

Pecos Street over I-70 Bridge Replacement

Value Engineering Study

**WILSON
& COMPANY**



Prepared for CDOT Region 6
Project Number: FBR 0704-224 (18149)
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Section 1 - Introduction

The purpose of a Value Engineering (VE) study is to complete a systematic evaluation and analysis of a project during the early design phases. The review is conducted to provide recommendations for:

- Meeting goals for function, safety, reliability and efficiency at the lowest overall cost;
- Improving the value and quality of the project, and;
- Shortening the time necessary to complete the project.

The project is located at the intersection of Pecos Street and Interstate 70, which is in the heart of the metropolitan area of Denver, Colorado. It is approximately one mile west of the largest and most complex interchange in the entire state, the crossing of I-70 and I-25. I-70 and I-25 are the major east/west and north/south routes, respectively, in the state.

The primary purpose of the project is to replace a structurally deficient bridge carrying Pecos Street traffic over I-70 and improve traffic operations in the interchange area. The project is funded through the Colorado Bridge Enterprise (CBE) and also received a grant through the Highways for Life (HFL) discretionary grant program.

Project Goals

- Replace the existing poor bridge structure and improve traffic operations and safety at the Pecos/I-70 interchange within the project budget.
- Advance the knowledge, experience and cost efficiency of the CDOT construction program and the construction industry in Accelerated Bridge Construction (ABC) and Construction Manager/General Contractor (CM/GC) project delivery.
- Provide a well-publicized, highly successful ABC project.
- Accelerate delivery of the construction schedule and obtain final project acceptance no later than October 2013.
- Minimize inconvenience to the traveling public and maximize safety of workers and the traveling public.
- Facilitate a collaborative partnership with all of the members of the project team and stakeholders.
- Provide a high quality design and construction.

Areas of Focus

Due to some of the unique aspects of this project; CM/GC delivery method, and proposed ABC technology, the VE Study Team focused their efforts in the following areas:

- Construction phasing, emphasis on roundabout construction.
- Pecos structure bridge elements (in keeping with accelerated bridge construction).
- Design elements that will reduce construction time and impacts such as pre-cast panels for roundabout pavement and/or approach slabs.
- Identify long lead time items and potential mitigations to schedule impacts.

The VE Study Team generated 5 proposals that they recommend be incorporated into the design. There were an additional 7 ideas that the study team recommends be taken into consideration during final design.

Study Constraints

The status of the project has already evaluated and determined a number of issues that typically may be part of a VE study. For this study the constraints are:

1. Roundabout Design – due to right of way constraints, the design of the roundabout is almost complete with the horizontal alignment set at this time. Further roundabout design is limited to vertical alignment and drainage considerations dictated by girder selection.
2. Accelerated Bridge Construction – the project will utilize the ABC technologies as committed in the Highways for Life grant.
3. Pedestrian Bridge Structure – the location and design will be determined by CDOT, Wilson & Company and Kiewit using the CM/GC process.
4. Right of Way – ROW plans are complete and acquisitions currently in process, so additional ROW acquisitions are discouraged.
5. MS4 Drainage – through a number of coordination meetings between CDOT and the City/County of Denver, the agencies’ respective standards and mitigation requirements have been discussed and intergovernmental negotiations have been made.

Qualifications Regarding the Proposals:

- The costs that are shown with each proposal reflect an order of magnitude cost savings relative to the original design concept it is compared to.
- The cost savings shown must carefully be evaluated by the design team. Additional savings or costs may be realized as the proposal is advanced to a final design.
- For the most part, the VE team used the unit costs available through CDOT’s construction cost data. In some cases, the VE team used their own unit costs for items not directly comparable/available.
- Some of the VE proposals are mutually exclusive, while others can be combined. Thus, the sum of all of the proposals cannot be added together.

Value Engineering Team

The VE Team member was comprised of the following members:

San Lee, PE	CDOT Staff Traffic
Hillary Isebrands, PE, PhD	FHWA Safety Specialist
Dave Paris	Kiewit, Project Manager
Dean Bigelow	Kiewit, Construction Manager
Fred Holderness, PE	TSH, Project Manager
Jeff Simmons, PE	TSH, Project Manager
Troy M Eisenbraun, PE	Facilitator – Wilson & Company



Review Board

The Review Board reviewed the Value Engineering Study and provided responses to the Value Engineering Proposals. The Review Board members included:

James Harvey	Kiewit Construction
John Pigiell	Kiewit Construction
Dave Paris	Kiewit Construction
Tamara Hunter-Maurer, PE	CDOT
Roy Guevara	CDOT
Mark Scholfield, PE	Wilson & Company
Tom Melton, PE	Wilson & Company
Scott Waterman, PE	Wilson & Company
Brian Hearn, PE	Wilson & Company
Jessica Boryn, EI	Wilson & Company

Section 2 – Brainstorming Ideas

The following table lists all of the ideas that the VE Team developed in an initial brainstorming activity. The purpose of this initial activity is to think of all the possible ideas that could improve the value while working within the constraints identified for the project. From this idea list, the VE Team evaluated the merits of each idea and developed a recommended action. Ideas that the VE Team agreed were worthy to investigate with the time available were then carried forward.

Idea No.	Idea Description	Recommended Action
1	Eliminate traditional approach slabs and use reinforced concrete pavement instead.	Incorporate
2	Change bridge foundation from spread footing to drilled shafts.	Incorporate
3	Instead of removing and replacing unsuitable soil under WB on-ramp terminal area, use reinforced concrete pavement supported by stone/soil cement columns.	Incorporate
4	Instead of the proposed roll-in method for ABC, construct the new structure to the west of the existing and slide in.	Design Consideration
5	Eliminate Northbound to Eastbound bypass lane on south roundabout and shift center of roundabout to the southeast to increase distance from end of bridge.	Eliminated
6	Eliminate U-turn movement on south roundabout.	Eliminated
7	Close either 48 th Avenue or the Westbound on/off ramps during construction.	Incorporate
8	Use a combination of Pedestrian Hybrid Beacon or Rectangular Rapid Flash Beacons for pedestrian signal systems.	Incorporate
9	Phasing recommendations varying from full to partial closure of Pecos Street.	Design Consideration
10	Review roundabout signing and pavement marking.	Design Consideration
11	Boost public involvement efforts and work more closely with local residents and businesses regarding phasing of work.	Design Consideration, combine with 12
12	Investigate options for accommodations for local traffic; example, arrange for shuttle service during Pecos closure.	Design Consideration, combine with 11
13	Identify long lead time items.	Design Consideration
14	Emphasize the need for a timely decision making process on such items as right of way, utilities, etc. or have a Plan B & C available.	Design Consideration
15	Construct bridge in two halves and either roll in or slide in.	Eliminated

Section 3 – Recommended Proposals

The following table identifies the proposals that the VE Team recommends to the Design Team to incorporate into the design. The right hand column in the table identifies the responses to the proposals from the Design Team.

Proposal No.	VE Proposal Summary Recommended Action: Incorporate into Design	<u>Design Team Response</u>
1	Eliminate traditional bridge approach slabs and use a reinforced concrete pavement section adjacent to the ends of the bridge. Savings potential: \$33,350	<i>Perhaps use flowable fill for backfill. Bridge Task Force will evaluate further.</i>
2	Change bridge foundation type from spread footings supporting an abutment wall to a series of drilled shafts supporting a precast or cast in place abutment beam. Savings potential: \$550,000	<i>Further evaluate.</i>
3	Instead of removing and replacing unsuitable soil under WB on-ramp terminal area, use reinforced concrete pavement supported by stone/soil cement columns. Savings potential: \$69,500	<i>Need additional soil investigation for this alternative.</i>
7	Close either 48 th Avenue or the Westbound on/off ramps during construction. Savings potential: \$420,000	<i>Consider in MOT Task Force.</i>
8	Use a combination of Pedestrian Hybrid Beacon or Rectangular Rapid Flash Beacons for pedestrian signal systems instead of traditional red/yellow/green signals. Savings potential: \$26,000 to \$35,000	<i>City and County of Denver does not want alternate types of pedestrian signals. Look at pedestrian hybrid beacon for off ramp.</i>

Section 4 Design Considerations

The following table identifies proposals that the VE Team recommends to the Design Team to consider as the design team progresses but they may or may not improve the Value. Where there was a potential cost savings identified, it has been included below. The right hand column in the table identifies the responses to the proposals from the Design Team.

Proposal No.	VE Proposal Summary Recommended Action: Design Consideration	<u><i>Design Team Response</i></u>
4	Instead of building the new structure off-site at a staging area, construct the new bridge at a temporary location west of the existing and use the slide-in method. This proposal is being recommended for consideration if approval for a reduction in the number of lanes of traffic on Pecos, or the full closure of Pecos, cannot be obtained. Savings potential: Not Calculated	<i>This approach may allow for adequate traffic operations across roadway structure but geometrics are inadequate for traffic entering/exiting ramps.</i>
9	A variety of phasing options ranging from full closure of Pecos for a short duration to multi-phase options carrying either 1 or 2 lanes of traffic in each direction were evaluated. Schematic layouts for each were developed and included in the VE proposal write-up. Savings potential: \$740,000 to \$1,160,000 (user delay costs)	<i>Further consideration and analysis to be performed.</i>
10	Review roundabout signing and pavement marking. Suggestions for modifications to the proposed signing and pavement markings from the VE study were transmitted separately. Savings potential: Not Calculated	<i>Suggestions are being addressed with Traffic Task Force (Wilson, CCD, CDOT, FHWA).</i>
11 & 12	Boost public involvement efforts and work more closely with local residents and business to make a reduction in Pecos traffic capacity or a complete shut down during construction acceptable. Savings potential: Not Calculated	<i>Public Relations and PI efforts are underway and will increase in coordinated efforts with CCD and CDOT PR.</i>
13	Items identified as requiring longer lead times to ensure fabrication and delivery were evaluated along with estimated lead times. Savings potential: Not Calculated	<i>Further consideration (good idea on sign structures).</i>
14	Emphasize the need for a timely decision making process on such items as right of way, utilities, etc. or have a Plan B & C available. Savings potential: Not Calculated	<i>Integrated into design process.</i>

Section 5- Proposal Descriptions

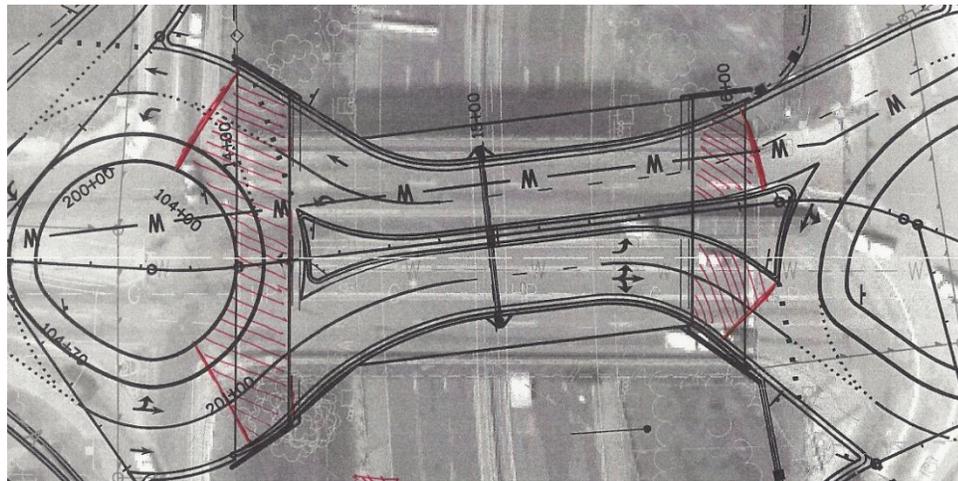
Value Engineering Proposal No. 1 Eliminate Traditional Bridge Approach Slabs Recommended Action: Incorporate

Summary: Using traditional 20' long bridge approach slabs, with the expansion joint at the end of the approach slab, places the location of the expansion joint within the limits of both roundabouts. Due to the pavement flares needed on the bridge to accommodate the roundabout geometry, this places the expansion joint locations in difficult places in terms of construction, maintenance and longevity.

Estimated potential cost savings: \$33,350

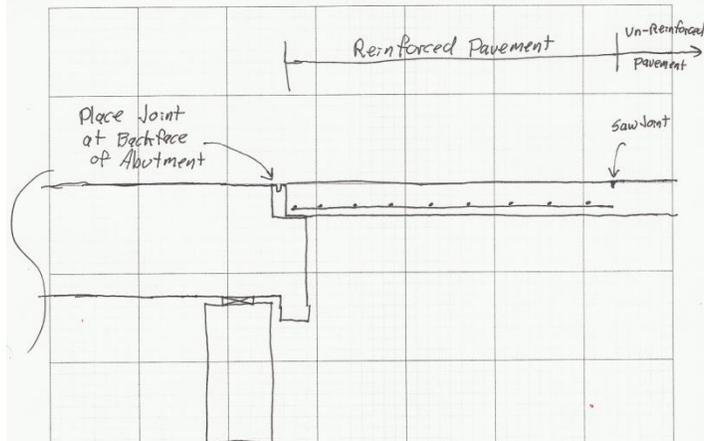
Discussion:

Due to the proximity of the bridge to both roundabouts, particularly the south one, construction of a traditional 20' long approach slab places the expansion joint and underlying sleeper slab in undesirable locations. At the south end, the expansion joint would fall within the limits of the roundabout and truck apron, and cross at an extreme skew. The north joint location is outside the roundabout pavement, but falls within a wide area of pavement and creates the need for a skewed joint angle.



Red hatched area depicts limits of reinforced pavement

This VE proposal recommends that the traditional approach slab be omitted, and as an alternate the section of pavement adjacent to the bridge reinforced as shown in the sketch at right. The expansion joint would be located at the end of the bridge, and the reinforced pavement section would rest on a paving lug on the abutment backwall.



Value Engineering Proposal No. 1 – cont'd
Eliminate Traditional Bridge Approach Slabs
Recommended Action: Incorporate

Related Value Engineer proposal:

None

Advantages of this Proposal:

- At south end of bridge, the expansion joint is no longer located in the truck apron area.
- Provides for a smoother driving surface by moving the expansion joint to the end of the bridge.
- Allows for more traditional, radial jointing pattern for roundabout pavement.
- Eliminates the need for a sleeper slab, reduces amount of reinforcing, and shortens length of expansion joints.
- Shortens the construction time, no longer need to construct or install a pre-cast sleeper slab.
- Provides for longer joint life and/or potentially less maintenance since the joint is less skewed than originally proposed.
- Could potentially use a compression type joint seal.

Advantages of original design concept:

- Provides more flexibility in choice of backfill material.
- Original design is tried and true method.
- Potential drainage through expansion joint is kept further away from abutment.

Risks associated with implementing this Proposal:

- Probably need to use some type of flowable fill for backfill the behind bridge abutments and under limits of reinforced concrete pavement section.
- If expansion joint leaks due to damage or inadequate maintenance, surface drainage could run down behind backwall.

Calculations: Cost savings were estimated on the following basis.

Shorter expansion joint length – 37' lf @ \$150/lf =	\$5,550
Eliminate 1 mat of rebar – 50 lbs/cy = 9,000 lbs @ \$1.00/lb =	\$9,000
Eliminate 2 sleeper slabs – 47 cy @ \$400/cy =	<u>\$18,800</u>
Cost Savings	\$33,350

Value Engineering Proposal No. 2
Change Bridge Foundation Type
Recommended Action: Incorporate

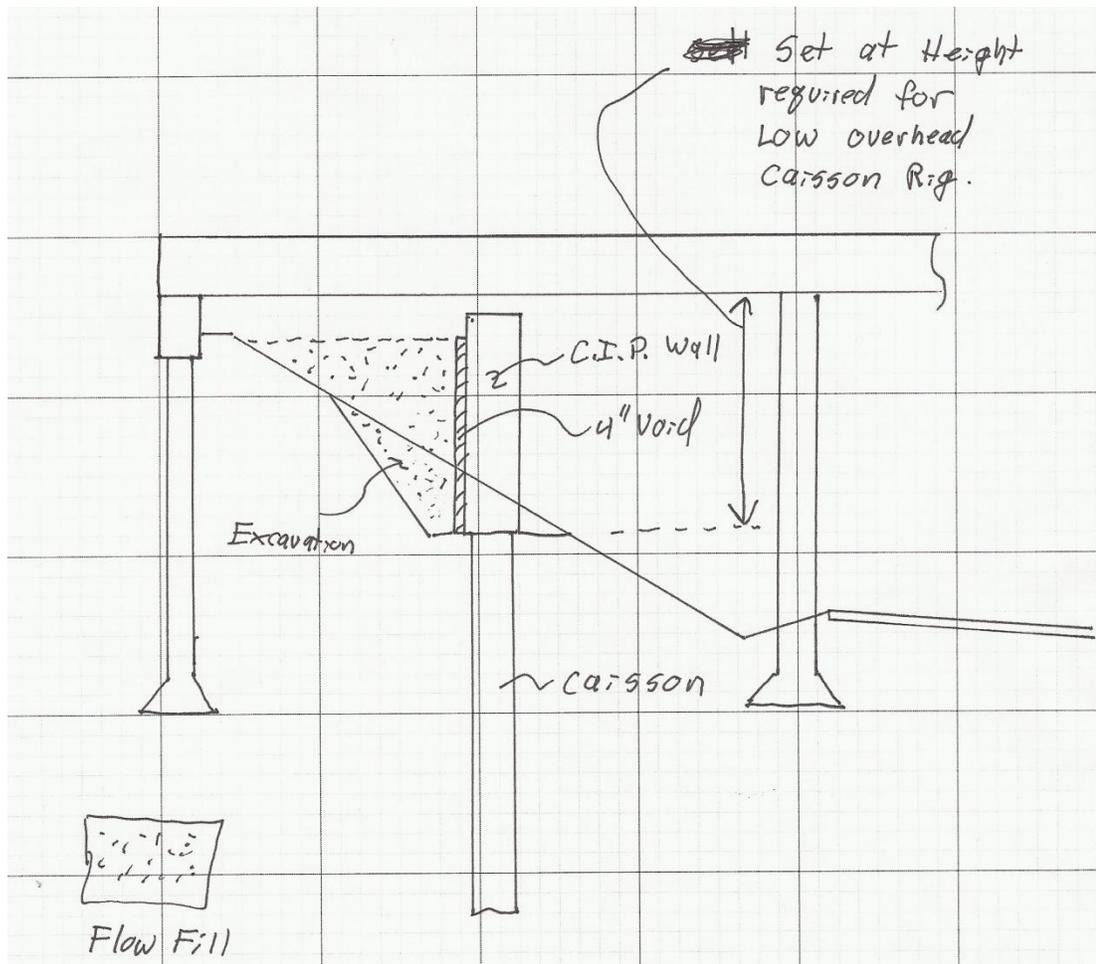
Summary: Instead of the current spread footing and abutment stem wall foundation, use a series of drilled shafts topped by a cast in place or precast abutment wall.

Estimated potential cost savings: \$550,000

Discussion:

The current design calls for spread footings constructed on shallow bedrock that is roughly just below the existing ditch elevation along I-70. The amount and depth of excavation necessary for construction of the spread footing will require the installation of a soil nail wall to stabilize the slope.

This VE proposal would substitute a series of drilled shafts topped by either a cast in place or precast abutment beam. Using a low headroom (8') drill rig, the depth and amount of excavation necessary for construction of the spread footing will require the installation of a soil nail wall to stabilize the slope.



Value Engineering Proposal No. 2 – cont'd
Change Bridge Foundation Type
Recommended Action: Incorporate

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Less excavation is required.
- Need for soil nail wall is eliminated.
- Lessens risk to existing structure caused by excavation necessary for spread footing design (stability).
- Elimination of soil nails reduces chance of hitting existing utilities.
- Lessens the need for shoulder or lane closures along I-70 to move equipment in, complete the excavation, etc.

Advantages of original design concept:

- Less risk on original design dependant on risk assessment associated with final geotechnical recommendation for drilled shaft construction.
- Work area is larger and there is no/less of a need for specialized equipment due to low head room.

Risks associated with implementing this Proposal:

- Depth of drilled shafts could vary.
- Need to utilize low headroom equipment for construction of the drilled shafts.
- May need a short MSE wall or some type of flowable fill above the top of the drilled shafts.
- Depending on the type of backfill, some type of abutment drainage system may be needed.

Calculations: Cost savings were estimated on the following basis.

	Spread Footing	Drilled Shaft	Difference
Excavation/Backfill	\$290,000	\$145,000	\$145,000
Substructure (conc/rebar)	\$600,000	\$420,000	\$180,000
Shoring	\$300,000	\$75,000	<u>\$225,000</u>
Total			\$550,000

Value Engineering Proposal No. 3 Alternative to Address Unsuitable Soil Recommended Action: Incorporate

Summary: Instead of excavating and replacing the anticipated unsuitable soil in the area of 48th Avenue and the WB on ramp, use a reinforced concrete pavement section and add stone or soil cement columns to allow the existing soil to remain in place.

Estimated potential cost savings: \$69,500

Discussion:

The soils report identifies the potential for unsuitable soils at both the west on/off ramp intersections with Pecos due to expected low R values. The report recommends removal of the upper 4 to 5' of unsuitable material and replacement with granular material. There are numerous underground utilities, particularly in the vicinity of the WB on ramp that would require removal and replacement of the soil over/under and/or around the utility complicating completion of this work.

Under this proposal, the unsuitable soil under the north area (WB on ramp and 48th Ave) would be left in place and required support values obtained by installation of stone or soil cement columns. The pavement section in this area would be reinforced to better transfer the traffic loads to the columns. The spacing and depth of the stone/soil cement columns would need to be determined, but for comparison purposes, 8' deep columns on 12' centers were used to develop cost estimates.

Of note, the existing pavement does not show signs of distress typically associated with poor underlying soils. If additional soil borings are needed on the project prior to start of construction, further investigation of the extent and severity of the unsuitable soil is recommended.

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Less risk of damaging underground utilities.
- Eliminates need to remove and waste unsuitable material.
- Shorter construction time.

Advantages of original design concept:

- Proven approach to replace unsuitable material.

Risks associated with implementing this Proposal:

- Need accurate subsurface utility locations and depths.
- May end up with an irregular pattern of stone or soil cement columns that make uniform support of the pavement section difficult.

Value Engineering Proposal No. 3 – cont'd
Alternative to Address Unsuitable Soil
Recommended Action: Incorporate

Calculations: Cost savings are based on removal/replacement versus the proposed method for an area 120' x 125' under the WB on ramp. Due to few utilities and smaller area, the west side of the EB off ramp would be treated as recommended in the soils report.

Remove and replace 4' unsuitable soil	
$(120' \times 125' \times 4') / 27 = 2,222 \text{ cy @ } \$50/\text{cy} =$	\$111,100
versus	
Add reinf steel to pavement section	
50 lbs/cy pavement = 532 cy x 50 lbs @\$1.00 =	\$26,600
Install 100 – 8' deep stone/soil cement columns @\$150 each =	<u>\$15,000</u>
Cost Savings	\$69,500

Value Engineering Proposal No. 4 Use Slide-In Versus Roll-In ABC Method Recommended Action: Design Consideration

Summary: Instead of building the new structure off-site at a staging area, construct the new bridge at a temporary location west of the existing and use the slide-in method to move into place when construction of the roundabouts are complete.

Estimated potential cost savings: Not calculated

Discussion:

In looking at phasing and maintenance of traffic required to accommodate 4 through lanes of traffic and a left turn lane on Pecos during construction, this idea was developed to provide an alternative if a partial or complete closure of Pecos is not possible.

Under this VE proposal, the new structure would be built west of the existing and constructed over I-70 as opposed to being built off-site and rolled in at the appropriate time. Temporary connections to Pecos would be constructed to the north and south as shown on the sketch below. A majority of the roundabouts could be constructed prior to demolition of the existing bridge and slide-in of the new structure.



Since the temporary location of the new bridge conflicts with the new pedestrian bridge, an alternative location and route for handling pedestrian traffic would be needed, probably on a temporary basis. This might require the relocation of the pedestrian bridge after the new Pecos bridge is in place.

Since this proposal is not consistent with several goals of the project and may require additional right of way, it is being presented for consideration by the design team in the event the short-term closure of Pecos and/or a reduction in the number of traffic lanes to be provided during construction becomes an issue with local agencies.

Value Engineering Proposal No. 4 – cont'd
Use Slide-In Versus Roll-In ABC Method
Recommended Action: Design Consideration

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Provides for more lanes of traffic that can be carried on Pecos during construction.
- Allows a larger portion of the roundabouts to be constructed prior to slide in of the new bridge.

Advantages of original design concept:

- Better meets goals of the project.
- No conflict with proposed site of pedestrian bridge or routing of pedestrian traffic during construction.
- No need for temporary abutments to be built along I-70.
- Safer work environment for constructing the bridge – off site vs over traffic.
- While a cost comparison wasn't developed, it is anticipated the original concept would be less expensive than the proposed.

Risks associated with implementing this Proposal:

- Geometrics of proposed roadway connections need to be evaluated.
- Not consistent with goals of project to incorporate roll in ABC technology.
- Will need to obtain approval for additional short-term (overnight) closures of I-70 to build the bridge over traffic.
- More risk for accidents for workers and traveling public.
- Additional right of way or easements may be needed to construct the temporary tie-ins for Pecos.
- May need to install then later relocate the pedestrian bridge.

Calculations: N/A

Value Engineering Proposal No. 5
Eliminate NB-EB Bypass Lane and Shift Location of South Roundabout
Recommended Action: Eliminated

Summary: The need for the NB to EB bypass lane on the south roundabout was evaluated with respect to the proposed traffic volumes.

Estimated potential cost savings: Not calculated

Discussion:

The existing design of the south roundabout requires a substantial widening of the proposed structure due to the close proximity of the roundabout and bridge. A review of the traffic volumes indicated it might be possible to eliminate the bypass lane and shift the roundabout to the southeast, thus increasing the distance between the center of the roundabout and bridge. This would allow a reduction in the width needed at the south end of the bridge.

Related Value Engineer proposal:

VE Proposal No. 6

Advantages of this Proposal:

- Did not evaluate.

Advantages of original design concept:

- Did not evaluate.

Risks associated with implementing this Proposal:

- Not consistent with prior reviews and approvals obtained for the project.

Calculations: N/A

Value Engineering Proposal No. 6
Eliminate U-Turn Lane on South Roundabout
Recommended Action: Eliminated

Summary: Eliminate the U-Turn Lane on the South Roundabout

Estimated potential cost savings: Not calculated

Discussion:

The WB left turn movement onto Pecos from 47th Avenue will be eliminated with the additional of a median limiting access at this location. There are currently very few left turn movements (13 pm peak hour) onto Pecos from this location. There are other routes available (46th Ave), or traffic wanting to turn south onto Pecos could turn right from 47th Avenue and travel through both roundabouts before going south.

Related Value Engineer proposal:

VE Proposal No. 5

Advantages of this Proposal:

- Did not evaluate.

Advantages of original design concept:

- Did not evaluate.

Risks associated with implementing this Proposal:

- Not consistent with prior reviews and approvals obtained for the project.
- Does not meet local EMS desire to have the U-turn movement available for emergency vehicles.

Calculations: N/A

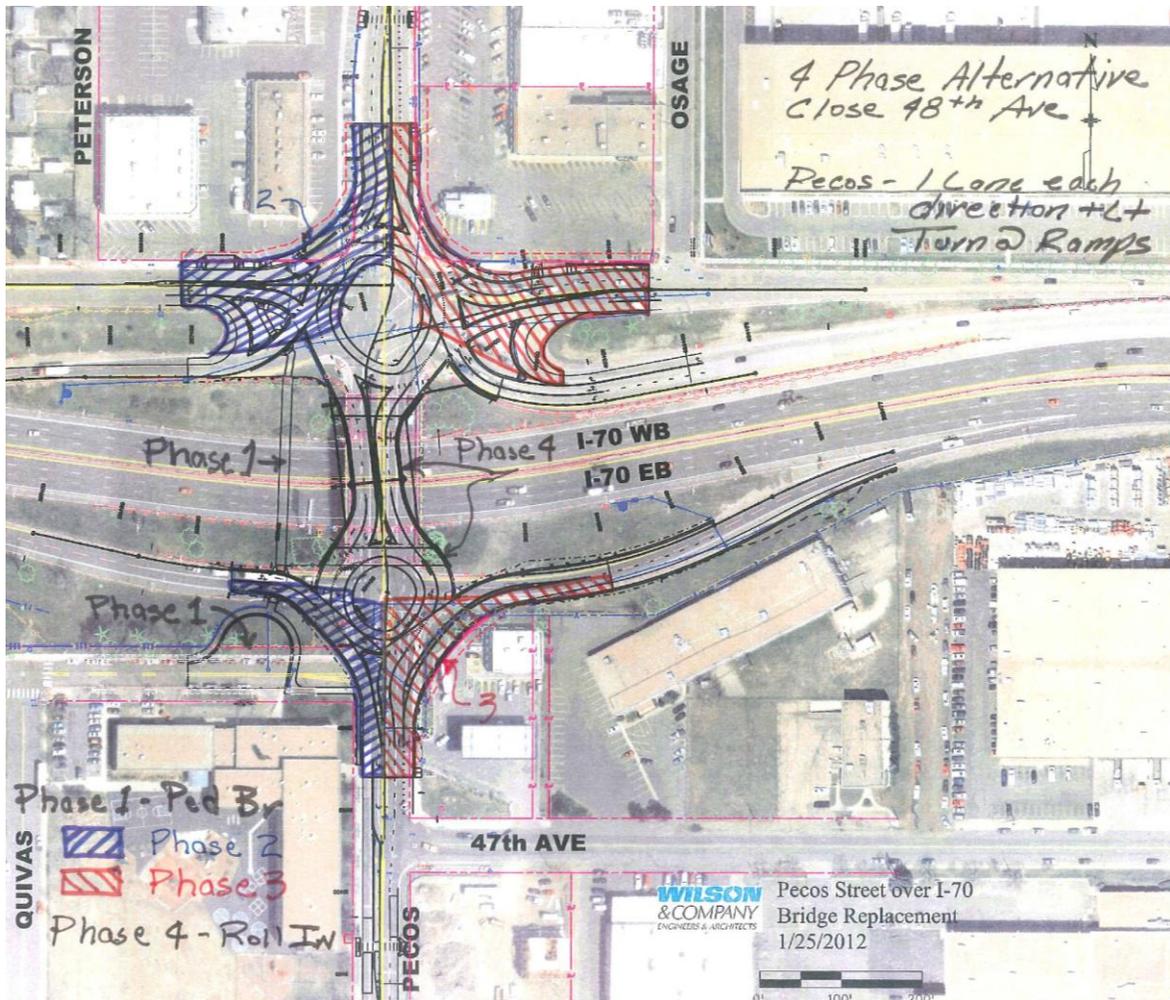
Value Engineering Proposal No. 7
Close 48th Avenue During Construction
Recommended Action: Incorporate

Summary: Allow the short term closure of 48th Avenue in conjunction with construction of the project.

Estimated potential cost savings: \$420,000 (user delay costs)

Discussion:

Allowing the full closure of 48th Avenue reduces the number of construction phases anticipated for the project by 2 and shortens the estimated construction duration by 21 calendar days. A sketch outlining the limits of construction for the phases necessary to complete the ramps and 48th Avenue is shown below. These are rough construction limits only, and would need to be refined to determine actual limits based on jointing plans, etc. The intent is to close and construct the hatched area, while keeping ramp traffic active. When I-70 is closed for the bridge roll in, the ramp pavement and the remainder of the roundabout would be completed.



Value Engineering Proposal No. 7 – cont'd
Close 48th Avenue During Construction
Recommended Action: Incorporate

A reduction in the number of traffic lanes on Pecos would be required to accommodate this phasing plan. It was assumed traffic could be reduced to one lane in each direction with a dedicated left turn lane for the WB and EB on ramps. A right turn lane or taper would be provided for the ramps where there was adequate room.

Related Value Engineer proposal:

VE Proposal No. 9 – other phasing options

Advantages of this Proposal:

- Shorter construction duration.
- Lower user delay costs.
- Better quality of construction, smoother ride and more durable due to fewer construction operations to complete.

Advantages of original design concept:

- Provides for better access.
- May be more consistent with local expectations.

Risks associated with implementing this Proposal:

- May be local opposition to closing 48th Ave.
- May impact or require need for detour route.
- May increase truck traffic on Pecos north of 48th Ave.

Calculations: See table below. In comparing user delay costs only, and assuming other construction and traffic control costs were equal, the difference between maintaining traffic on 48th Avenue versus closing is \$420,000.

Alternative Description	Full Close Duration (Cal Day)	Full Closure User Delay	Total Full Closure Delay	Phasing Duration (Cal Day)	Phasing User Delay	Total Phasing Delay	Total User Delay
Full Closure of Pecos	21	72,000	1,512,000			0	\$1,512,000
3 Lane, 4 Phase, 48th Closed	4	72,000	288,000	53	20,000	1,060,000	\$1,420,000
3 Lane, 6 Phase, 48th Open	4	72,000	288,000	74	20,000	1,480,000	\$1,840,000
4 Lane, 8 Phase	4	72,000	288,000	111	20,000	2,220,000	\$2,580,000
5 Lane	Deemed Impractical					Not Calculated	

Value Engineering Proposal No. 8
Pedestrian Signal Type
Recommended Action: Incorporate

Summary: Instead of traditional red/yellow/green signals, install a combination of Rectangular Rapid Flash Beacon (RRFB) and Pedestrian Hybrid Beacon (PHB) aka HAWK signals at the proposed pedestrian crossings.

Estimated potential cost savings: \$26,000 to \$35,000

Discussion:

High pedestrian and bike traffic along the project requires effort to increase safety at the proposed crossing sites. This proposal would change the type of signals to be installed and add an RRFB to one of the pedestrian crossing locations.

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Due to high traffic volumes, a PHB would be preferred over an RRFB on South Pecos, so for consistency use PHB’s for both locations on Pecos.
- PHB’s result in less delay for vehicles than traditional crossing signals.
- PHB’s rest in dark vs. green for traditional signals, so energy costs are lower.
- PHB is FHWA proven safety countermeasure.
- Adding an RRFB at the I-70 EB exit ramp crossing increases awareness of the pedestrian crossing, which addresses a concern about high speeds coming off interstate and transitioning to local streets/speed limits.
- Higher visibility is critical at this location for safety of pedestrians as this is a multiple threat location due to 2-lane crossing. Stop/yield line and supportive signing is recommended.

Advantages of original design concept:

- Familiar technology and equipment.

Risks associated with implementing this Proposal:

- Driver compliance/recognition.
- New/innovative technology (but research and application has shown good safety benefits for both PHB & RRFB).

Calculations: Cost savings were estimated on the following basis:

Traditional Signal Installations - \$80,000 to \$100,000 X 2 =	\$160,000 to \$200,000
versus	
PHB Installations - \$62,000 to \$75,000 X 2 =	\$124,000 to \$150,000
Add RRFB at EB Exit Ramp - \$10,000 to \$15,000 =	<u>\$10,000 to \$15,000</u>
Cost Savings	\$26,000 to \$35,000

Value Engineering Proposal No. 9
Construction Phasing Options
Recommended Action: Design Consideration

Summary: An evaluation of the various phasing options that appear to be feasible to construct the project in accordance with the stated goals and objectives.

Estimated potential cost savings: \$740,000 to \$1,160,000 (user delay costs)

Discussion:

Aside from the 50 hour shutdown of the project, including I-70, for installation of the new bridge structure, previous discussions with the City of Denver included a desire to maintain 5 lanes of traffic on Pecos Street during construction. Since existing Pecos is a 4-lane section immediately south and north of the project limits, a cursory review of the proposed improvements indicated it would not be possible to provide a continuous 5-lane section (2 through lanes in each direction and a left turn lane) during construction without major changes in the current design approach.

A variety of construction phasing scenarios were developed, ranging from complete closure of Pecos Street for a short duration, to 3-lane and 4-lane configurations, with and without the closure of 48th Avenue. The estimated construction duration for each alternative was developed, and the associated user delay costs tabulated for each scenario. Schematic layouts depicting the various phases of construction for providing 3 lanes on Pecos are included on the following pages. A schematic for the full closure of Pecos was not developed, nor one showing the additional phases that would be needed to provide 4 lanes during construction.

All options assumed the proposed pedestrian bridge would be put into service during the first phase of the project, and remain open except for a short time during demolition of the existing bridge. It was also assumed that access could be provided to all adjacent businesses either directly from Pecos or a side street during construction. It was also assumed that approval for the designation and use of alternate routes, or in the event of complete closure of Pecos, detour routes on local streets would be obtainable.

Related Value Engineer proposal:

VE Proposal No. 7

Advantages of the Various Phasing Options:

- Option 1 –Full Closure of Pecos for 21 Calendar Days.
 - Highest ranked in terms of quality, cost, and safety.
 - Provides for the shortest construction duration and better meets goals for ABC demonstration project.
 - Easiest to transition into full roundabout operations.
 - Better quality of construction, smoother ride and more durable due to fewer construction operations to complete.

Value Engineering Proposal No. 9 – cont'd
Construction Phasing Options
Recommended Action: Design Consideration

- Option 2-4 Maintain Traffic on Pecos.
 - Less severe impact on local traffic.
 - Lessens/eliminates need for detours/alternate routes.
 - More in line with local expectations in terms of access.

Advantages of original design concept:

- Provides for better access and maintenance of traffic.
- May be more consistent with local agency expectations.

Risks associated with implementing the Various Phasing Options:

- Option 1 –Full Closure of Pecos for 21 Calendar Days.
 - Emergency vehicle access.
 - Public/business consent.
 - Additional public involvement needed.
 - Potential for undue business hardship.
 - Impact on detour routes.
- Option 2-4 Maintain Traffic on Pecos.
 - Does not meet all goals of the project.
 - Increasing safety concerns associated with multiple traffic shifts and longer exposure to worker/traffic interface.
 - Multiple construction operations sacrifice quality and ride.
 - Construction production.
 - Harder to put roundabout into final traffic operation.
 - Feasibility of maintaining truck turning ability during construction
 - Amount of temporary work needed for signals, striping, signing, etc.

Risks associated with original design concept:

- Providing 5 lanes of traffic not feasible with current design approach.
- Major design revisions to accommodate traffic as stated may result in a design that is not consistent with project goals.

Calculations: See table on following page. The estimated user delay costs were calculated based on the estimated time Pecos would need to be closed, including the 50 hour window for closure of I-70, along with the duration of time for the remaining work. Construction costs were assumed to be equal in other aspects.

**Value Engineering Proposal No. 9 – cont'd
Construction Phasing Options
Recommended Action: Design Consideration**

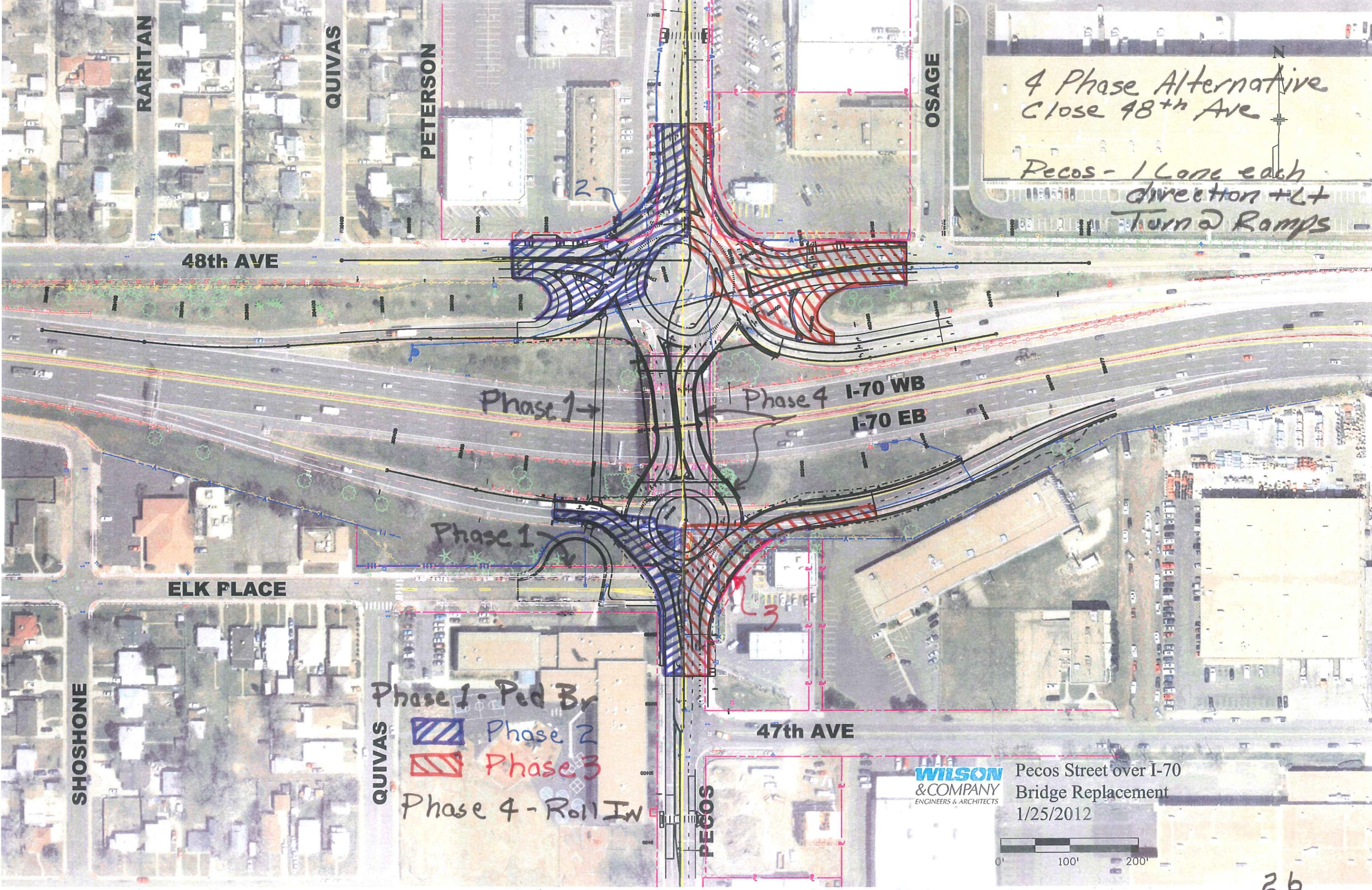
Alternative Description	Full Close Duration (Cal Day)	Full Closure User Delay	Total Full Closure Delay	Phasing Duration (Cal Day)	Phasing User Delay	Total Phasing Delay	Total User Delay
Full Closure of Pecos	21	72,000	1,512,000			0	\$1,512,000
3 Lane, 4 Phase, 48th Closed	4	72,000	288,000	53	20,000	1,060,000	\$1,420,000
3 Lane, 6 Phase, 48th Open	4	72,000	288,000	74	20,000	1,480,000	\$1,840,000
4 Lane, 8 Phase	4	72,000	288,000	111	20,000	2,220,000	\$2,580,000
5 Lane	Deemed Impractical					Not Calculated	

Note – 1st and last phase of each alternative is installation of the pedestrian bridge and roll-in of the bridge, respectively.

Estimated user delay cost savings range from \$740,000 to \$1,160,000 using the 4 lane, 8 phase alternative as a starting point for comparison.

Along with comparing the alternatives on user delay costs, each was ranked according to conformance with major goals for the project. Based on the factors shown below, and the associated weights assigned, each of the options was ranked from 1 to 4, with 1 being the most preferred.

Alternative Description	User Cost	Maint	Quality	Safety	Traffic - Opening Day Operation	Traffic - During Construction Operation	Construction Cost	Duration of Impacts	Average	Weighted Average
	20%	10%	15%	25%	5%	10%	5%	10%		100%
Full Closure of Pecos	1.06	1	1	1	1	4	1	1	1.38	1.31
3 Lane, 4 Phase, 48th Closed	1.00	2	2	2	2	3	1	2	1.88	1.85
3 Lane, 6 Phase, 48th Open	1.30	3	3	3	2	2	1	3	2.29	2.41
4 Lane, 8 Phase	1.82	4	4	4	2	1	1	4	2.73	3.01
5 Lane	Deemed Impractical - Not Calculated									



4 Phase Alternative
Close 48th Ave

Pecos - 1 Lane each
direction + L +
Turn @ Ramps

48th AVE

Phase 1 →

Phase 4 I-70 WB
I-70 EB

Phase 1 ↓

ELK PLACE

47th AVE

Phase 1 - Ped Br

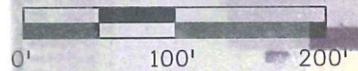
Phase 2

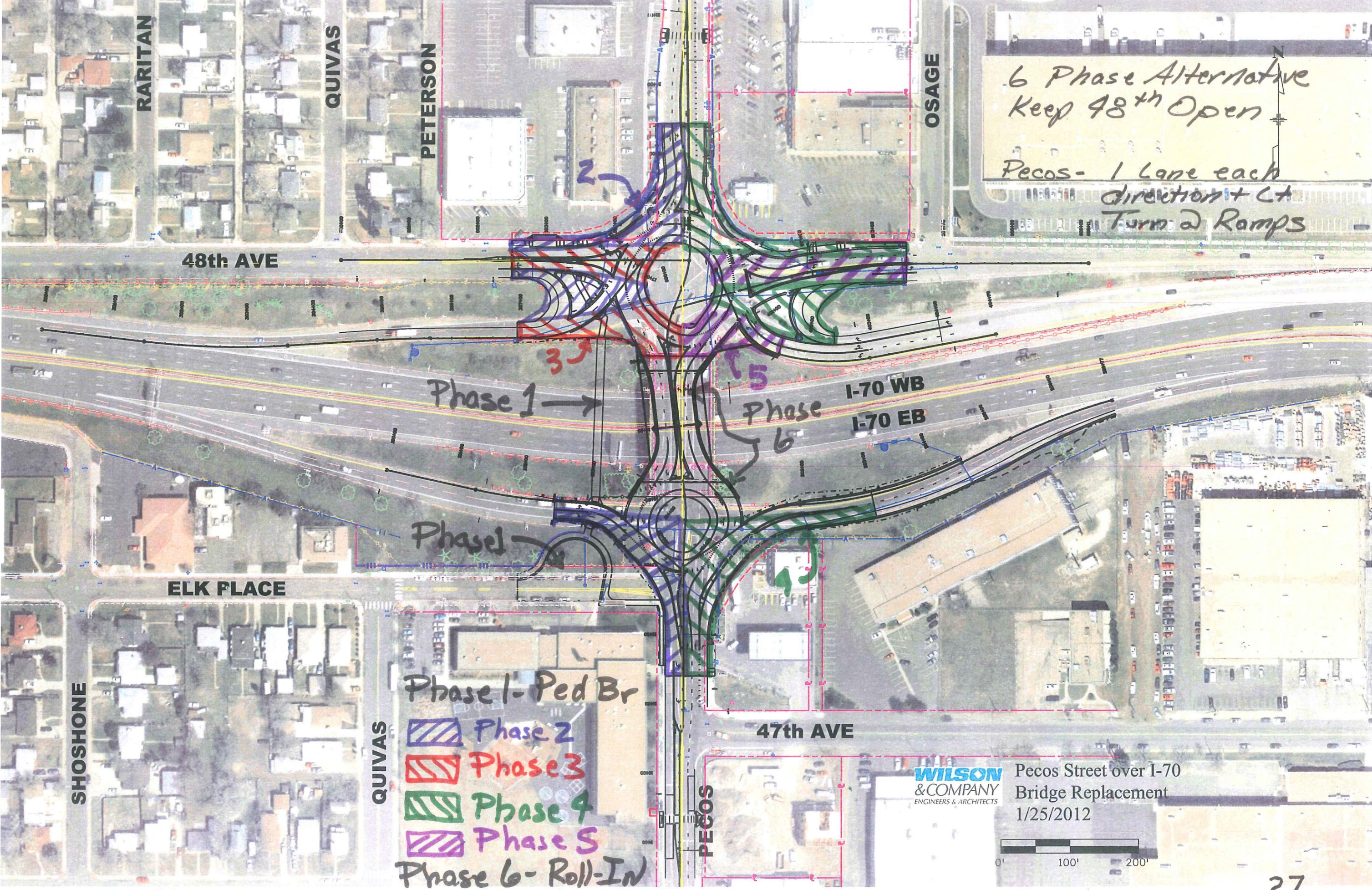
Phase 3

Phase 4 - Roll IW

WILSON
& COMPANY
ENGINEERS & ARCHITECTS

Pecos Street over I-70
Bridge Replacement
1/25/2012





6 Phase Alternative
Keep 48th Open

Pecos - 1 Lane each
direction + CA
Turn @ Ramps

48th AVE

Phase 1 →

Phase 6

I-70 WB

I-70 EB

Phase 4

ELK PLACE

Phase 1 - Ped Br

Phase 2

Phase 3

Phase 4

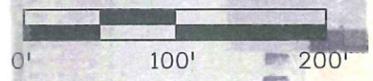
Phase 5

Phase 6 - Roll-In

47th AVE

WILSON & COMPANY
ENGINEERS & ARCHITECTS

Pecos Street over I-70
Bridge Replacement
1/25/2012



Value Engineering Proposal No. 10
Review Roundabout Signing and Pavement Marking
Recommended Action: Design Consideration

Summary: Review the signing and pavement marking layout for conformance to the latest guides and policies.

Estimated potential cost savings: Not calculated

Discussion:

The potential for driver confusion regarding the proposed signing and striping plans was identified during the VE study. A complete listing of the notes and discussion has been submitted for consideration by the design team.

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Improve operation of roundabouts.

Advantages of original design concept:

- None

Risks associated with implementing this Proposal:

- None

Calculations: N/A

Value Engineering Proposal No. 11
Increase Emphasis on Public Involvement
Recommended Action: Design Consideration

Summary: Boost public involvement efforts and work more closely with local residents and business to make a reduction in Pecos traffic capacity or a complete shut down during construction acceptable.

Estimated potential cost savings: Not calculated

Discussion:

The need to increase in public involvement efforts and the potential to work more closely with local residents and business was identified as important to gain consensus for a reduction in Pecos traffic capacity or a complete shut down during construction. Increased efforts could include such items as trying to identify peak periods of business activity to try to avoid with partial or complete shutdowns.

Related Value Engineer proposal:

VE Proposal No. 12

Advantages of this Proposal:

- Improve local acceptance and buy-in of proposed construction impacts/schedules.
- Helps achieve one of the stated project goals of establishing a collaborative partnership with all team members and stakeholders.

Advantages of original design concept:

- None

Risks associated with implementing this Proposal:

- None

Calculations: N/A

Value Engineering Proposal No. 12
Investigate Options for Local Traffic
Recommended Action: Design Consideration

Summary: Investigate options for accommodating local traffic during construction.

Estimated potential cost savings: Not calculated

Discussion:

As part of an increased emphasis on public involvement, options to make complete or partial shutdowns of traffic on Pecos acceptable to local residents were identified. Potential options include arranging for temporary shuttle service to/from both north and south of I-70 to the business areas during times Pecos is closed. This could be tied to temporary relocation of neighborhood transit stops to areas outside the proposed construction limits.

Related Value Engineer proposal:

VE Proposal No. 11

Advantages of this Proposal:

- Improve local acceptance and buy-in of proposed construction impacts/schedules.
- Helps achieve one of the stated project goals of establishing a collaborative partnership with all team members and stakeholders.

Advantages of original design concept:

- None

Risks associated with implementing this Proposal:

- None

Calculations: N/A

Value Engineering Proposal No. 13
Long Lead Time Items
Recommended Action: Design Consideration

Summary: Items identified as requiring longer lead times to ensure fabrication and delivery were evaluated along with estimated lead times.

Estimated potential cost savings: Not calculated

Discussion:

A review of potential items that require a long time to fabricate and deliver identified 4 items or groups of items that need additional consideration to ensure timely delivery. In addition, estimated lead times from completion of design to delivery to the project site were estimated for a couple of items, based on recent experience of the VE team members. The estimated time shown below includes shop drawing preparation, review and approval.

<u>Item</u>	<u>Estimated Time</u>
Girders – Steel or Concrete	Unknown
Pre-Fabricated Pedestrian Bridge	8 Weeks
Overhead Sign Supports	14 Weeks
Traffic Signal & Light Poles	Unknown

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Maintain project schedule.

Advantages of original design concept:

- None

Risks associated with implementing this Proposal:

- None

Calculations: N/A

Value Engineering Proposal No. 14
Emphasize Need for Timely Decision Making Process
Recommended Action: Design Consideration

Summary: During a discussion of the potential risks associated with meeting the proposed project schedule, several items were identified as critical path items.

Estimated potential cost savings: Not calculated

Discussion:

Emphasize the need for a timely decision making process on such items as right of way, utilities, or any other critical path items to ensure the project stays on schedule. In the event critical decisions on one or more items are delayed, it may be necessary to develop alternative plans and/or schedules.

Other schedule considerations:

- Adjust schedule to get more favorable weather conditions.
- Take into account timing of local, high traffic generating events like the annual Stock Show.
- Optimize schedule for work on Pecos to lessen impact on local neighborhood (i.e., – which day of week has least impact).
- Coordinate schedule with other major highway projects.
- If detours are used, also take into account timing of other local projects and detours.

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Maintain project schedule.

Advantages of original design concept:

- None

Risks associated with implementing this Proposal:

- None

Calculations: N/A

Value Engineering Proposal No. 15
Construct Bridge in Halves and Roll- or Slide-In
Recommended Action: Eliminated

Summary: Instead of constructing the bridge as a single unit, construct in halves with a longitudinal joint located under the proposed median on the bridge.

Estimated potential cost savings: Not calculated

Discussion:

Due to the potential for racking such a wide structure if built as a single unit and moved into place from a staging area, the idea of building the bridge in halves was discussed. One variation on this would be to build half the structure on temporary abutments west of the existing bridge, and build the other half at a staging area and move into place. This would allow the demonstration of both the roll-in and slide-in ABC bridge technologies.

Related Value Engineer proposal:

None

Advantages of this Proposal:

- Offer opportunity to highlight both ABC methods that have been considered.
- Offers some flexibility in handling Pecos traffic during construction. Northbound traffic could be carried on existing roadway and Southbound over the temporary bridge location.

Advantages of original design concept:

- Lower overall costs.
- Better meets project goals.

Risks associated with implementing this Proposal:

- Higher overall costs since both ABC methods needed.
- Requires construction over I-70.
- Requires approval of additional short term closures of I-70 for temporary abutment construction.

Calculations: N/A