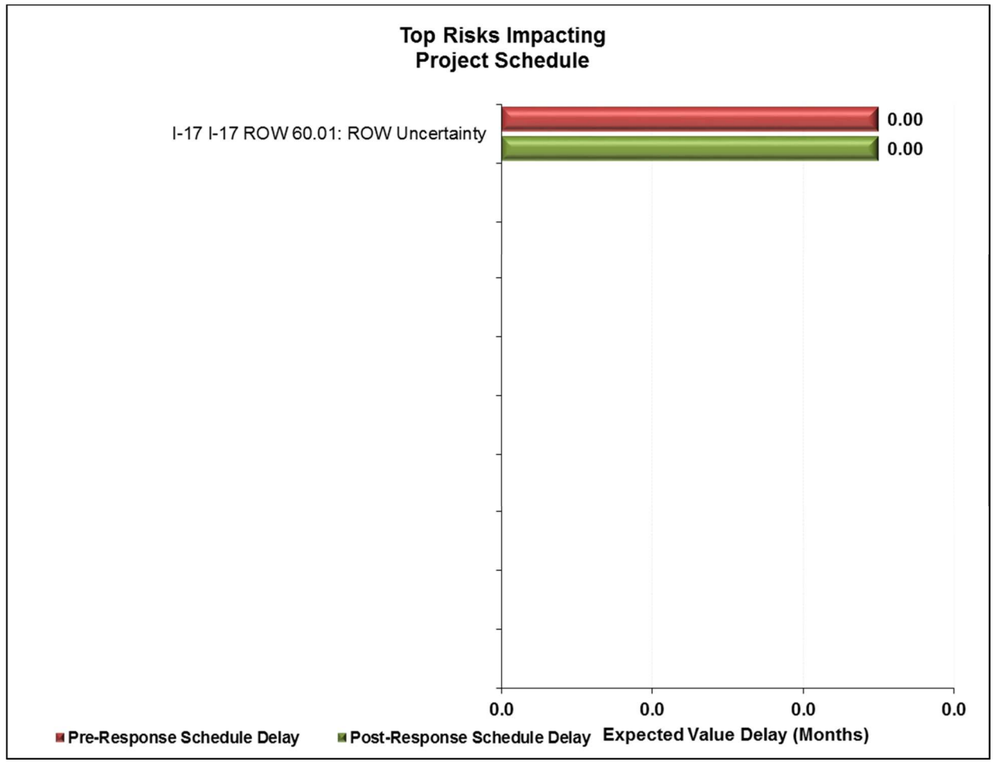
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	10/11/17	6/10/20	32.00
200	Right-of-Way / Utilities	9/10/18	9/9/20	24.02
300	Construction	6/10/20	7/5/22	24.84
310	Construction Engineering	6/10/20	7/5/22	24.84
400	Project Completion	7/5/22	7/5/22	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Note: ROW Uncertainty risk is quantified with a range of +/- 6 months impact but the expected value impact is zero months as depicted in the chart.

Project	I-17	Scenario	Risk ID	I-17 I-17 UTL 20.01
Sub-Project	I-17	Indian School	Status	Active

Utility Relocations

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.50	$0.75	$1.00	$0.56	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The assumption is that the utilities in the south bridge are not impacted. There is an existing 48-inch PCCP waterline along the south side of Indian School Road. East and west of I-17, the waterline skews north to run along the median. The risk is that the exact location of the line is unknown and might need to be relocated, especially at the embankments. The base has a $2 M allowance for utilities. Approximately 600 feet on both sides of the freeway might need to be relocated. Other utilities such as 8-inch sewer, smaller waterlines, SW Gas, telecommunication, 12-inch irrigation, and other miscellaneous utilities. The risk that the $2 M allowance might not be sufficient.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$0.50	$0.75	$1.00	$0.56	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Advance the design and coordination with City of Phoenix. Consider acquiring ROW early to accommodate utility relocations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Utility Coordinator / Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ROW 60.01
Sub-Project	I-17	Indian School	Status	Active

ROW

Risk Trigger		Flowchart Activity	ROW
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$2.00	-$1.00	$1.00	-$0.83	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00			

The base includes $6.5 M based on 2.6 acres of impacts (neat line) at $2.5 M / acre. This area does not include any additional property required for full takes or access control. At this level of design and estimation, there is an uncertainty that it could be $2 M lower or $1 M higher and the schedule could be more or less depending on relocation. The Motel 6 and restaurant on the northwest corner; billboards and sliver takes on the northeast corner.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$2.00	-$1.00	$1.00	-$0.83	Strategy	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00	Mitigate	

Refine design and ROW estimates.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.03
Sub-Project	I-17	Indian School	Status	Active

Design Uncertainty

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These are concept level designs, There is an opportunity that optimization could be done by minimizing median widths, landscaping buffers, and possibly even turn lanes. There is also a potential for added scope for items such as turn lanes, lengthening the project to accommodate tie-ins, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 30.01
Sub-Project	I-17	Indian School	Status	Active

Aesthetics: decorative bridge railing and ped fencing

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	
Schedule (Mo)				0.00			

The base does not assume complex aesthetic treatments and railing. There is a risk that stakeholders may require complex aesthetics and railings. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.01
Sub-Project	I-17	Indian School	Status	Active

Storm drain outfall on the east side of I-17

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.80	$1.50	$0.21	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The base assumes $400 k for retrofitting onsite drainage, The risk is that the added impervious on the east side needs to drain into the city outfall. To mitigate the peak flows on site, it may require detention basins for quality and quantity,. Adding cost to the project. On the northeast corner, there is minimal ROW for basin location and ROW may need to be acquired.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.80	$1.50	$0.21	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design and coordinate with the city. Consider total take ROW remainders for basin locations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.02
Sub-Project	I-17	Indian School	Status	Active

Storm drain water quality - West side

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Base assumes all onsite water pre and post construction outfalls directly to ADOT storm drain pipe in the SB Frontage road. This risk addresses the possibility that water quality requirements will have to be met before the water gets dumped into the outfall.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider total take ROW remainders for basin locations, if required.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 900.01
Sub-Project	I-17	Indian School	Status	Active

Concept Approval by Agency Officials

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Elected and agency officials may want an opportunity to approve the conceptual design since platform diamonds are a new concept to the area. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/16/2017
Schedule (Mo)				0.00		

Present the concept design (including visualization and proof of concept) to the concerned officials.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 30.01
Sub-Project	I-17	Indian School	Status	Active

Stakeholder required scope changes

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The design is not fully vetted with stakeholders. There is a risk that the stakeholders might request additional scope adding cost to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Strategy	5/16/2017
Schedule (Mo)				0.00		

Work with stakeholders to identify the requirements early.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.01
Sub-Project	I-17	Indian School	Status	Active

Unforeseen underground issues

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.25	$0.50	$1.00	$0.41	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Geotechnical, unknown or abandoned utilities. The infrastructure in this area is dated and there is a high likelihood of unknown and/or abandoned utilities

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.25	$0.50	$1.00	$0.14	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete geotechnical investigation and SUE investigations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.02
Sub-Project	I-17	Indian School	Status	Active

Protect in place the storm water line along the SB Frontage road

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The existing storm water drain behind the existing abutment structures along the SB Frontage road will need to be protected in place during the demo and construction of the structures. This may require temporary or permanent walls not included in the base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider using secant wall abutments, temporary shoring, sheet pile wall evaluated against storm water pipe relocation.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 20.01
Sub-Project	I-17	Indian School	Status	Active

COA Reports

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These projects may or may not require COA reports. Base cost does not include COA costs, which may be up to $750 k.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.30	$0.40	$0.50	$0.04	Strategy	5/16/2017
Schedule (Mo)				0.00		

Coordinate with FHWA a proof of concept.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.01
Sub-Project	I-17	Indian School	Status	Active

ITS/FMS

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
30%							
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The risk is that the planned advanced ITS/FMS that might be in place at the time of this project construction would need to be maintained, updated, or reconstructed. An additional risk is that the planned advanced ITS/FMS is not in place, but would be included in this project, Base assumes $150 k and only the current infrastructure exists.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
30%						
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate with the ITS improvements project on I-17 with ADOT TSMO and with the COP for their arterial ITS improvements; advance the design; and update the cost.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments	Last Review	Date MC Last Updated
		5/16/2017
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 CTR 40.01
Sub-Project	I-17	Indian School	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.29	$0.59	$0.88	$0.29	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.29	$0.59	$0.88	$0.29	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Cost Risk Assessment (CRA)

Results

Project Name: I-17 & Northern Platform TI

TRACS Number: U0008

Project Description: Upgrade the I-17 and Northern interchange to a three level platform diamond, by adding a new east-west flyover over the interchange along Northern Avenue.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$44.0	$41.2	$45.9	$48.0
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Jul 2022	Jul 2022	Mar 2023	Aug 2023

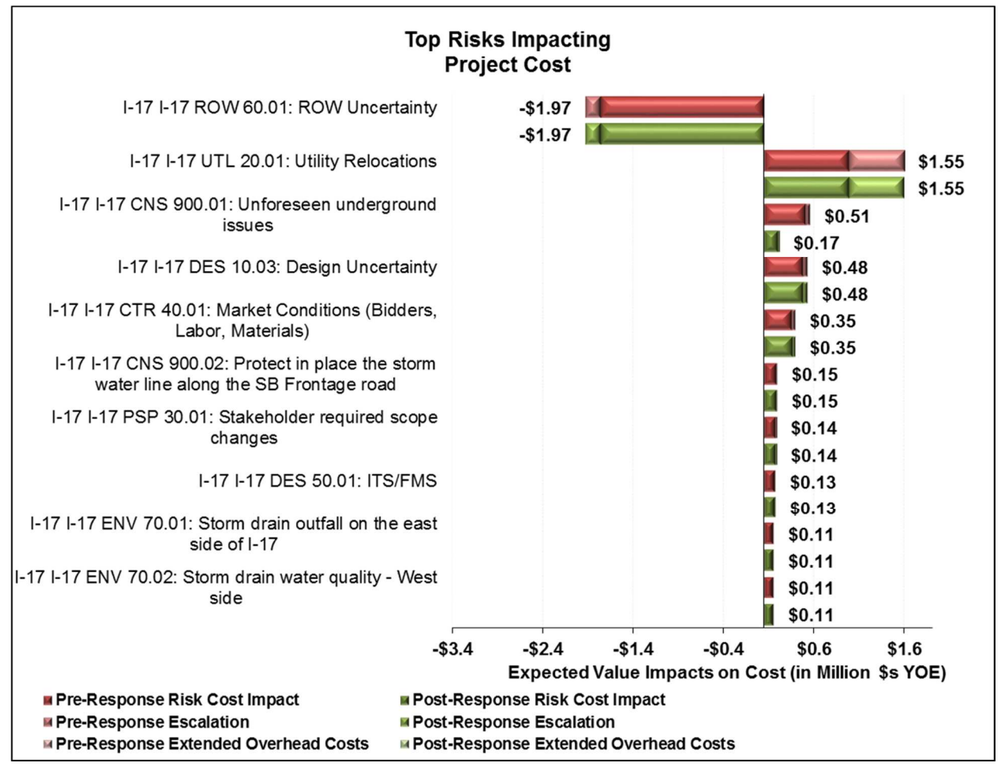
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$2,167,833	$2,396,301	$2,639,145
200	Right-of-Way / Utilities	$7,985,150	$7,985,150	$7,985,150
300	Construction	$28,220,927	$31,259,300	$34,346,401
310	Construction Engineering	$2,021,437	$2,349,966	$2,442,762
400	Project Completion	$0	$0	$0
Total		**$40,395,347**	**$43,990,717**	**$47,413,458**

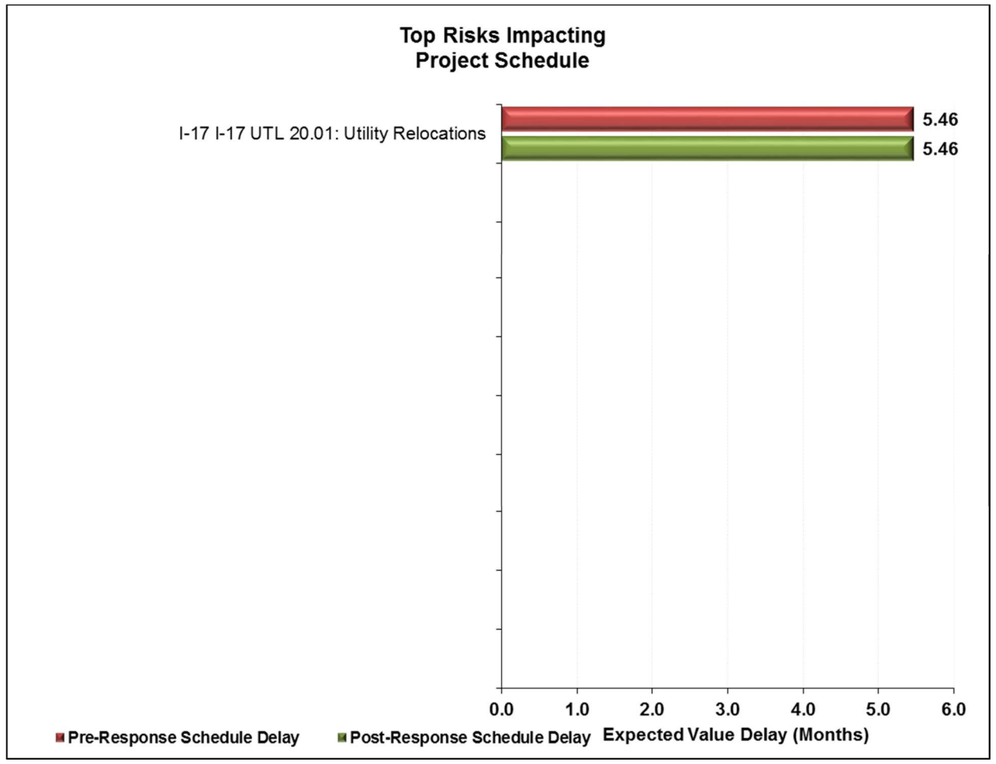
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	10/11/17	6/10/20	32.00
200	Right-of-Way / Utilities	4/11/19	10/12/20	18.10
300	Construction	6/10/20	7/5/22	24.84
310	Construction Engineering	6/10/20	7/5/22	24.84
400	Project Completion	7/5/22	7/5/22	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Note: ROW Uncertainty risk is quantified with a range of +/- 6 months impact but the expected value impact is zero months and is NOT depicted in the chart.

Project	I-17	Scenario	Risk ID	I-17 I-17 UTL 20.01
Sub-Project	I-17	Northern	Status	Active

Utility Relocations

Risk Trigger		Flowchart Activity	Construction / ROW
Dependency & Correlation	Cost to construction; schedule to ROW		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$1.00	$1.25	$1.50	$0.94	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)	3.00	6.00	12.00	4.88			

The assumption is that the utilities in the north half of the bridge are impacted. The base has a $2 M allowance for utilities such as 12-inch waterline, 8-inch SW Gas, Century Link telecommunication, SRP electrical bank, and other miscellaneous utilities. There is a 69 kV line that needs relocated along the north side of Northern. The 69 kV would require early ROW for relocation and could be a schedule risk with design and long lead for the poles. The risk is that the $2 M allowance might not be sufficient. Temporary relocation of some of these utilities maybe required based on construction phasing.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$1.00	$1.25	$1.50	$0.94	Strategy	5/16/2017
Schedule (Mo)	3.00	6.00	12.00	4.88	Mitigate	

Early agreement on the decision to widen Northern to the north. Early coordination with the 69 kV utility company. Advance the design and coordination with City of Phoenix. Consider acquiring ROW early to accommodate utility relocations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Utility Coordinator / Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ROW 60.01
Sub-Project	I-17	Northern	Status	Active

ROW

Risk Trigger		Flowchart Activity	ROW
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$3.00	-$2.00	$0.00	-$1.83	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00			

The base includes $7.25 M based on 2.9 acres of impacts (neat line) at $2.5 M / acre. This area does not include any additional property required for full takes or access control. Concept design assumes impacts to 4 structures (2 operating businesses). At this level of design and estimation, there is an uncertainty that it could be $3 M lower and the schedule could be more or less depending on relocation. The actual business parcels could be closer to 3.5 acres (includes a partial acquisition of the K-Mart building). Because majority of the parcels are currently vacant, the base cost of $2.5 M per acre maybe on the high side.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$3.00	-$2.00	$0.00	-$1.83	Strategy	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00	Mitigate	

Refine design and ROW estimates. Consider early acquisitions on current vacant properties (K-Mart, Village Inn, and the parcel on the northeast corner).

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.03
Sub-Project	I-17	Northern	Status	Active

Design Uncertainty

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These are concept level designs, There is an opportunity that optimization could be done by minimizing median widths, landscaping buffers, and possibly even turn lanes. There is also a potential for added scope for items such as turn lanes, lengthening the project to accommodate tie-ins, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 30.01
Sub-Project	I-17	Northern	Status	Active

Aesthetics: decorative bridge railing and ped fencing

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	
Schedule (Mo)				0.00			

The base does not assume complex aesthetic treatments and railing. There is a risk that stakeholders may require complex aesthetics and railings. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.01
Sub-Project	I-17	Northern	Status	Active

Storm drain outfall on the east side of I-17

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The base assumes $400 k for retrofitting onsite drainage, The risk is that the added impervious on the east side needs to drain into the city outfall. To mitigate the peak flows on site, it may require detention basins for quality and quantity,. Adding cost to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design and coordinate with the city. Consider total take ROW remainders for basin locations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.02
Sub-Project	I-17	Northern	Status	Active

Storm drain water quality - West side

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Base assumes all onsite water pre and post construction outfalls directly to ADOT storm drain pipe in the SB Frontage road. This risk addresses the possibility that water quality requirements will have to be met before the water gets dumped into the outfall.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider total take ROW remainders for basin locations, if required.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 900.01
Sub-Project	I-17	Northern	Status	Active

Concept Approval by Agency Officials

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Elected and agency officials may want an opportunity to approve the conceptual design since platform diamonds are a new concept to the area. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/16/2017
Schedule (Mo)				0.00		

Present the concept design (including visualization and proof of concept) to the concerned officials.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 30.01
Sub-Project	I-17	Northern	Status	Active

Stakeholder required scope changes

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The design is not fully vetted with stakeholders. There is a risk that the stakeholders might request additional scope adding cost to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Strategy	5/16/2017
Schedule (Mo)				0.00		

Work with stakeholders to identify the requirements early.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.01
Sub-Project	I-17	Northern	Status	Active

Unforeseen underground issues

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.25	$0.50	$1.00	$0.41	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Geotechnical, unknown or abandoned utilities. The infrastructure in this area is dated and there is a high likelihood of unknown and/or abandoned utilities

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.25	$0.50	$1.00	$0.14	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete geotechnical investigation and SUE investigations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.02
Sub-Project	I-17	Northern	Status	Active

Protect in place the storm water line along the SB Frontage road

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The existing storm water drain behind the existing abutment structures along the SB Frontage road will need to be protected in place during the demo and construction of the structures. This may require temporary or permanent walls not included in the base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider using secant wall abutments, temporary shoring, sheet pile wall evaluated against storm water pipe relocation.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 20.01
Sub-Project	I-17	Northern	Status	Active

COA Reports

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These projects may or may not require COA reports. Base cost does not include COA costs, which may be up to $750 k.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.30	$0.40	$0.50	$0.04	Strategy	5/16/2017
Schedule (Mo)				0.00		

Coordinate with FHWA a proof of concept.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 900.03
Sub-Project	I-17	Northern	Status	Active

Project deferral

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Project deferral of Northern due to overlap with LRT construction on Dunlap. Deferring this project could also help with the ROW acquisition and the utility relocation, specifically the OH power, and also with the temporary relocation of the utilities in the north half of the bridge. Northern would have to be deferred 2.5 years to not have any overlap with the construction on Dunlap. This is a watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.01
Sub-Project	I-17	Northern	Status	Active

ITS/FMS

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
30%							
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The risk is that the planned advanced ITS/FMS that might be in place at the time of this project construction would need to be maintained, updated, or reconstructed. An additional risk is that the lanned advanced ITS/FMS is not in place, but would be included in this project, Base assumes $150 k and only the current infrastructure exists.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
30%						
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate with the ITS improvements project on I-17 with ADOT TSMO and with the COP for their arterial ITS improvements; advance the design; and update the cost.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CTR 40.01
Sub-Project	I-17	Northern	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.31	$0.63	$0.94	$0.31	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.31	$0.63	$0.94	$0.31	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Cost Risk Assessment (CRA)

Results

Project Name: I-17 & Glendale Platform TI

TRACS Number: U0007

Project Description: Upgrade the I-17 and Glendale interchange to a three level platform diamond, by adding a new east-west flyover over the interchange along Glendale Avenue.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$43.0	$40.1	$46.3	$49.2
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Feb 2027	Feb 2027	May 2027	Aug 2027

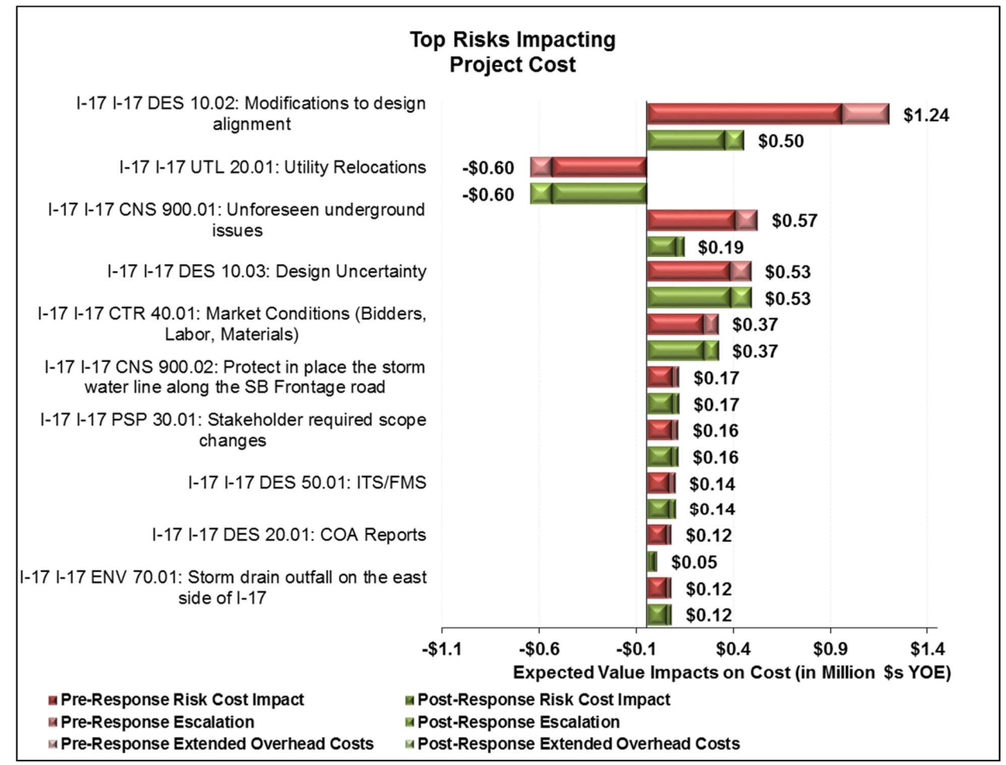
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$2,052,421	$2,254,601	$2,496,285
200	Right-of-Way / Utilities	$9,086,550	$9,086,550	$9,086,550
300	Construction	$26,778,282	$29,407,905	$32,560,654
310	Construction Engineering	$2,021,437	$2,205,702	$2,442,762
400	Project Completion	$0	$0	$0
Total		**$39,938,691**	**$42,954,758**	**$46,586,251**

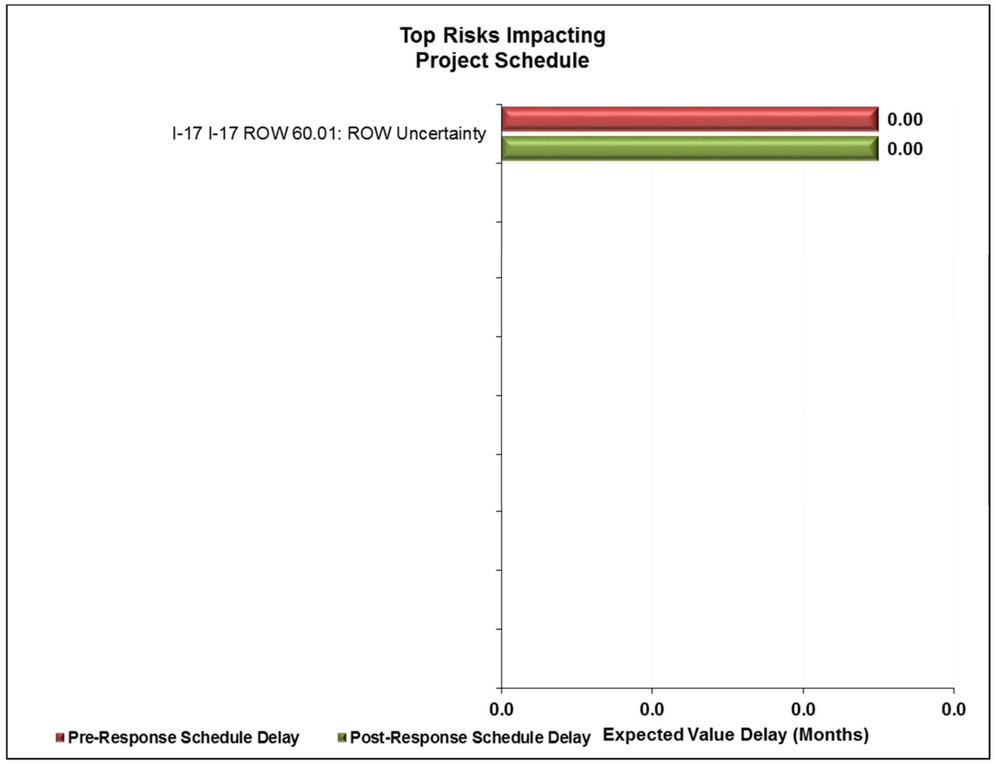
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	5/18/22	1/15/25	32.00
200	Right-of-Way / Utilities	9/15/23	5/19/25	20.14
300	Construction	1/15/25	2/9/27	24.84
310	Construction Engineering	1/15/25	2/9/27	24.84
400	Project Completion	2/9/27	2/9/27	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Note: ROW Uncertainty risk is quantified with a range of +/- 6 months impact but the expected value impact is zero months as depicted in the chart.

Project	I-17	Scenario	Risk ID	I-17 I-17 UTL 20.01
Sub-Project	I-17	Glendale	Status	Active

Utility Relocations

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	-$1.00	-$0.75	-$0.25	-$0.53	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The assumption is that the utilities in the south bridge are not impacted. The base has a $2 M allowance for utilities such as sewer, smaller waterlines, SW Gas, telecommunication, irrigation, and other miscellaneous utilities. The opportunity is that the $2 M allowance might not be excessive.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	-$1.00	-$0.75	-$0.25	-$0.53	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Advance the design and coordination with City of Phoenix. Consider acquiring ROW early to accommodate utility relocations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Utility Coordinator / Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.02
Sub-Project	I-17	Glendale	Status	Active

Modifications to design alignment

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$3.00	$4.00	$5.00	$1.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Design concept assumes TI shifts completely to the north. There is a risk that the impacts to Homestead park could require some revisions to the alignment to avoid impacts to the park. This would have significant utility impacts (including the irrigation siphon, and water and sewer lines). Additional ROW impacts to the south side of Glendale. Utilities in the south side of the bridge would all need to be relocated since that portion of the bridge would need to be removed.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$3.00	$4.00	$5.00	$0.40	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Refine the design to minimize impacts to the park and design mitigation for any potential impacts to the park.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ROW 60.01
Sub-Project	I-17	Glendale	Status	Active

ROW

Risk Trigger		Flowchart Activity	ROW
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$3.00	$0.00	$3.00	$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00			

The base includes $8.25 M based on 3.3 acres of impacts (neat line) at $2.5 M / acre. This area does not include any additional property required for full takes or access control. Concept design assumes impacts to 5 businesses. At this level of design and estimation, there is an uncertainty that it could be $3 M lower or higher and the schedule could be more or less depending on relocation.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$3.00	$0.00	$3.00	$0.00	Strategy	5/16/2017
Schedule (Mo)	-6.00	0.00	6.00	0.00	Mitigate	

Refine design and ROW estimates.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.03
Sub-Project	I-17	Glendale	Status	Active

Design Uncertainty

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
100%							
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These are concept level designs, There is an opportunity that optimization could be done by minimizing median widths, landscaping buffers, and possibly even turn lanes. There is also a potential for added scope for items such as turn lanes, lengthening the project to accommodate tie-ins, etc.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
100%						
Cost ($M)	-$2.00	$0.00	$3.00	$0.17	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 30.01
Sub-Project	I-17	Glendale	Status	Active

Aesthetics: decorative bridge railing and ped fencing

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The base does not assume complex aesthetic treatments and railing. There is a risk that stakeholders may require complex aesthetics and railings. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.01
Sub-Project	I-17	Glendale	Status	Active

Storm drain outfall on the east side of I-17

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The base assumes $400 k for retrofitting onsite drainage, The risk is that the added impervious on the east side needs to drain into the city outfall. To mitigate the peak flows on site, it may require detention basins for quality and quantity,. Adding cost to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete preliminary design and coordinate with the city. Consider total take ROW remainders for basin locations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.02
Sub-Project	I-17	Glendale	Status	Active

Storm drain water quality - West side

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Base assumes all onsite water pre and post construction outfalls directly to ADOT storm drain pipe in the SB Frontage road. This risk addresses the possibility that water quality requirements will have to be met before the water gets dumped into the outfall.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider total take ROW remainders for basin locations, if required.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 900.01
Sub-Project	I-17	Glendale	Status	Active

Concept Approval by Agency Officials

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Elected and agency officials may want an opportunity to approve the conceptual design since platform diamonds are a new concept to the area. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/16/2017
Schedule (Mo)				0.00		

Present the concept design (including visualization and proof of concept) to the concerned officials.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 30.01
Sub-Project	I-17	Glendale	Status	Active

Stakeholder required scope changes

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The design is not fully vetted with stakeholders. There is a risk that the stakeholders might request additional scope adding cost to the project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$0.10	$0.15	$0.25	$0.12	Strategy	5/16/2017
Schedule (Mo)				0.00		

Work with stakeholders to identify the requirements early.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.01
Sub-Project	I-17	Glendale	Status	Active

Unforeseen underground issues

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.25	$0.50	$1.00	$0.41	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

Geotechnical, unknown or abandoned utilities. The infrastructure in this area is dated and there is a high likelihood of unknown and/or abandoned utilities

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.25	$0.50	$1.00	$0.14	Strategy	5/16/2017
Schedule (Mo)				0.00		

Complete geotechnical investigation and SUE investigations.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.02
Sub-Project	I-17	Glendale	Status	Active

Protect in place the storm water line along the SB Frontage road

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The existing storm water drain behind the existing abutment structures along the SB Frontage road will need to be protected in place during the demo and construction of the structures. This may require temporary or permanent walls not included in the base cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.05	$0.10	$0.30	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00		

Consider using secant wall abutments, temporary shoring, sheet pile wall evaluated against storm water pipe relocation.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 20.01
Sub-Project	I-17	Glendale	Status	Active

COA Reports

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
25%							
Cost ($M)	$0.30	$0.40	$0.50	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

These projects may or may not require COA reports. Base cost does not include COA costs, which may be up to $750 k.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.30	$0.40	$0.50	$0.04	Strategy	5/16/2017
Schedule (Mo)				0.00		

Coordinate with FHWA a proof of concept.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.01
Sub-Project	I-17	Glendale	Status	Active

ITS/FMS

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
30%							
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Project Rank Cost	Project Rank Schedule	5/16/2017
Schedule (Mo)				0.00			

The risk is that the planned advanced ITS/FMS that might be in place at the time of this project construction would need to be maintained, updated, or reconstructed. An additional risk is that the planned advanced ITS/FMS is not in place, but would be included in this project, Base assumes $150 k and only the current infrastructure exists.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
30%						
Cost ($M)	$0.20	$0.30	$0.60	$0.10	Strategy	5/16/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate with the ITS improvements project on I-17 with ADOT TSMO and with the COP for their arterial ITS improvements; advance the design; and update the cost.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/16/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CTR 40.01
Sub-Project	I-17	Glendale	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.29	$0.59	$0.88	$0.29	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.29	$0.59	$0.88	$0.29	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Cost Risk Assessment (CRA)

Results

Project Name: I-17 & Thunderbird Platform TI

TRACS Number: U0010

Project Description: Upgrade the I-17 and Thunderbird interchange to a three level platform diamond by elevating I-17 to a third level over the current interchange.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$82.9	$72.1	$81.5	$86.7
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Jan 2025	Jan 2025	Jan 2025	Jan 2025

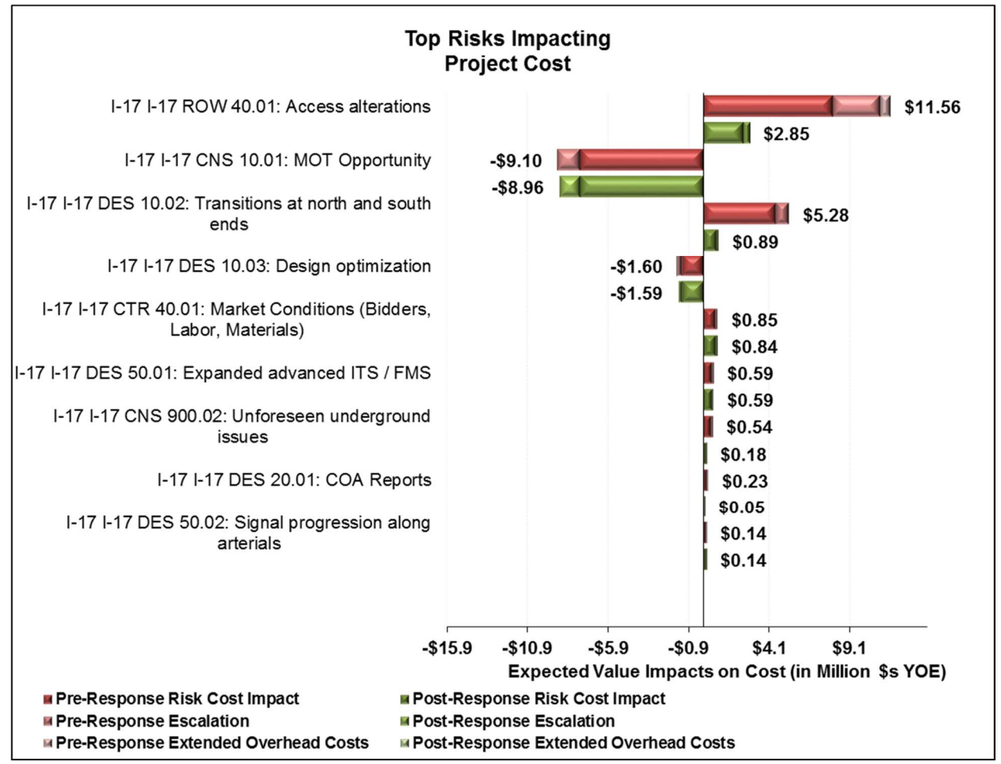
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$5,144,308	$5,481,792	$5,898,751
200	Right-of-Way / Utilities	$385,490	$385,490	$385,490
300	Construction	$67,176,149	$71,573,120	$77,015,968
310	Construction Engineering	$5,170,138	$5,491,303	$5,906,839
400	Project Completion	$0	$0	$0
Total		**$77,876,085**	**$82,931,704**	**$89,207,048**

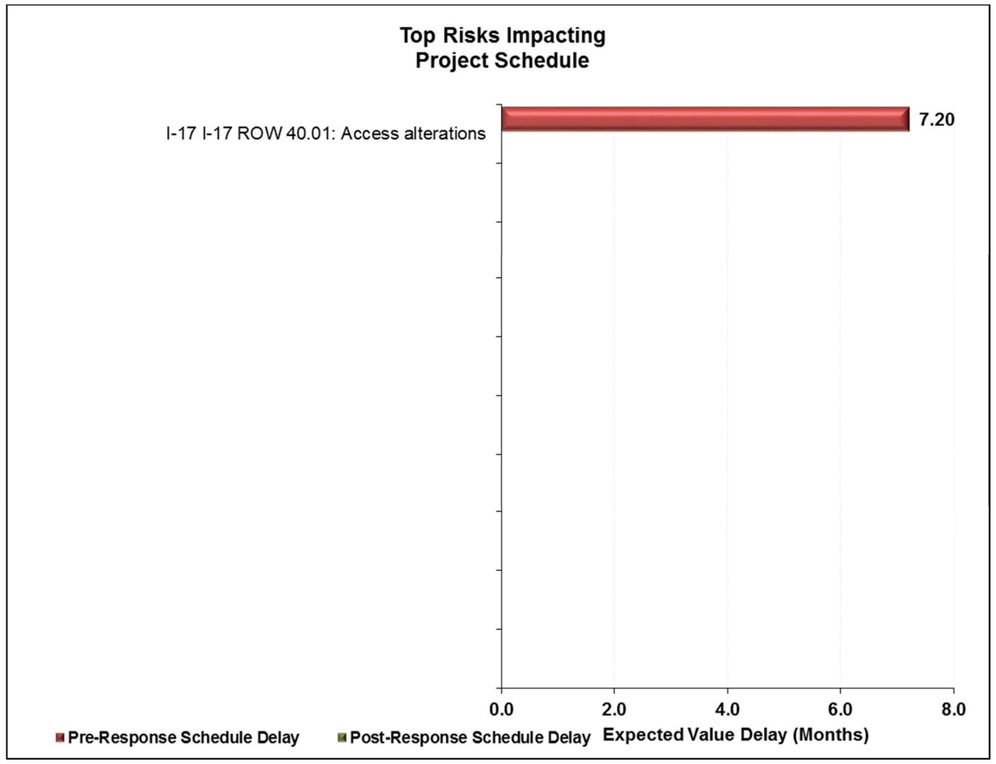
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	11/7/19	7/6/22	31.97
200	Right-of-Way / Utilities	8/5/21	11/7/22	15.11
300	Construction	7/6/22	1/14/25	30.36
310	Construction Engineering	7/6/22	1/14/25	30.36
400	Project Completion	1/14/25	1/14/25	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Project	I-17	Scenario	Risk ID	I-17 I-17 ROW 40.01
Sub-Project	I-17	Thunderbird	Status	Active

Access alterations

Risk Trigger		Flowchart Activity	ROW
Dependency & Correlation	Cost to ROW; schedule to design		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$5.00	$10.00	$15.00	$8.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)	6.00	9.00	12.00	7.20			

On the west side: Currently large businesses such as Best Buy, Lowe's, QT, and others have full access at the signal of 28th Ave and Thunderbird. The concept design may cut off left turns and through traffic on 28th Ave - essentially making their access right-in right-out. This could have high impacts to those businesses. Base estimate does not have any cost for accommodations for access.
On the east side: there is a Home Depot at the signal that would require access modifications. Since these costs are not included in the base cost, there is a risk that design alterations and expensive mitigation might be required.
The schedule would be a delay in building consensus around design concept.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$1.00	$3.00	$5.00	$2.40	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

On the west side: Consider adding a bulb U-turn at 28th Ave to accommodate access to the businesses on the southwest corner.
On the east side: Mitigate through frontage road access.
Advance predesign 12 months to mitigate potential delays; and, early coordination with business owners on concept design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 10.01
Sub-Project	I-17	Thunderbird	Status	Active

MOT Opportunity

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
85%							
Cost ($M)	-$10.00	-$9.00	-$8.00	-$7.65	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The base estimate has $14 M for items such as temporary structures, mainline detours, phasing, staging, etc. At 0% design, the construction staging plans are not developed. However, the structures required for the platform on Level 2 are very close to the existing profile of I-17. And, if built first could be used for mainline detours. This is an opportunity to reduce the assumed MOT cost and impacts. Some temporary paving and walls maybe required in the west side due to the close proximity of the existing ramps.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
85%						
Cost ($M)	-$10.00	-$9.00	-$8.00	-$7.65	Strategy	5/18/2017
Schedule (Mo)				0.00	Exploit	

Confirm interchange type; develop MOT plans; and exploit the opportunity.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.01
Sub-Project	I-17	Thunderbird	Status	Active

Combine Thunderbird and drainage projects

Risk Trigger		Flowchart Activity	Watch List
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

There is a possibility that the thunderbird and drainage projects could get combined to realize better efficiencies and eliminate throwaway or rebuilding on the drainage basins. Another option is that the drainage project can be split into 2 projects. However, the economies of scale of the specialized work on the drainage project will not be realized if the drainage project is split into 2 projects. Upon further discussion, it is not prudent to split the drainage project.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.01
Sub-Project	I-17	Thunderbird	Status	Active

Expanded advanced ITS / FMS

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.80	$1.00	$1.20	$0.50	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Base assumes $0.5 M for existing FMS modifications and perpetuating operations through construction, but nothing for next generation ITS. This risk adds $1 M for scope expansion to include the next generation ITS.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.80	$1.00	$1.20	$0.50	Strategy	5/18/2017
Schedule (Mo)				0.00	Accept	

Coordinate with the ITS improvements project on I-17 with ADOT TSMO and with the COP for their arterial ITS improvements; advance the design; and update the cost.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 20.01
Sub-Project	I-17	Thunderbird	Status	Active

COA Reports

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.30	$0.40	$0.50	$0.20	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

These projects may or may not require COA reports. Base cost does not include COA costs, which may be up to $750 k.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.30	$0.40	$0.50	$0.04	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate with FHWA a proof of concept.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.02
Sub-Project	I-17	Thunderbird	Status	Active

Signal progression along arterials

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
60%							
Cost ($M)	$0.15	$0.20	$0.25	$0.12	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Signal progression to the next intersections out would need to be synchronized with platform diamond signals. Signal revisions at 28th Ave and the business on the east side could add additional cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
60%						
Cost ($M)	$0.15	$0.20	$0.25	$0.12	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Advance the design and run microsimulation to evaluate removal of signals at 28th Ave and business access on the east side or relocating the 28th Ave signal to the west, 325 feet.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.02
Sub-Project	I-17	Thunderbird	Status	Active

Unforeseen underground issues

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.25	$0.50	$1.00	$0.41	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Geotechnical, unknown or abandoned utilities. The infrastructure in this area is dated and there is a high likelihood of unknown and/or abandoned utilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.25	$0.50	$1.00	$0.14	Strategy	5/18/2017
Schedule (Mo)				0.00		

Complete geotechnical investigation.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.02
Sub-Project	I-17	Thunderbird	Status	Active

Transitions at north and south ends

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$2.00	$5.00	$10.00	$4.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The base assumes that the ramps could be tied in within existing ROW. The ultimate I-17 shows these ramps impacting drainage features, utilities, and extending outside of the current ROW.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$1.00	$3.00	$5.00	$0.75	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Vertically tie-in the ramps sooner; narrow the I-17 walls at the transitions to maintain within existing ROW. This may require minor reconstruction with the ultimate project.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.03
Sub-Project	I-17	Thunderbird	Status	Active

Design optimization

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	-$6.00	-$3.00	$3.00	-$2.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The design is incomplete. There are opportunities to refine the design that could result in opportunities that reduce cost and impacts not defined in others.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$6.00	-$3.00	$3.00	-$2.00	Strategy	5/18/2017
Schedule (Mo)				0.00	Exploit	

Advance the design and perform a VE study on the updated design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 20.02
Sub-Project	I-17	Thunderbird	Status	Active

Public and stakeholder involvement

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Elected and agency officials / stakeholders may want an opportunity to approve the conceptual design since platform diamonds are a new concept to the area. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CTR 40.01
Sub-Project	I-17	Thunderbird	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.72	$1.43	$2.15	$0.72	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.72	$1.43	$2.15	$0.72	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated

Next Review	Risk Assignment

Cost Risk Assessment (CRA)

Results

Project Name: I-17 & Bell Platform TI

TRACS Number: U0009

Project Description: Upgrade the I-17 and Bell interchange to a three level platform diamond by elevating I-17 to a third level over the current interchange. Scope also includes expanding the existing park and ride in the southwest quadrant.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$96.1	$85.5	$96.3	$101.9
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Feb 2027	Feb 2027	Feb 2027	Feb 2027

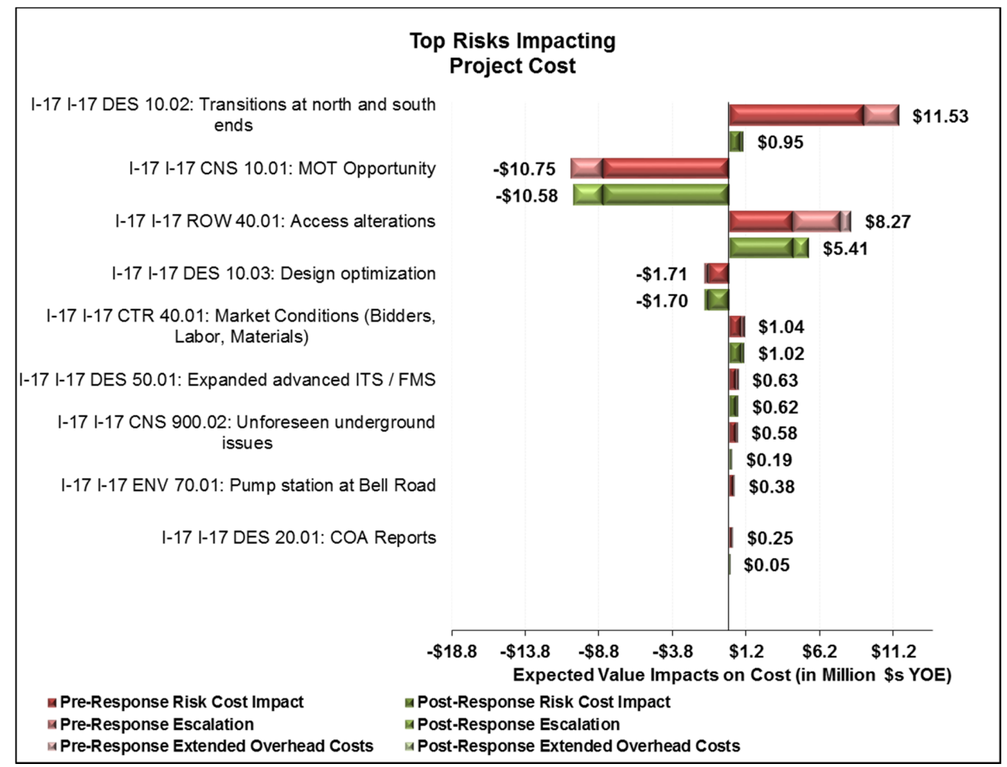
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$5,872,446	$6,316,798	$6,849,566
200	Right-of-Way / Utilities	$991,260	$991,260	$991,260
300	Construction	$76,689,720	$82,482,986	$89,438,944
310	Construction Engineering	$5,911,455	$6,341,422	$6,874,863
400	Project Completion	$0	$0	$0
Total		**$89,464,882**	**$96,132,466**	**$104,154,633**

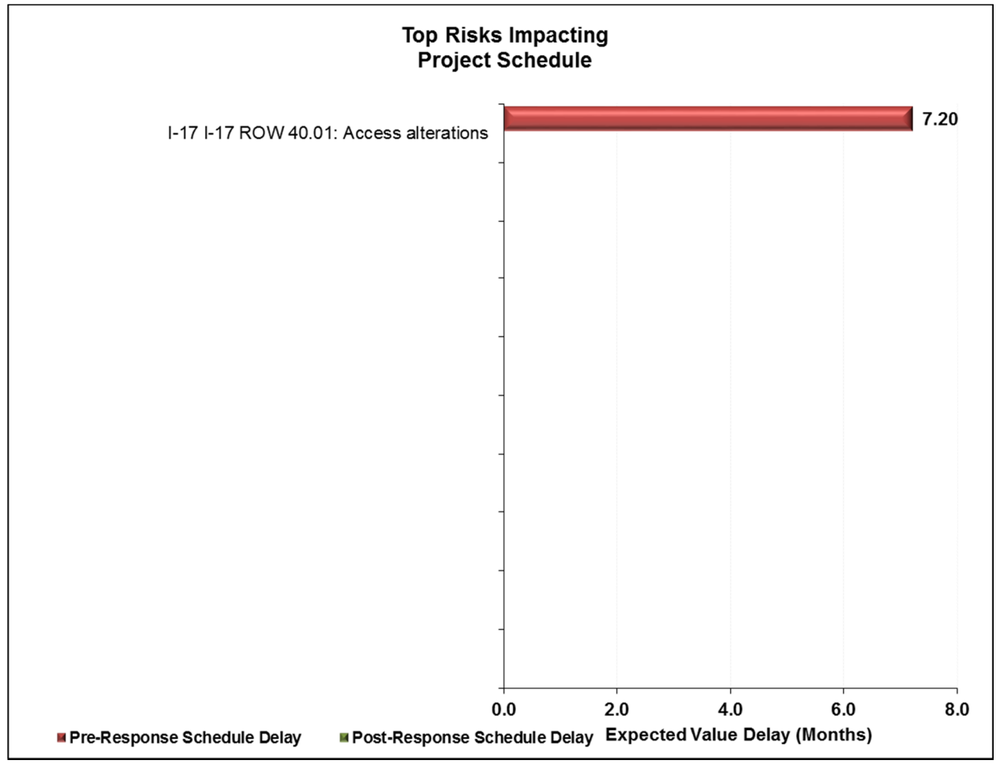
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	5/18/22	1/15/25	32.00
200	Right-of-Way / Utilities	9/15/23	5/19/25	20.14
300	Construction	1/15/25	2/9/27	24.84
310	Construction Engineering	1/15/25	2/9/27	24.84
400	Project Completion	2/9/27	2/9/27	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Project	I-17	Scenario	Risk ID	I-17 I-17 ROW 40.01
Sub-Project	I-17	Bell	Status	Active

Access alterations

Risk Trigger		Flowchart Activity	ROW
Dependency & Correlation	Cost to ROW; schedule to design		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$3.00	$5.00	$8.00	$4.13	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)	6.00	9.00	12.00	7.20			

On the west side: The park and ride, Fry's, and Red Roof Inn could all have access impacts.
On the west side: Auto Nation, Waffle House, Shell, and Fairfield Inn could all have access impacts.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$3.00	$5.00	$8.00	$4.13	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Change the design to provide adequate access to the businesses.
Advance predesign 12 months to mitigate potential delays; and, early coordination with business owners on concept design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 ENV 70.01
Sub-Project	I-17	Bell	Status	Active

Pump station at Bell Road

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
20%							
Cost ($M)	$1.00	$1.50	$2.00	$0.30	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

There is a pump station at the northwest corner. The concept design clips a corner of the pump station and may require relocation. The pump station will be required in the ultimate project. The base cost has no cost to address this.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
0%						
Cost ($M)	$1.00	$1.50	$2.00	$0.00	Strategy	5/18/2017
Schedule (Mo)				0.00	Avoid	

Optimize the design to accommodate the pump station at its current location.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 10.01
Sub-Project	I-17	Bell	Status	Active

MOT Opportunity

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
85%							
Cost ($M)	-$11.00	-$10.00	-$9.00	-$8.50	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The base estimate has $14 M for items such as temporary structures, mainline detours, phasing, staging, etc. At 0% design, the construction staging plans are not developed. However, the structures required for the platform on Level 2 are very close to the existing profile of I-17. And, if built first could be used for mainline detours. This is an opportunity to reduce the assumed MOT cost and impacts.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
85%						
Cost ($M)	-$11.00	-$10.00	-$9.00	-$8.50	Strategy	5/18/2017
Schedule (Mo)				0.00	Exploit	

Confirm interchange type; develop MOT plans; and exploit the opportunity.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.01
Sub-Project	I-17	Bell	Status	Active

Park and ride improvements at Bell - use of highway funds

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The base assumes $8 M for park and ride improvements. The risk is whether or not these improvements will be part of this project. The ramp realignment will require moving the existing dedicated bus stop to the park and ride. This is a non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/18/2017
Schedule (Mo)				0.00		

There needs to be discussion between MAG, ADOT, and VM regarding plans to improve the park and ride.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.01
Sub-Project	I-17	Bell	Status	Active

Expanded advanced ITS / FMS

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.80	$1.00	$1.20	$0.50	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Base assumes $0.5 M for existing FMS modifications and perpetuating operations through construction, but nothing for next generation ITS. This risk adds $1 M for scope expansion to include the next generation ITS.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.80	$1.00	$1.20	$0.50	Strategy	5/18/2017
Schedule (Mo)				0.00	Accept	

Coordinate with the ITS improvements project on I-17 with ADOT TSMO and with the COP for their arterial ITS improvements; advance the design; and update the cost.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments	Last Review	Date MC Last Updated
		5/18/2017
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 20.01
Sub-Project	I-17	Bell	Status	Active

Stakeholder coordination (Transit)

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The park and ride lot operations during construction requires public involvement / Valley Metro coordination efforts prior to construction. This is non-quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments	Last Review	Date MC Last Updated
	Next Review	Risk Assignment

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 20.01
Sub-Project	I-17	Bell	Status	Active

COA Reports

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.30	$0.40	$0.50	$0.20	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

These projects may or may not require COA reports. Base cost does not include COA costs, which may be up to $750 k.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.30	$0.40	$0.50	$0.04	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Coordinate with FHWA a proof of concept.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 50.02
Sub-Project	I-17	Bell	Status	Active

Signal progression along arterials

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Signal progression to the next intersections out would need to be synchronized with platform diamond signals. This is a non-quantifiable watch list item. The work can be done with the base cost and its uncertainties.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CNS 900.02
Sub-Project	I-17	Bell	Status	Active

Unforeseen underground issues

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.25	$0.50	$1.00	$0.41	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Geotechnical, unknown or abandoned utilities. The infrastructure in this area is dated and there is a high likelihood of unknown and/or abandoned utilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$0.25	$0.50	$1.00	$0.14	Strategy	5/18/2017
Schedule (Mo)				0.00		

Complete geotechnical investigation.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.02
Sub-Project	I-17	Bell	Status	Active

Transitions at north and south ends

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$5.00	$10.00	$20.00	$8.13	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The base assumes that the ramps could be tied in within existing ROW. The ultimate I-17 shows these ramps impacting drainage features, utilities, and extending outside of the current ROW.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
25%						
Cost ($M)	$1.00	$3.00	$5.00	$0.75	Strategy	5/18/2017
Schedule (Mo)				0.00	Mitigate	

Vertically tie-in the ramps sooner; narrow the I-17 walls at the transitions to maintain within existing ROW. This may require minor reconstruction with the ultimate project.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 DES 10.03
Sub-Project	I-17	Bell	Status	Active

Design optimization

Risk Trigger		Flowchart Activity	Design
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	-$6.00	-$3.00	$3.00	-$2.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

The design is incomplete. There are opportunities to refine the design that could result in opportunities that reduce cost and impacts not defined in others.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$6.00	-$3.00	$3.00	-$2.00	Strategy	5/18/2017
Schedule (Mo)				0.00	Exploit	

Advance the design and perform a VE study on the updated design.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/18/2017
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 PSP 20.02
Sub-Project	I-17	Bell	Status	Active

Public and stakeholder involvement

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/18/2017
Schedule (Mo)				0.00			

Elected and agency officials / stakeholders may want an opportunity to approve the conceptual design since platform diamonds are a new concept to the area. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17	Scenario	Risk ID	I-17 I-17 CTR 40.01
Sub-Project	I-17	Bell	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	

Dependency & Correlation	

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.82	$1.65	$2.47	$0.82	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.82	$1.65	$2.47	$0.82	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

I-17 Drainage Improvements; ACDC Canal to Greenway Road CRA Workshop Results

May 17, 2017

Cost Risk Assessment (CRA)

Results

Project Name: I-17 Drainage Improvements

TRACS Number: U0011

Project Description: Replace four existing pumpstations at Peoria, Cactus, Thunderbird, and Greenway TIs on I-17 with a gravity storm drain pipe to the ACDC canal, running largely under the SB frontage road. Pipe sizes vary from 24" to 72" and can be up to 25 deep to the flowline. The infields at Thunderbird will be excavated for new detention basins.

CRA Cost and Schedule Results

Cost Results (Millions 2017 $s)	Base Cost 2017 $s	10th Percentile 2017 $s	70th Percentile 2017 $s	90th Percentile 2017 $s
Post-Response Results Total Project Cost (2017 $s)	$25.3	$25.7	$29.2	$30.9
Schedule Results	**Base Completion**	**10th Percentile Completion**	**70th Percentile Completion**	**90th Percentile Completion**
Post-Response Project Completion	Dec 2020	Dec 2020	Mar 2021	May 2021

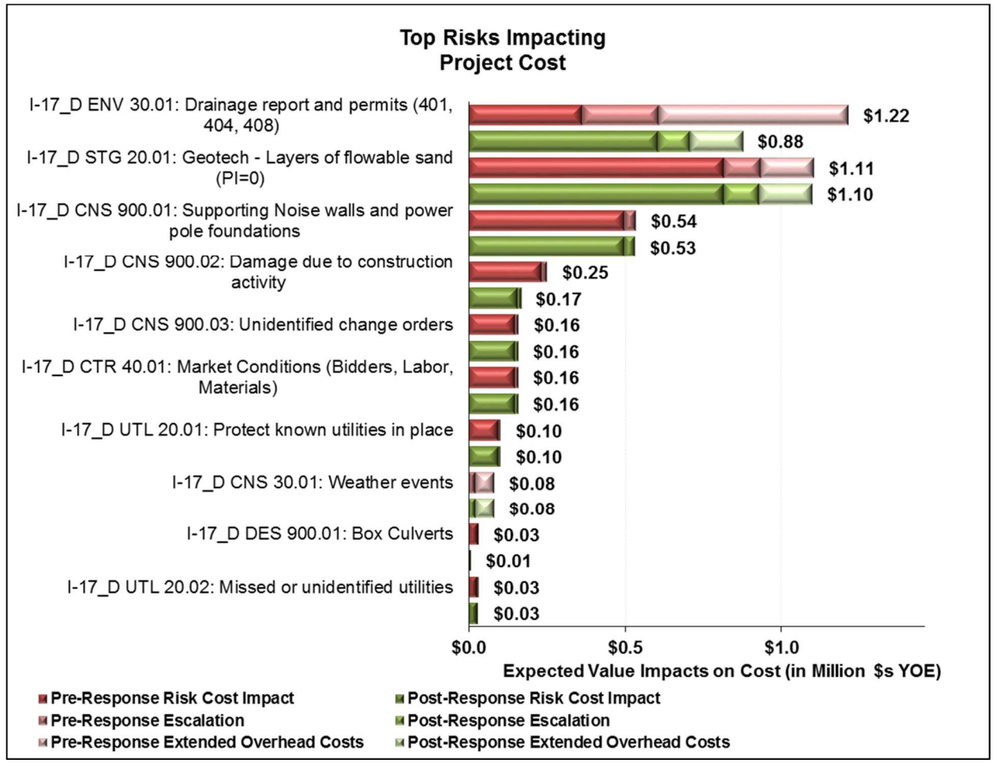
Base Costs by Activity

Activity ID	Activity Name	Total		
		Low	Base	High
100	Design / Environmental	$550,700	$550,700	$550,700
200	Right-of-Way / Utilities	$0	$0	$0
300	Construction	$20,060,889	$22,697,696	$25,416,068
310	Construction Engineering	$1,792,098	$2,027,924	$2,271,090
400	Project Completion	$0	$0	$0
Total		**$22,403,687**	**$25,276,320**	**$28,237,858**

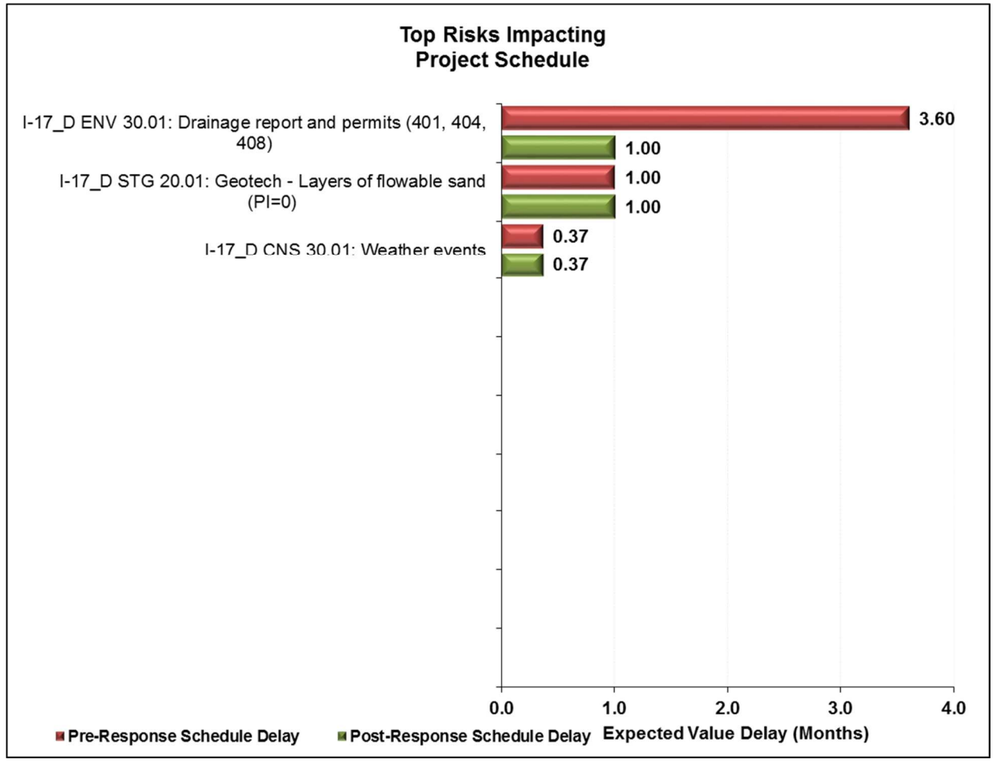
Base Schedule by Activity

Activity ID	Activity Name	Start Date	End Date	Duration (Months)
100	Design / Environmental	12/19/17	1/15/19	12.91
200	Right-of-Way / Utilities	8/13/18	5/17/19	9.13
300	Construction	1/15/19	12/14/20	23.00
310	Construction Engineering	1/15/19	12/14/20	23.00
400	Project Completion	12/14/20	12/14/20	0.03

Tornado Chart of Top Cost Risks



Tornado Chart of Top Schedule Risks



Project	I-17 Drainage	Risk ID	I-17_D I-17_D UTL 20.01
Sub-Project	I-17 Drainage	Status	Active

Protect known utilities in place

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)	$0.05	$0.10	$0.20	$0.09	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

Greenway - 54" sewer, 48" water. Close proximity, COP requires 4-foot offset from pressurized water pipe during construction (may require more per revised standards). The risk is that the waterline might need shutting down. COP allows shutdowns between Oct and Apr. This is a schedule risk. At Greenway, this is a non quantifiable watch list item.
Quarter mile south of Thunderbird - existing 28" water line is noted as abandoned in place by COP.
Between I-17 Sta 705 and 710 - a new COP waterline crosses I-17 (24" pipe in a 48" sleeve). This needs to be protected in place. This is not shown on the plans.
Sweetwater - gravity sewer in a steel sleeve. The risk is that the sewer line is lower than shown on plans and might be in conflict with the storm drain.
The cost for protecting utilities in place is part of the unit cost for installation of the pipe. This risk cost is the uncertainty in bidder's reaction.
The contract plans show locations for gas, communications, irrigation, and power that need protected in place.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	$0.05	$0.10	$0.20	$0.09	Strategy	5/17/2017
Schedule (Mo)				0.00		

Get exact location of the existing sewer line around Sta 699+50. Include a bid item to field verify the location of the sewer line.
Add a bid item for protect in place utilities that includes a table of the known utilities that need to be protected in place.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D UTL 20.02
Sub-Project	I-17 Drainage	Status	Active

Missed or unidentified utilities

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
10%							
Cost ($M)	$0.10	$0.25	$0.50	$0.03	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

The 95% plans indicate known and possible utility locations. The risk is that additional utilities might be found during construction that conflict with the design, resulting in change orders. This could be protect in place or relocate. The noise wall project exposed a number of utilities resulting in low probability of finding additional unknown utilities.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
10%						
Cost ($M)	$0.10	$0.25	$0.50	$0.03	Strategy	5/17/2017
Schedule (Mo)				0.00	Accept	

Hold a reserve for change orders.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D STG 20.01
Sub-Project	I-17 Drainage	Status	Active

Geotech - Layers of flowable sand (PI=0)

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.10	$1.00	$3.00	$0.59	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)	1.00	2.00	3.00	1.00			

Project records indicate that at some locations along the project there are incidences of flowable sand (PI=0). And, the condition is worse in wet conditions. The risk is that a pocket of flowable sand could result in overexcavation and potential sink holes in adjacent sites. Field repairs can vary between $100k and $3M. In reviewing the constructability report, this issue was noted; but, it could not be found in the boring logs. May require additional shoring in the areas where the flowable sand is not very deep.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.10	$1.00	$3.00	$0.59	Strategy	5/17/2017
Schedule (Mo)	1.00	2.00	3.00	1.00	Mitigate	

Ascertain the limits and extents with further geotechnical investigations, and include boring logs in the plans.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D ENV 10.01
Sub-Project	I-17 Drainage	Status	Active

Environmental document update

Risk Trigger		Flowchart Activity	Watch List
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

The original environmental document is a CE, which has not been reevaluated since 2006. The risk is that a new CE will be required. This is a non quantifiable watch list item

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D ENV 30.01
Sub-Project	I-17 Drainage	Status	Active

Drainage report and permits (401, 404, 408)

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
30%							
Cost ($M)	$0.50	$1.00	$2.00	$0.33	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)	6.00	12.00	18.00	3.60			

The risk is that the permit condition for 401 could require quality treatments that are not currently in the base design, especially in the 3 downstream miles. This could require ROW and basins or large underground tanks.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.50	$1.00	$2.00	$0.54	Strategy	5/17/2017
Schedule (Mo)	1.00	2.00	3.00	1.00	Mitigate	

Coordinate with Corps to determine applicability of water quality to this project. Offer that we have the ability to treat in our basins 50% of the flow, upstream of Thunderbird; this is an improvement over the existing condition.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		Monthly

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 900.01
Sub-Project	I-17 Drainage	Status	Active

Supporting Noise walls and power pole foundations

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

Power pole foundations are mitigated by drilled shafts. Noise walls are on shallow spread footings. These may require additional shoring during construction. Base estimate has $1,500 per foot to jack and bore a 72-inch pipe. Between Cactus and Peoria, there is a pinch point on noise walls approximately 1000 feet that requires additional shoring or jack and bore.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.50	$1.00	$1.50	$0.50	Strategy	5/17/2017
Schedule (Mo)				0.00	Mitigate	

Conduct an industry outreach / constructability review. Include in advertisement for final designer experienced construction advisor. Evaluate shoring cost versus jack and bore at the pinch points.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 80.01
Sub-Project	I-17 Drainage	Status	Active

Construction sequencing with VM NW Phase II and other projects

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.10	$0.20	$0.30	$0.10	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)	0.25	0.50	1.00	0.27			

VM is scheduled to be under construction Aug 2019 through Spring 2023. The last mile of the outfall is in direct conflice with the plans for the station. There is a risk if both contractors are in the same area at the same time leading to potential delays to one or both projects. This is a nonquantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)	-$0.30	-$0.20	-$0.10	-$0.16	Strategy	5/17/2017
Schedule (Mo)				0.00		

There must be coordination with the VM NW Phase II project. Consider specifying the order of work to complete thd downstream outfall first to eliminate conflicts with VM NW Phase II station and guideway work. Consider coordination with the VM work for them to do their work on the closed section of the SB frontage road prior to reopening the frontage road. Revise the drainage project to avoid full pavement and curb on the frontage road in the vicinity of the LRT project.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D ROW 60.01
Sub-Project	I-17 Drainage	Status	Active

Temporary Construction Easements

Risk Trigger		Flowchart Activity	Watch List
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

Base cost assumes all construction within the existing ROW. The risk is that temporary construction easements maybe required for construction activities not currently defined. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/17/2017
Schedule (Mo)				0.00		

The final designer to identify TCE required for constructability.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 10.01
Sub-Project	I-17 Drainage	Status	Active

MOT

Risk Trigger		Flowchart Activity	Watch List
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

The base schedule assumes 13 months for construction. However, due to the vicinity of the mall in the last downstream mile of the project, there might be moratoriums on construction between Thanksgiving and New Year's. Additionally, the closure of the frontage road required for this project and the VM project needs to be coordinated. Lastly, access to properties and businesses adjacent to the project might be impacted. This is a non quantifiable watch list risk.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/17/2017
Schedule (Mo)				0.00		

Review and coordinate special provisions with COP and VM, and with fire and life safety (access requirements).

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 900.02
Sub-Project	I-17 Drainage	Status	Active

Damage due to construction activity

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.15	$0.25	$0.50	$0.21	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

The risk is that the contractor might bid a premium because of the dense urban characteristics of the project area knowing that he will be responsible for any damages. Example damages could be to the surrounding sidewalks, curbs, and homes damaged by the vibration during compaction and/or heavy equipment.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.15	$0.25	$0.50	$0.14	Strategy	5/17/2017
Schedule (Mo)				0.00	Mitigate	

Document damages to the existing infrastructure around the project area to minimize the probability of change orders.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Construction manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 30.01
Sub-Project	I-17 Drainage	Status	Active

Weather events

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation	no contractor overhead		

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
80%							
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)	0.10	0.50	0.75	0.38			

The risk is that the deep trenches are susceptible to work shutdowns due to heavy rains. This project is a multi season project; therefore it could have multiple project shutdowns.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
80%						
Cost ($M)				$0.00	Strategy	5/17/2017
Schedule (Mo)	0.10	0.50	0.75	0.38		

Do not charge the contractor working days during weather events.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D DES 900.01
Sub-Project	I-17 Drainage	Status	Active

Box Culverts

Risk Trigger		Flowchart Activity	Construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
5%							
Cost ($M)	$0.25	$0.50	$1.00	$0.03	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

There is a risk of removing the box culverts between Thunderbird and Greenway along the NB Frontage Road. Base estimate does not show cost for box culverts (details D1 & D2). The risk is that a significant weather event while a portion of the box culvert is removed for excavation could trigger severe flooding.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
1%						
Cost ($M)	$0.25	$0.50	$1.00	$0.01	Strategy	5/17/2017
Schedule (Mo)				0.00	Mitigate	

Require an approved workplan to execute the work at an appropriate time of the year and an expedited work plan for the box culvert work. Consider using precast box culvert elements or temporary piping to mitigate this risk.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Design Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CTR 10.01
Sub-Project	I-17 Drainage	Status	Active

Delivery method

Risk Trigger		Flowchart Activity	Watch list
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
Cost ($M)				$0.00	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

The assumed base is D-B-B. The risk is that the complexity of the work involved does not lend itself to the lowest bid. This is a non quantifiable watch list item.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
Cost ($M)				$0.00	Strategy	5/17/2017
Schedule (Mo)				0.00		

Conduct an industry outreach / constructability review. Include in advertisement for final designer experienced construction advisor. Consider using a D-B-B with ATC's.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CNS 900.03
Sub-Project	I-17 Drainage	Status	Active

Unidentified change orders

Risk Trigger		Flowchart Activity	construction
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
75%							
Cost ($M)	$0.10	$0.20	$0.30	$0.15	Project Rank Cost	Project Rank Schedule	5/17/2017
Schedule (Mo)				0.00			

Assume approximately 1% of the $ 23 M is not covered in the other identified risks.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
75%						
Cost ($M)	$0.10	$0.20	$0.30	$0.15	Strategy	5/17/2017
Schedule (Mo)				0.00	Accept	

Hold a reserve for unknown unknowns.

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
Project Manager		To		

Review Comments

Last Review	Date MC Last Updated
	5/17/2017
Next Review	**Risk Assignment**

Project	I-17 Drainage	Risk ID	I-17_D I-17_D CTR 40.01
Sub-Project	I-17 Drainage	Status	Active

Market Conditions (Bidders, Labor, Materials)

Risk Trigger		Flowchart Activity	
Dependency & Correlation			

Pre-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Program Rank Cost	Program Rank Schedule	Date Pre Last Updated
50%							
Cost ($M)	$0.15	$0.30	$0.45	$0.15	Project Rank Cost	Project Rank Schedule	5/22/2017
Schedule (Mo)				0.00			

There could be a shortage of skilled labor and / or project materials and /or a reduced number of bidders due to the large number of projects in the Greater Phoenix area when this project is expected to be constructed. The cost is a range of 1%, 2%, or 3% of the base construction cost.

Post-Response Quantification

Probability	Low	Most Likely	High	Total Expected Value Impact	Additional Cost to Respond	Date Post Last Updated
50%						
Cost ($M)	$0.15	$0.30	$0.45	$0.15	Strategy	5/22/2017
Schedule (Mo)				0.00		

Monitoring and Control

Risk Owner	Risk Aging	From		Status Interval
		To		

Review Comments

Last Review	Date MC Last Updated
Next Review	**Risk Assignment**