I-19 CORRIDOR PROFILE STUDY

NOGALES TO JUNCTION I-10

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Draft Working Paper 6: Solution Evaluation and Prioritization

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ACRONYMS

AADT	Average Annual Daily Traffic
ADOT	Arizona Department of Transportation
AZTDM	Arizona Travel Demand Model
BCA	Benefit Cost Analysis
DCR	Design Concept Report
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HERE	Real time traffic conditions database produced by American Digital Cartography Inc.
HPMS	Highway Performance Monitoring System
I-19	Interstate 19
LCCA	Life Cycle Cost Analysis
LOS	Level of Service
MAP 21	Moving Ahead for Progress in the 21st Century
MP	Milepost
NB	Northbound
OP	Overpass
PAG	Pima Association of Governments
PARA	Planning Assistance for Rural Areas Studies
PES	Performance Evaluation Score
P2P	Planning to Programming
PDI	Pavement Distress Index
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
RTP	Regional Transportation Plan
SEAGO	Southeast Arizona Council of Governments
SB	Southbound
SHSP	Strategic Highway Safety Plan
SPUI	Single Point Urban Interchange
SR	State Route
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTTI	Truck Travel Time Index
UP	Underpass
V/C	Volume to Capacity Ratio

1 INTRODUCTION

Interstate 19 (I-19) is a major corridor for intrastate and international commerce between Mexico and the United States. It is one of nine Arizona Department of Transportation (ADOT) defined corridors that play a key role in the understanding the overall health of the statewide transportation system. The statewide plan, *What Moves You Arizona*, and the *Planning to Programming Linkage (P2P)* have begun developing a framework to integrate the planning and programming process in a transparent, defensible, logical, and reproducible way. The I-19 Corridor Profile Study is one piece that begins to connect strategic decisions to on-the-ground improvements.

Corridor Study Purpose

This series of corridor profile studies examine significant state corridors and compare performance to goals using performance measures identified in the P2P process. The purpose of these studies is to identify the gap between measured performance and stated goals and to perform a comparative analysis both within the I-19 corridor and with other statewide significant corridors. This effort results in the prioritization of solutions that will improve the overall performance of the I-19 corridor. The process by which this corridor profile study will achieve the desired results focuses on the following process areas:

- Inventory past recommendations for improvements that have been completed or are in progress;
- Provide an overall assessment of the existing health of the corridor, based on system performance measures;
- Recommend a range of solution sets to help improve the overall performance;
- Determine how proposed corridor improvements are prioritized through a risk-based evaluation process; and
- Complete a P2P ranking of proposed improvements and recommend strategic initiatives.

Corridor Study Objectives

The I-19 Corridor Profile Study defines solution sets and improvements that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor. Corridor benefits are documented by three investment types including preservation, modernization, and expansion. The main objective of this study is to identify potential actions that increase the performance of the I-19 corridor to acceptable levels. These actions or projects were analyzed based on risk potential, life-cycle costs, and cost-benefits to produce a prioritized list of projects that help achieve corridor goals. The following goals have been identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals;
- Match solutions with deficiencies in measured performance; and
- Prioritize improvements that efficiently preserve, modernize, and expand transportation infrastructure.

Study Location and Corridor Segments

The I-19 Corridor is a multi-modal corridor located in southern Arizona that serves international, regional, and local traffic and commerce demand between the United States and Mexico. I-19 spans approximately 64 miles from the international border near Nogales, Arizona north to the junction with Interstate 10 (I-10) at milepost 63.69 in Tucson, Arizona as illustrated in **Figure 1.**

The I-19 Corridor is divided into six planning segments for analysis and evaluation. These planning segments allow the corridor to be analyzed at a detailed level so that location-specific needs can be readily identified and compared to other segments on this or other corridors. Segmentation by similar characteristics enables the analysis to highlight anomalies or instances of poor performance within the context of each segment. Planning segments for the I-19 Corridor are defined in **Table 1.**

The planning segments were created to define a consistent method of grouping data and to define a level of granularity appropriate for supporting long range corridor-level priorities. In order to measure and compare planning segments to each other and to the system as a whole, the root data set is normalized to represent each planning segment.

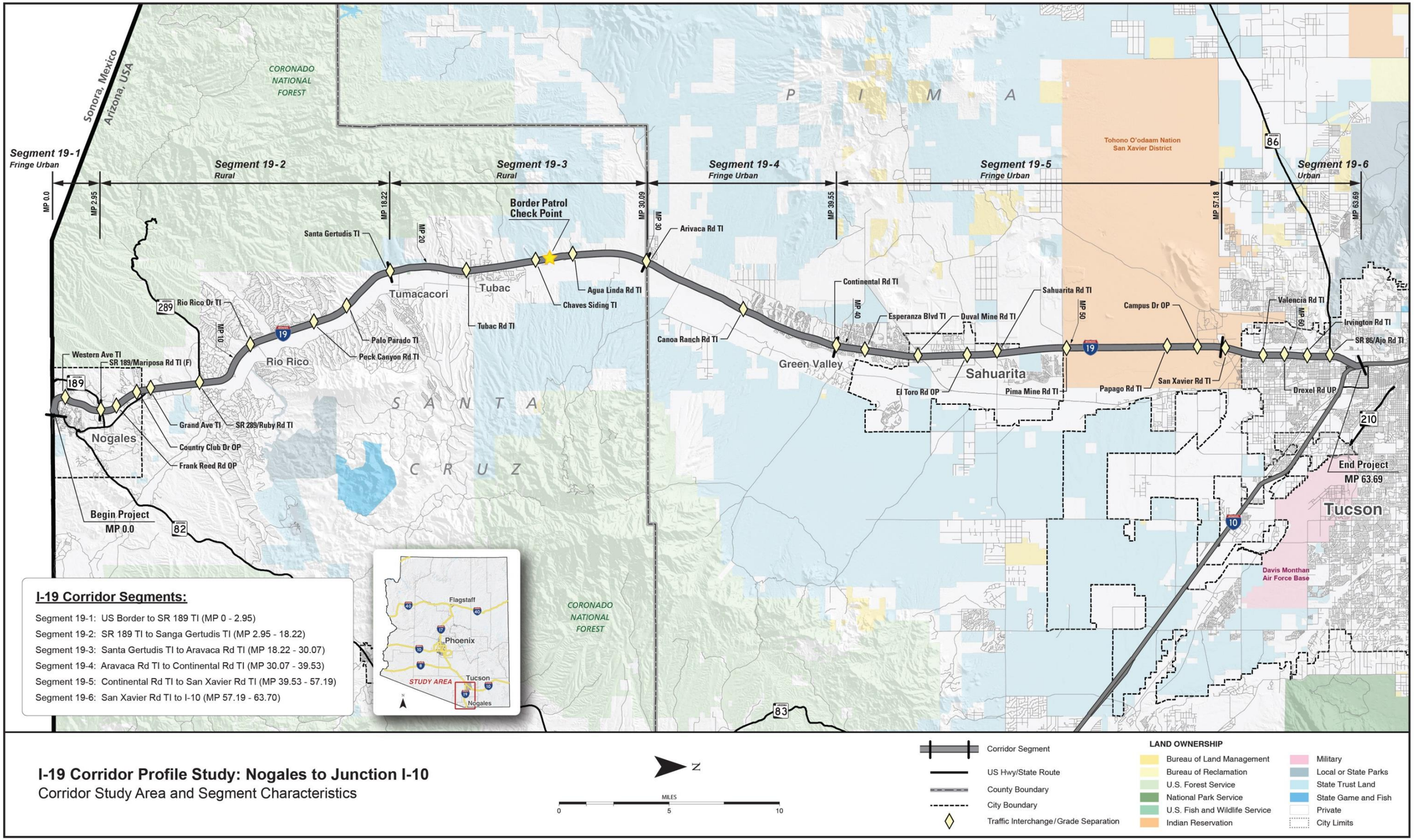
Table 1 I-19 Corridor Segments

Corridor Segments				
Segment	Segment Name	Begin MP	End MP	Description
19-1	Nogales (south)	0.00	2.95	Fringe urban, rolling terrain, transition from 4-lane surface street to 4-lane divided, 0 interchanges, Santa Cruz County, City of Nogales
19-2	Nogales to Santa Gertudis TI (Rock Corral Rd)	2.95	18.22	Rural, level terrain, 4-lane divided, 6 interchanges, Santa Cruz County,
19-3	Santa Gertudis TI to Aravaca Rd TI	18.22	30.07	Rural, level terrain, 4-lane divided, 3 interchanges, Santa Cruz County,
19-4	Aravaca Rd TI to Continental Rd TI	30.07	39.53	Fringe urban, level terrain, 4-lane divided, 4 interchanges, Pima County,
19-5	Continental Rd TI to San Xavier Rd. TI	39.53	57.19	Fringe urban, level terrain, 4-lane divided, 7 interchanges, Pima County, Tohono O'odham Nation San Xavier District
19-6	Tucson	57.19	63.70	Urban, level terrain, 4-lane divided, 7 interchanges, Pima Co., City of Tucson, Tohono O'odham Nation San Xavier District

Working Paper #6 Objectives

The objective of Working Paper #6 is to document the evaluation of the strategic solutions (projects) identified for the I-19 Corridor. This evaluation includes a Life-Cycle Cost Analysis (LCCA) for pavement and bridge projects and a Benefit Cost Analysis (BCA) on freight, safety, and mobility projects that have multiple options. In addition, this evaluation also includes a risk based performance effectiveness evaluation on each recommendation to determine the amount of benefit to the performance scores each project produces. The result of this evaluation is a prioritized list of recommendations for the I-19 corridor.

Figure 1 Corridor Location and Segments



2 CANDIDATE SOLUTION EVALUATION PROCESS

Candidate Solutions identified in Working Paper #5 were be evaluated in multiple ways including a Life Cycle Cost or Benefit Cost Analysis (where applicable), Risk Analysis, and a Performance Effectiveness Analysis. The methodology and approach to this analysis is described below. **Figure 2** illustrates the candidate solution evaluation process.

Life Cycle Cost Analysis or Benefit Costs Analysis

All pavement and bridge candidate solutions have multiple options, rehabilitate the area of need, or fully reconstruct the issue area or structure. These options were evaluated through a life cycle cost analysis (LCCA) to determine the best approach for each location where a pavement or bridge solution is recommended. The LCCA may eliminate options from further consideration and identifies which options should be carried forward for further evaluation.

Any mobility, safety, or freight strategic issue area that resulted in multiple independent candidate solutions was evaluated through a benefit cost analysis (BCA) to determine which solutions should be eliminated or carried forward. After the LCCA and BCA, the remaining options were advanced to the Performance Effectiveness Evaluation.

Performance Effectiveness Evaluation

After the LCCA and BCA processes are complete, all remaining candidate solutions were evaluated based on their performance effectiveness. This process included determining a performance effectiveness score based on how much each solution impacts the existing Performance and Needs scores for each project segment. This evaluation also includes a Performance Area Risk Evaluation to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

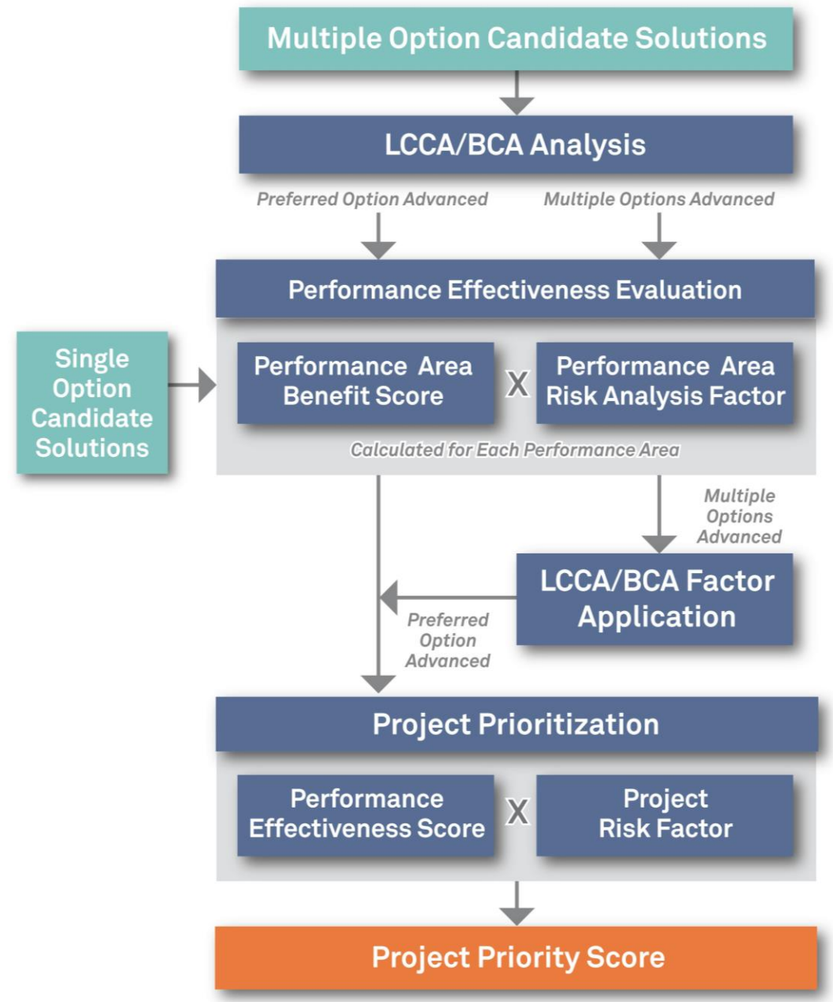
Risk Analysis

All candidate solutions that were advanced through the Performance Effectiveness Evaluation were also evaluated through a Risk Analysis process. This process examines the risk of not implementing a recommended solution in terms of overall corridor performance. The results of this analysis were combined with the Performance Effectiveness scores to determine the highest priority solutions in the corridor.

The highest ranking solutions are presented as recommended strategic investments and compared to other projects nominated through the ADOT Planning to Programming Link (P2P) process.

Strategic solutions are not intended to be a substitute or replacement for traditional ADOT project development processes in which various ADOT technical groups and consultants develop candidate projects for consideration in the performance-based programming in the P2P Link process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight.

Figure 2 Solution Evaluation Process



3 CANDIDATE SOLUTION EVALUATION

The principal objective of the corridor profile study is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. The corridor profile process is intended to provide input to the Planning to Programming Link (P2P) and assign strategic solutions to one of the three investment categories: Preservation, Modernization, or Expansion.

The performance system and performance needs previously documented in Working Papers #2 and #4, respectively, served as a foundation for developing strategic solutions for corridor preservation, modernization, and expansion.

Strategic Solutions developed for the I-19 corridor were considered along with other candidate projects in the ADOT programming process. Strategic solutions address elevated levels (high or medium) of need and focus on investments in Modernization projects to optimize current infrastructure. Ideally, strategic solutions should address overlapping needs and reduce costly repetitive maintenance. In addition, they should provide a measureable benefit identified through a benefit/cost ratio, risk, LCCA, or performance effectiveness.

Strategic solutions were derived from previous reports, field reviews, ADOT staff input, observable trends in the performance data, current standards, national and local best practices, and engineering judgement. **Table 2** contains the candidate strategic solutions for the I-19 corridor. Cost estimates for each candidate solution are contained in **Appendix A**.

Following the distribution of Draft Working Paper #5 (Strategic Solutions), several modifications were made to the Performance System (Draft Working Paper #2). These modifications resulted in revisions to the Needs Assessment (Draft Working Paper #4) and the resulting strategic solutions (Draft Working Paper #5). Therefore, the candidate solutions shown in Table 2 may differ from those shown in Draft Working Paper #5.

Table 2 Candidate Solutions

Candidate Solutions						
Solution #	**BMP**	**EMP**	**Name**	**Option**	**Scope**	**P/M/E**
CS19.1	2.9	30.1	Nogales to Tubac Shoulder & Roadside Improvements	-	Rehabilitate shoulders and enhance roadway delineation (pavement marking, delineators, rumble strips) Sahuarita Rd to Irvington Rd.	M
CS19.2	11.0	11.0	Rio Rico TI Ramp Lighting	-	NB on ramp; SB on-off ramps	M
CS19.3	12.0	12.0	Agua Fria Canyon Bridge SB (#906)	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS19.4	15.7	15.7	Palo Parado TI Ramp Lighting	-	NB on-off ramps; SB on-off ramps	M
CS19.5	15.7	15.7	Palo Parado Rd Bridge (#937)	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS19.6	26.5	26.5	Agua Linda TI Ramp Lighting	-	NB on-off ramps; SB on-off ramps	M
CS19.7	39.5	39.5	Sahuarita TI Ramp Improvements	-	Construct/extend parallel entrance and exit ramps at Sahuarita TI	M
CS19.8	39.5	61.9	Sahuarita to Tucson Shoulder & Roadside Improvements	-	Rehabilitate shoulders and enhance roadway delineation (pavement marking, delineators, rumble strips) Sahuarita Rd to Irvington Rd.	M
CS19.9	45.8	45.8	El Toro Bridge OP NB (#1572)	-	Rehabilitate bridge following programmed design FY 2016	P
CS19.10	45.8	45.8	El Toro Bridge OP SB (#1573)	-	Rehabilitate bridge following programmed design FY 2016	P
CS19.11	49.6	49.6	Pima Mine TI Ramp Improvements	-	Construct/extend parallel entrance and exit ramps at Pima Mine TI	M
CS19.12	54.4	54.4	Papago TI Ramp Improvements	-	Construct/extend parallel entrance and exit ramps at Papago TI	M
CS19.13	57.0	57.0	San Xavier (SB) TI Ramp Improvements	-	Construct/extend parallel entrance and exit ramps at San Xavier (SB) TI	M
CS19.14	57.0	61.9	I-19/Tucson Ramp Improvements	-	Improve entry/exit ramps and implement ramp metering at Irvington Rd SB, Valencia Rd NB/SB, and San Xavier Rd NB	M
CS19.15	57.0	64.0	I-19 Tucson Variable Speed Limits	-	Implement Variable Speed Limits	M
CS19.16	57.0	61.9	I-19/Tucson Widening	-	Construct new general purpose lane (inside) in NB/SB direction between Irvington Rd and San Xavier Rd	E
CS19.17	59.5	62.0	Drexel-Irvington Pedestrian Overpass and Barrier Fencing	-	Construct pedestrian overpass between Drexel and Irvington; construct 8' barrier fencing Valencia to Ajo Way (east side)	M
CS19.18	60.3	60.3	Airport Wash Bridge NB (#1121)	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS19.19	60.3	60.3	Airport Wash Bridge SB (#1122)	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS19.20	61.9	61.9	Irvington Rd TI UP (#1123)	-	Rehabilitate bridge following programmed design FY 2019	P
CS19.21	62.0	63.7	Ajo Way/I-19 NB/SB Pavement	-	Rehabilitate pavement as modification to existing programmed project, including extending project limit to MP 62-63 NB	P

Life-Cycle Cost Analysis and Benefit-Cost Analysis

A life-cycle cost analysis (LCCA) or benefit-cost analysis (BCA) was conducted for any candidate solutions that contain multiple options. The intent of the LCCA and BCA was to determine which options warrant further investigation and eliminate options that would not be considered strategic. An LCCA was performed on Pavement and Bridge candidate solutions while a BCA was performed on Mobility, Safety, or Freight candidate solutions (where required). All dollar amounts are in 2015 dollars.

Life-Cycle Cost Analysis

Life-Cycle Cost Analysis is an economic analysis that compares cost streams over time and presents the results in a common measure, the present value of all future costs. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For both bridge and pavement LCCA, the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping the bridge or pavement serviceable over a long period of time. User costs were not directly considered.

LCCA is performed to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short term costs which often dominate the considerations in transportation investment decision making and programming.

<u>Bridge</u>

For the bridge LCCA, three basic strategies were analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Bridge replacement (large upfront cost but small ongoing costs afterwards).
- Bridge rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement).
- On-going repairs until replacement (low upfront and more frequent ongoing costs until replacement).

The bridge LCCA model developed for the Corridor Profile Studies reviews the characteristics of the candidate bridges including bridge ratings and deterioration rates to develop the three improvement strategies (full replacement, rehabilitation until replacement, and repair until replacement). Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length to span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance. The following assumptions are included in the bridge LCCA model:

- The bridge LCCA only addresses the structural condition of the bridge and does not address other issues or costs.
- The bridge will require replacement near the end of it's 75 year service life regardless of current condition.
- The bridge elevation, pier height, skew angle, and length to span ratio can affect the replacement and rehabilitation costs.
- The current and historical ratings were used to estimate a rate of deterioration for each candidate bridge.
- Following bridge replacement, repairs will be needed every 20 years.
- Different bridge repair and rehabilitation strategies have different costs, expected service life, and benefit to the bridge rating.
- The present value of future costs was calculated at a 3% discount rate.
- If the LCCA evaluation recommends rehabilitation or repair, the project was not considered strategic and the rehabilitation or repair will be addressed by normal programming processes.
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 10% - 15% should be considered equally. In such a case, the project should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed.

Based on the candidate solutions presented in **Table 2**, LCCA was conducted on four bridges on the I-19 corridor. A summary of this analysis is shown in **Table 3.** Additional detailed information regarding the bridge LCCA is provided in the I-19 Bridge LCCA Technical Memorandum in **Appendix B**.

<u>Pavement</u>

The LCCA approach to pavement was very similar to the process used for bridges. For the pavement LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Pavement replacement (large upfront cost but small ongoing costs afterwards – could be replacement with asphalt or concrete pavement).
- Pavement major rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement).
- Pavement minor rehabilitation until replacement (low upfront and ongoing costs until replacement).

The pavement LCCA model developed for the Corridor Profile Studies reviews the characteristics of the candidate paving locations including the historical rehabilitation frequency to develop potential improvement strategies (full replacement, major rehabilitation until replacement, and minor rehabilitation until replacement, for either concrete or asphalt, as applicable). Each strategy consists of a set of corrective actions that contribute to keeping the pavement serviceable over the analysis period. The following assumptions are included in the pavement LCCA model:

- The pavement LCCA only addresses the condition of the pavement and does not address other issues or costs.
- The historical pavement rehabilitation frequencies at each location were used to estimate the future rehabilitation frequencies.
- Different pavement replacement and rehabilitation strategies have different costs and expected service life.
- The present value of future costs were discounted at 3%.
- If the LCCA evaluation recommends rehabilitation or repair, the project was not considered strategic and the rehabilitation will be addressed by normal programming processes.

- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 10% - 15% should be considered equally. In such a case, the project should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed.

As shown in **Table 3**, the following conclusions were determined based on the LCCA:

- Rehabilitation or repair was determined to be the most effective approach for all the candidate solutions evaluated.
- The following bridges do not require replacement according to the results of the LCCA, therefore, it is assumed that these will be addressed by normal programming processes and were dropped from further consideration:
    - Agua Fria Canyon Bridge SB (CS19.3)
    - Palo Parado Road Bridge (CS 19.5)
- While Airport Wash Bridge NB (CS 19.18) and Airport Wash Bridge SB (CS 19.19) do not qualify for a standalone bridge replacement according to LCCA results, improvements to these structures were recommended through other Candidate Solutions.
- LCCA was not conducted on the following bridges because design funds are currently programmed in the ADOT 5 Year STIP. This I-19 Corridor Profile Study recommends advancing those projects to construction.
    - El Toro Rd. Bridge NB (CS 19.9)
    - El Toro Rd. Bridge SB (CS.19.10)
    - Irvington Rd. TI UP (CS 19.20)
- There are no Candidate Solutions that require a pavement LCCA for the I-19 Corridor.

Benefit Cost Analysis

In a BCA, the benefits and costs of a project are estimated and compared to each other to determine if the benefits exceed the costs. This is accomplished by quantifying the benefits in dollars and using a ratio (benefits divided by costs) to make the comparison. If the resulting ratio is greater than 1.0, then the benefits are greater than the costs. The higher the ratio is above 1.0, the more the benefits exceed the costs. For the Corridor Profile Studies, the BCA computes agency costs and user benefits over time and presents the results in a common measure, the present value in dollars. A BCA may be performed to compare options for Mobility and Safety solutions (when applicable).

A number of assumptions were used in the analysis, including:

- Analysis period is 2020 - 2039, or 20 full years of operation.
- Construction takes place over 2020-2021.
- All values are in 2015 dollars.
- Approximately $9.7 million (in 2015) for fatality and $2.6 million (in 2015) for incapacitating injury, based on USDOT guidance.
- Value of time is approximately $28 per hour (in 2015) for trucks and $19 per hour (in 2015) for autos based on USDOT guidance.
- Auto occupancy rate of 1.55 people (2009 National Household Travel Survey).
- The present value of future costs was discounted at 3%.
- Trucks are 100% business use and autos are 100% personal use.
- O&M costs are 1% (per year) of initial capital costs starting in 2025.
- Residual value in 2039 is pro-rated based on 60 year service life (and discounted at 3%).
- Emission rates based on US Environmental Protection Agency's (EPA) guidance.
- Value of emissions based on USDOT guidance.

There are no Candidate Solutions that require a BCA for the I-19 Corridor.

Table 3 LCCA Results

Life Cycle Cost Analysis Results								
Candidate Solution	Present Value at 3% Discount Rate ($)			Ratio of Present Value Compared to Lowest Present Value			Other Needs	Results
	Replace	Rehab	Repair	Replace	Rehab	Repair		
Airport Wash Bridge NB (CS19.16)	$1,044,000	$927,000	**$756,000**	1.38	1.23	1.00	Yes	Not strategic as a stand-alone project; carry forward for further evaluation with other Candidate Solutions
Airport Wash Bridge SB (CS19.17)	$1,044,000	$951,000	**$764,000**	1.36	1.24	1.00	Yes	Not strategic as a stand-alone project; carry forward for further evaluation with other Candidate Solutions
Agua Fria Canyon Bridge SB (CS19.3)	$566,000	$588,000	**$412,000**	1.37	1.43	1.00	No	Not strategic as a stand-alone project and no other Needs – no further evaluation
Palo Parado Road Bridge (CS 19.5)	$1,263,000	$1,074,000	**$912,000**	1.38	1.18	1.00	No	Not strategic as a stand-alone project and no other Needs – no further evaluation

Performance Effectiveness Evaluation

After the LCCA and BCA processes were complete, all remaining candidate solutions were evaluated based on their performance effectiveness. This process included determining a performance effectiveness score based on how much each solution impacts the existing Performance and level of Need scores for each project segment. The results of this evaluation were combined with the results of a risk analysis to determine a Performance Effectiveness Score. The objectives of the Performance Effectiveness Evaluation include:

- Measure of benefit in performance system versus cost of solution.
- Include risk factors to help differentiate between similar solutions.
- Applicable to each Performance Area that is affected by the candidate solution.
- Accounts for Emphasis Areas that were identified for the corridor.

The Performance Effectiveness Evaluation includes the following steps:

- Estimate the post-project performance for each of the five performance areas (Bridge, Pavement, Safety, Mobility, and Freight).
- Use the post-project performance scores to calculate a post-project level of Need for each of the five performance areas (Bridge, Pavement, Safety, Mobility, and Freight).
- Compare the pre-project level of Need to the post-project level of Need to determine the reduction in level of Need (potential project benefit) for each of the five performance areas (Bridge, Pavement, Safety, Mobility, and Freight).
- Calculate performance area risk weighting factors for each of the five performance areas (Bridge, Pavement, Safety, Mobility, and Freight).
- Using the reduction in level of Need (benefit) and risk weighting factors, calculate the Performance Effectiveness Score.

For each Performance Area, a slightly different approach was used to estimate the post-project performance. This process was based on the following assumptions:

- Pavement:
  - The IRI rating would decrease (to 30 for replacement or 45 for rehabilitation).
  - The Cracking rating would decrease (to 0 for replacement or rehabilitation).
- Bridge:
  - The structural ratings would increase (+1 for repair, +2 for rehabilitation, or increase to 8 for replacement).
  - The bridge sufficiency rating would increase (+10 for repair, +20 for rehabilitation, or increase to 98 for replacement).
- Mobility:
  - Additional lanes would increase the capacity and therefore revise the Mobility Index and two secondary measures.
  - Other improvements (ramp metering, parallel ramps, variable speed limits) may also increase the capacity (to a lesser extent than additional lanes) and therefore revise the Mobility Index and two secondary measures.
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTI secondary measure.
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the PTI secondary measure.
  - Changes in the Safety Index (due to crash reductions) would have direct effect on the Closure Extent secondary measure.
- Safety:
  - Crash Mitigation Factors were developed and applied to estimate the reduction in crashes. See **Appendix C**.
- Freight:
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Freight Index and the TPTI secondary measure.
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTTI secondary measure.
  - Changes in the Safety Index (due to crash reductions) would have direct effect on the Closure Duration secondary measure.

The Performance Area Risk Assessment is intended to develop a numeric risk weighting factor for each of the five Performance Areas (Bridge, Pavement, Safety, Mobility, and Freight). This risk assessment addresses other considerations for each Performance Area that are not directly included in the Performance System. A risk weighting factor is calculated for each candidate solution based on the specific characteristics at the project location. For example, the Pavement Risk Factor is based on factors such as the elevation, daily traffic volumes, and amount of truck traffic. Performance Area Risk Factors are provided in **Appendix D**.

Following the calculation of the reduction in level of Need (benefit) and the Performance Area Risk Factors, these values were used to calculate the Performance Effectiveness Score. In addition, the reduction in level of Need in each Emphasis Area was also included the in the Performance Effectiveness Score. The performance Effectiveness Score (PES) can be described as follows:

PES = (Sum of all Risk Factored Benefit Scores + Sum of all Risk Factored Emphasis Area Scores) x 100 / Cost x VMT / 10,000

Where,

Risk Factored Benefit Score = Reduction in Segment-Level Need (benefit) x Performance Area Risk Weighting Factor (calculated for each Performance Area)

Risk Factored Emphasis Area Score = Reduction in Corridor-Level Need x Performance Area Risk Factors x Emphasis Area Factor (calculated for each Emphasis Area)

Cost = estimate cost of candidate solution in $millions

VMT = vehicle miles travelled at location of candidate solution based on current (2014) daily volume and length of project

The resulting PES values are shown in **Table 4**. Additional information regarding the Performance Effectiveness Scoring is included in **Appendix E**.

Table 4 Initial Performance Effectiveness Scores

Initial Performance Effectiveness Scores														
Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ million)	Risk Factored Benefit Score					Risk Factored Emphasis Area Scores			Total Factored Benefit Score	VMT/ 10,000	Performance Effectiveness Score
				Pavement	Bridge	Safety	Mobility	Freight	Safety	Mobility	Freight			
19.1	Nogales - Tubac Shoulder Improvements	3 - 30	$8.27	0.00	0.00	6.03	0.15	0.38	0.58	0.00	0.00	7.14	49.76	4297
19.2	Rio Rico Ramp Lighting	11	$0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
19.4	Palo Parado Ramp Lighting	15.7	$0.20	0.00	0.00	0.14	0.003	0.00	0.03	0.00	0.00	0.18	2.06	181
19.6	Agua Linda Ramp Lighting	26.5	$0.20	0.00	0.00	0.10	0.004	0.01	0.02	0.00	0.00	0.14	1.61	112
19.7	Sahuarita TI Ramp Improvements	46.8	$6.37	0.00	0.00	0.65	0.01	0.00	0.19	0.00	0.00	0.85	2.15	29
19.8	Sahuarita - Tucson Shoulder Improvements	40 - 57	$6.81	0.00	0.00	4.01	0.15	0.05	0.56	0.00	0.00	4.78	116.55	8176
19.11	Pima Mine TI Ramp Improvements	49.6	$7.32	0.00	0.59	0.82	0.01	0.01	0.21	0.00	0.00	1.64	3.69	83
19.12	Papago TI Ramp Improvements	54.4	$6.37	0.00	0.00	0.92	0.01	0.01	0.25	0.00	0.00	1.19	3.69	69
19.13	San Xavier TI Ramp Improvements	57	$4.48	0.00	0.35	0.48	0.01	0.01	0.13	0.00	0.00	0.97	3.69	80
19.14	Tucson Area Parallel Ramps	57 - 61.9	$18.11	0.00	0.39	2.16	0.10	0.02	0.25	0.00	0.00	2.92	31.83	531
19.15	Tucson Variable Speed Limits	57 - 64	$24.99	0.00	0.00	0.91	0.05	0.01	0.10	0.00	0.00	1.07	45.99	214
19.16	Tucson Area GP Widening	57 - 61.9	$32.80	2.68	0.35	0.73	11.30	0.02	0.08	0.13	0.00	15.29	31.83	1485
19.17	Drexel/Irvington Pedestrian Overpass	59.5 - 62	$2.15	0.00	0.00	5.28	0.12	0.05	0.63	0.00	0.00	6.08	16.86	4761
19.21	Ajo Way Pavement Rehab	62 - 63.7	$2.23	4.07	0.00	1.06	0.03	0.01	0.12	0.00	0.00	5.29	3.37	801

Following the LCCA and BCA, the following Candidate Solutions were eliminated from further consideration as standalone projects or have been directly recommended for construction programming. These Candidate Solutions have not been evaluated for prioritization.

- *Agua Fria Canyon Bridge SB (CS19.3) – Eliminated*
- *Palo Parado Road Bridge (CS19.5) - Eliminated*
- **El Toro Road Bridge NB (CS19.9) – Advance to Programming**
- **El Toro Road Bridge SB (CS19.10) – Advance to Programming**
- *Airport Wash Bridge NB (CS19.18) – Eliminated*
- *Airport Wash Bridge SB (CS19.19) – Eliminated*
- **Irvington Road TI Underpass (CS19.20) Advance to Programming**

4 CANDIDATE SOLUTION PRIORTIZATION

Following the calculation of the Performance Effectiveness Scores (PES), an additional step was taken to develop the prioritized list of projects. A risk probability and consequence analysis was conducted to develop a project-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure. **Figure 3** shows the risk matrix that was used to develop the risk weighting factors.

Figure 3 Risk Matrix

		Risk Matrix				
		Severity/Consequence				
		Insignificant	Minor	Significant	Major	Catastrophic
Frequency/Likelihood	Very Rare	Low	Low	Low	Moderate	Major
	Rare	Low	Low	Moderate	Major	Major
	Seldom	Low	Moderate	Moderate	Major	Severe
	Common	Moderate	Moderate	Major	Severe	Severe
	Frequent	Moderate	Major	Severe	Severe	Severe

Using the risk matrix in **Figure 3**, numeric values were assigned to each category of frequency and severity. The higher the risk, the higher the numeric factor that was assigned. The risk weight for each area of the matrix was calculated by multiplying the severity factor times the frequency factor. These numeric factors are shown in **Figure 4**.

Figure 4 Numeric Risk Matrix

			Numeric Risk Matrix				
			Severity/Consequence				
			Insignificant	Minor	Significant	Major	Catastrophic
		Weight	1.00	1.05	1.10	1.15	1.20
Frequency/Likelihood	Very Rare	1.00	1.00	1.05	1.10	1.15	1.20
	Rare	1.05	1.05	1.10	1.16	1.21	1.26
	Seldom	1.10	1.10	1.16	1.21	1.27	1.32
	Common	1.15	1.15	1.21	1.27	1.32	1.38
	Frequent	1.20	1.20	1.26	1.32	1.38	1.44

Using the values in Figure 4, risk weighting factors were calculated for each of the 4 risk categories (low, moderate, major, and severe). These values are simply the average of the values in Figure 4 that fall within each category. The resulting average risk weighting factors are:

Low	Moderate	Major	Severe
1.07	1.18	1.24	1.36

The risk weighting factors listed above were assigned to the five performance areas as follows:

- Safety = 1.36
  - The Safety performance area quantifies the likelihood of fatal or incapacitating crashes; therefore, it was assigned the highest (Severe) risk weight.
- Bridge = 1.24
  - The Bridge performance area focuses on the structural adequacy of the bridges. A failure may result in crashes or traffic being detoured for long periods of time resulting in significant travel time increases; therefore, it was assigned the Major (1.24) risk weighting factor.
- Mobility and Freight = 1.18
  - The Mobility and Freight performance areas focus on capacity and congestion. Failure in either of these performance areas would result in increased travel times but would not have significant effect on safety (crashes) that would not already be addressed in the Safety performance area; therefore, they were assigned the Moderate (1.18) risk weighing factor.
- Pavement = 1.07
  - The Pavement performance area focuses on the ride quality of the pavement. Failure in this performance area would likely be a spot location that would not dramatically affect drivers beyond what is already captured in the Safety performance area.

The benefit in each performance area was calculated for each candidate solution as part of the Performance Effectiveness Evaluation. Using this information, and the risk factors listed above, a weighted (based on benefit) project-level numeric risk factor was calculated for each candidate solution. For example, a solution that has 50% of its benefit in Safety and 50% of its benefit in Mobility would have a risk factor of 1.27 (0.50 x 1.18 + 0.50 x 1.36 = 1.27). These risk factors were applied directly to the Performance Effectiveness Scores shown in Table 4. Candidate Solutions were prioritized based on these results, and identified in **Table 5.** Additional information regarding the performance scoring system is contained in **Appendix F**.

Summary of Prioritized Projects

Table 5 prioritizes the strategic solutions recommended as a result of this corridor profile study. These solutions would increase the performance of the I-19 corridor across all performance areas. Solutions that address multiple areas score higher in this process. Several projects on the corridor scored high on the Performance Effectiveness Scale due to overlapping impacts in Safety, Mobility, and Freight.

- Two of the top three projects include shoulder and roadside improvements through much of the corridor that would reduce the incidence of run off the road type vehicle crashes that often result in fatal and serious injuries.
- Additional benefits to Mobility and Freight would occur due to the reduction in the number of incidents that cause delays along I-19.
- The I-19 Tucson Widening project would increase capacity on this congested segment, reduce delays, and improve safety.
- The Ajo Way/I-19 Pavement Rehabilitation project scored well due to extending the improvements of a previously programmed project to address pavement issues.
- The Drexel/Irvington Pedestrian Overpass and Barrier Fencing project would help reduce the high number of fatal vehicle-pedestrian crashes resulting from pedestrians attempting to cross I-19.
- The remaining traffic interchange ramp and lighting improvements would increase safety at those locations as well as improve traffic throughput by reducing delay and the potential for conflicting movements in the merge areas.

Table 5 Prioritized Project List

Prioritized Project List							
Rank	Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ million)	Performance Effectiveness Score	Risk Factor	Prioritization Score
1	CS19.8	Sahuarita - Tucson Shoulder & Roadside Improvements	40 - 57	6.8	8176	1.352	11057
2	CS19.17	Drexel/Irvington Pedestrian Overpass and Barrier Fencing	59.5 - 62	2.2	4761	1.355	6450
3	CS19.1	Nogales to Tubac Shoulder & Roadside Improvements	3 - 30	8.3	4297	1.347	5787
4	CS19.16	I-19 Tucson Widening	57 - 61.9	32.8	1485	1.172	1741
5	CS19.21	Ajo Way/I-19 NB/SB Pavement Rehab	62 - 63.7	2.2	801	1.136	910
6	CS19.14	I/19/Tucson Ramp Improvements	57 - 61.9	18.1	531	1.355	709
7	CS19.15	I-19/Tucson Variable Speed Limits	57 - 64	25.0	214	1.337	286
8	CS19.4	Palo Parado Ramp Lighting	15.7	0.20	181	1.357	246
9	CS19.6	Agua Linda Ramp Lighting	26.5	0.20	112	1.342	151
10	CS19.11	Pima Mine TI Ramp Improvements	49.6	7.3	83	1.325	110
11	CS19.13	San Xavier (SB) TI Ramp Improvements	57	4.5	80	1.324	107
12	CS19.12	Papago TI Ramp Improvements	54.4	6.4	69	1.356	94
13	CS19.7	Sahuarita TI Ramp Improvements	46.8	6.4	29	1.358	40
14	CS19.2	Rio Rico TI Ramp Lighting	11	0.15	0	-	-

5 NEXT STEPS

The strategic investments recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P Link process. Rather, these strategic investments are intended to complement ADOT's project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for the I-19 corridor will be considered along with other candidate projects in the ADOT statewide programming process.

The concluding step in the corridor profile studies will be to produce a final report for the Round 1 studies (I-19, I-17, and I-40 west) that summarizes working papers 1 through 6. Additional final reports for rounds 2 and 3 will be completed following the full development of those working papers.

Upon completion of all three rounds, the results will be incorporated into a summary document comparing all corridors and is expected to provide a solid performance-based review of statewide needs.

Appendix A Cost Estimates

CS #	Project Name	Solution	BMP	EMP	Length	Sq Ft	Unit	Unit Cost	Total Construction Cost	PE 0.03	Design 0.10	ROW -		Total
19.1	Nogales to Tubac Shoulder and Roadside Improvements	Rehabilitate Shoulder (AC)	2.9	30.1	27.2	na	mile	$ 231,000	$ 6,283,000	$188,000	$ 628,000	-		$7,099,000
		Install High-Visibility Edge Line Striping	2.9	30.1	27.2	na	mile	$23,800	$ 647,000	$19,000	$65,000	-		$731,000
		Install High-Visibility Delineators	2.9	30.1	27.2	na	mile	$ 14,300	$ 389,000	$ 12,000	$39,000	-		$440,000
								Solution Total	**$7,319,000**	**$ 219,000**	**$732,000**	-		**$8,270,000**
19.2	Rio Rico Ramp Lighting	Install Lighting	11.0	11.0	< 1.0 m	na	each (6)	$22,000	$ 132,000	$3,960	$ 13,200	-		**$ 149,160**
19.3	Agua Fria Canyon Bridge SB (#906)	Rehabilitate Bridge	12.0	12.0	< 1.0 m	3,818	sf	$140	$ 535,000	$16,000	$54,000	-		**$605,000**
		Replace Bridge	12.0	12.0	< 1.0 m	3,818	sf	$ 280	$1,069,000	$32,000	$107,000	-		**$1,208,000**
19.4	Palo Parado Ramp Lighting	Install LIghting	15.7	15.7	< 1.0 m	na	each (8)	$ 22,000	$ 176,000	$5,000	$ 18,000	-		**$199,000**
19.5	Palo Parado Road TI UP (#937)	Rehabilitate Bridge	15.7	15.7	< 1.0 m	8,366	sf	$140	$1,171,000	$35,000	$117,000	-		**$1,323,000**
		Replace Bridge	15.7	15.7	< 1.0 m	8,366	sf	$ 280	$2,342,000	$70,000	$234,000	-		**$2,646,000**
19.6	Agua Linda Ramp Lighting	Install Lighting	26.5	26.5	< 1.0 m	na	each (8)	$22,000	$ 176,000	$5,000	$18,000	-		**$199,000**
19.7	Sahuarita TI Ramp Improvements	Widen & Modify Entry/Exit Ramp	46.8	46.8	< 1.0 m	na	each (4)	$1,361,800	$ 5,447,000	$163,000	$545,000	-		$6,155,000
		Widen Box Culverts (2x5 barrel BC)			12	na	per ft width	$8,000	$192,000	$ 6,000	$ 19,000	-		$217,000
								Solution Total	**$ 5,639,000**	**$ 169,000**	**$564,000**	-		**$6,372,000**
19.8	Sahuarita to Tucson Shoulder and Roadside Improvements	Rehabilitate Shoulder (AC)	39.5	61.9	22.4	na	mile	$231,000	$5,174,000	$155,000	$ 517,000	-		$5,846,000
		Install High-Visibility Edge Line Striping	39.5	61.9	22.4	na	mile	$23,800	$533,000	$16,000	$53,000	-		$602,000
		Install High-Visibility Delineators	39.5	61.9	22.4	na	mile	$ 14,300	$ 320,000	$10,000	$ 32,000	-		$362,000
								Solution Total	**$6,027,000**	**$181,000**	**$602,000**			**$6,810,000**
19.9	El Toro Bridge OP NB (#1572)	Rehabilitate Bridge	45.8	45.8	< 1.0 m	10,028	sf	$140	$1,404,000	$42,000	$140,000	-		**$1,586,000**
		Replace Bridge	45.8	45.8	< 1.0 m	10,028	sf	$280	$2,808,000	$84,000	$281,000	-		**$3,173,000**
19.10	El Toro Bridge OP SB (#1573)	Rehabilitate Bridge	45.8	45.8	< 1.0 m	10,028	sf	$ 140	$ 1,404,000	$42,000	$ 140,000	-		**$1,586,000**
		Replace Bridge	45.8	45.8	< 1.0 m	-	sf	$ 280	$2,808,000	$84,000	$281,000	-		**$3,173,000**
19.11	Pima Mine TI Ramp Improvements	Widen & Modify Entry/Exit Ramp	49.6	49.6	< 1.0 m	-	each (4)	$1,361,800	$5,447,000	$ 163,000	$545,000	-		$6,155,000
		Widen Bridge (NB off-ramp)				-	sf	$390	$ 1,039,000	$ 31,000	$ 104,000	-		$1,174,000
								Solution Total	**$ 6,486,000**	**$ 194,000**	**$649,000**	-		**$7,329,000**
19.12	Papago TI Ramp Improvements	Widen & Modify Entry/Exit Ramp	54.4	54.4	< 1.0 m	-	each (4)	$1,361,800	$ 5,447,000	$ 163,000	$545,000	-		$6,155,000
		Widen Box Culverts (2)			12	-	per ft width	$8,000	$192,000	$ 6,000	$19,000	-		$217,000
								Solution Total	**$5,639,000**	**$ 169,000**	**$564,000**	-		**$6,372,000**
19.13	San Xavier TI (SB) Ramp Improvements	Widen & Modify Entry/Exit Ramp	57.0	57.0	< 1.0 m	-	each (2)	$1,361,800	$ 2,724,000	$82,000	$ 272,000	-		$3,078,000
		Widen Bridge (NB off-ramp)				-	sf	$390	$1,240,000	$37,000	$124,000	-		$1,401,000
								Solution Total	**$3,964,000**	**$119,000**	**$396,000**	-		**$4,479,000**

CS #	Project Name	Solution	BMP	EMP	Length	Sq Ft	Unit	Unit Cost	Total Construction Cost	PE 0.03	Design 0.10	ROW -		Total
19.14	Tucson Area Parallel Ramps	Widen & Modify Entry/Exit Ramps	57.0	61.9	4.9	na								
		Irvington Rd TI (SB) - Ramp Improvements				na	each (x2)	$1,361,800	$ 2,724,000	$ 82,000	$272,000	-		$3,078,000
		Ramp Meters (High)				na	each (x1)	$ 330,000	$330,000	$ 10,000	$33,000	-		$373,000
		Widen Bridge (Airport Wash NB/SB)				3,492	sf	$390	$1,362,000	$ 41,000	$ 136,000	-		$1,539,000
		Rehab Bridge (Airport Wash NB/SB)				6,350	sf	$ 140	$889,000	$27,000	$89,000	-		$1,005,000
		Valencia Rd TI (NB/SB) - Ramp Improvements				na	each (x4)	$1,361,800	$5,447,000	$ 163,000	$545,000	-		$6,155,000
		Ramp Meters (High)				na	each (x2)	$330,000	$660,000	$ 20,000	$66,000	-		$746,000
		San Xavier Rd TI (NB) - Ramp Improvements				na	each (x2)	$1,361,800	$2,724,000	$ 82,000	$272,000	-		$3,078,000
		Ramp Meters (High)				na	each (x1)	$ 330,000	$330,000	$ 10,000	$33,000	-		$373,000
		Widen Bridge (NB/SB) north of San Xavier				3,996	sf	$390	$ 1,558,000	$ 47,000	$ 156,000	-		$1,761,000
								Solution Total	**$16,024,000**	**$ 482,000**	**$ 1,602,000**	-		**$18,108,000**
19.15	Tucson Variable Speed Limits	Implement Varialbe Speed Limits, wireless, overhead - NB	57	64	7	na	mile	$1,580,000	$11,060,000	$ 332,000	$1,106,000	-		$12,498,000
		Implemtn Variable Speed Limits, wireless, overhead - SB	64	57	7	na	mile	$1,580,000	$11,060,000	$332,000	$1,106,000	-		$12,498,000
								Solution Total	**$ 22,120,000**	**$ 664,000**	**$2,212,000**	-		**$24,996,000**
19.16	Tucson Area GP Widening	Construct New General Purpose Lanes (AC) (both directions)	57.0	61.9	4.9	na	lane mile	$2,640,000	$25,872,000	$ 776,000	$ 2,587,000	-		$29,235,000
		Widen Bridge (Airport Wash NB/SB)				3,492	sf	$390	$1,362,000	$ 41,000	$136,000	-		$ 1,539,000
		Rehab Bridge (Airport Wash NB/SB)				6,350	sf	$140	$889,000	$ 27,000	$ 89,000	-		$ 1,005,000
		Rehab Bridge (Airport Wash NB/SB)				6,350	sf	$140	$889,000	$ 27,000	$89,000	-		$ 1,005,000
								Solution Total	**$29,012,000**	**$871,000**	**$2,901,000**	-		**$32,784,000**
19.17	Drexel/Irvington Ped Overpass	Construct pedestrian overpass	59.5	62	2.5	4900	sf	$300	$1,470,000	$44,000	$147,000	-		$ 1,661,000
		Barrier Fencing			13200	na	lf	$ 33	$436,000	$ 13,000	$44,000	-		$ 493,000
								Solution Total	**$ 1,906,000**	**$57,000**	**$ 191,000**	-		**$ 2,154,000**
19.18	Airport Wash Bridge (NB) #1121	Rehabilitate Bridge	60.3	60.3	< 1.0 m	6,350	sf	$ 140	$ 889,000	$ 27,000	$89,000	-		**$ 1,005,000**
		Replace Bridge	60.3	60.3	< 1.0 m	6,350	sf	$280	$1,778,000	$ 53,000	$178,000	-		**$2,009,000**
19.19	Airport Wash Bridge (SB) #1122	Rehabilitate Bridge	60.3	60.3	< 1.0 m	6,350	sf	$140	$889,000	$27,000	$89,000	-		**$ 1,005,000**
		Replace Bridge	60.3	60.3	< 1.0 m	6,350	sf	$280	$1,778,000	$53,000	$ 178,000	-		**$2,009,000**
19.21	Ajo Way/I-19 SB Pavement	Rehabilitate Pavement (AC)	62.0	63.7	1.7	na	per mile (38' width)	$590,000	$2,006,000	$60,000	$201,000	-		**$ 2,267,000**
		Replace Pavement (AC)	62.0	63.7	1.7	na	per mile (38' width)	$3,170,000	$10,778,000	$323,000	$1,078,000	-		**$12,179,000**

Appendix B Life Cycle Cost Analysis Technical Memo

Introduction

This section presents the results of a Life Cycle Cost Analysis (LCCA) for selected bridges on I-19. The LCCA is used to assess the potential for bridges to advance as strategic projects in the set of corridor recommendation, either on their own as a bridge-only strategic project, or combined with other needs associated with the roadway segment within which the bridge is located.

The format of this section is as follows.

- how bridge improvements work now
- what is a life cycle cost analysis and why is it performed
- I-19 bridges identified for LCCA (and why)
- the I-19 corridor bridge profile LCCA model
- results of I-19 LCCA and how used in the CPS
- next steps

How Bridges Are Cared For Now

ADOT's essential objective is to keep each bridge in working order (rating of 4 or higher) in an economical manner. Key considerations involved in achieving this objective include the traffic volumes and role of the roadway facility for which the bridge is a feature, the rate of deterioration of the bridge and its major components or subsystems, the user impact of restrictions or detours should the bridge not perform adequately, and the total funding available for bridge maintenance, repair, rehabilitation, and replacement over a time period. Bridges have a long design life (typically 75 years) so they are seldom completely replaced unless a larger improvement project on the associated roadway is required to add capacity or make other operational or safety improvements.

In a perfect world with adequate funding, ADOT's bridge managers would apply "optimal" or most cost-effective (i.e. economical) corrective actions to maintain a bridge's performance at 4 or higher. In the less than perfect real world with funding often in short supply, less expensive but sometimes less economical actions are applied to keep the bridges in service due to overall funding limitations. This approach tends to minimize ADOT costs in the short term but can contribute to increased costs in the longer term. If occasional short term funding limitations are followed by adequate funding levels, this adverse consequence can generally be remedied. But if funding limitations become the norm then the avoidable future cost increases can become a serious liability for the agency. The bridge Life Cycle Cost Analysis has been proposed as part of this Corridor Profile Study in order to identify cases where spending more money sooner may provide a more economical strategy over time to keeping a bridge in working order. It also provides an opportunity to consider if other non-bridge needs on the associated roadway may be combined with bridge needs to develop a solution strategy that accomplishes multiple objectives with reduced interruption to the traveling public.

Life Cycle Cost Analysis – What and Why

Life Cycle Cost Analysis is an economic study that compares the cost stream over time of a set of improvement actions from different alternatives and presents the results in a common measure, the present value of all future costs. The alternatives are focused on achieving the same or very similar objectives. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For this bridge life cycle cost analysis the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping a bridge serviceable over a long period of time. LCCA often also includes user costs (i.e. benefits) but those were omitted for this initial analysis except in a qualitative manner. The focus has remained on ADOT agency costs.

The reason for performing life cycle cost analysis is to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short term costs which often dominate the considerations in transportation investment decision making.

In this bridge life cycle cost analysis, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges. These strategies are immediate bridge replacement (large up-front cost but small ongoing costs afterwards), immediate rehabilitation until replacement (moderate up-front costs then small to moderate ongoing costs until replacement), and ongoing repairs until replacement (low up front and ongoing costs until replacement).

Bridges Selected for I-19 LCCA

Four bridges were selected for LCCA on the I-19 corridor. The criteria for selection included where bridge ratings indicate a score of 4 or multiple scores of 5 for substructure, superstructure, or deck rating and the bridge has a high level of historical investment.

The bridges selected for LCCA analysis are:

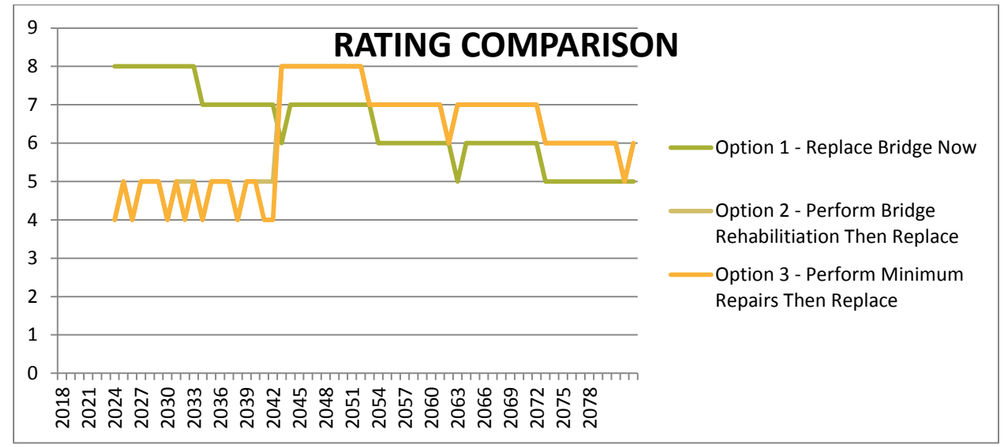
a. Airport Wash Northbound (#1121) – deck rating 5, superstructure rating 5
b. Airport Wash Southbound (#1122) - deck rating 5, superstructure rating 5
c. Agua Fria Canyon Southbound (#906) - deck rating 5, superstructure rating 5, superstructure rating 5
d. Palo Parado Rd. Bridge (#937) - deck rating 5, superstructure rating 5

The CPS Bridge LCCA Model Overview

The bridge LCCA model for the Corridor Profile Studies reviews the characteristics of the selected bridges including bridge ratings and deterioration rates to develop three economical improvement strategies as outlined earlier – full replacement, rehabilitation until replacement, and repair until replacement. Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length to span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance.

The effect on the bridge performance over time for each strategy is shown on Figure 1 for illustration from one of the I-19 bridges, the Airport Wash Bridge northbound.

Figure 1



This bridge hits the 75 year replacement limit in 2040. The three strategies had very close average rating over the analysis period but varied by year depending on when the full replacement was scheduled. Thus the three strategies had similar condition outcomes for the bridge over time.

The cost of the set of improvement actions in each strategy that resulted in the ratings chart above is shown in Table a-3. Agency costs are shown in total undiscounted and discounted (present value at 3%) 2015 $ over the 65 year analysis period.

Table 1

COST COMPARISON 2015 $		
OPTION	UNDISCOUNTED	PV AT 3%
Option 1 (Replace)	$ 1,317,387.44	$1,043,688.03
Option 2 (Rehab)	$ 1,780,746.94	$950,922.15
Option 3 (Repair)	$ 1,565,037.44	$764,131.10

In this case the Option 1 full replacement immediately is the lowest cost in undiscounted dollars, but the Option 3 repair strategy (followed by replacement when the bridge life hits 75 years) is the lowest cost in discounted dollars, which is a better metric to use.

The next section of this chapter shows how the results are used in identifying candidate strategic bridge projects, first looking at the bridges alone, then afterwards looking at the bridge in the context of the other needs on its connecting roadway.

Life Cycle Cost Results

This section reviews the life cycle cost results from several perspectives. These are:

- undiscounted total ADOT costs over the analysis period
- discounted total ADOT costs over the analysis period
- how close the various strategies are
- combining bridge LCCA results with other needs on the connecting roadway

ADOT Future Costs by Bridge Strategy - Undiscounted

Table 2 summarizes the bridge life cycle cost results for the four I-19 bridges selected for this analysis. The results are all in 2015 dollars. The "ADOT Cost" portion of the table shows undiscounted costs (i.e. no time value of money) for the future corrective actions for each bridge improvement strategy over the analysis period. The shading colors indicate the rank order of the costs with green as the lowest, yellow as second, and red as highest.

Table 2

I-19 Bridge				ADOT Future Costs: 2021 - 2080		
				2015 $1,000 Undiscounted		
Item	Name	Number	Type	1-Replace	2-Rehab	3-Repair
1	Airport Wash NB	1121		$1,317	$1,749	$1,565
2	Airport Wash SB	1122		$1,317	$1,781	$1,565
3	Agua Fria Canyon	906		$718	$1,035	$858
4	Palo Parado Rd	937		$1,614	$2,018	$1,872

Source: AECOM 2015

All four bridges in all improvement strategy cases kept the bridge rating above 4 in all years with an average rating over the analysis period 6.2 to 6.5 depending on the strategy. Full replacement was always the highest average rating (about 6.5) and minimum repair was always the lowest average rating (about 6.2). Thus the difference in bridge condition and performance was very small.

The total cost of mitigation strategies for these four bridges range from a low of $700,000 to a high of $2,000,000 over the analysis period. Full bridge replacement as soon as possible is the lowest cost strategy to keep these bridges at rating of 4 or higher over the analysis period, followed by the minimum repair strategy (until required end of life replacement) with the rehabilitation strategy (until end of life replacement) coming in third. Full replacement immediately introduces a major corrective action up front followed by minimal minor repair actions over the remaining years of the analysis period, hence its lowest undiscounted costs.

ADOT Future Costs by Bridge Strategy – Present Value Costs (at 3% discount rate)

The time value of money was not considered in the previous section but is actually an important consideration. This section describes how discounting future investments affects the comparative results of the different bridge improvement strategies.

Table 3 shows the total cost for the same corrective actions as in Table b-1 except that the future expenditures are discounted to present value costs at a 3% discount rate. As with Table b-1 the color shading indicates the rank order of the strategies. The order is affected by discounting of future investments.

Table 3

I-19 Bridge				ADOT Future Costs: 2021-2080		
				2015 $1,000 Present Value 3%		
Item	Name	Number	Type	1-Replace	2-Rehab	3-Repair
1	Airport Wash NB	1121		$1,044	$927	$756
2	Airport Wash SB	1122		$1,044	$951	$764
3	Agua Fria Canyon	906		$566	$588	$412
4	Palo Parado Rd	937		$1,263	$1,074	$912

Source: AECOM 2015

In this discounted perspective the repair strategy is the lowest cost generally followed by the rehabilitation strategy with the full replacement most often the highest cost. Again the average bridge condition rating is similar in all three cases. This reinforces the experience of ADOT Bridge Group that replacing a bridge is a very rare event unless a related mobility need creates a larger project. From this initial perspective Option 3 "Repair Until Replace" remains the non strategic default strategy.

Future Costs Present Value – Tolerance Band around Lowest Cost Strategy

While the previous section looked at the LCCA results in pure rank order, this section examines "how close" the rankings are to see if there are differences among strategies that are small enough to be assumed a tie and thus modify the interpretation of results.

Table 4

I-19 Bridge				% Above Next Lower Value Present Value 3%			% High to Lowest
Item	Name	Number	Type	1-Replace	2-Rehab	3-Repair	
1	Airport Wash NB	1121		12.6%	22.7%	0.0%	38.1%
2	Airport Wash SB	1122		9.8%	24.4%	0.0%	36.6%
3	Agua Fria Canyon	906		37.5%	3.8%	0.0%	42.8%
4	Palo Parado Rd	937		17.6%	17.7%	0.0%	38.5%

Source: AECOM 2015

A “tolerance” of 15% of the difference between strategies was established as a tie. This tolerance suggests that if the second lowest cost strategy is within 15% of the lowest cost and the second lowest cost is a more aggressive strategy than the lowest cost strategy, then the two strategies are essentially tied, and the designation goes to the more aggressive strategy. This test acknowledges the high degree of uncertainty in the analysis.

Table 4 shows the same color ranking, and for the second highest cost and highest cost strategy, the percentage value shown is the percent that that strategy is above the next lower strategy. So the yellow percentage is above the green, and the red percentage is above the yellow. If the yellow is 15% or less then it is tied with the green and the more aggressive strategy of the two is considered lowest cost. If the red value is 15% or less then the red strategy is considered a tie with the yellow strategy which may come into play in the “other needs” consideration presented later in this section. Finally the fourth percentage column on the right is the percent that the highest cost strategy (red shading) is above the lowest cost strategy (green shading). If this percentage is less than or equal to 15% and the highest cost strategy is more aggressive than the lowest cost strategy, then the revised designation of lowest cost strategy goes to the highest cost approach.

For I-19 all four bridges had Option 3 Repair as the lowest cost strategy and a more aggressive strategy was not within 15% of the lowest cost strategy. Thus from a bridge-only perspective without considerations of other needs on the associated roadway, there are no candidate strategic bridge projects to advance in the evaluation. However the next section introduces “other needs” into the assessment to see if those considerations bump any I-19 bridges into a potential strategic project.

Other Considerations Combined with Life Cycle Cost Analysis

Other considerations in the reassessment of the LCCA results are focused on non LCCA results that may still tag a bridge for replacement due to widening (or lengthening) driven by other non LCCA factors such as adding a travel lane to increase roadway capacity.

The connecting roadway for both of the Airport Wash bridges (northbound and southbound) has been tagged for a mobility improvement with a travel lane widening which would also be required for the bridges. Thus these two bridges are identified for Option 1 Full Replacement due the mobility improvements. Increases in bridge deck areas to account for the added travel lane plus bringing the bridges up to current standards were accounted for in the cost and benefit calculations moving forward.

The other two I-19 bridges selected for LCCA, Agua Fria Canyon and Palo Parado Road, do not have other needs to combine that might tag the bridge as part of a strategic project.

These results are now advanced into the performance review step.

Table 5 Unit Costs

ITEM	UNIT COST	LIFE	RATING
BRIDGE DECK			
Replace (Deck)	$78.13	25	Rating = 8
Rehab (Deck Concrete Overlay)	$10.00	15	+ 2
Rehab (Deck Epoxy Overlay)	$5.00	10	+ 1
Repair (Deck)	$3.00	6	+ 0
Replace (Bridge)	$156.25	75	Rating = 8
Repair (After Bridge Replace)	$3.00	20	+ 0
Repair (After Rehab)	$3.00	10	+ 0
SUPERSTRUCTURE			
Replace (Supr - Stl)	$78.13	50	Rating = 8
Rehab (Supr - Stl)	$39.06	15	+ 2
Repair (Supr - Stl)	$5.00	7	+ 1
Replace (Supr - Conc)	$78.13	50	Rating = 8
Rehab (Supr - Conc)	$39.06	15	+ 2
Repair (Supr - Conc)	$5.00	7	+ 1
Replace (Bridge)	$156.25	75	Rating = 8
Repair (After Bridge Replace)	$3.00	20	+ 1
Repair (After Rehab)	$3.00	10	+ 1
SUBSTRUCTURE			
Replace (Substr)	$78.13	75	Rating = 8
Rehab (Substr)	$39.06	50	+ 2
Repair (Substr)	$5.00	6	+ 1
Rehab (Substr - Scour)	$39.06	50	+ 2
Repair (Substr - Scour)	$5.00	6	+ 1
Replace (Bridge)	$156.25	75	Rating = 8
Repair (After Bridge Replace)	$3.00	20	+ 1
Repair (After Rehab)	$3.00	10	+ 1

Complete documentation of the LCCA analysis is provided for the four structures on I-19 on the following pages.

AGUA FRIA CANYON (#906) / I-19 / MP 11.97

Bridge Information	
Bridge Deck Area (A225)	3754 SF
Year Built (N27)	1967
Exp Service Life	75 YR
Total Bridge Length (N49)	92 LF
Number of Spans (N45+N46)	4
Skew Angle (N34)	0 DEG
Average Elevation	3413 FT
Max Pier Height	12 FT
* Amount of Widening for Bridge	4 FT
Revised Deck Area (Bridge Replace)	4122 FT
**Scour Critical Rating (N113)	7

Deterioration Slope

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000480x	-0.175x	5.71
Superstr	y =	-0.000410x	-0.150x	6.68
Deck	y =	-0.000481x	-0.176x	5.70

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**
****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:
1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	3413	1.00
Pier Height > 30ft	12	1.00
Length to # span ratio	23.00	1.25
Skew > 30degrees	0.00	1.00

L to # Span Multiplier

L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier

Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$125.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$156.25

Elevation Multiplier

Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier

Pier H	Multiplier
<30	1.00
=>30	1.10

User input cell
Only manipulate cell value after consulting with team

Bridge History (Inspections/As-builts)

Description	Category	Year
Bridge was originally built in 1967 (I-19-1(22)).		1967
Additional bank protection was added in 1969 (I-19-1-905).	Rehab (Substr - Scour)	1969
Flood damage repair was performed on the banks in 1983. (19-1(90))	Repair (Substr - Scour)	1983
A scour protection slab was added in 1984. (19-1-916 RD).	Rehab (Substr - Scour)	1984
The barriers were replaced in 1987. (19-1(89)).	Repair (Deck)	1987
Current inspection notes AC wearing surface looks ok, but soffit area has multiple cracks (transverse/longitudinal/random hairline). South		
abutment has narrow to medium sized vertical/horizontal cracks with heavy water stains. North abutment exhibits cracking as well with a		
patched area. Localized scour was aboserved at west end of north abutment.		

Replace / Rehab / Repair Information

BRIDGE DECK

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Deck)	Full Deck Replacement	$78.13	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$10.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$5.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$3.00	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$156.25	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 0

SUPERSTRUCTURE - STEEL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Stl)	Full SuperStr Replacement	$78.13	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$39.06	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$5.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Conc)	Full SuperStr Replacement	$78.13	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$39.06	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$156.25	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

SUBSTRUCTURE - STRUCTURAL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Substr)	Full SubStr Replacement	$78.13	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$39.06	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Rehab (Substr - Scour)	Add scour protection slabs	$39.06	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$156.25	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

3. When superstructure replacement is selected, either deck replacement or deck rehab should be selected as well.

AGUA FRIA CANYON (#906) / I-19 / MP 11.97

Option 1 - Replace Bridge Now

Bridge Deck Area =	3754 SF
Widen Deck Area =	4122 SF
Year Built =	1967
Exp Service Life =	75 YR

Notes:
1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000480x	-0.175x	5.71
Superstr	y =	-0.000410x	-0.150x	6.68
Deck	y =	-0.000481x	-0.176x	5.70

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	5						5						5								
1	2016	5						5						5								
2	2017	5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
3	2018	5						5						5								
4	2019	5						5						5								
5	2020	4						5						5								
6	2021	8	Replace (Bridge)	$156.25	$644,062.50	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$644,062.50	$539,392.20
7	2022	8						8						8						8		
8	2023	8						8						8						8		
9	2024	8						8						8						8		
10	2025	8						8						8						8		
11	2026	8						8						8						8		
12	2027	8						8						8						8		
13	2028	8						8						8						8		
14	2029	8						8						8						8		
15	2030	8						8						8						8		
16	2031	7						7						7						7		
17	2032	7						7						7						7		
18	2033	7						7						7						7		
19	2034	7						7						7						7		
20	2035	7						7						7						7		
21	2036	7						7						7						7		
22	2037	7						7						7						7		
23	2038	7						7						7						7		
24	2039	7						7						7						7		
25	2040	6						6						6						6		
26	2041	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 0	7	$37,098.00	$17,202.15
27	2042	7						7						7						7		
28	2043	7						7						7						7		
29	2044	7						7						7						7		
30	2045	7						7						7						7		
31	2046	7						7						7						7		
32	2047	7						7						7						7		
33	2048	7						7						7						7		
34	2049	7						7						7						7		
35	2050	7						7						7						7		
36	2051	6						6						6						6		
37	2052	6						6						6						6		
38	2053	6						6						6						6		
39	2054	6						6						6						6		
40	2055	6						6						6						6		
41	2056	6						6						6						6		
42	2057	6						6						6						6		
43	2058	6						6						6						6		
44	2059	6						6						6						6		
45	2060	5						5						5						5		
46	2061	6	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 0	6	$37,098.00	$9,524.41
47	2062	6						6						6						6		
48	2063	6						6						6						6		
49	2064	6						6						6						6		
50	2065	6						6						6						6		
51	2066	6						6						6						6		
52	2067	6						6						6						6		
53	2068	6						6						6						6		
54	2069	6						6						6						6		
55	2070	5						5						5						5		
56	2071	5						5						5						5		
57	2072	5						5						5						5		
58	2073	5						5						5						5		
59	2074	5						5						5						5		
60	2075	5						5						5						5		
61	2076	5						5						5						5		
62	2077	5						5						5						5		
63	2078	5						5						5						5		
64	2079	5						5						5						5		
65	2080	5						5						5						5		
																				Total Cost =	**$718,258.50**	**$566,118.76**

Average Rating =	6.45
End Rating =	5

Comments:

AGUA FRIA CANYON (#906) / I-19 / MP 11.97

Option 2 - Perform Bridge Rehabilitiation Then Replace

Bridge Deck Area =	3754 SF
Widen Deck Area =	4122 SF
Year Built =	1967
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.)
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000480x	-0.175x	5.71
Superstr	y =	-0.000410x	-0.150x	6.68
Deck	y =	-0.000481x	-0.176x	5.70

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	5						5						5								
1	2016	5						5						5								
2	2017	5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
3	2018	5						5						5								
4	2019	5						5						5								
5	2020	4						4						4								
6	2021	6	Rehab (Substr)	$39.06	$146,640.63	50	+ 2	6	Rehab (Supr - Conc)	$39.06	$146,640.63	15	+ 2	6	Rehab (Deck Concrete Overlay)	$10.00	$37,540.00	15	+ 2	6	$330,821.25	$277,057.59
7	2022	6						6						6						6		
8	2023	6						6						6						6		
9	2024	6						6						6						6		
10	2025	6						6						6						6		
11	2026	6						6						6						6		
12	2027	6						6						6						6		
13	2028	6						6						6						6		
14	2029	6						5						5						5		
15	2030	6						5						5						5		
16	2031	6						5						5						5		
17	2032	6						5						5						5		
18	2033	6						5						5						5		
19	2034	6						5						5						5		
20	2035	6						5						5						5		
21	2036	6						5						5						5		
22	2037	6						4						4						4		
23	2038	6						5	Repair (After Rehab)	$3.00	$11,262.00	10	+ 1	5	Repair (After Rehab)	$3.00	$11,262.00	10	+ 0	5	$22,524.00	$11,412.72
24	2039	6						5						5						5		
25	2040	6						5						5						5		
26	2041	6						5						5						5		
27	2042	8	Replace (Bridge)	$156.25	$644,062.50	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$644,062.50	$289,949.89
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	8						8						8						8		
36	2051	8						8						8						8		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	7						7						7						7		
45	2060	7						7						7						7		
46	2061	6						6						6						6		
47	2062	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 0	7	$37,098.00	$9,247.00
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	7						7						7						7		
56	2071	7						7						7						7		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	6						6						6						6		
65	2080	6						6						6						6		
																				Total Cost =	**$1,034,505.75**	**$587,667.20**

Average Rating =	6.42
End Rating =	6

Comments:

AGUA FRIA CANYON (#906) / I-19 / MP 11.97

Option 3 - Perform Minimum Repairs Then Replace

Bridge Deck Area =	3754 SF
Widen Deck Area =	4122 SF
Year Built =	1967
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000480x	-0.175x	5.71
Superstr	y =	-0.000410x	-0.150x	6.68
Deck	y =	-0.000481x	-0.176x	5.70

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	5						5						5								
2	2017	5						5						5								
3	2018	5						5						5								
4	2019	5						5						5								
5	2020	4						5						5								
6	2021	4						5						5	Repair (Deck)	$3.00	$11,262.00	6	+ 0	4	$11,262.00	$9,431.75
7	2022	4						4						5						4		
8	2023	5	Repair (Substr)	$5.00	$18,770.00	6	+ 1	5	Repair (Supr - Conc)	$5.00	$18,770.00	7	+ 1	5						5	$37,540.00	$29,634.42
9	2024	5						5						5						5		
10	2025	5						5						5						5		
11	2026	5						5						5						5		
12	2027	5						5						5	Repair (Deck)	$3.00	$11,262.00	6	+ 0	5	$11,262.00	$7,898.94
13	2028	4						5						5						4		
14	2029	5	Repair (Substr)	$5.00	$18,770.00	6	+ 1	4						5						4	$18,770.00	$12,409.18
15	2030	5						5	Repair (Supr - Conc)	$5.00	$18,770.00	7	+ 1	5						5	$18,770.00	$12,047.75
16	2031	5						5						5						5		
17	2032	5						5						5						5		
18	2033	5						5						5	Repair (Deck)	$3.00	$11,262.00	6	+ 0	5	$11,262.00	$6,615.24
19	2034	4						5						5						4		
20	2035	5	Repair (Substr)	$5.00	$18,770.00	6	+ 1	5						5						5	$18,770.00	$10,392.49
21	2036	5						5						5						5		
22	2037	5						4	Repair (Supr - Conc)	$5.00	$18,770.00	7	+ 1	5						4	$18,770.00	$9,795.92
23	2038	5						5						5						5		
24	2039	5						5						5	Repair (Deck)	$3.00	$11,262.00	6	+ 0	5	$11,262.00	$5,540.16
25	2040	4						5						5						4		
26	2041	5	Repair (Substr)	$5.00	$18,770.00	6	+ 1	5						5						5	$18,770.00	$8,703.55
27	2042	8	Replace (Bridge)	$156.25	$644,062.50	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$644,062.50	$289,949.89
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	8						8						8						8		
36	2051	8						8						8						8		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	7						7						7						7		
45	2060	7						7						7						7		
46	2061	6						6						6						6		
47	2062	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$12,366.00	20	+ 0	7	$37,098.00	$9,247.00
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	7						7						7						7		
56	2071	7						7						7						7		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	6						6						6						6		
65	2080	6						6						6						6		
																				Total Cost =	$857,598.50	$411,666.29

Average Rating =	6.18
End Rating =	6

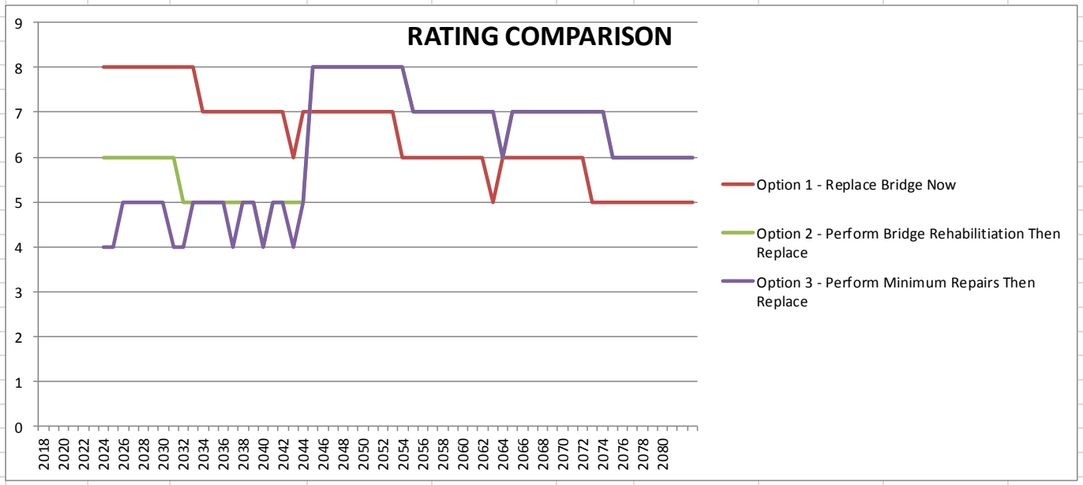
Comments:

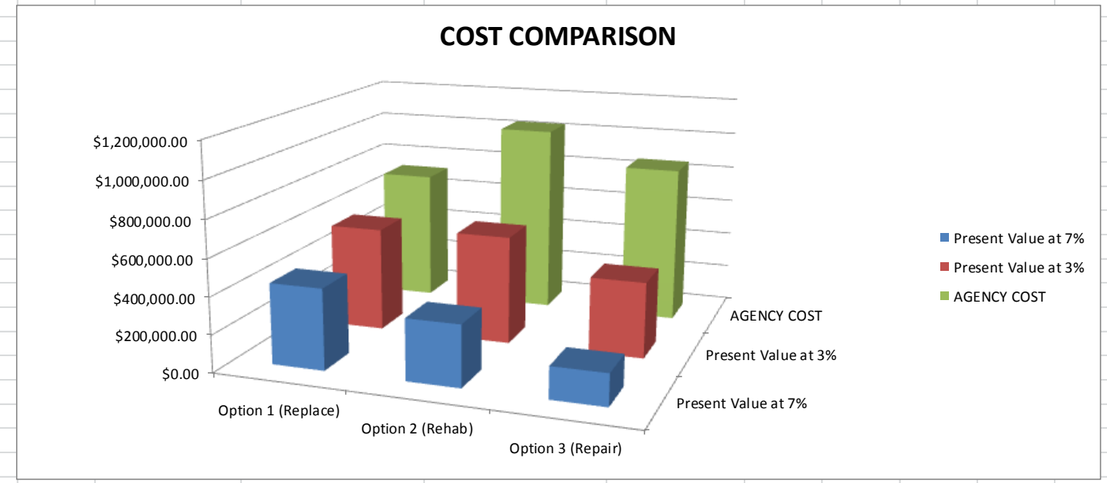
AGUA FRIA CANYON (#906) / I-19 / MP 11.97

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 718,258.50	$566,118.76	$437,204.96
Option 2 (Rehab)	$ 1,034,505.75	$587,667.20	$330,383.56
Option 3 (Repair)	$ 857,598.50	$411,666.29	$171,499.45

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	69.43%	96.33%	132.33%
3 (Repair)	83.75%	137.52%	254.93%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	5
Option 2 (Rehab)	6.42	6
Option 3 (Repair)	6.18	6





	Present Value at 7%	Present Value at 3%	AGENCY COST
Option 1 (Replace)	$437,204.96	$566,118.76	$ 718,258.50
Option 2 (Rehab)	$330,383.56	$587,667.20	$ 1,034,505.75
Option 3 (Repair)	$171,499.45	$411,666.29	$ 857,598.50

PALO PARADO ROAD (#937) / I-19 / MP 15.65

Bridge Information	
Bridge Deck Area (A225)	8366 SF
Year Built (N27)	1966
Exp Service Life	75 YR
Total Bridge Length (N49)	252 LF
Number of Spans (N45+N46)	4
Skew Angle (N34)	0 DEG
Average Elevation	3372 FT
Max Pier Height	22 FT
* Amount of Widening for Bridge	8 FT
Revised Deck Area (Bridge Replace)	10382 FT
**Scour Critical Rating (N113)	N/A

Deterioration Slope

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000557x	-0.203x	4.92
Superstr	y =	-0.000293x	-0.107x	9.35
Deck	y =	-0.000515x	-0.188x	5.32

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**
****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:
1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	3372	1.00
Pier Height > 30ft	22	1.00
Length to # span ratio	63.00	1.1
Skew > 30degrees	0.00	1.00

L to # Span Multiplier

L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier

Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$125.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$137.50

Elevation Multiplier

Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier

Pier H	Multiplier
<30	1.00
=>30	1.10

User input cell
Only manipulate cell value after consulting with team

Bridge History (Inspections/As-builts)		
Description	Category	Year
Bridge has had no work performed to it since original construction.		
Current inspection records note deck surface has extensive narrow to medium size transverse and map cracks with pop outs and delaminations.		
Soffit area also has hairline sized transverse/longitudinal/random cracks with exposed tips of steel stirrups at overhangs.		
Repair recommendations currently only state "monitor transverse and map cracks on the top deck."		

Replace / Rehab / Repair Information

BRIDGE DECK

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Deck)	Full Deck Replacement	$68.75	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$10.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$5.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$3.00	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$137.50	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 0

SUPERSTRUCTURE - STEEL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Stl)	Full SuperStr Replacement	$68.75	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$34.38	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$5.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Conc)	Full SuperStr Replacement	$68.75	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$34.38	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$137.50	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

SUBSTRUCTURE - STRUCTURAL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Substr)	Full SubStr Replacement	$68.75	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$34.38	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Rehab (Substr - Scour)	Add scour protection slabs	$34.38	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$137.50	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

3. When superstructure replacement is selected, either deck replacement or deck rehab should be selected as well.

PALO PARADO ROAD (#937) / I-19 / MP 15.65

Option 1 - Replace Bridge Now

Bridge Deck Area =	8366 SF
Widen Deck Area =	10382 SF
Year Built =	1966
Exp Service Life =	75 YR

Notes:
1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000557x	-0.203x	4.92
Superstr	y =	-0.000293x	-0.107x	9.35
Deck	y =	-0.000515x	-0.188x	5.32

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	8	Replace (Bridge)	$137.50	$1,427,525.00	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,427,525.00	$1,195,529.71
7	2022	8						8						8						8		
8	2023	8						8						8						8		
9	2024	8						8						8						8		
10	2025	8						8						8						8		
11	2026	8						8						8						8		
12	2027	8						8						8						8		
13	2028	8						8						8						8		
14	2029	8						8						8						8		
15	2030	8						8						8						8		
16	2031	7						7						7						7		
17	2032	7						7						7						7		
18	2033	7						7						7						7		
19	2034	7						7						7						7		
20	2035	7						7						7						7		
21	2036	7						7						7						7		
22	2037	7						7						7						7		
23	2038	7						7						7						7		
24	2039	7						7						7						7		
25	2040	6						6						6						6		
26	2041	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 0	7	$93,438.00	$43,326.71
27	2042	7						7						7						7		
28	2043	7						7						7						7		
29	2044	7						7						7						7		
30	2045	7						7						7						7		
31	2046	7						7						7						7		
32	2047	7						7						7						7		
33	2048	7						7						7						7		
34	2049	7						7						7						7		
35	2050	7						7						7						7		
36	2051	6						6						6						6		
37	2052	6						6						6						6		
38	2053	6						6						6						6		
39	2054	6						6						6						6		
40	2055	6						6						6						6		
41	2056	6						6						6						6		
42	2057	6						6						6						6		
43	2058	6						6						6						6		
44	2059	6						6						6						6		
45	2060	5						5						5						5		
46	2061	6	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 0	6	$93,438.00	$23,988.95
47	2062	6						6						6						6		
48	2063	6						6						6						6		
49	2064	6						6						6						6		
50	2065	6						6						6						6		
51	2066	6						6						6						6		
52	2067	6						6						6						6		
53	2068	6						6						6						6		
54	2069	6						6						6						6		
55	2070	5						5						5						5		
56	2071	5						5						5						5		
57	2072	5						5						5						5		
58	2073	5						5						5						5		
59	2074	5						5						5						5		
60	2075	5						5						5						5		
61	2076	5						5						5						5		
62	2077	5						5						5						5		
63	2078	5						5						5						5		
64	2079	5						5						5						5		
65	2080	5						5						5						5		
																				Total Cost =	**$1,614,401.00**	**$1,262,845.37**

Average Rating =	6.45
End Rating =	5

Comments:

PALO PARADO ROAD (#937) / I-19 / MP 15.65

Option 2 - Perform Bridge Rehabilitiation Then Replace

Bridge Deck Area =	8366 SF
Widen Deck Area =	10382 SF
Year Built =	1966
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.)
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000557x	-0.203x	4.92
Superstr	y =	-0.000293x	-0.107x	9.35
Deck	y =	-0.000515x	-0.188x	5.32

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						7	Rehab (Supr - Conc)	$34.38	$287,581.25	15	+ 2	7	Rehab (Deck Concrete Overlay)	$10.00	$83,660.00	15	+ 2	5	$371,241.25	$310,908.70
7	2022	5						7						7						5		
8	2023	5						7						7						5		
9	2024	5						7						7						5		
10	2025	4						7						7						4		
11	2026	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	7						7						5	$41,830.00	$30,218.88
12	2027	5						7						7						5		
13	2028	5						7						7						5		
14	2029	5						7						7						5		
15	2030	5						6						6						5		
16	2031	4						6						6						4		
17	2032	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	6						6						5	$41,830.00	$25,307.84
18	2033	5						6						6						5		
19	2034	5						6						6						5		
20	2035	5						6						6						5		
21	2036	5						6						6						5		
22	2037	4						6						6						4		
23	2038	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	5						5						5	$41,830.00	$21,194.92
24	2039	5						5						5						5		
25	2040	5						5						5						5		
26	2041	8	Replace (Bridge)	$137.50	$1,427,525.00	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,427,525.00	$661,935.82
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	8						8						8						8		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	7						7						7						7		
45	2060	6						6						6						6		
46	2061	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 0	7	$93,438.00	$23,988.95
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	7						7						7						7		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	6						6						6						6		
65	2080	5						5						5						5		
																				Total Cost =	**$2,017,694.25**	**$1,073,555.10**

Average Rating =	6.25
End Rating =	5

Comments:

PALO PARADO ROAD (#937) / I-19 / MP 15.65

Option 3 - Perform Minimum Repairs Then Replace

Bridge Deck Area =	8366 SF
Widen Deck Area =	10382 SF
Year Built =	1966
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000557x	-0.203x	4.92
Superstr	y =	-0.000293x	-0.107x	9.35
Deck	y =	-0.000515x	-0.188x	5.32

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						5						5	Repair (Deck)	$3.00	$25,098.00	5	+ 0	5	$25,098.00	$21,019.18
7	2022	5						5						5						5		
8	2023	5						4						5						4		
9	2024	4						5	Repair (Supr - Conc)	$5.00	$41,830.00	9	+ 1	5						4	$41,830.00	$32,059.21
10	2025	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	5						5						5	$41,830.00	$31,125.45
11	2026	5						5						5	Repair (Deck)	$3.00	$25,098.00	5	+ 0	5	$25,098.00	$18,131.33
12	2027	5						5						5						5		
13	2028	5						5						5						5		
14	2029	4						5						5						4		
15	2030	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	5						5						5	$41,830.00	$26,849.09
16	2031	5						5						5	Repair (Deck)	$3.00	$25,098.00	5	+ 0	5	$25,098.00	$15,640.24
17	2032	5						4						5						4		
18	2033	5						5	Repair (Supr - Conc)	$5.00	$41,830.00	9	+ 1	5						5	$41,830.00	$24,570.72
19	2034	4						5						5						4		
20	2035	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	5						5						5	$41,830.00	$23,160.26
21	2036	5						5						5	Repair (Deck)	$3.00	$25,098.00	5	+ 0	5	$25,098.00	$13,491.41
22	2037	5						5						5						5		
23	2038	5						5						5						5		
24	2039	4						5						5						4		
25	2040	5	Repair (Substr)	$5.00	$41,830.00	5	+ 1	5						5						5	$41,830.00	$19,978.24
26	2041	8	Replace (Bridge)	$137.50	$1,427,525.00	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,427,525.00	$661,935.82
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	8						8						8						8		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	7						7						7						7		
45	2060	6						6						6						6		
46	2061	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$31,146.00	20	+ 0	7	$93,438.00	$23,988.95
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	7						7						7						7		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	6						6						6						6		
65	2080	5						5						5						5		
																				Total Cost =	$1,872,335.00	$911,949.89

Average Rating =	6.20
End Rating =	5

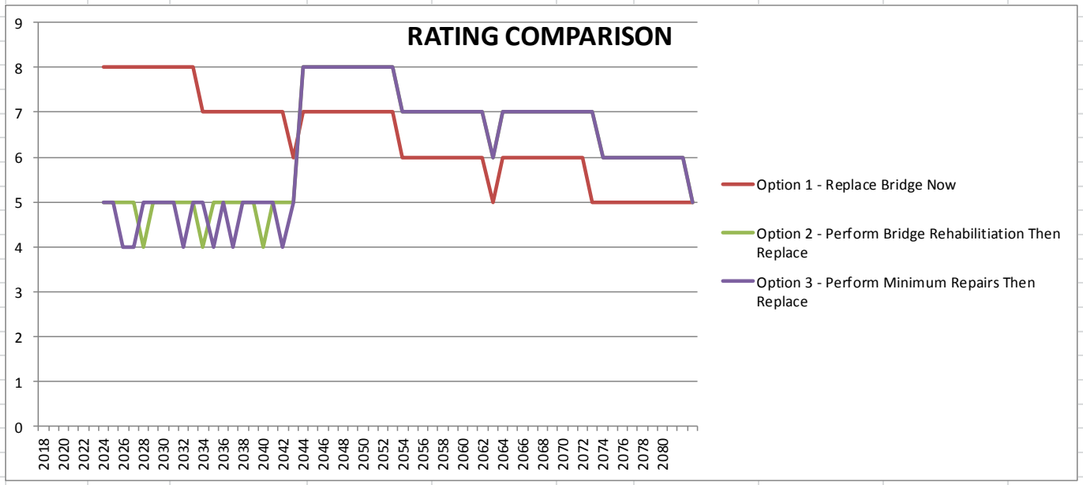
Comments:

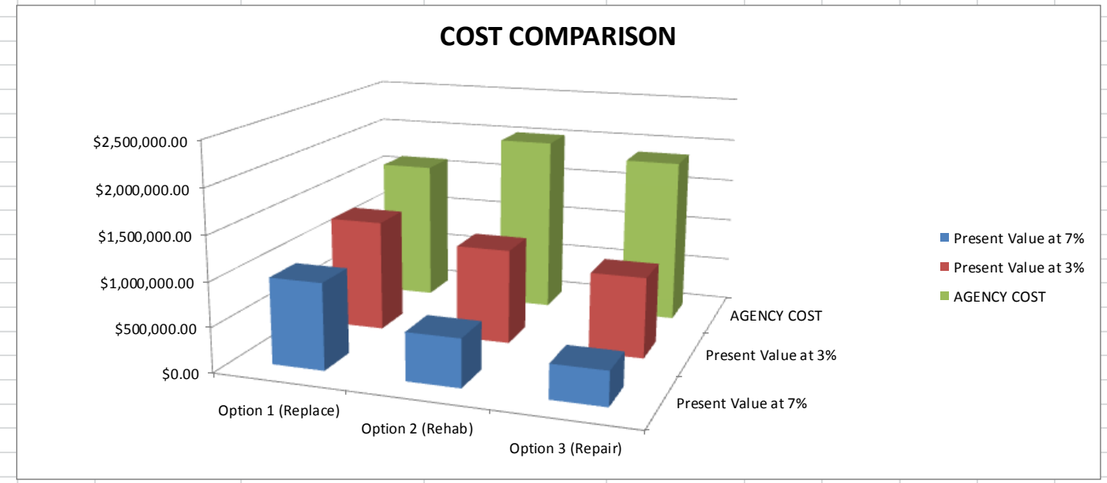
PALO PARADO ROAD (#937) / I-19 / MP 15.65

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 1,614,401.00	$1,262,845.37	$971,467.64
Option 2 (Rehab)	$ 2,017,694.25	$1,073,555.10	$539,284.30
Option 3 (Repair)	$ 1,872,335.00	$911,949.89	$383,252.94

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	80.01%	117.63%	180.14%
3 (Repair)	86.22%	138.48%	253.48%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	5
Option 2 (Rehab)	6.25	5
Option 3 (Repair)	6.20	5





	Present Value at 7%	Present Value at 3%	AGENCY COST
Option 1 (Replace)	$971,467.64	$1,262,845.37	$ 1,614,401.00
Option 2 (Rehab)	$539,284.30	$1,073,555.10	$ 2,017,694.25
Option 3 (Repair)	$383,252.94	$911,949.89	$ 1,872,335.00

AIRPORT WASH (#1121) / I-19 / MP 60.32

Bridge Information	
Bridge Deck Area (A225)	6350 SF
Year Built (N27)	1965
Exp Service Life	75 YR
Total Bridge Length (N49)	147 LF
Number of Spans (N45+N46)	4
Skew Angle (N34)	34 DEG
Average Elevation	2454 FT
Max Pier Height	16 FT
* Amount of Widening for Bridge	4 FT
Revised Deck Area (Bridge Replace)	6938 FT
**Scour Critical Rating (N113)	7

Deterioration Slope

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000550x	-0.201x	4.98
Superstr	y =	-0.000380x	-0.139x	7.21
Deck	y =	-0.000380x	-0.139x	7.21

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**
****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:
1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	2454	1.00
Pier Height > 30ft	16	1.00
Length to # span ratio	36.75	1.25
Skew > 30degrees	34.00	1.10

L to # Span Multiplier

L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier

Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$125.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$171.88

Elevation Multiplier

Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier

Pier H	Multiplier
<30	1.00
=>30	1.10

User input cell
Only manipulate cell value after consulting with team

Bridge History (Inspections/As-builts)

Description	Category	Year
Bridge was originally constructed in 1965 (19-1(5)RD).		1965
Scour slab was added in 2003 (I-019-A-504).	Rehab (Substr - Scour)	2003
Inspection notes wide sized transverse, diagonal, longitudinal and map cracks in deck.		
Soffit has narrow to medium sized longitudinal and random clocks…east edge of deck has minor spall.		
Abutments/piers have few narrow/medium sized vertical cracks.		
Inspection only recommends rehab of top deck surface.		

Replace / Rehab / Repair Information

BRIDGE DECK

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Deck)	Full Deck Replacement	$85.94	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$10.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$5.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$3.00	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 0

SUPERSTRUCTURE - STEEL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Stl)	Full SuperStr Replacement	$85.94	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$42.97	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$5.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Conc)	Full SuperStr Replacement	$85.94	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$42.97	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

SUBSTRUCTURE - STRUCTURAL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Substr)	Full SubStr Replacement	$85.94	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$42.97	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Rehab (Substr - Scour)	Add scour protection slabs	$42.97	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

3. When superstructure replacement is selected, either deck replacement or deck rehab should be selected as well.

AIRPORT WASH (#1121) / I-19 / MP 60.32

Option 1 - Replace Bridge Now

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:
1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000550x	-0.201x	4.98
Superstr	y =	-0.000380x	-0.139x	7.21
Deck	y =	-0.000380x	-0.139x	7.21

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6						5						5								
1	2016	6						5						5								
2	2017	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$998,702.86
7	2022	8						8						8						8		
8	2023	8						8						8						8		
9	2024	8						8						8						8		
10	2025	8						8						8						8		
11	2026	8						8						8						8		
12	2027	8						8						8						8		
13	2028	8						8						8						8		
14	2029	8						8						8						8		
15	2030	8						8						8						8		
16	2031	7						7						7						7		
17	2032	7						7						7						7		
18	2033	7						7						7						7		
19	2034	7						7						7						7		
20	2035	7						7						7						7		
21	2036	7						7						7						7		
22	2037	7						7						7						7		
23	2038	7						7						7						7		
24	2039	7						7						7						7		
25	2040	6						6						6						6		
26	2041	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$28,954.03
27	2042	7						7						7						7		
28	2043	7						7						7						7		
29	2044	7						7						7						7		
30	2045	7						7						7						7		
31	2046	7						7						7						7		
32	2047	7						7						7						7		
33	2048	7						7						7						7		
34	2049	7						7						7						7		
35	2050	7						7						7						7		
36	2051	6						6						6						6		
37	2052	6						6						6						6		
38	2053	6						6						6						6		
39	2054	6						6						6						6		
40	2055	6						6						6						6		
41	2056	6						6						6						6		
42	2057	6						6						6						6		
43	2058	6						6						6						6		
44	2059	6						6						6						6		
45	2060	5						5						5						5		
46	2061	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$16,031.14
47	2062	6						6						6						6		
48	2063	6						6						6						6		
49	2064	6						6						6						6		
50	2065	6						6						6						6		
51	2066	6						6						6						6		
52	2067	6						6						6						6		
53	2068	6						6						6						6		
54	2069	6						6						6						6		
55	2070	5						5						5						5		
56	2071	5						5						5						5		
57	2072	5						5						5						5		
58	2073	5						5						5						5		
59	2074	5						5						5						5		
60	2075	5						5						5						5		
61	2076	5						5						5						5		
62	2077	5						5						5						5		
63	2078	5						5						5						5		
64	2079	5						5						5						5		
65	2080	5						5						5						5		
																				Total Cost =	**$1,317,387.44**	**$1,043,688.03**

Average Rating =	6.45
End Rating =	5

Comments:

AIRPORT WASH (#1121) / I-19 / MP 60.32

Option 2 - Perform Bridge Rehabilitiation Then Replace

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.)
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000550x	-0.201x	4.98
Superstr	y =	-0.000380x	-0.139x	7.21
Deck	y =	-0.000380x	-0.139x	7.21

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						5						4						4		
7	2022	5						6	Rehab (Supr - Conc)	$42.97	$272,859.50	15	+ 2	6	Rehab (Deck Concrete Overlay)	$10.00	$63,500.00	15	+ 2	5	$336,359.50	$273,491.05
8	2023	5						6						6						5		
9	2024	5						6						6						5		
10	2025	4						6						6						4		
11	2026	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	6						6						5	$31,750.00	$22,936.88
12	2027	5						6						6						5		
13	2028	5						6						6						5		
14	2029	5						6						6						5		
15	2030	5						6						6						5		
16	2031	4						5						5						4		
17	2032	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$19,209.27
18	2033	5						5						5						5		
19	2034	5						5						5						5		
20	2035	5						5						5						5		
21	2036	5						5						5						5		
22	2037	4						5						5						4		
23	2038	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$16,087.46
24	2039	5						5						5						5		
25	2040	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$569,546.28
26	2041	8						8						8						8		
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	7						7						7						7		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	6						6						6						6		
45	2060	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$16,512.08
46	2061	7						7						7						7		
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	6						6						6						6		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	5						5						5						5		
65	2080	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$9,142.34
																				Total Cost =	**$1,748,996.94**	**$926,925.36**

Average Rating =	6.25
End Rating =	6

Comments:

AIRPORT WASH (#1121) / I-19 / MP 60.32

Option 3 - Perform Minimum Repairs Then Replace

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000550x	-0.201x	4.98
Superstr	y =	-0.000380x	-0.139x	7.21
Deck	y =	-0.000380x	-0.139x	7.21

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						4						5						4		
7	2022	5						5	Repair (Supr - Conc)	$5.00	$31,750.00	7	+ 1	5	Repair (Deck)	$3.00	$19,050.00	7	+ 0	5	$50,800.00	$41,305.05
8	2023	5						5						5						5		
9	2024	5						5						5						5		
10	2025	4						5						5						4		
11	2026	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$22,936.88
12	2027	5						5						5						5		
13	2028	5						4						5						4		
14	2029	5						5	Repair (Supr - Conc)	$5.00	$31,750.00	7	+ 1	5	Repair (Deck)	$3.00	$19,050.00	7	+ 0	5	$50,800.00	$33,584.78
15	2030	5						5						5						5		
16	2031	4						5						5						4		
17	2032	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$19,209.27
18	2033	5						5						5						5		
19	2034	5						5						5						5		
20	2035	5						5						5						5		
21	2036	5						4	Repair (Supr - Conc)	$5.00	$31,750.00	7	+ 1	5	Repair (Deck)	$3.00	$19,050.00	7	+ 0	4	$50,800.00	$27,307.50
22	2037	4						5						5						4		
23	2038	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$16,087.46
24	2039	5						5						5						5		
25	2040	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$569,546.28
26	2041	8						8						8						8		
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	7						7						7						7		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	6						6						6						6		
45	2060	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$16,512.08
46	2061	7						7						7						7		
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	6						6						6						6		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	5						5						5						5		
65	2080	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$9,142.34
																				Total Cost =	**$1,565,037.44**	**$755,631.64**

Average Rating =	6.22
End Rating =	6

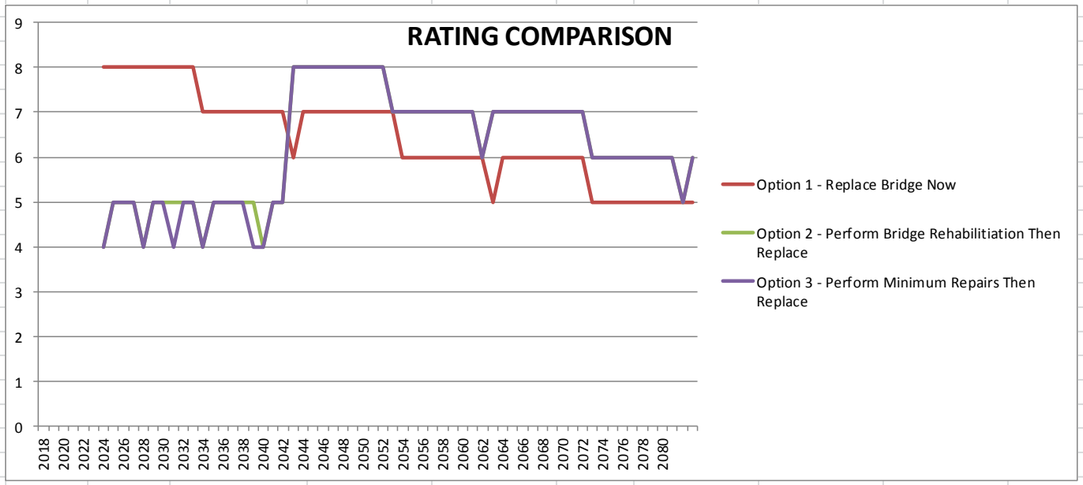
Comments:

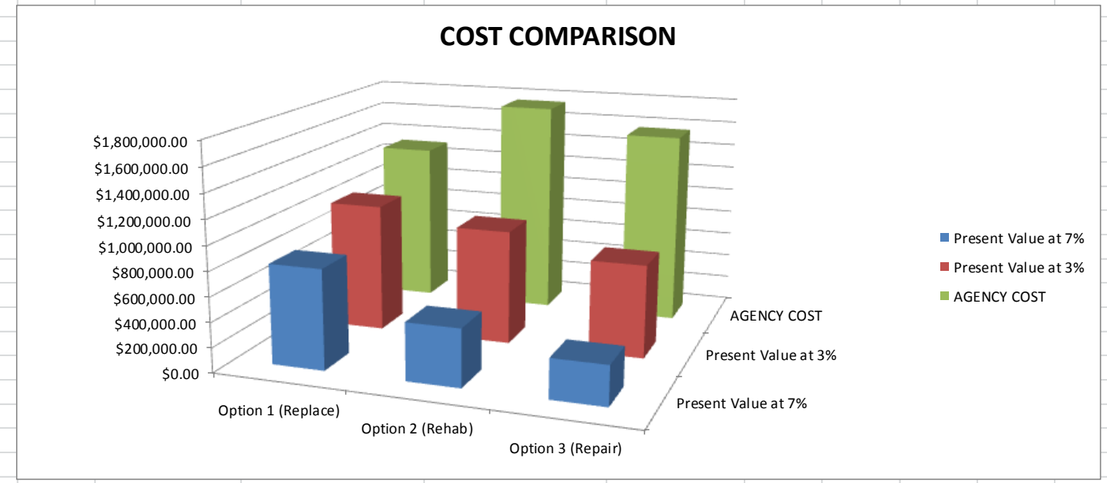
AIRPORT WASH (#1121) / I-19 / MP 60.32

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 1,317,387.44	$1,043,688.03	$808,146.21
Option 2 (Rehab)	$ 1,748,996.94	$926,925.36	$464,759.95
Option 3 (Repair)	$ 1,565,037.44	$755,631.64	$318,897.82

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	75.32%	112.60%	173.88%
3 (Repair)	84.18%	138.12%	253.42%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	5
Option 2 (Rehab)	6.25	6
Option 3 (Repair)	6.22	6





	Present Value at 7%	Present Value at 3%	AGENCY COST
Option 1 (Replace)	$808,146.21	$1,043,688.03	$ 1,317,387.44
Option 2 (Rehab)	$464,759.95	$926,925.36	$ 1,748,996.94
Option 3 (Repair)	$318,897.82	$755,631.64	$ 1,565,037.44

AIRPORT WASH (#1122) / I-19 / MP 60.32

Bridge Information	
Bridge Deck Area (A225)	6350 SF
Year Built (N27)	1965
Exp Service Life	75 YR
Total Bridge Length (N49)	147 LF
Number of Spans (N45+N46)	4
Skew Angle (N34)	34 DEG
Average Elevation	2454 FT
Max Pier Height	16 FT
* Amount of Widening for Bridge	4 FT
Revised Deck Area (Bridge Replace)	6938 FT
**Scour Critical Rating (N113)	7

Deterioration Slope

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000594x	-0.217x	4.61
Superstr	y =	-0.000300x	-0.110x	9.13
Deck	y =	-0.000436x	-0.159x	6.28

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**
****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:
1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	2454	1.00
Pier Height > 30ft	16	1.00
Length to # span ratio	36.75	1.25
Skew > 30degrees	34.00	1.10

L to # Span Multiplier

L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier

Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$125.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$171.88

Elevation Multiplier

Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier

Pier H	Multiplier
<30	1.00
=>30	1.10

User input cell
Only manipulate cell value after consulting with team

Bridge History (Inspections/As-builts)

Description	Category	Year
Bridge was originally constructed in 1965 (19-1(5)RD).		1965
Scour slab was added in 2003 (I-019-A-504).	Rehab (Substr - Scour)	2003
Inspection notes wide sized transverse, diagonal, longitudinal and map cracks in deck.		
Soffit has narrow to medium sized longitudinal and random clocks…east edge of deck has minor spall.		
Abutments/piers have few narrow/medium sized vertical cracks.		
Inspection only recommends rehab of top deck surface.		

Replace / Rehab / Repair Information

BRIDGE DECK

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Deck)	Full Deck Replacement	$85.94	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$10.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$5.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$3.00	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 0

SUPERSTRUCTURE - STEEL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Stl)	Full SuperStr Replacement	$85.94	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$42.97	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$5.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Supr - Conc)	Full SuperStr Replacement	$85.94	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$42.97	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

SUBSTRUCTURE - STRUCTURAL

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Replace (Substr)	Full SubStr Replacement	$85.94	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$42.97	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR

ITEM	DESCRIPTION	UNIT COST (Per SF)	LIFE (YRS)	RATING BENEFIT
Rehab (Substr - Scour)	Add scour protection slabs	$42.97	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$5.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$171.88	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$3.00	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$3.00	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

3. When superstructure replacement is selected, either deck replacement or deck rehab should be selected as well.

AIRPORT WASH (#1122) / I-19 / MP 60.32

Option 1 - Replace Bridge Now

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000594x	-0.217x	4.61
Superstr	y =	-0.000300x	-0.110x	9.13
Deck	y =	-0.000436x	-0.159x	6.28

		Substructure						*Superstructure*						*Deck*							*Summary*	
	Year	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	Total Cost Per Year	Present Value at 3%
0	2015	6						5						5								
1	2016	6						5						5								
2	2017	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$998,702.86
7	2022	8						8						8						8		
8	2023	8						8						8						8		
9	2024	8						8						8						8		
10	2025	8						8						8						8		
11	2026	8						8						8						8		
12	2027	8						8						8						8		
13	2028	8						8						8						8		
14	2029	8						8						8						8		
15	2030	8						8						8						8		
16	2031	7						7						7						7		
17	2032	7						7						7						7		
18	2033	7						7						7						7		
19	2034	7						7						7						7		
20	2035	7						7						7						7		
21	2036	7						7						7						7		
22	2037	7						7						7						7		
23	2038	7						7						7						7		
24	2039	7						7						7						7		
25	2040	6						6						6						6		
26	2041	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$28,954.03
27	2042	7						7						7						7		
28	2043	7						7						7						7		
29	2044	7						7						7						7		
30	2045	7						7						7						7		
31	2046	7						7						7						7		
32	2047	7						7						7						7		
33	2048	7						7						7						7		
34	2049	7						7						7						7		
35	2050	7						7						7						7		
36	2051	6						6						6						6		
37	2052	6						6						6						6		
38	2053	6						6						6						6		
39	2054	6						6						6						6		
40	2055	6						6						6						6		
41	2056	6						6						6						6		
42	2057	6						6						6						6		
43	2058	6						6						6						6		
44	2059	6						6						6						6		
45	2060	5						5						5						5		
46	2061	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$16,031.14
47	2062	6						6						6						6		
48	2063	6						6						6						6		
49	2064	6						6						6						6		
50	2065	6						6						6						6		
51	2066	6						6						6						6		
52	2067	6						6						6						6		
53	2068	6						6						6						6		
54	2069	6						6						6						6		
55	2070	5						5						5						5		
56	2071	5						5						5						5		
57	2072	5						5						5						5		
58	2073	5						5						5						5		
59	2074	5						5						5						5		
60	2075	5						5						5						5		
61	2076	5						5						5						5		
62	2077	5						5						5						5		
63	2078	5						5						5						5		
64	2079	5						5						5						5		
65	2080	5						5						5						5		
																				Total Cost =	**$1,317,387.44**	**$1,043,688.03**

Average Rating =	6.45
End Rating =	5

Comments:

AIRPORT WASH (#1122) / I-19 / MP 60.32

Option 2 - Perform Bridge Rehabilitiation Then Replace

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.)
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000594x	-0.217x	4.61
Superstr	y =	-0.000300x	-0.110x	9.13
Deck	y =	-0.000436x	-0.159x	6.28

	Year	*Substructure* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	*Superstructure* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	*Deck* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	*Summary* Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						5						4						4		
7	2022	5						6	Rehab (Supr - Conc)	$42.97	$272,859.50	15	+ 2	6	Rehab (Deck Concrete Overlay)	$10.00	$63,500.00	15	+ 2	5	$336,359.50	$273,491.05
8	2023	4						6						6						4		
9	2024	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	6						6						5	$31,750.00	$24,333.73
10	2025	5						6						6						5		
11	2026	5						6						6						5		
12	2027	4						6						6						4		
13	2028	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	6						6						5	$31,750.00	$21,620.21
14	2029	5						6						6						5		
15	2030	5						6						6						5		
16	2031	4						5						5						4		
17	2032	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$19,209.27
18	2033	5						5						5						5		
19	2034	5						5						5						5		
20	2035	4						5						5						4		
21	2036	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$17,067.19
22	2037	5						5						5						5		
23	2038	5						5						5						5		
24	2039	5						5						5						5		
25	2040	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$569,546.28
26	2041	8						8						8						8		
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	7						7						7						7		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	6						6						6						6		
45	2060	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$16,512.08
46	2061	7						7						7						7		
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	6						6						6						6		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	5						5						5						5		
65	2080	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$9,142.34
																				Total Cost =	**$1,780,746.94**	**$950,922.15**

Average Rating =	6.23
End Rating =	6

Comments:

AIRPORT WASH (#1122) / I-19 / MP 60.32

Option 3 - Perform Minimum Repairs Then Replace

Bridge Deck Area =	6350 SF
Widen Deck Area =	6938 SF
Year Built =	1965
Exp Service Life =	75 YR

Notes:

1. Red fill in "Year" column means current bridge is nearing the end of its expected service life.
2. When superstructure replacement is selected, deck replacement should be selected as well.
3. Deck Rehab does not account for any deck widening during replacement.
4. Widened deck area applies to bridge replacement only.
5. Repair deck (after bridge replace) should provide a deck deterioration of 1 point every 20 years. Repair (Deck) should maintain deck rating for life of repair, if the rating would otherwise drop a point (i.e., if the rating would drop from a "5" to a "4", Repair Deck would maintain a "5" at that year.
6. For other repair items, the "+" value rating should be applied to improve the bridge rating's value for that year.

Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000594x	-0.217x	4.61
Superstr	y =	-0.000300x	-0.110x	9.13
Deck	y =	-0.000436x	-0.159x	6.28

	Year	*Substructure* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	*Superstructure* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	*Deck* Rating	Item	Cost (Per SF)	Cost (Total)	Service Life	Rating Increase	Minimum Rating	*Summary* Total Cost Per Year	Present Value at 3%
0	2015	6	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.					5	No Rehab/Repair Work Can Be Done. Not Yet In 5-Year Program.							
1	2016	6						5						5								
2	2017	6						5						5								
3	2018	6						5						5								
4	2019	6						5						5								
5	2020	5						5						5								
6	2021	5						4						5	Repair (Deck)	$3.00	$19,050.00	6	+ 0	4	$19,050.00	$15,954.08
7	2022	5						5	Repair (Supr - Conc)	$5.00	$31,750.00	9	+ 1	5						5	$31,750.00	$25,815.66
8	2023	4						5						5						4		
9	2024	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$24,333.73
10	2025	5						5						5						5		
11	2026	5						5						5						5		
12	2027	4						5						5	Repair (Deck)	$3.00	$19,050.00	6	+ 0	4	$19,050.00	$13,361.29
13	2028	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$21,620.21
14	2029	5						4						5						4		
15	2030	5						5	Repair (Supr - Conc)	$5.00	$31,750.00	9	+ 1	5						5	$31,750.00	$20,379.12
16	2031	4						5						5						4		
17	2032	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$19,209.27
18	2033	5						5						5	Repair (Deck)	$3.00	$19,050.00	6	+ 0	5	$19,050.00	$11,189.87
19	2034	5						5						5						5		
20	2035	4						5						5						4		
21	2036	5	Repair (Substr)	$5.00	$31,750.00	5	+ 1	5						5						5	$31,750.00	$17,067.19
22	2037	5						5						5						5		
23	2038	5						4						5						4		
24	2039	5						4						4						4		
25	2040	8	Replace (Bridge)	$171.88	$1,192,503.44	75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	Replace (Bridge)			75	Rating = 8	8	$1,192,503.44	$569,546.28
26	2041	8						8						8						8		
27	2042	8						8						8						8		
28	2043	8						8						8						8		
29	2044	8						8						8						8		
30	2045	8						8						8						8		
31	2046	8						8						8						8		
32	2047	8						8						8						8		
33	2048	8						8						8						8		
34	2049	8						8						8						8		
35	2050	7						7						7						7		
36	2051	7						7						7						7		
37	2052	7						7						7						7		
38	2053	7						7						7						7		
39	2054	7						7						7						7		
40	2055	7						7						7						7		
41	2056	7						7						7						7		
42	2057	7						7						7						7		
43	2058	7						7						7						7		
44	2059	6						6						6						6		
45	2060	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	7	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	7	$62,442.00	$16,512.08
46	2061	7						7						7						7		
47	2062	7						7						7						7		
48	2063	7						7						7						7		
49	2064	7						7						7						7		
50	2065	7						7						7						7		
51	2066	7						7						7						7		
52	2067	7						7						7						7		
53	2068	7						7						7						7		
54	2069	7						7						7						7		
55	2070	6						6						6						6		
56	2071	6						6						6						6		
57	2072	6						6						6						6		
58	2073	6						6						6						6		
59	2074	6						6						6						6		
60	2075	6						6						6						6		
61	2076	6						6						6						6		
62	2077	6						6						6						6		
63	2078	6						6						6						6		
64	2079	5						5						5						5		
65	2080	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 1	6	Repair (After Bridge Replace)	$3.00	$20,814.00	20	+ 0	6	$62,442.00	$9,142.34
																				Total Cost =	**$1,565,037.44**	**$764,131.10**

Average Rating =	6.18
End Rating =	6

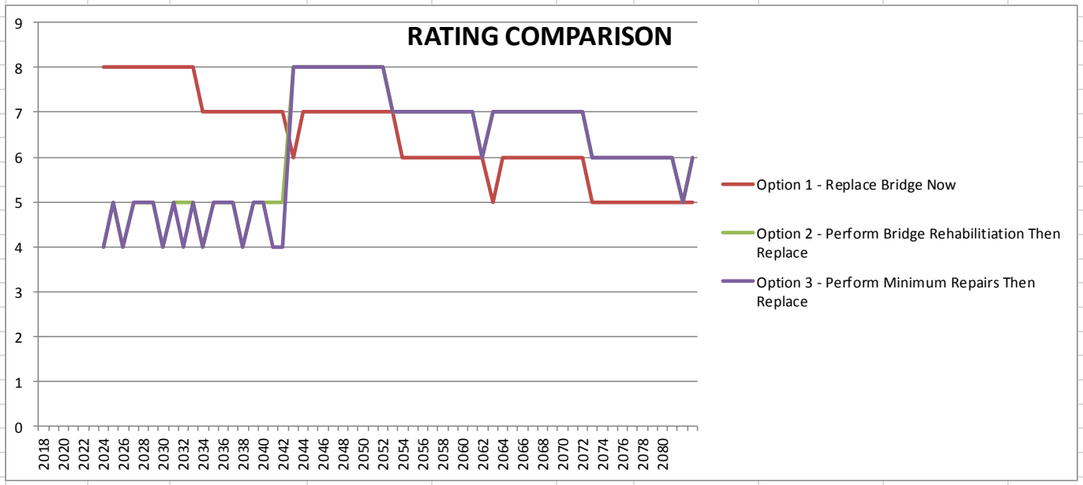
Comments:

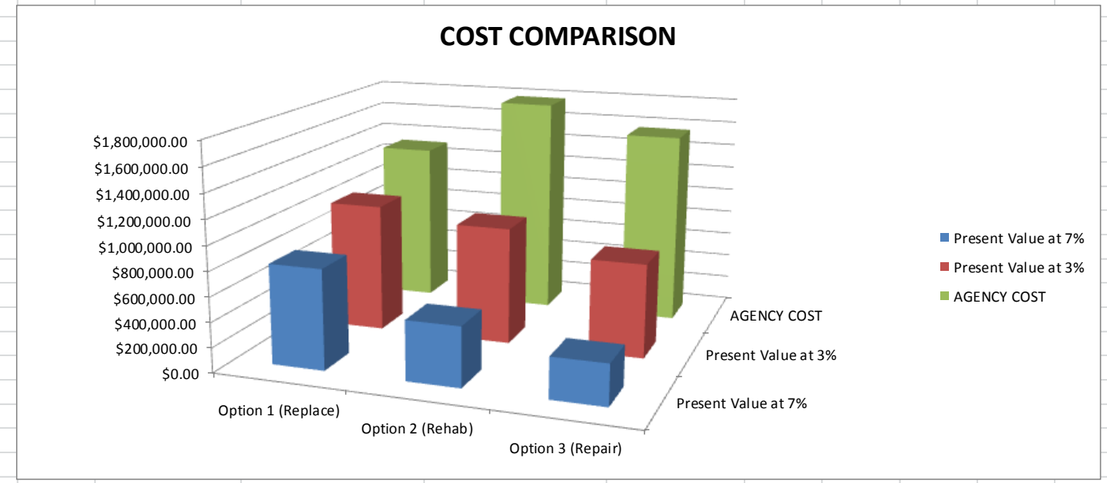
AIRPORT WASH (#1122) / I-19 / MP 60.32

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 1,317,387.44	$1,043,688.03	$808,146.21
Option 2 (Rehab)	$ 1,780,746.94	$950,922.15	$481,091.25
Option 3 (Repair)	$ 1,565,037.44	$764,131.10	$329,691.88

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	73.98%	109.76%	167.98%
3 (Repair)	84.18%	136.58%	245.12%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	5
Option 2 (Rehab)	6.23	6
Option 3 (Repair)	6.18	6





	Present Value at 7%	Present Value at 3%	AGENCY COST
Option 1 (Replace)	$808,146.21	$1,043,688.03	$ 1,317,387.44
Option 2 (Rehab)	$481,091.25	$950,922.15	$ 1,780,746.94
Option 3 (Repair)	$329,691.88	$764,131.10	$ 1,565,037.44

Appendix C Crash Modification Factors

SOLUTION	CONST COST	UNIT	FACTOR	TOTAL CONST COST	DESCRIPTION	CMF for Corridor Profile Studies	CMF Notes
REHABILITATION							
Rehabilitate Pavement (AC)	$270,000	Mile	2.20	$590,000	Mill and replace 1"-3" AC pvmt; accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, striping, RPMs, rumble strips	0.71	Avg of 3 values from clearinghouse; include striping, RPMs etc. 0.92 x 0.77 = 0.71
Rehabilitate Bridge	$65	SF	2.20	$140	Based on deck area; bridge only - no other costs included	0.95	Assumed - should have a minor effect on crashes at the bridge
GEOMETRIC IMPROVEMENT							
Re-profile Roadway	$968,000	Mile	2.20	$2,130,000	Includes excavation of approximately 3", pavement replacement (AC), striping, RPMs, rumble strips, for one direction of travel of 2-lane roadway (38' width)	0.80	Assumed - this is similar (but slightly conservative) to rehab pavement. This solution is intended to address vertical clearance at bridge, not profile issue.
Realign Roadway	$2,960,000	Mile	2.20	$6,510,000	All costs per direction except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.50	Based on CalTrans and NC DOT
Improve Skid Resistance	$668,500	Mile	2.20	$1,470,000	Average cost of pvmt replacement and variable depth paving to increase super-elevation; for one direction of travel on two lane roadway; includes pavement, striping, RPMs, rumble strips	0.67	Avg of 5 values from clearinghouse (0.77) and calculated value from HSM (0.87), times 0.77 to account for striping, RPMs, etc.
INFRASTRUCTURE IMPROVEMENT							
Construct Auxiliary Lanes (AC)	$914,000	Mile	2.20	$2,011,000	For addition of aux lane (AC) in one direction of travel; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.78	Average of 4 values from clearinghouse
Construct Climbing Lane (High)	$3,000,000	Mile	2.20	$6,600,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, steep slopes on both sides of road	0.75	From HSM
Construct Climbing Lane (Medium)	$2,250,000	Mile	2.20	$4,950,000	All costs except bridges; applicable to areas with medium or large fills and cuts, retaining walls, rock blasting, steep slopes on one side of road	0.75	From HSM
Construct Climbing Lane (Low)	$1,500,000	Mile	2.20	$3,300,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.75	From HSM
Construct Reversible Lane (Low)	$2,400,000	Lane-Mile	2.20	$5,280,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.70 for uphill and 0.85 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Reversible Lane (High)	$4,800,000	Lane-Mile	2.20	$10,560,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, mountainous terrain	0.70 for uphill and 0.85 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Entry/Exit Ramp	$730,000	Each	2.20	$1,610,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork & drainage; does not include any major structures or improvements on crossroad	1.09	Average of 16 values on clearinghouse; for adding a ramp not reconstructing
Modify Entry/Exit Ramp	$445,000	Each	2.20	$979,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting existing ramp to parallel-type configuration	0.21	Average of 4 values from clearinghouse (for exit ramps) and equation from HSM (for entrance ramp)
Widen & Modify Entry/Exit Ramp	$619,000	Each	2.20	$1,361,800	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting 1-lane ramp to 2-lane ramp and converting to parallel-type ramp	0.21	Will be same as "Modify Ramp"

SOLUTION	CONST COST	UNIT	FACTOR	TOTAL CONST COST	DESCRIPTION	CMF for Corridor Profile Studies	CMF Notes
Replace Pavement (AC)(with over excavation)	$1,440,000	Mile	2.20	$3,170,000	Accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, over excavation, striping, RPMs, rumble strips	0.71	Same as rehab
Replace Pavement (PCCP)(with over excavation)	$1,730,000	Mile	2.20	$3,810,000	Accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, over excavation, striping, RPMs, rumble strips	0.71	Same as rehab
Replace Bridge	$125	SF	2.20	$280	Based on deck area; bridge only - no other costs included	0.95	Assumed - should have a minor effect on crashes at the bridge
Widen Bridge	$175	SF	2.20	$390	Based on deck area; bridge only - no other costs included	0.90	Assumed - should have a minor effect on crashes at the bridge
Install Pedestrian Bridge	$135	SF	2.20	$300	Includes cost to construct bridge based on linear feet of the bridge. This costs includes and assumes ramps and sidewalks leading to the structure.		
Implement Automated Bridge De-icing	$115	SF	2.20	$250	Includes cost to replace bridge deck and install system	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
OPERATIONAL IMPROVEMENT							
Implement Variable Speed Limits (Wireless, Overhead)	$718,900	Mile	2.20	$1,580,000	Includes 2 signs per mile (foundations and structures), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Ground-mount)	$169,700	Mile	2.20	$373,300	Includes 2 signs per mile (foundations and posts), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Solar, Overhead)	$502,300	Mile	2.20	$1,110,000	Includes 2 signs per mile (foundations and structures), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Solar, Ground-mount)	$88,400	Mile	2.20	$194,500	Includes 2 signs per mile (foundations and posts), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse
Implement Ramp Metering (Low)	$25,000	Each	2.20	$55,000	For each entry ramp location; urban area with existing ITS backbone infrastructure; includes signals, poles, timer, pull boxes, etc.	0.64	From 1 value from clearinghouse
Implement Ramp Metering (High)	$150,000	Mile	2.20	$330,000	Area without existing ITS backbone infrastructure; in addition to ramp meters, also includes conduit, fiber optic lines, and power	0.64	From 1 value from clearinghouse
Implement Shoulder Running (ATM components only)	$718,900	Mile	2.20	$1,581,600	Includes overhead signs, wireless communication, etc., but does not include shoulder widening	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
Implement Shoulder Running (ATM and shoulder widening)	$1,920,000	Mile	2.20	$4,224,000	Includes overhead signs, communication backbone, etc., and shoulder widening with pavement striping, striping, etc. to widen by 10'	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
Implement Shoulder Running (ATM and shoulder widening in mountainous terrain)	$3,120,000	Mile	2.20	$6,864,000	Includes overhead signs, communication backbone, etc., and shoulder widening in mountainous terrain with pavement striping, striping, etc. to widen by 10'	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
ROADSIDE DESIGN							
Install Guardrail	$130,000	Mile	2.20	$286,000	One side of road	0.62 (ROR)	0.62 is avg of 2 values from clearinghouse
Install Cable Barrier	$80,000	Mile	2.20	$176,000		0.81	0.81 is average of 5 values from clearinghouse
Widen Shoulder (AC)	$249,000	Mile	2.20	$548,000	Includes widening by a total of 4'; new pavement for 4' width and mill and replace existing 10' width; includes pavement, minor earthwork, striping edge lines, RPMs, and rumble strips	0.86 (1-4ft) 0.76 (4+ft)	0.86 is avg of 5 values from clearing house. 0.76 is calculated from HSM for >4 ft.
Rehabilitate Shoulder (AC)	$105,000	Mile	2.20	$231,000	One direction of travel (14' total shoulder width); includes paving (mill and replace), rumble strips, RPMs, and striping of both shoulders	0.75	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, etc; = 0.98*0.77=0.75

SOLUTION	CONST COST	UNIT	FACTOR	TOTAL CONST COST	DESCRIPTION	CMF for Corridor Profile Studies	CMF Notes
Replace Shoulder (AC)	$357,000	Mile	2.20	$785,000	Accounts for 14' width; for one direction of travel; includes pavement, rumble strips, striping, RPMs	0.75	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, etc; = 0.98*0.77=0.75
Install Rumble Strip	$5,500	Mile	2.20	$12,000	Both edges - one direction of travel; includes only rumble strip; no shoulder rehab or paving or striping	0.89	Average of 75 values on clearinghouse and consistent with HSM
Install Safety Edge	$80,000	Mile	2.20	$176,000		0.87	Average of 12 values on clearinghouse
Install Access Barrier Fence	$15	LF	2.20	$33	8' fencing along residential section of roadway	0.1 (ped only)	Equal to ped overpass
Remove Tree/Vegetation	$200,000	Mile	2.20	$440,000		0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
ROADWAY DELINEATION							
Install High-Visibility Edge Line Striping	$10,800	Mile	2.20	$23,800	2 edge lines and lane line - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
Install High-Visibility Delineators	$6,500	Mile	2.20	$14,300	Both edges - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
Install Raised Pavement Markers	$2,000	Mile	2.20	$4,400	Both edges - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
IMPROVED VISIBILITY							
Cut Side Slopes	$80	Lin Ft	2.20	$200	For small grading to correct sight distance issues; not major grading	0.85	Intent of this solution is to improve sight distance. Most CMF's are associated with vehicles traveling on slope. Recommended CMF is based on FDOT and NCDOT but is more conservative.
Install Lighting (connect to existing power)	$270,000	Mile	2.20	$594,000	One side of road only; offset lighting, not high-mast; does not include power supply; includes poles, luminaire, pull boxes, conduit, conductor	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
Install Lighting (solar powered LED)	$10,000	Pole	2.20	$22,000	Offset lighting, not high-mast; solar power LED; includes poles, luminaire, solar panel	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
DRIVER INFORMATION/WARNING							
Install Dynamic Message Sign (DMS)	$250,000	Each	2.20	$550,000	Includes sign, overhead structure, and foundations; wireless communication; does not include power supply	1.00	Not expected to reduce crashes
Install Dynamic Weather Warning Beacons	$40,000	Each	2.20	$88,000	Assumes solar operation and wireless communication or connection to existing power and communication; ground mounted; includes posts, foundations, solar panel, and dynamic sign	0.65 (weather related)	Avg of 3 values from HSM for dynamic/changeable warning signs
Install Speed Feedback Signs	$25,000	Each	2.20	$55,000	Assumes solar operation and no communication; ground mounted; includes regulatory sign, posts, foundations, solar panel, and dynamic sign	0.54	From HSM
Install Chevrons	$18,400	Mile	2.20	$40,500	On one side of road - includes signs, posts, and foundations	0.79	Average of 11 values on clearinghouse
Install Warning Signs	$2,500	Each	2.20	$5,500	Includes 2 signs, posts, and foundations	0.83	Average of 4 clearinghouse values
DATA COLLECTION							
Install Roadside Weather Information System (RWIS)	$60,000	Each	2.20	$132,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
Install Closed Circuit Television (CCTV) Camera	$25,000	Each	2.20	$55,000	Assumes connection to existing ITS backbone or wireless communication; does not include fiber-optic backbone infrastructure; includes pole, camera, etc	1.00	Not expected to reduce crashes

SOLUTION	CONST COST	UNIT	FACTOR	TOTAL CONST COST	DESCRIPTION	CMF for Corridor Profile Studies	CMF Notes
Install Vehicle Detection Stations	$15,000	Each	2.20	$33,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
WIDEN CORRIDOR							
Construct New General Purpose Lane (PCCP)	$1,740,000	Mile	2.20	$3,830,000	For addition of 1 GP lane (PCCP) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.87
Construct New General Purpose Lane (AC)	$1,200,000	Mile	2.20	$2,640,000	For addition of 1 GP lane (AC) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.88
ALTERNATE ROUTE							
Construct Frontage Roads	$2,400,000	Mile	2.20	$5,280,000	For 2-lane AC frontage road; includes all costs except bridges; for generally at-grade facility with minimal walls	0.90	Assumed - similar to new general purpose lane

Appendix D Performance Area Risk Factors

Pavement Performance Area

- Mainline Daily Traffic Volume
- Mainline Daily Truck Volume
- Elevation
- Interrupted Flow

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	< 6,000
0-5	6,000 – 160,000
5	>160,000

Mainline Daily Truck Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.00025)})$

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Bridge Performance Area

- Mainline Daily Traffic Volume
- Detour Length
- Elevation
- Scour Critical Rating
- Carries Mainline Traffic
- Vertical Clearance

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	<6,0000
0-5	6,000-160,000
5	>160,000

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5 >	9000’

Carries Mainline

Score	Condition
0	Does not carry mainline traffic
5	Carries mainline traffic

Detour Scale

Divides detour length by 10 and multiplies by 2.5

Score	Condition
0	0 miles
0-5	0-20 miles
5	> 20 miles

Scour

Variance below 8

Score	Condition
0	Rating > 8
0-5	Rating 8 - 3
5	Rating < 3

Vertical Clearance

Variance below 16’ x 2.5; (16 –Clearance) x 2.5

Score	Condition
0	>16’
0-5	16’-14’
5	<14’

Mobility Performance Area

- Mainline VMT
- Detour Length
- Buffer Index (PTI-TTI)

Mainline VMT

Exponential equation; score = 5-(5*e(ADT*-0.0000139))

Score	Condition
0	<16,000
0-5	16,000-400,000
5	>400,000

Buffer Index

Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Safety Performance Area

- Mainline Daily Traffic Volume
- Vertical Grade
- Shoulder width (Right)
- Elevation
- Interrupted Flow

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*e(ADT*-0.000039))

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5 >	9000’

Shoulder (Right side)

Variance below 10'

Score	Condition
0	10’ or above
0-5	10’ - 5’
5	5’ or less

Grade

Variance above 3% x 1.5

Score	Condition
0	< 3%
0-5	3% - 6.33%
5	>6.33%

Freight Performance Area

- Mainline Daily Truck Volume
- Detour Length
- Truck Buffer Index (TPTI-TTTI)

Mainline Daily Truck Volume

Exponential equation; score = 5-(5*e(ADT*-0.00025))

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Detour Length

Score	Condition
0 Detour	< 10 miles
5 Detour	> 10 miles

Truck Buffer Index

Truck Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Appendix E Performance Evaluation Scores

Post Project Performance Scores

		Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
		Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
		Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
		Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
		Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
	SAFETY	Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
		Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
		Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
		Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
		Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
		Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		Notes	**Description**															
SAFETY	DIRECTIONAL SAFETY	Enter current value from performance system (direction 1)	Orig Segment Directional Safety Index (direction 1)	1.340	1.340	1.590	1.340	1.590	2.110	0.800	2.110	2.110	2.110	2.110	0.800	0.800	0.800	0.800	0.800
		Enter current value from performance system (direction 1)	Orig Segment Directional Fatal Crashes (direction 1)	5	5	3	5	3	13	2	13	13	13	13	2	2	2	2	2
		Enter current value from performance system (direction 1)	Orig Segment Directional Incap Crashes (direction 1)	6	6	3	6	3	6	7	6	6	6	6	7	7	7	7	7
		Enter current value from performance system (direction 1)	Original Fatal Crashes in project limits (direction 1)	0	1	0	5	3	13	1	0	2	1	1	1	1	2	1	1
		Enter current value from performance system (direction 1)	Original Incap Crashes in project limits (direction 1)	0	1	1	6	3	6	5	0	0	1	2	0	4	7	7	0
		User entered value (direction 1)	CMF 1 (direction 1)	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.21	0.21	0.21	0.21	0.71	0.21	0.92	0.9	0.1
		User entered value (direction 1)	CMF 2 (direction 1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.1
		User entered value (direction 1)	CMF 3 (direction 1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Calculated Value (direction 1)	Total CMF (direction 1)	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.210	0.210	0.210	0.210	0.710	0.210	0.920	0.900	0.010
		Calculated Value (direction 1)	Fatal Crash reduction (direction 1)	0.000	0.250	0.000	1.250	0.750	3.250	0.250	0.000	1.580	0.790	0.790	0.290	0.790	0.160	0.100	0.990
		Calculated Value (direction 1)	Incap Crash reduction (direction 1)	0.000	0.250	0.250	1.500	0.750	1.500	1.250	0.000	0.000	0.790	1.580	0.000	3.160	0.560	0.700	0.000
		Calculated Value (direction 1)	Post-Project Segment Directional Fatal Crashes (direction 1)	5.000	4.750	3.000	3.750	2.250	9.750	1.750	13.000	11.420	12.210	12.210	1.710	1.210	1.840	1.900	1.010
		Calculated Value (direction 1)	Post-Project Segment Directional Incap Crashes (direction 1)	6.000	5.750	2.750	4.500	2.250	4.500	5.750	6.000	6.000	5.210	4.420	7.000	3.840	6.440	6.300	7.000
		User Entered Value - Enter in Needs spreadsheet to update segment level Safety Need (direction 1)	Post-Project Segment Directional Safety Index (direction 1)	1.340	1.280	1.580	1.010	1.190	1.580	0.690	2.110	1.860	1.980	1.970	0.710	0.480	0.720	0.750	0.480
		Enter current value from performance system (direction 2)	Orig Segment Directional Safety Index (direction 2)	1.320	1.320	1.120	1.320	1.120	0.860	2.040	0.860	0.860	0.860	0.860	2.040	2.040	2.040	2.040	2.040
		Enter current value from performance system (direction 2)	Orig Segment Directional Fatal Crashes (direction 2)	5	5	2	5	2	5	6	5	5	5	5	6	6	6	6	6
		Enter current value from performance system (direction 2)	Orig Segment Directional Incap Crashes (direction 2)	6	6	4	6	4	7	4	7	7	7	7	4	4	4	4	4
		Enter current value from performance system (direction 2)	Original Fatal Crashes in project limits (direction 2)	0	0	0	5	2	5	4	2	0	1	0	2	1	6	4	4
		Enter current value from performance system (direction 2)	Original Incap Crashes in project limits (direction 2)	0	0	1	6	4	7	4	1	0	2	1	0	1	4	4	0

SAFETY

			Solution #	**CS19.2**	**CS19.4**	**CS19.6**	**CS19.1-1**	**CS19.1-2**	**CS19.8-1**	**CS19.8-2**	**CS19.7**	**CS19.11**	**CS19.12**	**CS19.13**	**CS19.21**	**CS19.14**	**CS19.15**	**CS19.16**	**CS19.17**
			Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
			Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
			Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
			Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
			Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
			Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
			Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
			Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
			Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
			Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
			Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		User entered value (direction 2)	CMF 1 (direction 2)	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.21	0.21	0.21	0.21	0.71	0.21	0.92	0.9	0.1
		User entered value (direction 2)	CMF 1 (direction 2)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		User entered value (direction 2)	CMF 1 (direction 2)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Calculated Value (direction 2)	Total CMF (direction 2)	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.210	0.210	0.210	0.210	0.710	0.210	0.920	0.900	0.100
		Calculated Value (direction 2)	Fatal Crash reduction (direction 2)	0.000	0.000	0.000	1.250	0.500	1.250	1.000	1.580	0.000	0.790	0.000	0.580	0.790	0.480	0.400	3.600
		Calculated Value (direction 2)	Incap Crash reduction (direction 2)	0.000	0.000	0.250	1.500	1.000	1.750	1.000	0.790	0.000	1.580	0.790	0.000	0.790	0.320	0.400	0.000
		Calculated Value (direction 2)	Post-Project Segment Directional Fatal Crashes (direction 2)	5.000	5.000	2.000	3.750	1.500	3.750	5.000	3.420	5.000	4.210	5.000	5.420	5.210	5.520	5.600	2.400
		Calculated Value (direction 2)	Post-Project Segment Directional Incap Crashes (direction 2)	6.000	6.000	3.750	4.500	3.000	5.250	3.000	6.210	7.000	5.420	6.210	4.000	3.210	3.680	3.600	4.000
		User Entered Value - Enter in Needs spreadsheet to update segment level Safety Need (direction 2)	Post-Project Segment Directional Safety Index (direction 2)	1.320	1.320	1.110	0.990	0.840	0.640	1.690	0.600	0.860	0.720	0.850	1.850	1.770	1.880	1.900	0.870
		Calculated Value - verify that it matches current performance system	Current Safety Index	1.330	1.330	1.355	1.330	1.355	1.485	1.420	1.485	1.485	1.485	1.485	1.420	1.420	1.420	1.420	1.420
		Calculated Value - Enter in Needs spreadsheet to update segment level Safety Need	Post-Project Safety Index	1.330	1.300	1.345	1.000	1.020	1.110	1.190	1.350	1.360	1.350	1.410	1.280	1.125	1.300	1.325	0.675
	Needs	User entered value from Needs spreadsheet	Original Segment Safety Need	3.214	3.214	2.683	3.214	2.683	3.543	3.391	3.543	3.543	3.543	3.543	3.391	3.391	3.391	3.391	3.391
		User entered value from Needs spreadsheet	Post-Project Segment Safety Need	3.214	3.086	2.65	1.500	1.335	2.009	2.437	3.054	3.014	3.014	3.231	2.817	2.222	2.899	2.997	0.535

MOBILITY																	
		Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
		Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
		Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
		Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
		Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
		Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
		Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
		Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
		Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
		Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
		Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		Notes	**Description**															
MOBILITY	MOBILITY INDEX	Enter current value from performance system	Original Segment Mobility Index	0.320	0.320	0.260	0.320	0.260	0.560	1.010	0.560	0.560	0.560	0.560	1.010	1.010	1.010	1.010	1.010
		Value from above	Post-Project # of Lanes (both directions)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		User Entered Value - Enter in Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Mobility Index	0.320	0.320	0.260	0.320	0.260	0.560	1.010	0.560	0.560	0.560	0.560	1.010	1.010	1.010	0.760	1.010
	FUT V/C	Enter current value from performance system	Original Segment Future V/C	0.390	0.390	0.320	0.390	0.320	0.660	1.210	0.660	0.660	0.660	0.660	1.210	1.210	1.210	1.210	1.210
		User Entered Value - Enter in Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Future V/C	0.390	0.390	0.320	0.390	0.320	0.660	1.210	0.660	0.660	0.660	0.660	1.210	1.210	1.210	0.910	1.210
	PEAK HOUR V/C	Enter current value from performance system (direction 1)	Original Segment Peak Hour V/C (direction 1)	0.190	0.190	0.170	0.190	0.170	0.350	0.780	0.350	0.350	0.350	0.350	0.780	0.780	0.780	0.780	0.780
		Enter current value from performance system (direction 2)	Original Segment Peak Hour V/C (direction 2)	0.200	0.200	0.170	0.200	0.170	0.360	0.760	0.360	0.360	0.360	0.360	0.760	0.760	0.760	0.760	0.760
		Calculated value to be used in performance system	Adjusted total # of Lanes for use in directional peak hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
		User Entered Value - Enter in Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (direction 1)	0.190	0.190	0.170	0.190	0.170	0.350	0.780	0.320	0.320	0.320	0.320	0.780	0.680	0.710	0.580	0.780
		User Entered Value - Enter in Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (direction 2)	0.200	0.200	0.170	0.200	0.170	0.360	0.760	0.330	0.330	0.330	0.330	0.760	0.660	0.690	0.570	0.760
	TTI AND PTI	Calculated Value (both directions)	Safety Reduction Factor	1.000	0.977	0.993	0.752	0.753	0.747	0.838	0.909	0.916	0.909	0.949	0.901	0.792	0.915	0.933	0.475
		Calculated Value (both directions)	Safety Reduction	0.000	0.023	0.007	0.248	0.247	0.253	0.162	0.091	0.084	0.091	0.051	0.099	0.208	0.085	0.067	0.525
		Calculated Value (both directions)	Mobility Reduction Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.752	1.000
		Calculated Value (both directions)	Mobility Reduction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.248	0.000
		Assumed effect on TTI (% of mobility reduction)	Mobility effect on TTI	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Assumed effect on PTI (% of mobility reduction)	Mobility effect on PTI	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		Assumed effect on TTI (% of safety reduction)	Safety effect on TTI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Assumed effect on PTI (% of safety reduction)	Safety effect on PTI	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Enter current value from performance system (direction 1)	Original Directional Segment TTI (direction 1)	1.160	1.160	1.580	1.160	1.580	1.060	1.000	1.060	1.060	1.060	1.060	1.000	1.000	1.000	1.000	1.000
		Enter current value from performance system (direction 1)	Original Directional Segment PTI (direction 1)	1.250	1.250	2.500	1.250	2.500	1.110	1.030	1.110	1.110	1.110	1.110	1.030	1.030	1.030	1.030	1.030
		Enter current value from performance system (direction 2)	Original Directional Segment TTI (direction 2)	1.130	1.130	1.100	1.130	1.100	1.080	1.040	1.080	1.080	1.080	1.080	1.040	1.040	1.040	1.040	1.040
		Enter current value from performance system (direction 2)	Original Directional Segment PTI (direction 2)	1.220	1.220	1.170	1.220	1.170	1.150	1.140	1.150	1.150	1.150	1.150	1.140	1.140	1.140	1.140	1.140
		Calculated Value (both directions)	Reduction Factor for Segment TTI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.074	0.000
		Calculated Value (both directions)	Reduction Factor for Segment PTI	0.000	0.007	0.002	0.074	0.074	0.076	0.049	0.027	0.025	0.027	0.015	0.030	0.062	0.025	0.070	0.157
		Calculated Value - Enter in Needs spreadsheet to	Post-Project Directional Segment TTI (direction 1)	1.160	1.160	1.580	1.160	1.580	1.060	1.000	1.060	1.060	1.060	1.060	1.000	1.000	1.000	1.000	1.000

MOBILITY	Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
	Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
	Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
	Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
	Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
	Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
	Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
	Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
	Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
	Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
	Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
Notes	**Description**																
update segment level Freight Need (direction 1)																	
Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Directional Segment PTI (direction 1)	1.250	1.242	2.494	1.157	2.315	1.026	1.015	1.080	1.082	1.080	1.093	1.015	1.015	1.004	1.015	1.015
Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Directional Segment TTTI (direction 2)	1.130	1.130	1.100	1.130	1.100	1.080	1.040	1.080	1.080	1.080	1.080	1.040	1.040	1.040	1.020	1.040
Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Directional Segment TPTI (direction 2)	1.220	1.212	1.167	1.129	1.083	1.063	1.085	1.119	1.121	1.119	1.133	1.14	1.069	1.111	1.061	1.070
CLOSURE EXTENT: Enter current value from performance system (direction 1)	Orig Segment Directional Closure Extent (direction 1)	0.220	0.220	0.300	0.220	0.300	0.250	0.380	0.250	0.250	0.250	0.250	0.380	0.380	0.380	0.380	0.380
CLOSURE EXTENT: Enter current value from performance system (direction 2)	Orig Segment Directional Closure Extent (direction 2)	0.170	0.170	0.170	0.170	0.170	0.150	0.060	0.150	0.150	0.150	0.150	0.060	0.060	0.060	0.060	0.060
CLOSURE EXTENT: Enter value from HCRS	Segment Closures with fatalities/injuries	22	22	5	22	5	35	9	35	35	35	35	9	9	9	9	9
CLOSURE EXTENT: Enter value from HCRS	Total Segment Closures	30	30	9	30	9	43	20	43	43	43	43	20	20	20	20	20
CLOSURE EXTENT: Calculated Value (both directions)	% Closures with Fatality/Injury	0.73	0.73	0.56	0.73	0.56	0.81	0.45	0.81	0.81	0.81	0.81	0.45	0.45	0.45	0.45	0.45
CLOSURE EXTENT: Calculated Value (both directions)	Closure Reduction	0.000	0.017	0.004	0.182	0.137	0.206	0.073	0.074	0.069	0.074	0.041	0.044	0.093	0.038	0.030	0.236
CLOSURE EXTENT: Calculated Value (both directions)	Closure Reduction Factor	1.000	0.983	0.996	0.818	0.863	0.794	0.927	0.926	0.931	0.926	0.959	0.956	0.907	0.962	0.970	0.764
CLOSURE EXTENT: Calculated Value - Enter in Needs spreadsheet to update segment level Mobility Need (direction 1)	Post-Project Segment Directional Closure Extent (direction 1)	0.220	0.216	0.299	0.180	0.259	0.199	0.352	0.232	0.233	0.232	0.240	0.363	0.344	0.366	0.369	0.290
CLOSURE EXTENT: Calculated Value - Enter in Needs spreadsheet to update segment level Mobility Need (direction 2)	Post-Project Segment Directional Closure Extent (direction 2)	0.170	0.167	0.169	0.139	0.147	0.119	0.056	0.139	0.140	0.139	0.144	0.060	0.054	0.058	0.058	0.046
Needs: User entered value from Needs spreadsheet	Original Segment Mobility Need	0.589	0.589	0.505	0.589	0.505	0.723	4.317	0.723	0.723	0.723	0.723	4.317	4.317	4.317	4.317	4.317
Needs: User entered value from Needs spreadsheet	Post-Project Segment Mobility Need	0.589	0.587	0.504	0.572	0.492	0.705	4.294	0.713	0.714	0.713	0.716	4.304	4.262	4.279	1.256	4.282

FREIGHT	Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
	Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
	Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
	Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
	Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
	Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
	Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
	Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
	Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
	Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
	Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00

		Notes	Description															
FREIGHT	TTTI AND TPTI	Assumed effect on TTTI (% of mobility reduction)	Mobility effect on TTTI	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Assumed effect on TPTI (% of mobility reduction)	Mobility effect on TPTI	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
		Assumed effect on TTTI (% of safety reduction)	Safety effect on TTTI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Assumed effect on TPTI (% of safety reduction)	Safety effect on TPTI	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Enter current value from performance system (direction 1)	Original Directional Segment TTTI (direction 1)	1.040	1.040	1.430	1.040	1.430	1.030	1.020	1.030	1.030	1.030	1.030	1.020	1.020	1.020	1.020	1.020
		Enter current value from performance system (direction 1)	Original Directional Segment TPTI (direction 1)	1.090	1.090	4.910	1.090	4.910	1.050	1.060	1.050	1.050	1.050	1.050	1.060	1.060	1.060	1.060	1.060
		Enter current value from performance system (direction 2)	Original Directional Segment TTTI (direction 2)	1.040	1.040	1.030	1.040	1.030	1.030	1.080	1.030	1.030	1.030	1.030	1.080	1.080	1.080	1.080	1.080
		Enter current value from performance system (direction 2)	Original Directional Segment TPTI (direction 2)	1.080	1.080	1.060	1.080	1.060	1.060	1.200	1.060	1.060	1.060	1.060	1.200	1.200	1.200	1.200	1.200
		Calculated Value (both directions)	Reduction Factor for Segment TTTI (both directions)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.000
		Calculated Value (both directions)	Reduction Factor for Segment TPTI (both directions)	0.000	0.003	0.001	0.037	0.037	0.038	0.024	0.014	0.013	0.014	0.008	0.015	0.031	0.013	0.035	0.079
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Directional Segment TTTI (direction 1)	1.040	1.040	1.430	1.040	1.430	1.030	1.020	1.030	1.030	1.030	1.030	1.020	1.020	1.020	1.001	1.020
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Directional Segment TPTI (direction 1)	1.090	1.086	4.905	1.049	4.728	1.010	1.034	1.036	1.037	1.036	1.042	1.044	1.027	1.047	1.023	1.018
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Directional Segment TTTI (direction 2)	1.040	1.040	1.030	1.040	1.030	1.030	1.080	1.030	1.030	1.030	1.030	1.080	1.080	1.080	1.040	1.080
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Directional Segment TPTI (direction 2)	1.080	1.076	1.059	1.040	1.021	1.020	1.171	1.046	1.047	1.046	1.052	1.200	1.163	1.185	1.158	1.106
	FREIGHT INDEX	Enter current value from performance system (direction 1)	Original Segment TPTI (direction 1)	1.090	1.090	4.910	1.090	4.910	1.050	1.060	1.050	1.050	1.050	1.050	1.060	1.060	1.060	1.060	1.060
		Enter current value from performance system (direction 2)	Original Segment TPTI (direction 2)	1.080	1.080	1.060	1.080	1.060	1.060	1.200	1.060	1.060	1.060	1.060	1.200	1.200	1.200	1.200	1.200
		Calculated Value	Original Segment Freight Index	0.922	0.922	0.335	0.922	0.335	0.948	0.885	0.948	0.948	0.948	0.948	0.885	0.885	0.885	0.885	0.885
		Calculated Value	Post-Project Segment TPTI (direction 1)	1.090	1.086	4.905	1.049	4.728	1.010	1.034	1.036	1.037	1.036	1.042	1.044	1.027	1.047	1.023	1.018
		Calculated Value	Post-Project Segment TPTI (direction 2)	1.080	1.076	1.059	1.040	1.021	1.020	1.171	1.046	1.047	1.046	1.052	1.200	1.163	1.185	1.158	1.106
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need	Post-Project Segment Freight Index	0.922	0.925	0.335	0.957	0.348	0.985	0.907	0.961	0.960	0.961	0.955	0.891	0.913	0.896	0.917	0.942
	CLOSURE DURATION	Enter current value from performance system (direction 1)	Orig Segment Directional Closure Duration (dir 1)	45.090	45.090	87.900	45.090	87.900	39.820	66.470	39.820	39.820	39.820	39.820	66.470	66.470	66.470	66.470	66.470
		Enter current value from performance system	Orig Segment Directional Closure Duration (dir 2)	33.780	33.780	53.940	33.780	53.940	23.750	22.610	23.750	23.750	23.750	23.750	22.610	22.610	22.610	22.610	22.610

			Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
			Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
			Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
			Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
			Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
			Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
		FREIGHT	Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
			Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
			Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
			Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
			Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
			Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		(direction 2)																	
		Calculated Value	Segment Closures with fatalities	22	22	5	22	5	35	9	35	35	35	35	9	9	9	9	9
		Calculated Value	Total Segment Closures	30	30	9	30	9	43	20	43	43	43	43	20	20	20	20	20
		Calculated Value	% Closures with Fatality	0.73	0.73	0.56	0.73	0.56	0.81	0.45	0.81	0.81	0.81	0.81	0.45	0.45	0.45	0.45	0.45
		Calculated Value	Closure Reduction	0.000	0.017	0.004	0.182	0.137	0.206	0.073	0.074	0.069	0.074	0.041	0.044	0.093	0.038	0.030	0.236
		Calculated Value	Closure Reduction Factor	1.000	0.983	0.996	0.818	0.863	0.794	0.927	0.926	0.931	0.926	0.959	0.956	0.907	0.962	0.970	0.764
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Segment Directional Closure Duration (direction 1)	45.090	44.344	87.540	36.886	75.827	31.635	61.625	36.873	37.092	36.873	38.183	63.521	60.256	63.942	64.469	50.777
		Calculated Value - Enter in Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Segment Directional Closure Duration (direction 2)	33.780	33.221	53.719	27.634	46.531	18.868	20.962	21.993	22.123	21.993	22.774	22.610	20.496	21.750	21.929	17.272
	VERT CLR	Enter current value from performance system	Original Vertical Clearance	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
		User Entered Value - Enter in Needs spreadsheet to update segment level Freight Need	Post-Project Vertical Clearance	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Needs	User entered value from Needs spreadsheet	Original Segment Freight Need	0.531	0.531	0.911	0.531	0.911	0.207	0.644	0.207	0.207	0.207	0.207	0.644	0.644	0.644	0.644	0.644
		User entered value from Needs spreadsheet	Post-Project Segment Freight Need	0.531	0.53	0.909	0.518	0.804	0.195	0.638	0.203	0.203	0.203	0.205	0.642	0.636	0.641	0.637	0.624

BRIDGE																	
		Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
		Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
		Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
		Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
		Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
		Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
		Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
		Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
		Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
		Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
		Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
	Notes	Description																
BRIDGE	BRIDGE INDEX	Enter current value from performance system	Original Segment Bridge Index	None	None	None	None	None	None	None	None	5.30	None	5.30	None	6.05	None	6.06	None
		Enter current value from performance system	Original lowest rating for specific bridge	None	None	None	None	None	None	None	None	4	None	6	None	6	None	5	None
		User entered value (For repair +1, rehab +2, replace=8)	Post-Project lowest rating for specific bridge	None	None	None	None	None	None	None	None	6	None	8	None	8	None	7	None
		User Entered Value - Enter in Needs spreadsheet to update segment level Bridge Need	Post-Project Bridge Index	None	None	None	None	None	None	None	None	5.50	None	5.39	None	6.10	None	6.14	None
	SUFF RATING	Enter current value from performance system	Original Segment Sufficiency Rating	None	None	None	None	None	None	None	None	90.92	None	90.92	None	78.71	None	77.36	None
		Enter current value from performance system	Original Sufficiency Rating for specific bridge	None	None	None	None	None	None	None	None	91.00	None	90.89	None	90.89	None	89.97	None
		User entered value (For repair +10, rehab +20, replace=98)	Post-Project Sufficiency Rating for specific bridge	None	None	None	None	None	None	None	None	100.00	None	100.00	None	100.00	None	100.00	None
		User Entered Value - Enter in Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Sufficiency Rating	None	None	None	None	None	None	None	None	91.71	None	91.71	None	79.17	None	78.93	None
	BR RTNG	Enter current value from performance system	Original Segment Bridge Rating	None	None	None	None	None	None	None	None	4	None	4	None	5	None	5	None
		User Entered Value - Enter in Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Bridge Rating	None	None	None	None	None	None	None	None	4	None	4	None	5	None	5	None
	% FUN OB	Enter current value from performance system	Original Segment % Functionally Obsolete	None	None	None	None	None	None	None	None	21.33%	None	21.33%	None	27.42%	None	19.43%	None
		User Entered Value - Enter in Needs spreadsheet to update segment level Bridge Need (only remove from FO if replace or rehab)	Post-Project Segment % Functionally Obsolete	None	None	None	None	None	None	None	None	21.33%	None	12.64%	None	22.44%	None	19.43%	None
	Needs	User entered value from Needs spreadsheet	Original Segment Bridge Need	1.133	1.133	0.367	1.133	0.367	2.053	0.612	2.053	2.053	2.053	2.053	0.612	0.677	0.612	0.612	0.612
		User entered value from Needs spreadsheet	Post-Project Segment Bridge Need	1.133	1.133	0.367	1.133	0.367	2.053	0.612	2.053	1.853	2.053	1.94	0.612	0.573	0.612	0.517	0.612

PAVEMENT																	
			Solution #	CS19.2	CS19.4	CS19.6	CS19.1-1	CS19.1-2	CS19.8-1	CS19.8-2	CS19.7	CS19.11	CS19.12	CS19.13	CS19.21	CS19.14	CS19.15	CS19.16	CS19.17
			Description	TI Lighting	TI Lighting	TI Lighting	Shldr Rehab	Shldr Rehab	Shldr Rehab	Shldr Rehab	TI Improve	TI Improve	TI Improve	TI Improve	Pvmt Rehab	TI Improve	Var Speed	GP Widen	Ped Overpass
			Project Beg MP	11	15.7	26.5	2.95	18.24	39.55	57.18	46.8	49.6	54.4	57	62	57.18	57.18	57.18	59.5
			Project End MP	11	15.7	26.5	18.24	30.09	57.18	61.9	46.8	49.6	54.4	57	63	61.9	64	61.9	62
			Project Length (miles)	0	0	0	15.29	11.85	17.63	4.72	0	0	0	0	1	4.72	6.82	4.72	2.5
			Segment Beg MP	3	3	18	3	18	40	57	30	40	40	40	57	57	57	57	57
			Segment End MP	18	18	30	18	30	57	64	40	57	57	57	64	64	64	64	64
			Segment Length (miles)	15	15	12	15	12	17	7	10	17	17	17	7	7	7	7	7
			Segment #	2	2	3	2	3	5	6	5	5	5	5	6	6	6	6	6
			Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
			Project Type (one-way or two-way)	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way
			Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.35	4.00
		Notes	Description																
PAVEMENT	PAVEMENT INDEX	Enter current value from performance system	Original Segment Pavement Index	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.61	NO CHANGE	NO CHANGE	3.61	NO CHANGE
		Enter current value from performance system	Original Segment IRI in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	104-118	NO CHANGE	NO CHANGE	69-94	NO CHANGE
		Enter current value from performance system	Original Segment Cracking in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0	NO CHANGE	NO CHANGE	3-10	NO CHANGE
		For rehab, increase to 45; for replace increase to 30 (enter in Pvmt performance tool to calculate new performance)	Post-Project IRI in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	45	NO CHANGE	NO CHANGE	45	NO CHANGE
		Lower to 0 for rehab or replace (enter in Pvmt performance tool to calculate new performance)	Post-Project Cracking in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0	NO CHANGE	NO CHANGE	0	NO CHANGE
		User Entered Value - Enter in Needs spreadsheet to update segment level Pavement Need (from Pvmt performance tool)	Post-Project Pavement Index	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.78	NO CHANGE	NO CHANGE	3.78	NO CHANGE
	DIRECTION PSR	Enter current value from performance system (direction 1)	Original Segment Directional PSR (direction 1)	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.54	NO CHANGE	NO CHANGE	3.54	NO CHANGE
		Enter current value from performance system (direction 2)	Original Segment Directional PSR (direction 2)												3.57			3.57	
		Value from above	Original Segment IRI in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	104-118	NO CHANGE	NO CHANGE	69-94	NO CHANGE
		Value from above	Post-Project directional IRI in project limits	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	45	NO CHANGE	NO CHANGE	45	NO CHANGE
		User Entered Value - Enter in Needs spreadsheet to update segment level Pavement Need (from Pvmt performance tool)	Post-Project Directional PSR (direction 1)	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.73	NO CHANGE	NO CHANGE	3.91	NO CHANGE
		User Entered Value - Enter in Needs spreadsheet to update segment level Pavement Need (from Pvmt performance tool)	Post-Project Directional PSR (direction 2)	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.73	NO CHANGE	NO CHANGE	3.87	NO CHANGE
	% FAIL	Enter current value from performance system	Original Segment % Failure	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	18.8%	NO CHANGE	NO CHANGE	18.8%	NO CHANGE
		User Entered Value - Enter in Needs spreadsheet to update segment level Pavement Need (from Pvmt performance tool)	Post-Project Segment % Failure	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	9.4%	NO CHANGE	NO CHANGE	18.8%	NO CHANGE
	Needs	User entered value from Needs spreadsheet	Original Segment Pavement Need	0.03	0.03	0.505	0.03	0.505	0	0.891	0	0	0	0	0.891	0.891	0.891	0.891	0.891
		User entered value from Needs spreadsheet	Post-Project Segment Pavement Need	0.03	0.03	0.505	0.03	0.505	0	0.891	0	0	0	0	0.11	0.891	0.891	0.376	0.891

Performance Area Risk Factors

Solution Number	Segment	Mainline Traffic Vol (vpd) (2-way)	Solution Length (miles)	Bridge Detour Length (miles) (N19)	Elevation (ft)	Scour Critical Rating (0-9)	Carries Mainline Traffic (Y/N)	Bridge Vert. Clear (ft)	Mainline Truck Vol (vpd) (2-way)	Detour Length > 10 miles (Y/N)	Truck Buffer Index	Non-Truck Buffer Index	Grade (%)	Interrupted Flow (Y/N)	Outside/ Right Shoulder Width (ft)
19.2	2														
19.4	2	20,595	1		3,340					n		0.09	2.25	n	10
19.6	3	16,071	1		3,130				2,571	n	1.75	0.50	0.84	y	9.6
19.1-2	2	20,595	15.29		3,390				2,471	n	0.04	0.09	0.5	n	10
19.1-3	3	16,071	11.85		3,150				2,571	n	1.75	0.50	0.6	y	9.6
19.8-2	5	36,855	17.63		2,850				7,002	n	0.03	0.05	0.3	n	9.92
19.8-3	6	67,438	4.72		2,460				4,046	n	0.08	0.06	0.5	n	10
19.7	4	21,491	1		2,920					n		0.04	1.8	n	9.5
19.11	5	36,855	1	0	2,800	8	y	16.00	7,002	n	0.03	0.05	2.8	n	9.92
19.12	5	36,855	1		2,580				7,002	n	0.03	0.05	3.3	n	9.92
19.13	5	36,855	1	1	2,520	8	y	16.00	7,002	n	0.03	0.05	2.1	n	9.92
19.21	6	67,438	1		2,400				4,046	n	0.08	0.06	0.3	n	10
19.14	6	67,438	4.72	1	2,450	7	y	16.00	4,046	n	0.08	0.06	1.5	n	10
19.15	6	67,438	6.82		2,450				4,046	n	0.08	0.06	0.7	n	10
19.16	6	67,438	4.72	1	2,450	7	y	16.00	4,046	n	0.08	0.06	0.7	n	10
19.17	6	67,438	2.5		1,450				4,046	n	0.08	0.06	0.7	n	10

						Risk Score (0 to 10)				
						Bridge	Pavement	Mobility	Safety	Freight
19.2	n	n	n	n	n	0.00	0.00	0.00	0.00	0.00
19.4	n	n	y	y	n	0.00	0.00	1.43	1.10	0.00
19.6	n	n	y	y	y	0.00	0.00	4.00	3.09	4.92
19.1-2	n	n	y	y	y	0.00	0.00	3.89	1.10	1.81
19.1-3	n	n	y	y	y	0.00	0.00	6.43	3.09	4.92
19.8-2	n	n	y	y	y	0.00	0.00	3.67	1.55	2.96
19.8-3	n	n	y	y	y	0.00	0.00	3.69	1.85	2.66
19.7	n	n	y	y	n	0.00	0.00	1.13	1.33	0.00
19.11	y	n	y	y	y	2.93	0.00	1.67	1.55	2.96
19.12	n	n	y	y	y	0.00	0.00	1.67	1.73	2.96
19.13	y	n	y	y	y	3.10	0.00	1.67	1.55	2.96
19.21	n	y	y	y	y	0.00	5.21	2.43	1.85	2.66
19.14	y	n	y	y	y	3.71	0.00	3.69	1.85	2.66
19.15	n	n	y	y	y	0.00	0.00	3.73	1.85	2.66
19.16	y	y	y	y	y	3.71	5.21	3.69	1.85	2.66
19.17	n	n	y	y	y	0.00	0.00	3.41	1.85	2.66

Performance Effectiveness Scores – Five Performance Areas

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement					Bridge					Safety					Mobility					Freight				
				Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score
19.2	Rio Rico Ramp Lighting	11	0.149	0.03	0.03	0.00	0.00	0.000	1.133	1.133	0.00	0	0.000	3.214	3.214	0.00	0.00	0.000	0.589	0.589	0.000	0.00	0.000	0.531	0.531	0.000	0.00	0.000
19.4	Palo Parado Ramp Lighting	15.7	0.199	0.03	0.03	0.00	0.00	0.000	1.133	1.133	0.00	0	0.000	3.214	3.086	0.13	1.10	0.141	0.589	0.587	0.002	1.43	0.003	0.531	0.53	0.001	0.00	0.000
19.6	Agua Linda Ramp Lighting	26.5	0.199	0.505	0.505	0.00	0.00	0.000	0.367	0.367	0.00	0	0.000	2.683	2.65	0.03	3.09	0.102	0.505	0.504	0.001	4.00	0.004	0.911	0.909	0.002	4.92	0.010
19.1	Nogales - Tubac Shoulder Improvements	3 - 30	8.27	0.535	0.535	0.00	0.00	0.000	1.5	1.5	0.00	0	0.000	5.897	2.835	3.06	1.97	6.029	1.094	1.064	0.030	5.00	0.150	1.442	1.322	0.120	3.17	0.380
19.8	Sahuarita - Tucson Shoulder Improvements	40 - 57	6.81	0.891	0.891	0.00	0.00	0.000	2.665	2.665	0.00	0	0.000	6.934	4.446	2.49	1.61	4.014	5.040	4.999	0.041	3.67	0.151	0.851	0.833	0.018	2.90	0.052
19.7	Sahuarita TI Ramp Improvements	46.8	6.37	0	0	0.00	0.00	0.000	2.053	2.053	0.00	0	0.000	3.543	3.054	0.49	1.33	0.650	0.723	0.713	0.010	1.13	0.011	0.207	0.203	0.004	0.00	0.000
19.11	Pima Mine TI Ramp Improvements	49.6	7.32	0	0	0.00	0.00	0.000	2.053	1.853	0.20	2.93	0.586	3.543	3.014	0.53	1.55	0.820	0.723	0.714	0.009	1.67	0.015	0.207	0.203	0.004	2.96	0.012
19.12	Papago TI Ramp Improvements	54.4	6.372	0	0	0.00	0.00	0.000	2.053	2.053	0.00	0	0.000	3.543	3.014	0.53	1.73	0.915	0.723	0.713	0.010	1.67	0.017	0.207	0.203	0.004	2.96	0.012
19.13	San Xavier TI Ramp Improvements	57	4.479	0	0	0.00	0.00	0.000	2.053	1.94	0.11	3.1	0.350	3.543	3.231	0.31	1.55	0.484	0.723	0.716	0.007	1.67	0.012	0.207	0.205	0.002	2.96	0.006
19.21	Ajo Way Pavement Rehab	62 - 63.7	2.226	0.891	0.11	0.78	5.21	4.069	0.612	0.612	0.00	0	0.000	3.391	2.817	0.57	1.85	1.062	4.317	4.304	0.013	2.43	0.032	0.644	0.642	0.002	2.66	0.005
19.14	Tucson Area Parallel Ramps	57 - 61.9	18.108	0.891	0.891	0.00	0.00	0.000	0.677	0.573	0.10	3.71	0.386	3.391	2.222	1.17	1.85	2.163	4.317	4.262	0.055	3.69	0.203	0.644	0.636	0.008	2.66	0.021
19.15	Tucson Variable Speed Limits	57 - 64	24.996	0.891	0.891	0.00	0.00	0.000	0.612	0.612	0.00	0	0.000	3.391	2.899	0.49	1.85	0.910	4.317	4.279	0.038	3.73	0.142	0.644	0.641	0.003	2.66	0.008
19.16	Tucson Widening	57 - 61.9	32.78	0.891	0.376	0.52	5.21	2.683	0.612	0.517	0.10	3.71	0.352	3.391	2.997	0.39	1.85	0.729	4.317	1.256	3.061	3.69	11.295	0.644	0.637	0.007	2.66	0.019
19.17	Drexel/Irvington Pedestrian Overpass	59.5 - 62	2.154	0.891	0.891	0.00	0.00	0.000	0.612	0.612	0.00	0	0.000	3.391	0.535	2.86	1.85	5.284	4.317	4.282	0.035	3.41	0.119	0.644	0.624	0.020	2.66	0.053

Performance Effectiveness Scores – Emphasis Areas and Results

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Safety Emphasis Area						Mobility Emphasis Area						Freight Emphasis Area						Total Factored Score	VMT/10,000	Performance Effectiveness Score (Total Factored Score x 100/0cost x VMT/10,000)
				Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score			
19.2	Rio Rico Ramp Lighting	11	0.149	2.547	2.547	0	0.00	1.50	0.000	0.383	0.383	0	0.00	1.50	0.000	0	0.000	0	0.00	1.50	0.000	0.000	0.00	0.0
19.4	Palo Parado Ramp Lighting	15.7	0.199	2.547	2.528	0.019	1.10	1.50	0.031	0.383	0.383	0	1.43	1.50	0.000	0	0.000	0	0.00	1.50	0.000	0.175	2.06	181.1
19.6	Agua Linda Ramp Lighting	26.5	0.199	2.547	2.542	0.005	3.09	1.50	0.023	0.383	0.383	0	4.00	1.50	0.000	0	0.000	0	4.92	1.50	0.000	0.139	1.61	112.2
19.1	Nogales - Tubac Shoulder Improvements	3 - 30	8.27	2.547	2.35	0.197535	1.97	1.50	0.583	0.383	0.383	0	5.00	1.50	0.000	0	0.000	0	3.17	1.50	0.000	7.142	49.76	4297.1
19.8	Sahuarita - Tucson Shoulder Improvements	40 - 57	6.81	2.547	2.32	0.231707	1.61	1.50	0.561	0.383	0.383	0	3.67	1.50	0.000	0	0.000	0	2.90	1.50	0.000	4.778	116.55	8176.4
19.7	Sahuarita TI Ramp Improvements	46.8	6.372	2.547	2.45	0.097	1.33	1.50	0.194	0.383	0.383	0	1.13	1.50	0.000	0	0.000	0	0.00	1.50	0.000	0.855	2.15	28.8
19.11	Pima Mine TI Ramp Improvements	49.6	7.319	2.547	2.456	0.091	1.55	1.50	0.212	0.383	0.383	0	1.67	1.50	0.000	0	0.000	0	2.96	1.50	0.000	1.644	3.69	82.8
19.12	Papago TI Ramp Improvements	54.4	6.372	2.547	2.449	0.098	1.73	1.50	0.254	0.383	0.383	0	1.67	1.50	0.000	0	0.000	0	2.96	1.50	0.000	1.198	3.69	69.3
19.13	San Xavier TI Ramp Improvements	57	4.479	2.547	2.493	0.054	1.55	1.50	0.126	0.383	0.383	0	1.67	1.50	0.000	0	0.000	0	2.96	1.50	0.000	0.977	3.69	80.4
19.21	Ajo Way Pavement Rehab	62 - 63.7	2.226	2.547	2.504	0.043	1.85	1.50	0.119	0.383	0.383	0	2.43	1.50	0.000	0	0.000	0	2.66	1.50	0.000	5.287	3.37	800.9
19.14	Tucson Area Parallel Ramps	57 - 61.9	18.108	2.547	2.457	0.09	1.85	1.50	0.250	0.383	0.383	0	3.69	1.50	0.000	0	0.000	0	2.66	1.50	0.000	3.022	31.83	531.3
19.15	Tucson Variable Speed Limits	57 - 64	24.996	2.547	2.510	0.037	1.85	1.50	0.103	0.383	0.383	0	3.73	1.50	0.000	0	0.000	0	2.66	1.50	0.000	1.163	45.99	213.9
19.16	Tucson Widening	57 - 61.9	32.784	2.547	2.518	0.029	1.85	1.50	0.080	0.383	0.359	0.024	3.69	1.50	0.133	0	0.000	0	2.66	1.50	0.000	15.292	31.83	1484.7
19.17	Drexel/Irvington Pedestrian Overpass	59.5 - 62	2.154	2.547	2.32	0.226	1.85	1.50	0.627	0.383	0.383	0	3.41	1.50	0.000	0	0.000	0	2.66	1.50	0.000	6.083	16.86	4761.4

Appendix F Performance Evaluation Risk Factors

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement		Bridge		Safety		Mobility		Freight		Total Factored Score	Risk Factors					Weighted Risk Factor	VMT Performance Effectiveness Score (PES x VMT/10,000)	Prioritization Score
				Score	%	Score	%	Score	%	Score	%	Score	%		Pavement	Bridge	Safety	Mobility	Freight			
19.2	Rio Rico Ramp Lighting	11	0.149	0.000	#DIV/0!	0.000	#DIV/0!	0.000	#DIV/0!	0.000	#DIV/0!	0.000	#DIV/0!	0.000	1.07	1.27	1.36	1.18	1.18	#DIV/0!	0.0	**#DIV/0!**
19.4	Palo Parado Ramp Lighting	15.7	0.199	0.000	0.0%	0.000	0.0%	0.172	98.4%	0.003	1.6%	0.000	0.0%	0.175	1.07	1.27	1.36	1.18	1.18	1.357	181.1	**245.8**
19.6	Agua Linda Ramp Lighting	26.5	0.199	0.000	0.0%	0.000	0.0%	0.125	90.0%	0.004	2.9%	0.010	7.1%	0.139	1.07	1.27	1.36	1.18	1.18	1.342	112.2	**150.6**
19.1	Nogales - Tubac Shoulder Improvements	3 - 30	8.27	0.000	0.0%	0.000	0.0%	6.612	92.6%	0.150	2.1%	0.380	5.3%	7.142	1.07	1.27	1.36	1.18	1.18	1.347	4297.1	**5786.6**
19.8	Sahuarita - Tucson Shoulder Improvements	40 - 57	6.81	0.000	0.0%	0.000	0.0%	4.575	95.8%	0.151	3.2%	0.052	1.1%	4.778	1.07	1.27	1.36	1.18	1.18	1.352	8176.4	**11057.4**
19.7	Sahuarita TI Ramp Improvements	46.8	6.372	0.000	0.0%	0.000	0.0%	0.844	98.7%	0.011	1.3%	0.000	0.0%	0.855	1.07	1.27	1.36	1.18	1.18	1.358	28.8	**39.2**
19.11	Pima Mine TI Ramp Improvements	49.6	7.319	0.000	0.0%	0.586	35.6%	1.032	62.7%	0.015	0.9%	0.012	0.7%	1.644	1.07	1.27	1.36	1.18	1.18	1.325	82.8	**109.7**
19.12	Papago TI Ramp Improvements	54.4	6.372	0.000	0.0%	0.000	0.0%	1.169	97.6%	0.017	1.4%	0.012	1.0%	1.198	1.07	1.27	1.36	1.18	1.18	1.356	69.3	**93.9**
19.13	San Xavier TI Ramp Improvements	57	4.479	0.000	0.0%	0.350	35.9%	0.609	62.3%	0.012	1.2%	0.006	0.6%	0.977	1.07	1.27	1.36	1.18	1.18	1.324	80.4	**106.5**
19.21	Ajo Way Pavement Rehab	62 - 63.7	2.226	4.069	77.0%	0.000	0.0%	1.181	22.3%	0.032	0.6%	0.005	0.1%	5.287	1.07	1.27	1.36	1.18	1.18	1.136	800.9	**909.5**
19.14	Tucson Area Parallel Ramps	57 - 61.9	18.108	0.000	0.0%	0.386	12.8%	2.412	79.8%	0.203	6.7%	0.021	0.7%	3.022	1.07	1.27	1.36	1.18	1.18	1.335	531.3	**709.4**
19.15	Tucson Variable Speed Limits	57 - 64	24.996	0.000	0.0%	0.000	0.0%	1.013	87.1%	0.142	12.2%	0.008	0.7%	1.163	1.07	1.27	1.36	1.18	1.18	1.337	213.9	**286.0**
19.16	Tucson Widening	57 - 61.9	32.784	2.683	17.5%	0.352	2.3%	0.809	5.3%	11.428	74.7%	0.019	0.1%	15.292	1.07	1.27	1.36	1.18	1.18	1.172	1484.7	**1740.5**
19.17	Drexel/Irvington Pedestrian Overpass	59.5 - 62	2.154	0.000	0.0%	0.000	0.0%	5.533	97.0%	0.119	2.1%	0.053	0.9%	5.706	1.07	1.27	1.36	1.18	1.18	1.355	531.3	**6449.6**