ATKINS

Member of the SNC-Lavalin Group

I-25 at US 50 Interchange Reconstruction (PN 23255)

Final Value Engineering Report

Colorado Department of Transportation

December 2021

This page intentionally blank.

Table of Contents

1. Executive Brief

1.1. General

Atkins North America (ATKINS) conducted an independent Value Engineering (VE) Study of the 30% preliminary design Field Inspection Review (FIR) submission dated August 2021 for the planned I-25 and US-50B interchange reconstruction project as prepared by the ATKINS design team on behalf of the Colorado Department of Transportation (CDOT). The I-25 and US 50B interchange is intended to be reconstructed as a Diverging Diamond Intersection (DDI), converted from its current trumpet interchange configuration. This interchange reconstruction project is part of a larger overall New Pueblo Freeway program that will reconstruct the I-25 corridor that will enhance roadway safety and improve traffic operations.

The VE Study was performed under the auspices of CDOT. The VE Workshop was held both in-person within ATKINS Denver office and virtually using Microsoft Teams on September 27-29, 2021, executed in compliance with established VE standards and procedures supported by SAVE International, which are accepted by the Federal Highways Administration (FHWA).

The current project design as defined in the FIR submission has a total project cost estimated at $127 million, inclusive with contractor mobilization and construction engineering and inspection. The project overall budget is $128 million.

The I-25 at US 50B improvements are currently organized under one job number (JN), consolidated as a single design package, and anticipated to be released as a single construction package. At the time of the VE workshop, the design package was being updated as part of Final Office Review (FOR) development process.

The VE Team prepared Pareto Cost Model of the total construction cost is provided in Appendix A. The VE Team also prepared a qualitative Risk Register for the current project design, which is presented in Appendix B. The Function Analysis Systems Technique (FAST) Diagram prepared by the VE Team for the current project design is presented in Appendix C. The VE team consisted of the personnel from Atkins, AECOM and Granite Engineering Group as shown in the table below.

Table 1: Value Engineering Team Roster

Name	Discipline	Organization
Al Adelgren PE, CVS-Life	VE Team Leader	Faithful+Gould
Mutaz Said, PMP	Cost Estimating	Atkins
James Patanio	Hydraulics / Environmental	Atkins
Dennis Largent, PE	Construction Manager	Atkins
Jeff Stapleton, PE	Bridge / Structures Engineering	Atkins
Dan Liddle, PE	Construction Manager	Atkins
Don Holloway, PE	Traffic Engineering	AECOM
Ming Lin, PE, PG	Geotechnical Engineering	Granite Engineering Group

1.2. Project Background

The I-25 corridor is a heavily traveled, north-south roadway within the City of Pueblo, which connects northward to Colorado Springs and further to Denver and beyond to the Wyoming border, I-25 connects southward to Walsenburg then extends southward to Trinidad and beyond to the New Mexico border. The !-25 is a key economic corridor, serving as a bidirectional commuter and freight route with vehicle count of approximately 4,400 average daily traffic (ADT; 2020). The interchange at US 50B has through traffic vehicle count of more than 1,900 ADT (2020).

The I-25 and US 50B project is approximately 1.08 mile long with defined point of beginning (POB) at the north end of Mineral Palace Park, extending northward to the point of ending (POE) at the existing

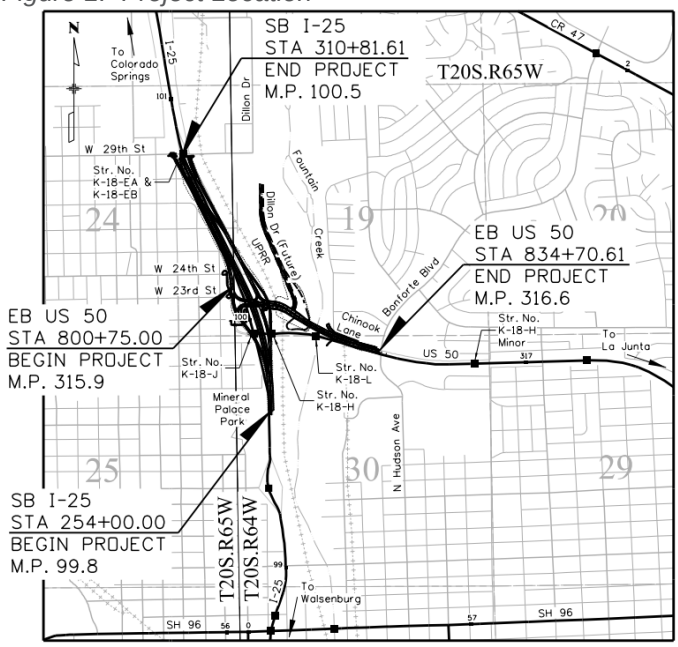
29th street intersection. The I-25 segment between POB and the POE has two travel lanes in both NB and SB directions. No lanes will be added to the current configuration. The I-25 mainline will be shifted eastward to improve the intersection geometrics for movements from southbound (SB) I-25 to eastbound (EB) US 50, and from westbound (WB) US 50 to SB I-25.

The I-25 mainline realignment will require ROW acquisitions along the east side, between the current US 50B interchange and 29th Street. The realignment will result with removal of the existing frontage road and closure of an at-grade crossing of the single Union Pacific Railroad (UPRR) track.

New collector / distributor (CD) roads will be constructed in both northbound (NB) and SB directions to improve exit and entrance ramp connectivity. The NB CD will replaced a portion of the closed NB side frontage road.

The planned DDI will provide intended 29th Street to NB I-25 entrance movement via the SB CD with a Texas U-turn style movement. The 29th Street intersection entrance ramp to NB I-25 was removed several years ago to accommodate the frontage road to Pueblo Mall.

Figure 1: Project Location



The US 50B portion of the project is approximately 0.64 miles long, from the I-25 eastward to the intersection at Bon Forte Boulevard / N Hudson Avenue. This section of US 50B will be realigned for connection to new bridges over I-25, necessary to provide adequate geometrics for the planned interchange conversion to DDI configuration.

The project will include a non-motorized traffic connection from Bon Forte / Hudson westward along EB side of US 50B, and across I-25 to the corner of 21st Street and Albany Avenue.

New bridges will be required to carry US 50B across the Fountain Creek, currently planned with a pier located within the creek channel. In addition, non-levee embankments will be required within the floodplain to carry US 50B as well as to accommodate the planned eventual Dillon Drive extension and connection to WB US 50B (outside of project scope).

New bridges will carry the realigned US 50B across the existing UPRR track. These bridges will improve horizontal and vertical clearances to meet current UPRR requirements.

The existing Chinook Lane will be realigned to accommodate the US 50B realignment. Several ROW sliver acquisitions will be required to complete this realignment.

Several alternative interchange configurations were considered during project planning and design development, prior to the VE review. The alternative configurations that were considered and subsequently rejected included:

- Trumpet interchange; similar to existing US 50B interchange
- Cloverleaf interchange
- Single point urban interchange (SPUI)
- Single, large diameter traffic circle
- Double traffic circle (dog-bone)

Constraints or challenges for the I-25 reconstruction project include:

- Environmental Impact Statement (EIS) has been completed.

- Project corridor includes realignment of I-25 mainline, relocation of US 50B interchange, and crossings over both Fountain Creek and a single Union Pacific Railroad (UPRR) north-south freight line track.
- Limited alternative routes for both I-25 and US 50B traffic.
- Two-lanes of I-25 north-south through traffic must be maintained; limited opportunities for one lane or total closure.
- Construction across and within the Fountain Creek floodplain.
- Right of way (ROW) acquisitions include former industrial sites, with unknown environmental considerations.
- Existing CDOT owned triangle (or sawtooth) shaped ROW parcels along west side of I-25 are maintained by City of Pueblo, and considered to be greenspace elements.
- Anticipated two-years construction schedule.
- Small footprint to redevelop interchange.

The I-25 / US 50B interchange work is anticipated to require approximately 2-2.5 years to complete, with work performed in five major phases. A formal schedule analysis will be performed during Final Office Review (FOR) documents development.

The I-25 / US 50B interchange reconstruction scope of work does not include extension of Dillon Drive and ultimate connection to US 50B WB. Likewise, the Fountain Creek channel improvements are also outside project scope.

Figure 1: Planned Interchange Configuration

The estimated total construction contract cost attributed to the FIR design documents was approximately $127 million, as noted above This amount included all permanent and temporary pavements, new bridge structures, traffic signals at the DDI, signage, pavement markings, and other roadway related items.

The FIR design cost estimate also included allowances for

- Force accounts (i.e., fuel, asphalt, etc.)
- Dispute resolution board.
- Contractor mobilization.
- Construction contingency including ROW acquisition.
- Construction engineering and inspection services

1.3. Objectives

The objectives of the I-25 at US 50B interchange reconstruction project are presented below:

- Reconstruction of the existing roadway while maintaining I-25 through traffic.
- Improve operations along the corridor through geometric enhancements.
- Retain two travel lanes on I-25 in both directions during construction, with allowed working exceptions.
- Retain one travel lane on US 50 in both directions during construction, with exception for required bridge closure.

The objectives for the Value Engineering Study included:

- Identify potential opportunities for cost reduction or schedule improvement.
- Identify potential opportunities to enhance traffic operations and corridor safety, in addition to the improvements included within the current design.

1.4. Value Target Areas

The VE Team targeted project areas where value could be increased by better constructability, better performance, and/or capital or life cycle cost avoidance while maintaining necessary functions, objectives, and budget.

The result was 88 creative ideas for the project across the five (5) value target areas shown in the table on the right. The abbreviations shown are used in the numbering of the creative ideas as presented in Appendix D.

Value Target Area	Abbreviation
Construction Management	CM
Enhance Safety	ES
Improve Operations	IO
Manage Traffic	MT
Protect Environment	PE

1.5. Summary of Results

After evaluation, twelve (12) of the 88 creative ideas were selected for further development, resulting in six (6) Quantitative VE Alternatives (cost avoidance), six (6) Qualitative VE Alternative (cost additive, value betterments). The results of this VE Study are presented in Section 2 of this report, Value Engineering Alternatives and Design Suggestions.

First, an “Alternatives Cost Summary” is provided to summarize the overall cost implications of the VE Study as will be discussed below. This is followed by a Summary of Alternatives and Design Suggestions spreadsheet. This summary has the Alternative Number, Alternative Title, Alternative Type, Mutual Exclusions, Inclusion in savings and cost implications as First Costs (initial capital), Present Worth (of future costs) and Life Cycle Costs for each VE Alternative. However, the VE Team did not develop any future costs; thus, the Life Cycle Costs are shown to equal First Cost.

A detailed write-up of every individual alternative developed during the workshop follows the summary list with text, sketches, capital cost estimates, and life cycle analyses as appropriate. However, costs for design changes were not included with the estimates.

Potential cost avoidance or savings are presented as a positive number. Thus, any cost numbers in parentheses represent potential additional costs to the project for suggested value enhancements or project scope betterments.

The collective impact of the VE Team recommended VE Alternatives is a range from a maximum additional $15,575,400 capital cost to a maximum potential capital cost avoidance of $3,655,600 if all compatible value improvement or cost avoidance ideas are accepted, respectively.

Acceptance of all recommended VE Alternatives would yield a net capital cost addition of approximately $11,920,000. CDOT implementation decisions will, of course, determine the ultimate cost implications. Please note that VE Alternatives that are mutually exclusive of recommended VE Alternatives were not included in the above totals.

The estimated cost avoidance and additive costs noted within the value alternatives were derived from the provided project FIR cost estimate. The VE Team utilized the FIR cost estimate unit costs to develop costing unless noted otherwise.

The contractor markups were presumed to be included within the defined unit costs, which were derived from the CDOT bids tabulation database. Unless noted otherwise, project markups (approximately 62.5%) included within the value alternatives were estimated based upon the construction in-direct costs identified within the FIR cost estimate. The project markups were based on the following assumptions:

- Mobilization (7.2%)
- Sum of force account (FA) allowances (5.5)
- Dispute Resolution Board (0.1%)
- Contingency (20%)
- Construction engineering and inspection (26%)

During the VE workshop in-brief presentation, CDOT indicated that final pavements selection would be based upon CDOT performed life cycle cost analysis (LCCA) calculations. The project design is currently based upon use of both hot-mix asphalt and concrete pavements. Therefore, the VE Team did not develop any pavement alternatives.

All the VE Alternatives, as developed during the VE Workshop, are included in Section 2 following the "Summary of Alternatives" spreadsheet. The VE Team also identified twenty-seven (27) Design Suggestions for which cost implications could not be determined. The Design Suggestion was deemed self-explanatory for design team consideration going forward.

1.6. Alternatives Consensus Review with CDOT

A workshop consensus review virtual meeting was conducted on Wednesday, 08 December, with CDOT and Atkins project development team. During the consensus virtual meeting, the intent for VE Alternatives and Design Suggestions was discussed.

Consensus implementation status was determined for each of the VE Alternatives. Ten (10) of the VE Alternatives were designated for Further Study (FS) as these items will require technical investigation and cost impact determination concurrent with project design development. However, VE Alternatives that pertain to the Fountain Creek bridge and floodplain crossing are mutually exclusive concepts.

The VE Alternatives to be further studied during design development include:

CM-07 **Provide Stakeholders with Option for Total US 50 Closure for Early Completion**

Full closure of US 50 would allow the contractor to accelerate work for construction of the new bridge across Fountain Creek. Short term full closure may reduce the adverse user cost impact, and could utilize existing CDOT facilities. The cost avoidance for schedule compression may be offset by the costs for additional contractor resources to complete this work element.

CM-11 **Move US 50 Crossing Over UPRR to the North and Align Perpendicular**

Realignment of the US 50 bridge from skew to perpendicular over the UPRR would reduce bridge length, improve ramp geometrics, and potentially reduce right of way impacts. However, realignment would increase horizontal curvature to bridge approaches and add superelevation transitions across the bridge structures.

CM-24 **Use Geosynthetic Reinforced Soil Integrated Bridge System**

Use of geosynthetic reinforced soil integrated bridge system for abutments may eliminate deep foundations, simplify construction, reduce construction costs, and reduce construction schedule. However, settlement would have to be considered during abutments design.

ES-01 **Split Collector / Distributor Roads to Eliminate Potential Weaving**

Splitting the NB collector / distributor road would eliminate potential weaving, but move the on-ramp gore point closer to Mineral Palace Park.

ES-12 **Move Bridge Rail from Inside Sidewalk Edge to Outside Edge of Bridge; Use Barrier Curb**

Moving the bridge guard rail to the outside edge would reduce bridge width, simplify bridge deck and superstructure construction, and simplify the approach guardrail layout. However, placement of the guard rail along the inside sidewalk edge provides better separation between pedestrians and vehicles on the bridge.

IM-02 **Eliminate DDI, Build Flyovers**

Use of direct connector flyovers would reduce impact to the Fountain Creek floodplain, reduce volume of imported fill, allow for higher speeds through the interchange, eliminate signalized traffic movement thereby reducing conflict points, and may improve construction phasing. However, flyovers would have significantly greater visual impact and would increase overall construction cost.

IM-03 **Continuous Bridge from Fountain Creek to UPRR; Eliminate Fill and Retaining Walls**

A continuous bridge structure spanning the Fountain Creek floodplain and UPRR tracks would reduce impacts to the floodplain, and eliminate imported fill requirements and retaining walls. However, full structured crossing would significantly increase construction costs.

MM-07 **Utilize Geofoam or Styrene Backfill**

Alternative backfill materials such as styrene or geofoam would reduce import requirements, which in turn reduces construction traffic and roadway wear along the approaches to the project. Construction schedule can be improved. CDOT and other agencies have previously used geofoam for backfill on highway construction projects. However, alternative backfill materials are sensitive to sunlight (ultraviolet) and petroleum solvents, and construction costs would likely increase.

PE-12 **Evaluate Water Quality Opportunities on West Side of Corridor and Separate Offsite Flows**

Inclusion of additional water quality basins or features within the project would increase the volume of on-site storm water runoff treatment before discharge, and may reduce construction costs. However, an additional jack-and-bore beneath the UPRR tracks would be required, and off-site drainage would not be treated before discharge.

PE-17 **Eliminate Pier Within Fountain Creek; Provide Two-Span Bridge Structure**

Eliminating the US 50 bridge structure support pier within Fountain Creek would reduce impacts to the floodplain associated with construction activities and avoid future scour related maintenance requirements. However, longer spans would be required which would increase structure depth thereby reducing freeboard over Fountain Creek. However, construction costs would increase.

The remaining two (2) VE Alternatives were designated Rejected (R) either due to the cost for implementation, or technical basis (i.e., slope required to sustain revegetation).

During the consensus review, the listing of Design Suggestions was also discussed. In summary, eleven (11) of the VE Team identified Design Suggestions have been Accepted (A) or were Already Being Done (ABD) within the reviewed design documents. Twelve (12) of the remaining Design Suggestions were designated for Further Study (FS), to be vetted as the design is being developed.

1.7. Acknowledgements

The Atkins VE Team thanks the CDOT personnel and the Atkins design team for their cooperation and support in preparation for this VE Study. The VE Team collectively appreciated the CDOT and Project Development Team staff for their attendance and participation during the Microsoft Teams conference calls / presentations convened as part of this virtual VE workshop. These conference calls include project in-brief during the Information Phase when the project development team presented the design basis to the VE Team, as well as during the mid-point review to discuss the items being considered and developed by the VE Team.

Lastly, Atkins wishes to thank all of the individuals that participated ruing the project consensus conference call. All conference call participates are listed within the following table.

Table 1: Acknowledgements

Name	Organization	Role	IB	OB	CR
Joe DeHeart	CDOT	Resident Engineer, Region 2	✓	✓	✓
Ajin Hu	CDOT	South Program Engineer, Region 2		✓	
Rob Frei	CDOT	Planning and Environmental Engineer, Region 2		✓	
Jason Nelson	CDOT	Traffic Program Engineer, Region 2		✓	
Armando Henriquez	FHWA	Area Engineer, Region 2		✓	
Tom Cotton	ATKINS	Design Team	✓	✓	✓

Legend:

- IB = VE Team project in-briefing conference calls
- OB = VE workshop out-brief conference call (29-September)
- CR = Consensus review / out-briefing conference call (08-December)

2. Value Alternatives

The Alternatives Cost Summary on the following page summarizes the overall cost implications of the VE Study, as discussed above. A “Summary of Alternatives” spreadsheet on the subsequent pages summarizes the results of the VE workshop, identifying the Alternative Number, Descriptive Alternative Title, Alternative Category, Mutual Exclusivity, Items included in totals, and Potential Impact on First (Capital) Costs (expressed as construction cost avoidance); Present Worth of Future Costs; and the resulting Life Cycle Cost over a 30-year service life, for each Alternative.

The six (6) Quantitative VE Alternatives that avoid cost, and six (6) Qualitative VE Alternative that add value (at an additional cost) which were developed during the VE Workshop are presented in their entirety on the pages following the “Summary of Alternatives” table, in order of their appearance within the table.

Alternatives Cost Summary

Creative and Evaluation Phase Results

Ideas As:	No. of Ideas
Alternative	12
Design Suggestion	27
Estimate Correction	0
Group with Other Alternative	21
Already Being Done	11
Dropped during Development	0
Eliminated by Evaluation	17
Total Creative Ideas	**88**

Value Target Functions
Construction Management (CM)
Enhance Safety (ES)
Improve Mobility (OPS) (IM)
Maintain Mobility (MOT) (MM)
Protect Environment (PE)

Development Phase Results

Alternatives As:	Developed	Included In Total	First Costs (Capital Costs)	Present Worth (of Future Costs)	Life Cycle Costs
Estimate Correction	0		$ -	$ -	$ -
Design Suggestion	0				
Quantitative	5	5	$ 3,660,000	$ -	$ 3,660,000
Qualitative	7	6	$ (15,580,000)	$ -	$ (15,580,000)
Cost Reduction	0	0	$ -	$ -	$ -
Total	**12**	**11**	**$ (11,920,000)**	**$ -**	**$ (11,920,000)**
Cost Avoidance		5	*$ 3,660,000*	*$ -*	*$ 3,660,000*

Consensus Results

Alternatives As:	Accepted	Other Status	First Costs (Capital Costs)	Present Worth (of Future Costs)	Life Cycle Costs
Estimate Correction	0		$ -	$ -	$ -
Design Suggestion	0				
Quantitative	0		$ -	$ -	$ -
Qualitative	0		$ -	$ -	$ -
Cost Reduction	0		$ -	$ -	$ -
Total	**0**		**$ -**	**$ -**	**$ -**
Cost Avoidance		0	*$ -*	*$ -*	*$ -*
% Acceptance (of Total)	0%		0%		0%
Further Study		22	$ (16,298,100)	$ -	$ (16,298,100)
Rejected		6	$ (6,315,000)	$ -	$ (6,315,000)

Alternatives Cost Summary

Legend - Alternative Types

	Alternative Types	Description
Qnt(+)	Quantitative	An alternative that results in a positive capital and life cycle cost avoidance while maintaining required functionality and performance, i.e. improved value.
Qlt(-)	Qualitative	An alternative that results in additional capital and/or life cycle costs (negative cost avoidance) while improving required functionality and performance, i.e. improved value.
DS	Design Suggestion	An alternative for which the team cannot define a reasonable cost impact during the workshop or that may simply be a suggestion to consider as design proceeds.
EC	Estimate Correction	An alternative to identify the cost impact of a significant issue discovered with the cost estimate during the workshop.
CR	Cost Reduction	An alternative that results in reduced costs without improving value.

Summary of Alternatives

ID No.	Alternative Title	Alter. Cat.	Mut. Excl.	Incl. (i)	Potential Costs ($) Initial	O&M (PW)	Life Cycle	Cons. Dec.	Consensus Comments	Key Alter.	Decision Makers
CM-07	Provide Stakeholders with Option for Total US 50 Closure for Early Completion	Qlt(-)		i	$ -	$ -	$ -	FS	Design team will investigate further to determine viability.		Owner, Designer
CM-10	Extend Full Ultimate Typical Section to the Limit of Construction and Extending the Limits of I-25 Mainline Improvements North an Additional 0.5 Miles	Qlt(-)		i	$ (6,422,200)	$ -	$ (6,422,200)	R	Excessive cost to implement.		Owner, Designer
CM-11	Move US 50 Crossing Over UPRR to the North and Align Perpendicular	Qnt(+)		i	$ 2,570,100	$ -	$ 2,570,100	FS	Design team will investigate further to determine viability.		Owner, Designer
CM-22	Steepen Slopes; Eliminate Short Retaining Walls	Qnt(+)		i	$ 107,200	$ -	$ 107,200	R	Slope criteria is based on plant growth and maintenance.		Owner, Designer
CM-24	Use Geosynthetic Reinforced Soil Integrated Bridge System	Qnt(+)		I	$ 689,500	$ -	$ 689,500	FS	Design team will investigate further to determine viability.		Owner, Designer
ES-01	Split Collector / Distributor Roads to Eliminate Potential Weaving	Qlt(-)		i	$ (886,100)	$ -	$ (886,100)	FS	Design team will investigate further to determine viability.		Owner, Designer
ES-12	Move Bridge Rail from Inside Sidewalk Edge to Outside Edge of Bridge; Use Barrier Curb	Qnt(+)		i	$ 238,500	$ -	$ 238,500	FS	Design team will investigate further to determine viability.		Owner, Designer
IM-02	Eliminate DDI, Build Flyovers	Qlt(-)		I	$ (4,195,100)	$ -	$ (4,195,100)	FS	Design team will investigate further to determine viability.		Owner, Designer
IM-03	Continuous Bridge from Fountain Creek to UPRR; Eliminate Fill and Retaining Walls	Qlt(-)	PE-17		$ (10,693,300)	$ -	$ (10,693,300)	FS	Design team will investigate further to determine viability.		Owner, Designer
MM-07	Utilize Geofoam or Styrene Backfill	Qlt(-)		i	$ (1,901,600)	$ -	$ (1,901,600)	FS	Design team will investigate further to determine viability.		Owner, Designer
PE-12	Evaluate Water Quality Opportunities on West Side of Corridor and Separate Offsite Flows	Qnt(+)		i	$ 50,300	$ -	$ 50,300	FS	Design team will investigate further to determine viability.		Owner, Designer
PE-17	Eliminate Pier Within Fountain Creek; Provide Two-Span Bridge Structure	Qlt(-)	IM-03	i	$ (2,170,400)	$ -	$ (2,170,400)	FS	Design team will investigate further to determine viability.		Owner, Designer

Alternative Category
Qnt(+) - Quantitative
Qlt(-) - Qualitative
DS - Design Suggestion
EC - Estimate Correction
CR - Cost Reduction

Incl. (i) Designations
i - Included in summary totals
m - Mutually exclusive with Alternative selected for totals
Blank - Not included in totals, but in report for reference

Consensus Decision
A - Accept
AM - Accept w/ Modification
FS - Further Study
R - Rejected
ABD - Already Being Done

CM-07 Quantitative Value Alternative

Title

Construction Management **Page 1 of 6**

Provide Stakeholders with Option for Total US 50 Closure for Early Completion

Original Concept

The original concept would be the normal sequencing of work and utilizing normal phasing and traffic control for construction of US 50.

Alternative Concept

Discuss with the stakeholders an option to get in, get it done and get out, by closing US 50 during the construction of that element of the project. This would then allow the contractor to accelerate that work and shorten the length of time that the stakeholders are impacted by the construction of the US 50 portion of the project.

Advantages

- Accelerated completion of the construction of the US 50 portion of the project.
- Shorter duration of impact to the stakeholders
- Improved worker safety
- Improved production
- Improved quality of work

Disadvantages

- US 50 closed requires detouring traffic
- Short term impacts to some locals and businesses
- Increased impact to the alternate routes, specifically the interchange at 29th Street
- Increased construction costs versus shortened construction duration (to be determined).
- Need for additional resources to produce accelerated schedule

Discussion / Justification

The justification is closing US 50 shortens the duration of impact to the traveling public, i.e. shortens the duration of construction of US 50. The concept of get in, get it done and get out is considered to be the choice of the traveling public for most construction projects.

Recommend further analysis in accordance with the Full Closure Strategic Analysis to determine potential user and schedule impacts.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$**	**$**	**$**

CM-07 Quantitative Value Alternative

Discussion / Justification (Continued)

In June 2014 CDOT's Applied Research and Innovation Branch published a document called the Full Closure Strategic Analysis. This provided a decision tool on if a full closure should be used. The authors utilized literature research as input for this tool. The following is an exert from the document regarding that literature research:

2.0 LITERATURE REVIEW A review of literature about full road closures was conducted to provide input for the decision support tool. Most of the available research available provided case studies of full road closure implementation. Overall, the documented case studies showed that using a full road closure had positive benefits and works well under the proper circumstances. When reviewing this literature, it is apparent the most significant benefit of full road closures is shorter project duration. Many of the case studies showed that the projects could be completed in 50 to 25 percent of the time required to complete if the road were to remain open. Surveys of the public in some of these closure reviews indicated that the public generally prefers a shorter time duration of full road closure to extended partial closures. Other benefits include improved worker safety, increased productivity, and improved product quality. All of these benefits are the result of not working near traffic and having a larger workspace available.

There are potential negatives to full closure as well. An exert from the report states the following:

A few projects did show increased costs due to the expense associated with closing the road. Some of the larger projects completed improvements to the alternate routes to prepare for the detouring traffic to add capacity, which added a cost that would have not otherwise been experienced, but in some cases also provided long-term value. There is also an additional cost in creating public awareness campaigns which is a necessity for a successful full road closure.
The decision on if a full closure should be used starts with is the availability of adequate local detour and regional alternate routes.

US 50 has an available adequate detour route with truck traffic utilizing SH 47 to access I-25 NB and SB and local traffic using Bonforte Blvd to Jerry Murphy Rd to SH 47 to access I-25 NB and SB. There could be an issue with this detour route for wind turbine blades or other wide loads.

One key process for the success of a full closure is public awareness.

Step 1 Worksheet
Full Closure

CDOT COLORADO Department of Transportation

Closure Scenario

State Highway Number	US 50
Milepoint Limits of section to be closed	316 to 316.5
Physical length of closed section (miles)	0.5
Direction of closed section (if divided highway)	
Number of Travel Lanes to be closed	4
Average Annual Daily Traffic (AADT) – highest recorded within the closure area (vehicles per day)	14,000
CDOT Access Category	Expressway
Statewide Functional Classification	
Current weekday lane closure allowed hours	None

Type, Schedule and Duration of Closure

Date(s) of closure	
Hours of closure	24/7
Number of exclusive private/business accesses to the highway within closed area	0
Activities planned to take place within closed area:	Bridge and roadway construction

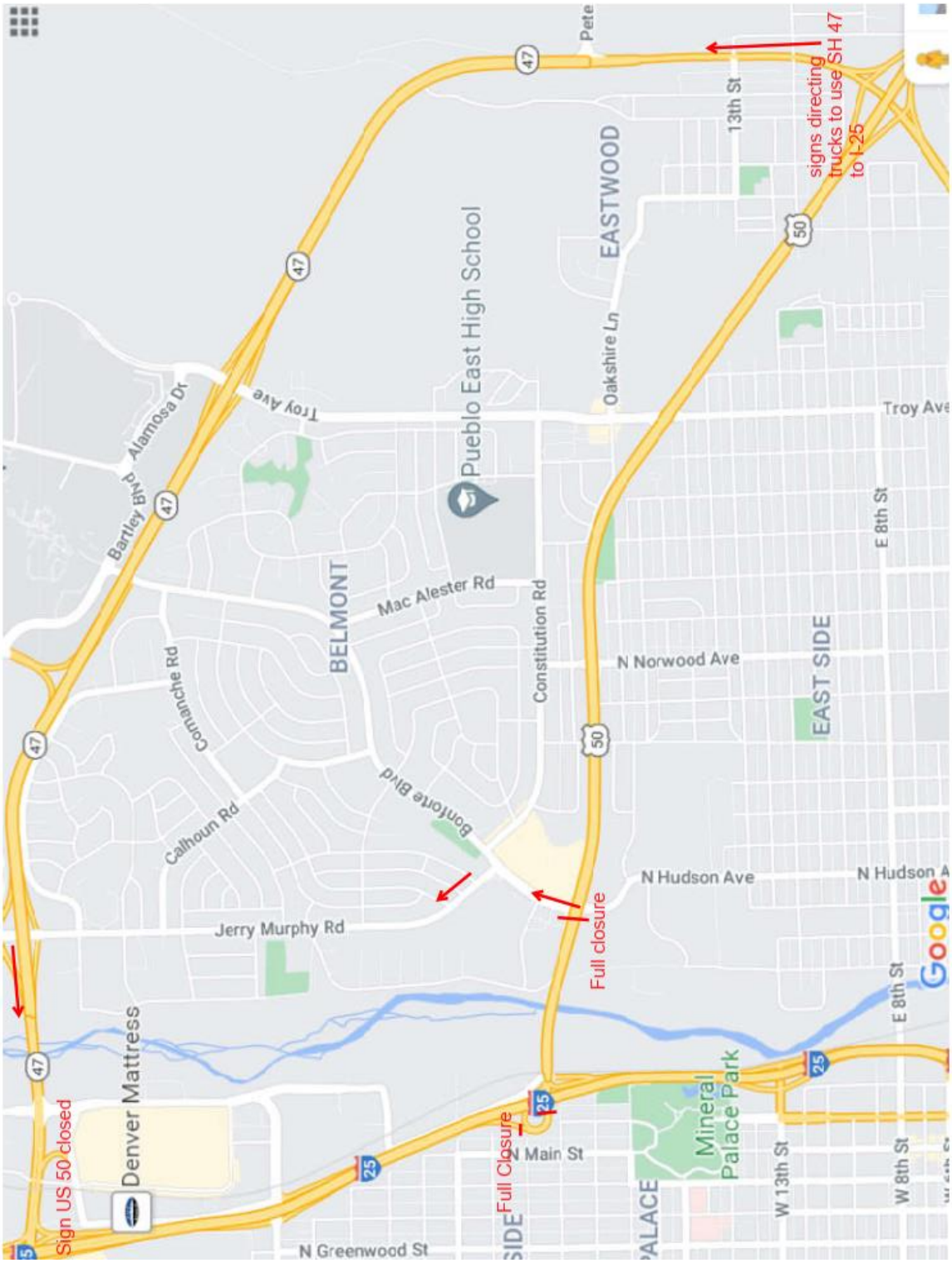
Proposed Detour Route(s)

Roads to be used:	SH 47 for trucks. Bonforte Blvd for locals
Functional Classification of Detour roads:	
Mileage of detour route:	4.6miles for trucks or 2.3miles for local traffic
Will the detour route use local roadways (i.e., non-state highways)?	Trucks use SH 47, local use local road
Which agencies could be involved?	
Have the agencies been contacted?	

Map of state highway segment(s) to be closed (may also be provided as attachment):

CM-07 Quantitative Value Alternative

Exhibits - Alternative Concept



CM-07 Quantitative Value Alternative

Exhibits - Alternative Concept

Additional Questions

1. How many days in advance can the public be made aware of the closure?

< 1 week	☐
1-2 weeks	☐
>2 weeks	☒

2. How might the closure affect emergency response? Will increase response time to I-25

The comparable length detour onto a lower classification roadway could cause minor delays for emergency response.

BENEFITS OF CLOSURE

Please estimate the time and cost savings anticipated to occur with implementation of the proposed full closure:

Benefit Category	Without full closure	With full closure	Savings
Time			
Cost			

Describe any other benefits of the proposed full closure. Possible benefits for consideration include:

a) Reduced construction time
b) Avoiding night work
c) Better construction efficiency
d) Enhanced worker safety
e) Enhanced traveler safety
f) Reduced cost of construction/maintenance
~~g) Potential to accommodate additional projects and/or maintenance activities~~
h) Better quality product
i) Less time spent setting up and taking down traffic control devices

Description of benefits:

At the end of Phase 4/start of phase 5:
East side: Rdwy construction from Bonforte to Fountain Creek bridge: Removal of HMA tie in to Bonforte, Grading, new HMA, Guardrail, Striping (approx 500ft).
Normal phase construction under traffic time estimate - 4 weeks (5 WDs per week X 4 = 20-8hr shifts).
With full closure - 7 calendar days (3-8hr shifts per cal day x 7 cal days = 21- 8hr shifts) if allowed to work 24/7.

West side: Rdwy construction of ramps at US 50 Loop. Removals, grading, HMA, striping. Work to be done concurrently with East side closure.

CM-07 Quantitative Value Alternative

Exhibits - Alternative Concept

Lane Closure Strategy Colorado Department of Transportation – Region 2

Table 2. Full Closure Rating Criteria – Step One

	Category	Favorable	Fair	Unfavorable
1	Impact to traffic (volume impacted (ADT x # of days, prorated)	<50,000	50,000-100,000	x >100,000
2	Functional equivalence of detour roadways	Detour is the same or higher functional class as closed highway	Detour route is a different functional class, but will accommodate traffic in similar fashion to closed highway	X Detour route is of functional class below the closed highway
3	Use of state highways as detour routes	Detour route uses all state highways	Detour route uses mixture of state highways and non-state highways x	Detour route uses all non-state highways
4	Impacts to businesses and local access	There are no direct, exclusive local accesses to the closed highway segment	Local accesses to the closed highway can be accommodated by equivalent alternate means	One or more exclusive local accesses would be closed by the full closure
5	Travel distance added by detour	3x travel distance or less	3-5x travel distance 5x or more travel x	5x or more travel distance
6	Local agency coordination	No agency coordination required	x 1 agency to coordinate with	2 or more local agencies involved
7	Advance public notice	>2 weeks notice x	1-2 weeks notice	<1 week notice
8	Potential for diversion out of area	well known regional travel options present	limited regional travel options present	very few good regional travel options present x
9	Construction time savings	>30% reduction in construction time	0-30% reduction in x construction time	No reduction in construction time
10	Ability to do concurrent work	Other activities can be done that would have required separate, additional full closure time	Additional activities can be accomplished that would not have required separate, additional full closure time	x No additional activities can be accomplished

14,000x7 days = 98,000

Bonforte & Jerry Murphy are class below US 50

Truck travel dist increases by 3-5x

1wk vs 4 wks

CM-10 Quantitative Value Alternative

Title

Construction Management **Page 1 of 5**

Extend Full Ultimate Typical Section to the Limit of Construction and Extending the Limits of I-25 Mainline Improvements North an Additional 0.5 Miles

Original Concept

The proposed design tie-in between existing and proposed involves a taper from the full width ultimate typical section to the existing pavement width.

Additionally, the northern work limits for I-25 improvements end at the south approach to the W. 29th Street Overpass Bridge.

Alternative Concept

The Alternative Concept proposes to extend the full width Ultimate typical section to the limit of construction.

The Alternative Concept also extends the reconstruction limit north of 29th Street.

Advantages

- Eliminates the need to modify this section when the next adjacent project occurs.
- Additional width can be used for traffic phasing (swapping detour pavement for permanent construction to remain).
- Ending the reconstruction north of 29th Street would occur at a location that is not within a horizontal curve and sight distance is better.
- The Northbound I-25 Bridge over 29th Street is narrower than the approach roadway and extending the limits eliminates the width constriction at the existing structure.

Disadvantages

- Added cost to increase project value and improve safety.

Discussion / Justification

The change to extend the full reconstruction width to the limit of construction is not anticipated to have a cost increase when considering the need for detour pavement to construct the reduced section while maintaining traffic.

The northbound termini to existing is a concern because the approach roadway will be new to improved design standards, tapering quickly to the existing non-standard section.
The cost is associated with extending the work limits an additional 0.5 miles to the north including the replacement of the I-25 Bridge over 29th Street.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$	$	$
Alternative Concept	$ 6,422,200	$	$ 6,422,200
Difference	**$ (6,422,200)**	**$**	**$ (6,422,200)**

CM-10 Quantitative Value Alternative

Discussion / Justification

I-25 Northbound Bridge over 29th Street (looking north)

I-25 Northbound north of 29th Street (looking north)

CM-10 Quantitative Value Alternative

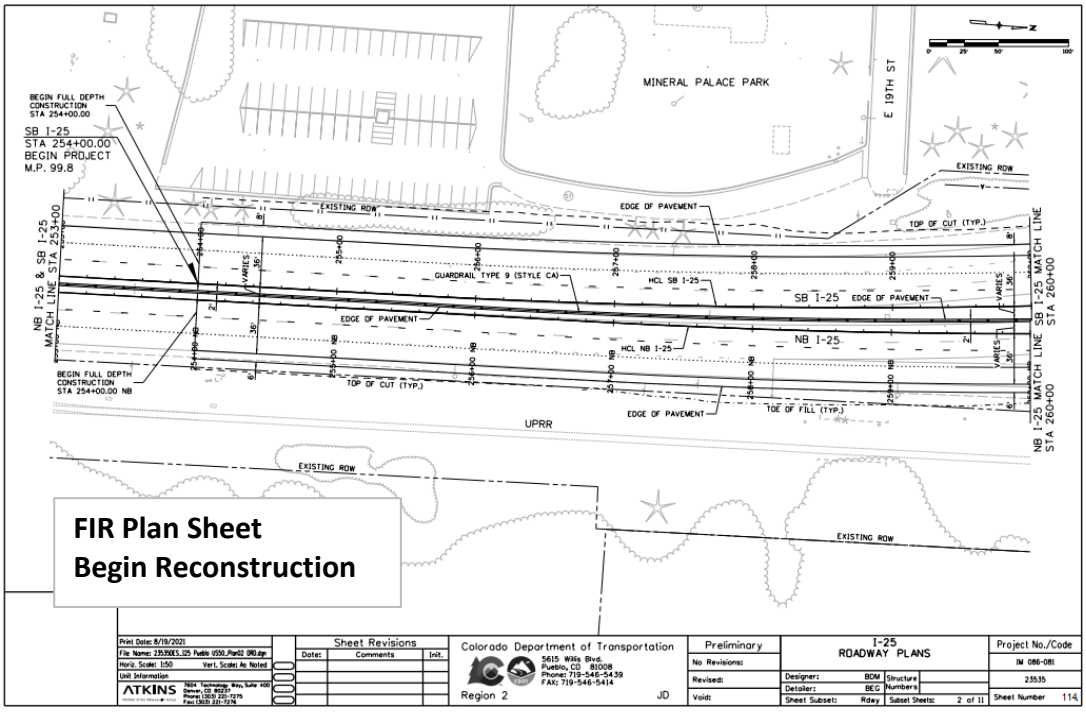
Discussion / Justification (Continued)

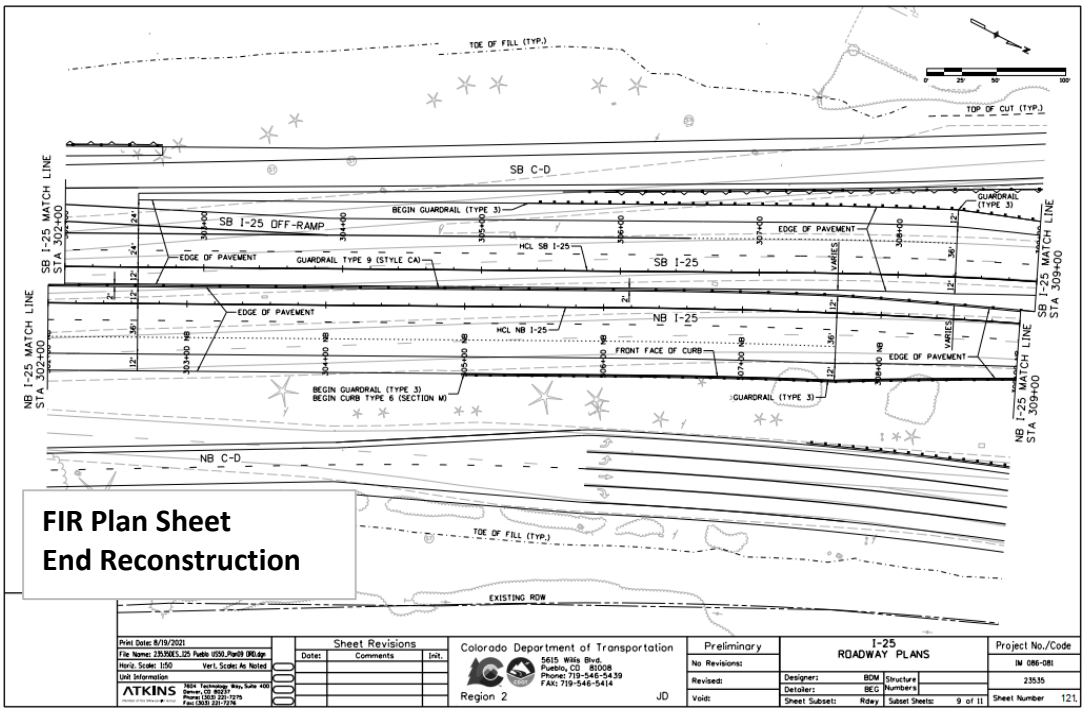
I-25 Southbound Bridge over 29th Street (looking south)

I-25 Southbound south of 29th Street (looking south)

CM-10 Quantitative Value Alternative

Exhibits - Original Concept





CM-10 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total

		Subtotal:	**$**
	65.2%	Markup:	$
		Total Cost (Rounded):	**$**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
I-25 Structure over 29th Street	SF	15000	175.00	2,625,000
Additional MOT/Traffic Control	LS	1	10%	262,500
Additional I-25 Reconstruction to North	Mile	0.5	2,000,000.00	1,000,000

			Subtotal:	**$ 3,887,500**
		65.2%	**Markup:**	$ 2,534,650
			Total Cost (Rounded):	**$ 6,422,200**
			Cost Difference:	**$ (6,422,200)**

CM-11 Quantitative Value Alternative

Title

Construction Management **Page 1 of 5**

Move US 50 Crossing Over UPRR to the North and Align Perpendicular

Original Concept

The proposed alignment of US 50 is shifted north of existing, beginning east of Fountain Creek to the proposed bridges over I-25. The location of the proposed US 50 Bridges over I-25 is located approximately 800' north of existing bridge crossing. At the location of the US 50 crossing with the UPRR, the railroad right-of-way is approximately 100' wide and the design proposes to span the entire ROW. The proposed abutments are to be located outside of the ROW.

Alternative Concept

The alternative concept proposes to move the US 50 crossing of the UPRR an additional 250' +/-. The existing railroad ROW at this location is reduced to 50'+/- at this location. Additionally, the design speed should be reduced to 40 mph (35 mph minimum) to allow for sharper horizontal curvature.

Alternately, consider rotating the proposed DDI Interchange to the southwest creating more room to shorten bridges and improve the west side ramp geometrics.

Advantages

- Reduces the EB Bridge over Railroad from 156' to 110' +/- (72% SF reduction)
- Reduces the WB Bridge over Railroad from 165' to 120' +/- (74% SF reduction)
- Increases US 50 to I-25 southbound parallel entrance ramp; potentially reducing ROW impacts and/or distance to neighborhoods between Mineral Palace Park and 19th Street.
- Improved west side (SB exit and SB entrance) Ramp geometrics.
- Bridges with perpendicular abutment and pier geometry is preferred.

Disadvantages

- Added / increased horizontal curvature
- Added superelevation transitions across bridge structures

Discussion / Justification

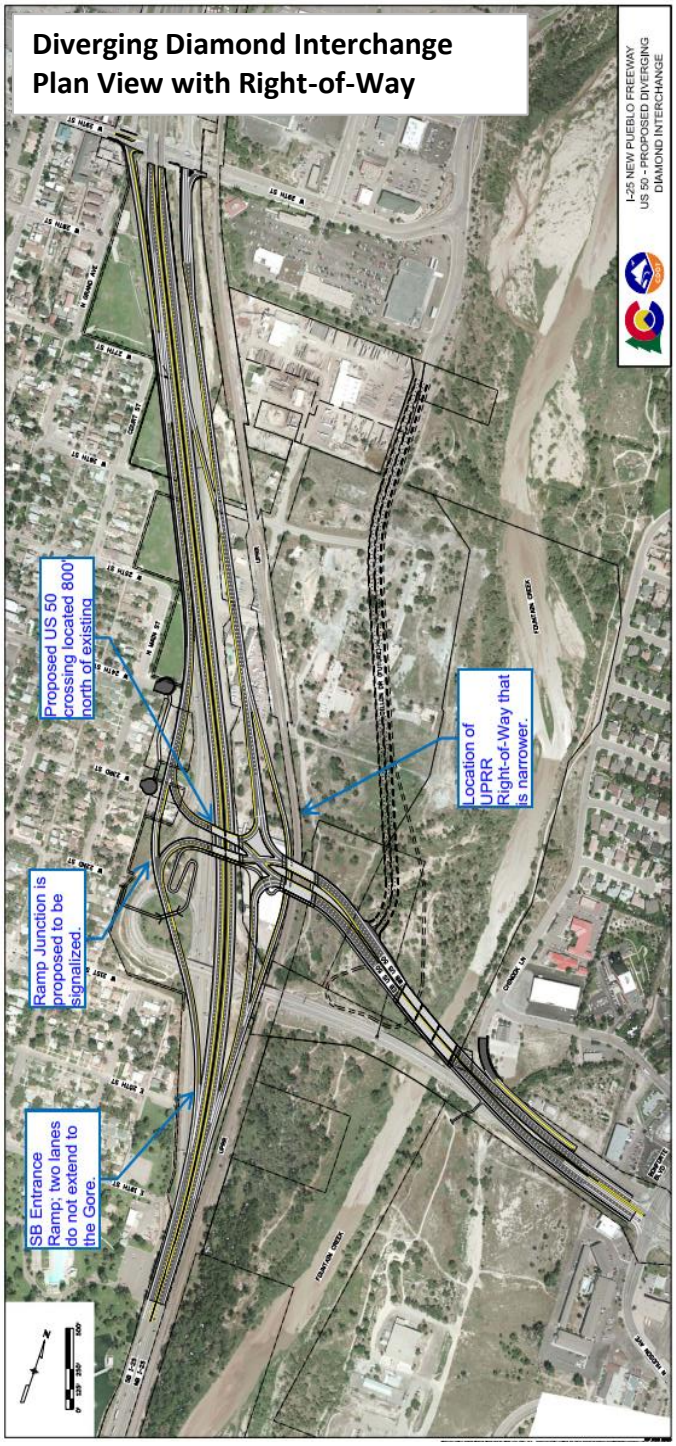
The Alternative Concept should be discussed with UPRR for confirmation. There is also the possibility of designing a similar concept with the current US 50 horizontal alignment that would place the east abutment inside the UPRR ROW. This would require an agreement with UPRR.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 9,484,000	$	$ 9,484,000
Alternative Concept	$ 6,913,900	$	$ 6,913,900
Difference	**$ 2,570,100**	**$**	**$ 2,570,100**

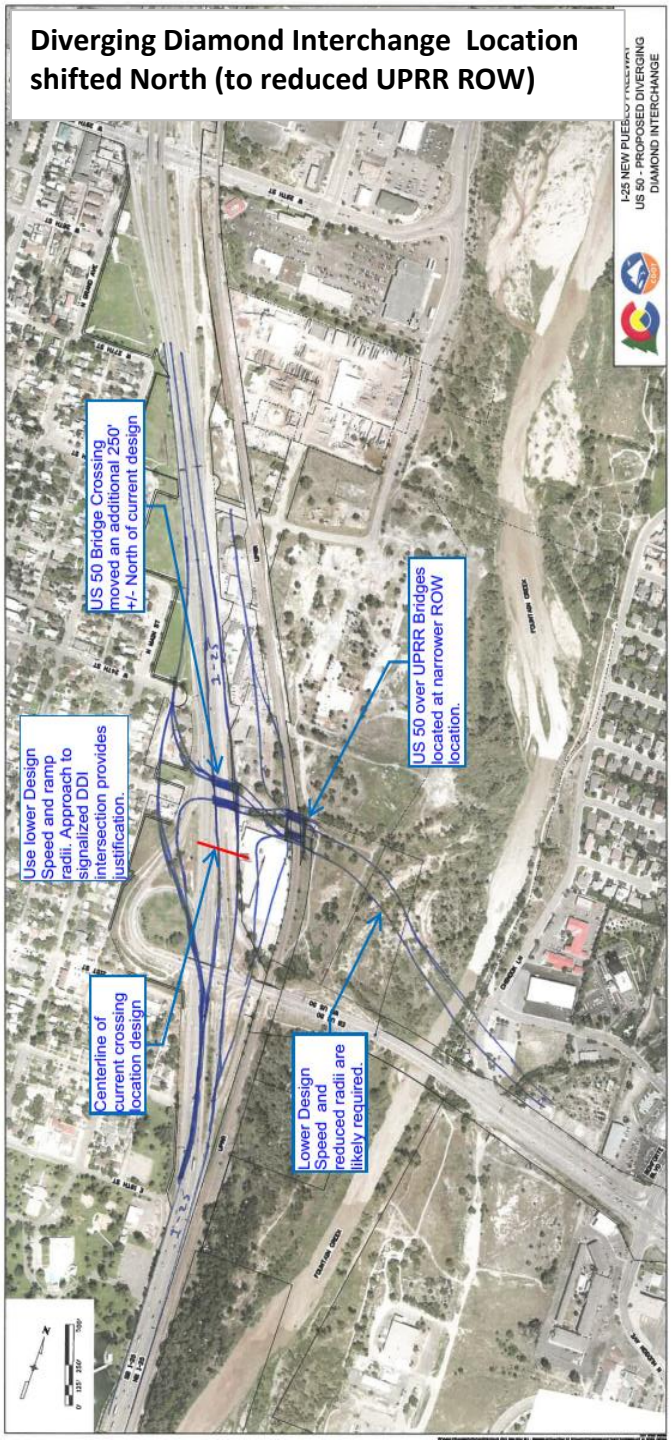
CM-11 Quantitative Value Alternative

Exhibits - Original Concept



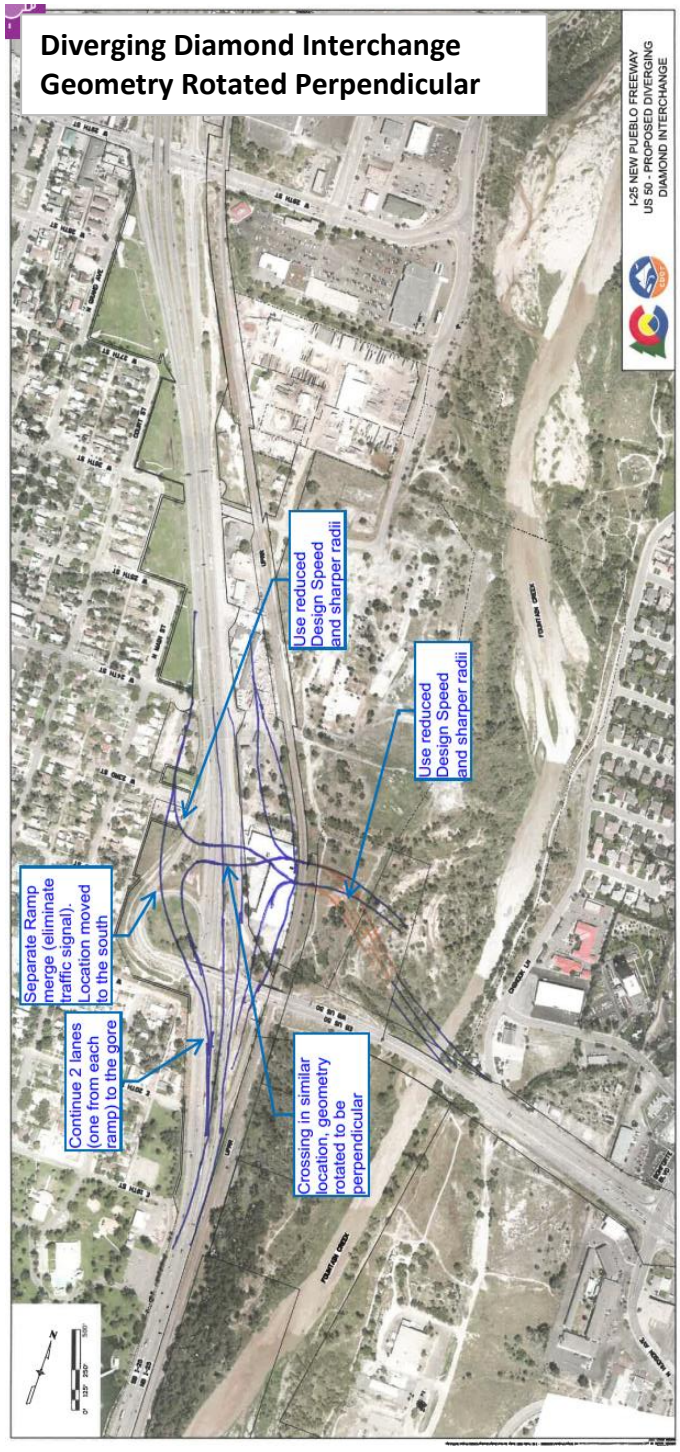
CM-11 Quantitative Value Alternative

Exhibits - Alternative Concept



CM-11 Quantitative Value Alternative

Exhibits - Alternative Concept



CM-11 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
EB over UPRR	LS	1	3,156,525.00	3,156,525
WB over UPRR	LS	1	2,584,424.00	2,584,424
			Subtotal:	**$ 5,740,949**
		65.2%	Markup:	$ 3,743,099
			Total Cost (Rounded):	**$ 9,484,000**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
EB over UPRR	LS	0.72	3,156,525.00	2,272,698
WB over UPRR	LS	0.74	2,584,424.00	1,912,474
			Subtotal:	**$ 4,185,172**
		65.2%	**Markup:**	$ 2,728,732
			Total Cost (Rounded):	**$ 6,913,900**
			Cost Difference:	**$ 2,570,100**

CM-22 Quantitative Value Alternative

Title

Steepen Slopes; Eliminate Short Retaining Walls

Original Concept

Utilize retaining wall to provide grade separation between path and ramps. Some of the retaining walls are short with an approximate height of 5-feet. Typical section of the short wall structures are shown in Figure 1.

Alternative Concept

Move the location of the path, steepen the slope and manage the material types used for the embankment, and eliminate the needs of retaining walls. Typically CDOT Class 1 materials can supports slope as steep at 2.5H:1V. See Figure 2.

Advantages

- Reduce the needs of retaining walls.
- Reduce construction cost.
- Reduce the construction time.
- No maintenance is needed for retaining walls.

Disadvantages

- Move the path to the toe of the slope
- Steeper slope may be challenging for maintenance, e.g. mowing.
- Water can collect on the path from the slope.

Discussion / Justification

By moving the path to the toe of the slope and steepening the slope, this can eliminate the needs for approximately 200 feet of retaining walls. This would not impact the mobility and foot traffic while reduce the cost and time for construction.

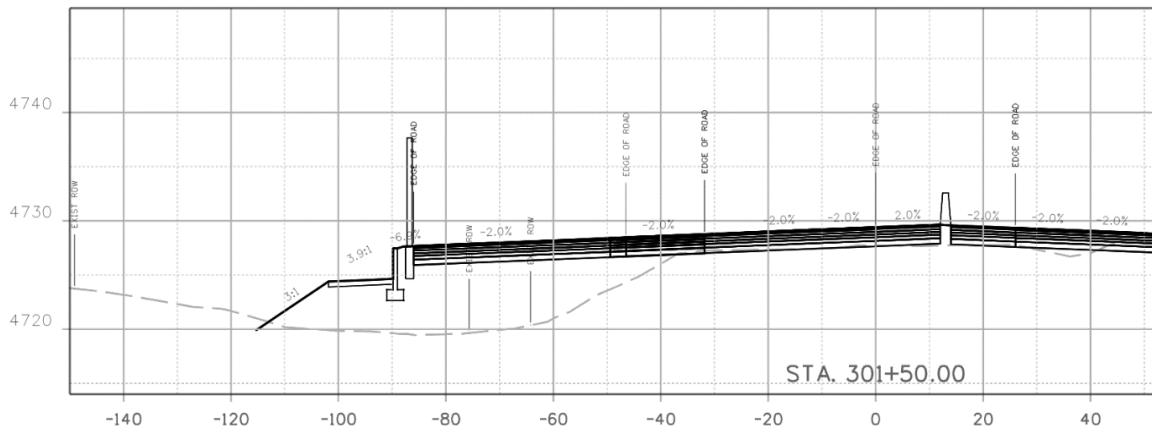
Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 227,000	$	$ 227,000
Alternative Concept	$ 119,800	$	$ 119,800
Difference	**$ 107,200**	**$**	**$ 107,200**

CM-22 Quantitative Value Alternative

Exhibits - Original Concept

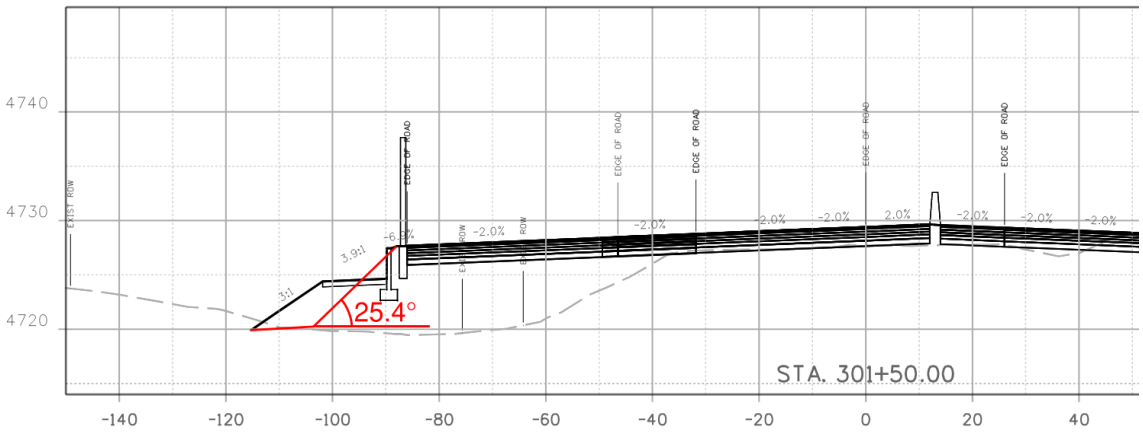
Figure 1



CM-22 Quantitative Value Alternative

Exhibits - Alternative Concept

Figure 2



CM-22 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Earthwork	CY	1870	42.00	78,540
Retaining Wall	SF	841	70.00	58,870
			Subtotal:	**$ 137,410**
		65.2%	Markup:	$ 89,591
			Total Cost (Rounded):	**$ 227,000**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Earthwork	CY	1185	42.00	49,770
Retaining Wall	SF	325	70.00	22,750
			Subtotal:	**$ 72,520**
		65.2%	**Markup:**	$ 47,283
			Total Cost (Rounded):	**$ 119,800**
			Cost Difference:	**$ 107,200**

CM-24 Quantitative Value Alternative

Title

Construction Management

Use Geosynthetic Reinforced Soil Integrated Bridge System

Original Concept

Abutment foundations behind MSE retaining walls are drilled concrete caissons to bedrock.

Alternative Concept

Use Geosynthetic Reinforced Soil - Integrated Bridge System (GRS-IBS) for abutment foundations for the four bridges over the railroad and I-25.

Advantages

- Eliminates deep foundations
- Simplifies construction
- Greatly reduces costs
- Reduces construction schedule

Disadvantages

- Settlement has to be considered in the design of the abutments.

Discussion / Justification

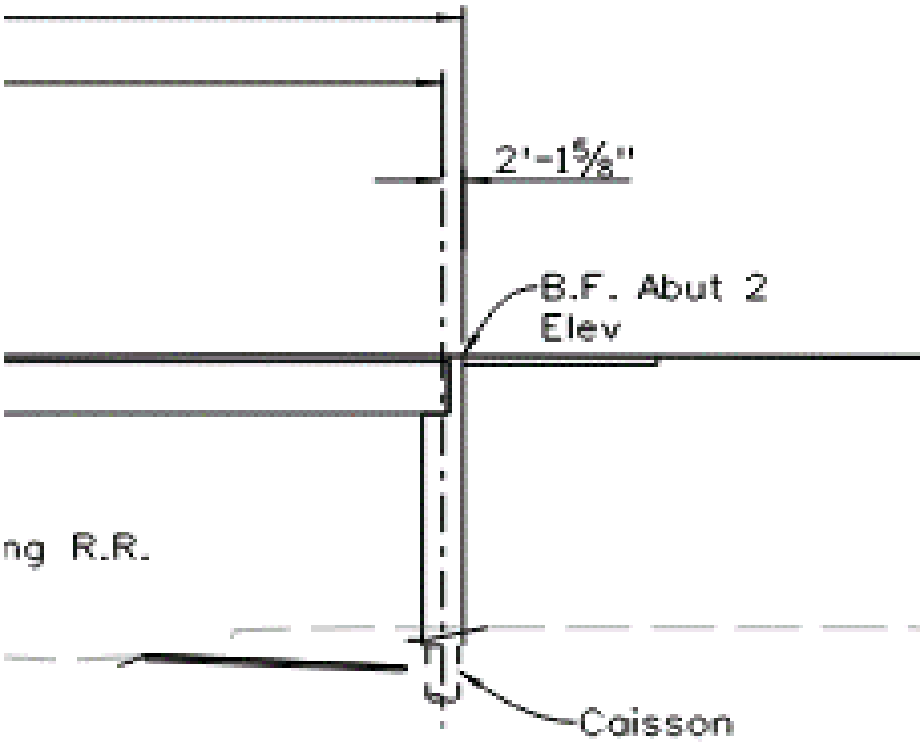
This is a CDOT Staff Bridge approved system, that greatly reduces foundation costs. This system works well with short bridges supported behind MSE retaining walls. CDOT just uses this system at their new I-70/Colfax bridge replacement.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 773,100	$	$ 773,100
Alternative Concept	$ 83,600	$	$ 83,600
Difference	**$ 689,500**	**$**	**$ 689,500**

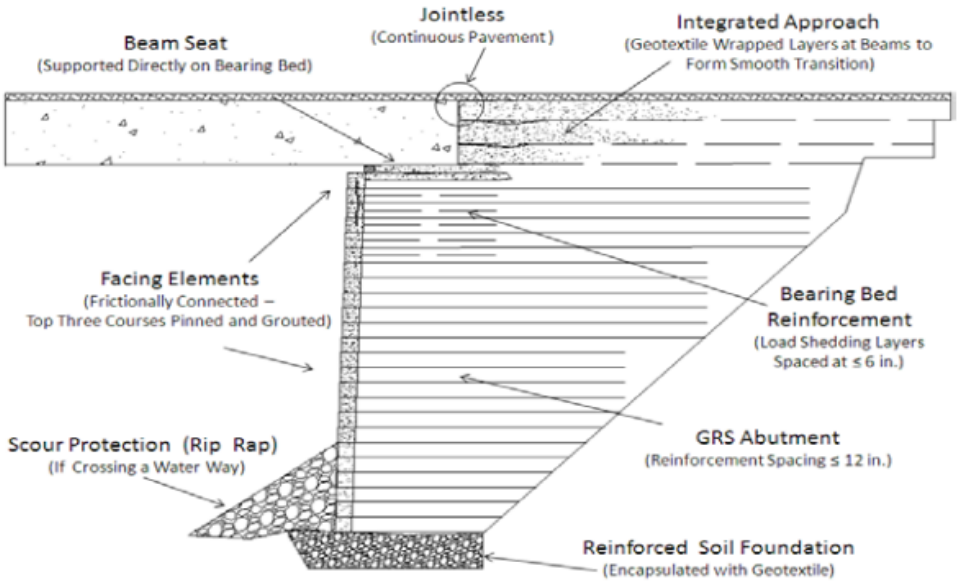
CM-24 Quantitative Value Alternative

Exhibits - Original Concept



CM-24 Quantitative Value Alternative

Exhibits - Alternative Concept



CM-24 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
36" diameter drilled caisson	Lin Feet	1440	325.00	468,000

	Subtotal:	**$**	**468,000**
65.2%	Markup:	$	305,136
	Total Cost (Rounded):	**$**	**773,100**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Structural Backfill	Cu Yds	575	60.00	34,500
Soil Reinforcement	Cu Yds	575	28.00	16,100

	Subtotal:	**$**	**50,600**
65.2%	**Markup:**	$	32,991
	Total Cost (Rounded):	**$**	**83,600**
	Cost Difference:	**$**	**689,500**

ES-01 Quantitative Value Alternative

Title

Enhance Safety

Split Collector / Distributor Roads to Eliminate Potential Weaving

Original Concept

Reconstruction of the US 50B and I-25 interchange ramps; the interchange will be modified from a trumpet interchange to a modified split diamond interchange configuration with a Texas U-Turn connection from the southbound C/D road to the northbound C/D road and 29th Street. Signalized intersections at the US 50B interchange ramp connections, with a two-phase signal at the west ramp terminal and a two-phase signal at the east ramp terminal.

Alternative Concept

The NB C/D road would be split into a separate NB US 50 on-ramp and a separate C/D road to 29th Street. Median separation on frontage road until after DDI. SB traffic signal at DDI eliminated. Educate public on DDI operations.

Advantages

- The short 1000-foot 2 lane weave between the NB 29th off-ramp movement and the NB US 50 ramp would be eliminated; potential accidental weaving would be avoided.
- Guide signing for destination descriptions would be simplified.
- C/D speed differential would be minimized due to weaving being executed by drivers who may be lost.
- Elimination of SB DDI traffic signal.
- Better public comprehension of the operational and safety benefits of the DDI.
- Additional opportunities for water quality management on the east side of I-25.

Disadvantages

- The NB on-ramp gore point may need to move to further to the north closer to Mineral Palace

Discussion / Justification

Potential of weaving by lost drivers would be eliminated. This would lead to significantly fewer vehicle conflicts. The SB DDI signal is eliminated which should lead to accident reduction. Little change in pavement quantities.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 578,200	$	$ 578,200
Alternative Concept	$ 1,464,300	$	$ 1,464,300
Difference	**$ (886,100)**	**$**	**$ (886,100)**

ES-01 Quantitative Value Alternative

Discussion / Justification (Continued)

Original Concept (continued):
I -25 will be realigned/reconstructed between 19th Street and 29th Street. This will correct some geometric deficiencies with the existing alignment, while also providing consistent lane widths, shoulder widths, and barrier to improve safety throughout the project area. US 50B will be realigned/reconstructed and widened to three lanes in each direction between the I-25 interchange and Bonforte Boulevard/Hudson Avenue.

The existing southbound I-25 off-ramp to 29th Street will be closed because of sub-standard ramp spacing to the north (approximately 1,000 feet).

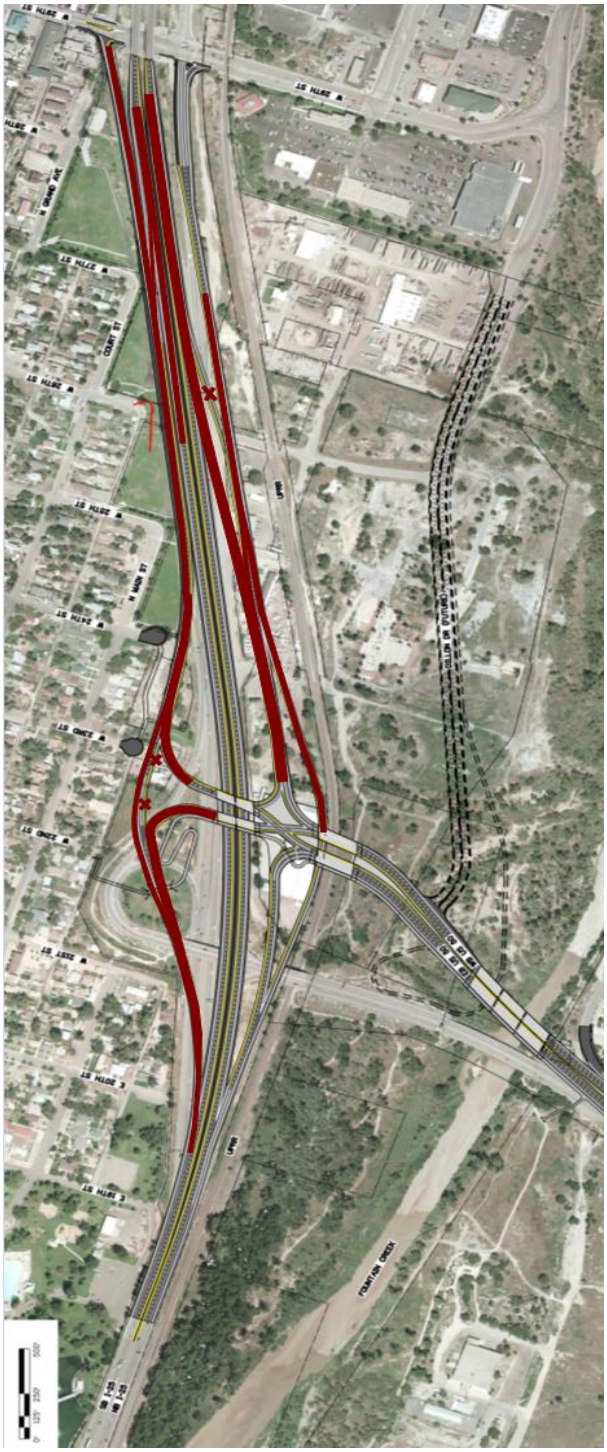
A southbound C/D road between US 50B and 29th Street will be constructed, running parallel to and near the southbound I-25 lanes. A southbound I-25 slip off-ramp will be constructed immediately south of 29th Street, connecting to the southbound C/D road. This connection will allow southbound traffic to exit the highway, pass through the US 50B interchange, and redirect to the northbound C/D road and the intersection at 29th Street.

A southbound I-25 on-ramp will be constructed, allowing traffic from both 29th Street and US 50B to enter the highway. A northbound I-25 off-ramp will be constructed, allowing exiting traffic to access either US 50B or to continue to the northbound C/D road and access 29th Street.

A northbound C/D road between US 50B and 29th Street will be constructed, set back from the northbound I-25 lanes. A northbound I-25 slip on-ramp will be constructed north of the US 50B interchange, allowing for traffic to exit the C/D road and enter the northbound lanes of the highway.

ES-01 Quantitative Value Alternative

Exhibits



ES-01 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Eliminate Intersection Signalization	EA	1	350,000.00	350,000
			Subtotal:	**$ 350,000**
		65.2%	Markup:	$ 228,200
			Total Cost (Rounded):	**$ 578,200**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Separate NB US 50 on-ramp and a separate C/D road to 29th Street	LF	3,200	$ 277.00	886,400
Additional MOT/Traffic Control	LS	1	10%	0
			Subtotal:	**$ 886,400**
		65.2%	**Markup:**	$ 577,933
			Total Cost (Rounded):	**$ 1,464,300**
			Cost Difference:	**$ (886,100)**

ES-12 Quantitative Value Alternative

Title

Enhance Safety

Move Bridge Rail from Inside Sidewalk Edge to Outside Edge of Bridge; Use Barrier Curb

Original Concept

For high speed, high volume roadways, walkways are protected with a combination of an inboard traffic barrier (Bridge Rail Type 10 MASH) and an outboard pedestrian railing, which is being proposed for all the bridges with sidewalks on this project.

Alternative Concept

Move the bridge rail from the inboard location to the exterior deck edge, using a combination railing for both vehicles and pedestrians.

Advantages

- Reduces the width of all effected bridges by 1 foot.
- Simplifies the design of the bridge deck superstructure.
- Simplifies the design and layout of the approach guardrail.

Disadvantages

- The original concept provides better separation between pedestrians and vehicles.

Discussion / Justification

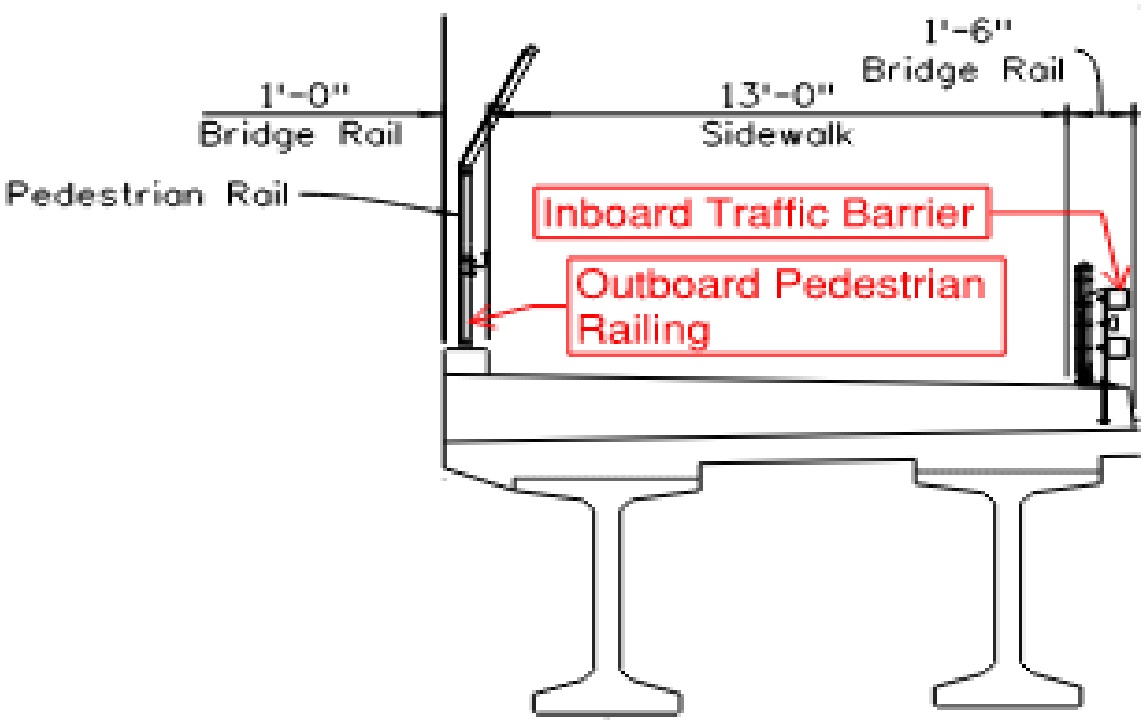
The alternative concept will simplify construction and reduce project costs. The low pedestrian traffic coupled with the low vehicle speeds could justify this reconfiguring.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 238,500	$	$ 238,500
Alternative Concept	$	$	$
Difference	**$ 238,500**	**$**	**$ 238,500**

ES-12 Quantitative Value Alternative

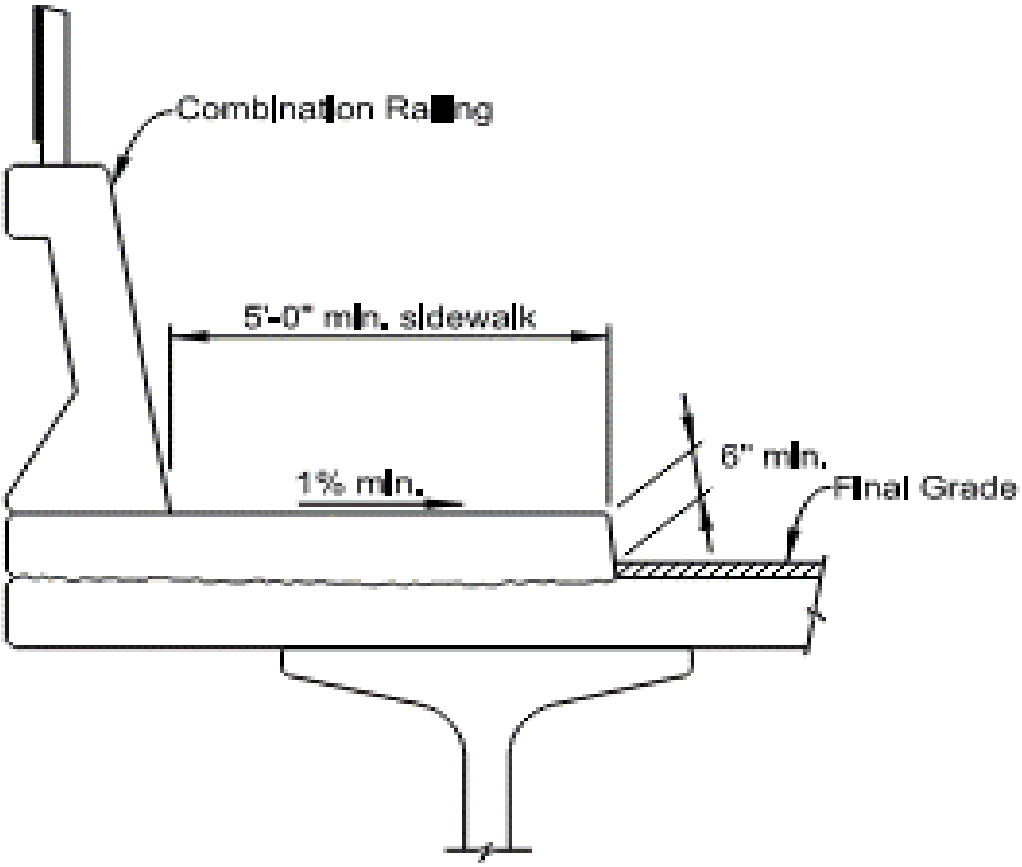
Exhibits - Original Concept



Original Proposed Sidewalk

ES-12 Quantitative Value Alternative

Exhibits - Alternative Concept



LOCAL URBAN STREET CROSSING

With approaching curb and walk
(Design Speed ≤ 45 MPH)

ES-12 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Bridge Deck	Sq Foot	722	200.00	144,400

	Subtotal:	**$**	**144,400**
65.2%	Markup:	$	94,149
	Total Cost (Rounded):	**$**	**238,500**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total

	Subtotal:	**$**	
65.2%	**Markup:**	$	
	Total Cost (Rounded):	**$**	
	Cost Difference:	**$**	**238,500**

IM-02 Quantitative Value Alternative

Title

Improve Mobility (OPS)

Eliminate DDI, Build Flyovers

Original Concept

The FIR concept has a DDI to accommodate vehicle trips between I-25 and US 50. This concept results in two traffic signals at the DDI.

Alternative Concept

The existing interchange condition at I-25 and US 50 has no traffic signals. The purpose of this alternative is to add direct connectors to eliminate traffic signals. This would be accomplished with grade separated structures.

Advantages

- Reduces backfill requirements
- Lower impact to the Fountain Creek channel and flood plain
- May allow for a higher speed I-25 curve through the interchange
- Eliminates a signaling traffic movements
- May improve construction phasing

Disadvantages

- There may significant cost impacts associated with added bridge, but part of this would be offset by reduced fill in the Fountain Creek channel and floodplain.
- The resulting interchange will be higher in elevation and could have a larger visual impact.

Discussion / Justification

With this alternative, there would be direct connector bridges for the WB US 50 to SB I-25 and for the SB I-25 to EB US 50 movements. This results in the removal of the base concept DDI and its two traffic signals. The crossings of the direct connectors would also be grade-separated adding a third level to the interchange, one level more than the base design.

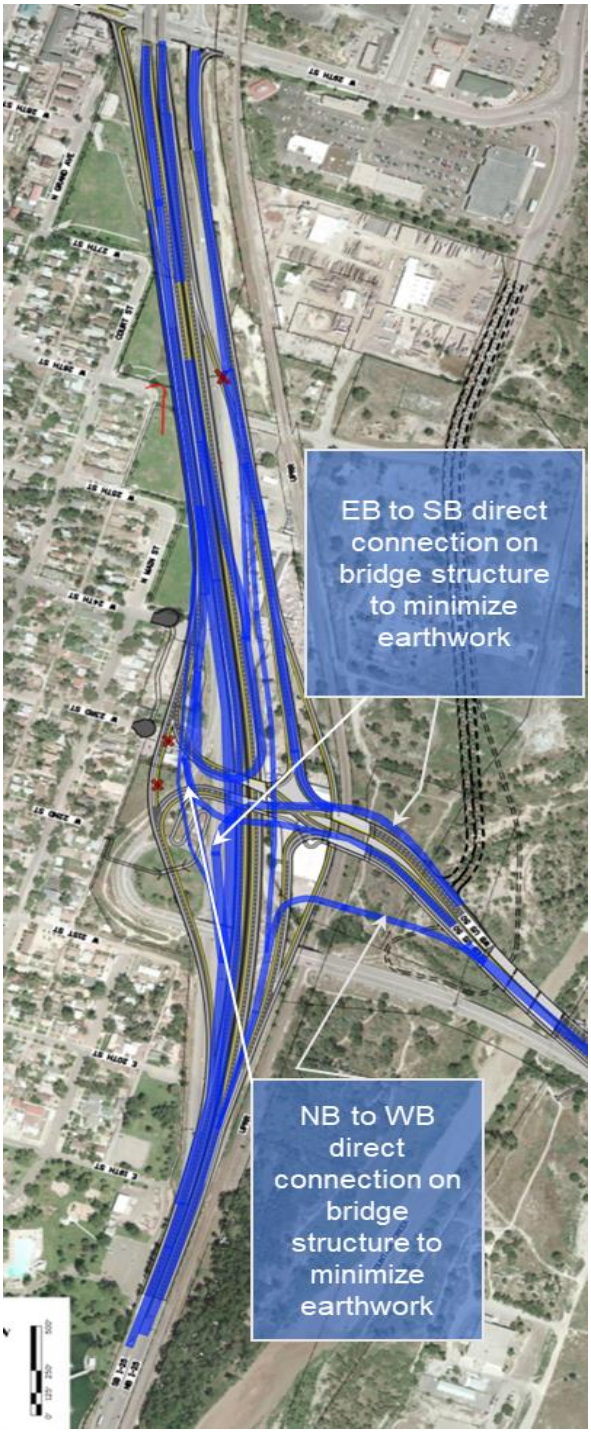
The direct connectors would be primarily installed on bridge structures and this will reduce the amount of fill and channel disruption. As the direct connectors would be at a higher elevation than the SB to NB U-turn loop from 29th Street, there would need to be constructed a separate bridge over I-25 for this movement.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 1,156,400	$	$ 1,156,400
Alternative Concept	$ 5,351,500	$	$ 5,351,500
Difference	**$ (4,195,100)**	**$**	**$ (4,195,100)**

IM-02 Quantitative Value Alternative

Exhibits - Alternative Concept



IM-02 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Eliminate Intersection Signalization	EA	2	350,000.00	700,000
			Subtotal:	**$ 700,000**
		65.2%	Markup:	$ 456,400
			Total Cost (Rounded):	**$ 1,156,400**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Eliminate Intersection Signalization	EA		350,000.00	
Adding direct connectors	Mile	1.6	2,000,000.00	3,239,394
			Subtotal:	**$ 3,239,394**
		65.2%	**Markup:**	$ 2,112,085
			Total Cost (Rounded):	**$ 5,351,500**
			Cost Difference:	**$ (4,195,100)**

IM-03 Quantitative Value Alternative

Title IM-03 **Improve Mobility (OPS)**

Continuous Bridge from Fountain Creek to UPRR; Eliminate Fill and Retaining Walls

Original Concept

The Original Concept accounts for US 50 to utilize a bridge to cross Fountain Creek, which would lead to an earthen berm roadway, and then connecting to bridge crossing over the railroad. The earthen roadway is created through an import of fill material to achieve the desired roadway elevation.

Alternative Concept

The Alternative Concept is to remove the earthen roadway and replace it with an elevated roadway between the bridges that crosses Fountain Creek and the railroad. The span that crosses Fountain Creek will be lengthened to remove the piles that are currently proposed to be placed within Fountain Creek.

Advantages

- Reduction of imported fill material.
- May create a net benefit to the floodway / floodplain. May reduce the width of the floodplain.
- May reduce the pile scour potential within Fountain Creek.
- Removal of abutments on the west side of Fountain Creek and the east side of the railroad
- Might allow for less impactful connection opportunity with Dillon Drive.

Disadvantages

- Increase costs for elevated structures and bridges.
- Increase costs for lengthening the span over Fountain Creek

Discussion / Justification

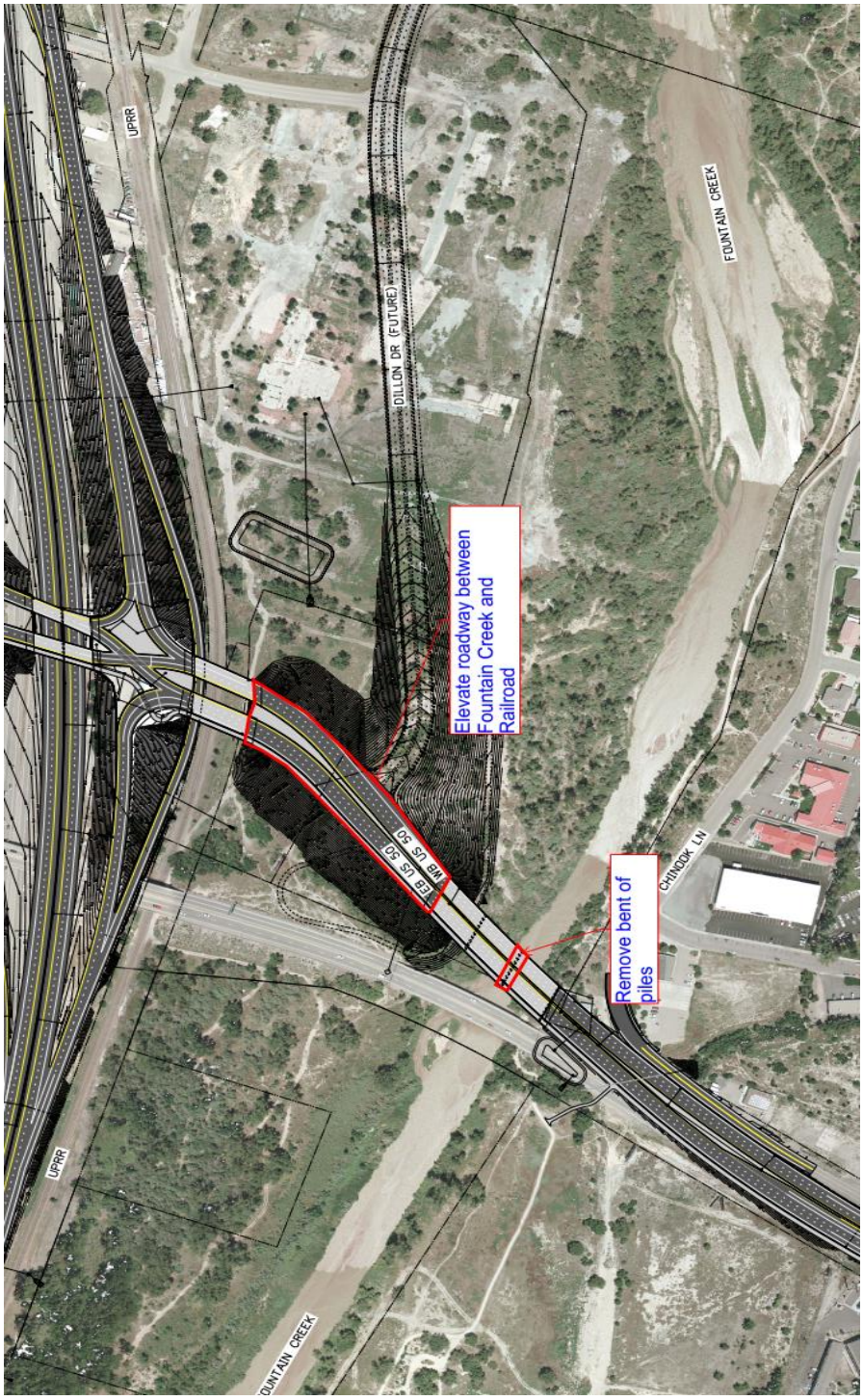
The impact of adding the proposed fill in the floodway / floodplain is a major concern. The proposed elevated roadway would likely remove the concern and likely reduce the floodway and floodplain width. The removal of the proposed piers from the channel of Fountain Creek will likely improve the hydraulics of the creek from the Original Concept.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 15,291,000	$	$ 15,291,000
Alternative Concept	$ 25,984,300	$	$ 25,984,300
Difference	**$ (10,693,300)**	**$**	**$ (10,693,300)**

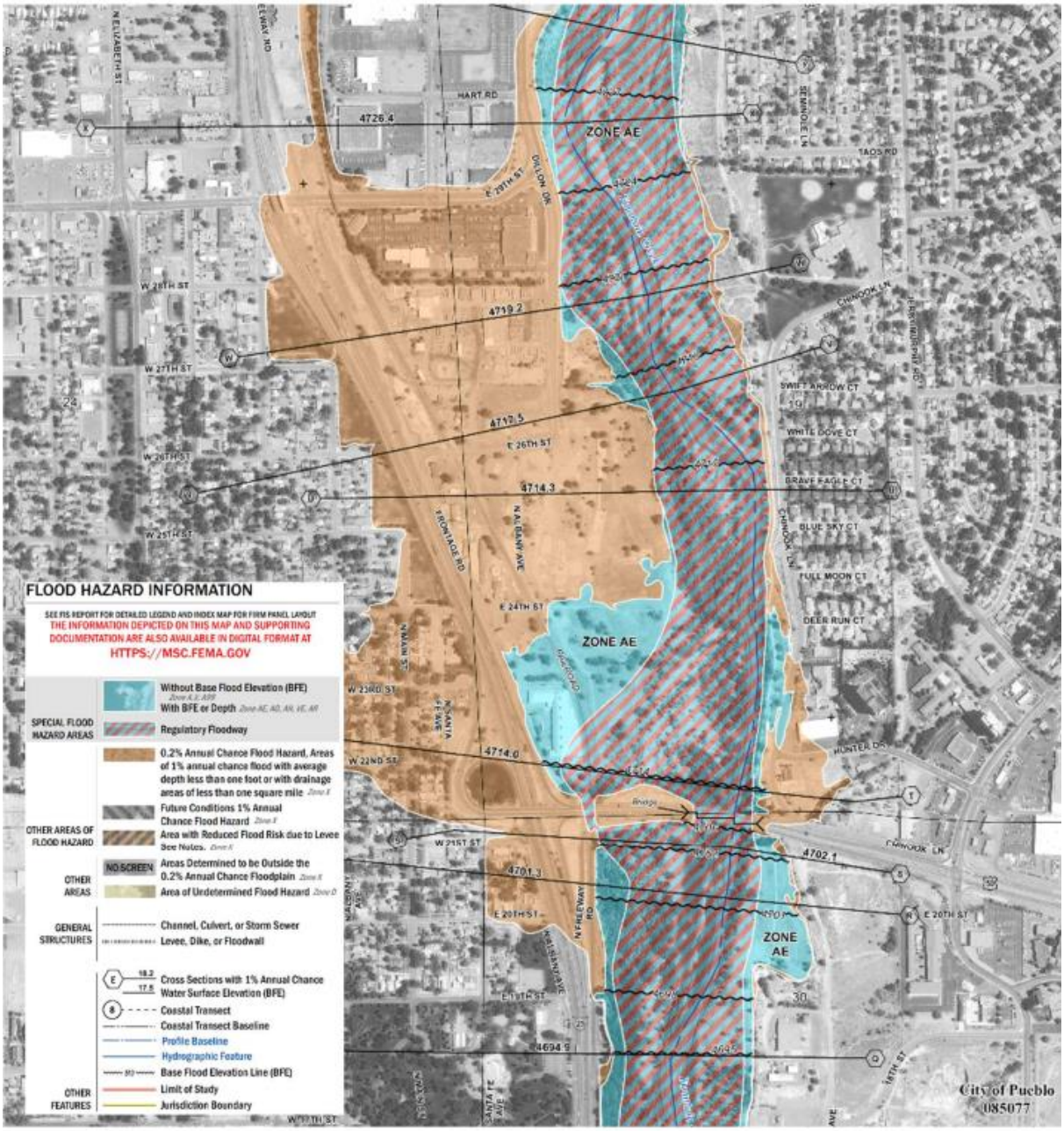
IM-03 Quantitative Value Alternative

Exhibits



IM-03 Quantitative Value Alternative

Exhibits



IM-03 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Backfill (Class 1)	Cu Yds	188880	42.00	7,932,960
Soil Reinforcement	Cu Yds	13390	28.00	374,920
Wall Facing	Sq Feet	17240	55.00	948,200
			Subtotal:	**$ 9,256,080**
		65.2%	Markup:	$ 6,034,964
			Total Cost (Rounded):	**$ 15,291,000**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Bridge	Sq Feet	78645	200.00	15,729,000
			Subtotal:	**$ 15,729,000**
		65.2%	**Markup:**	$ 10,255,308
			Total Cost (Rounded):	**$ 25,984,300**
			Cost Difference:	**$ (10,693,300)**

MM-07 Quantitative Value Alternative

Title

Maintain Mobility (MOT)

Utilize Geofoam or Styrene Backfill

Original Concept

All embankment will utilize either import or on-site soils for embankment. The materials will be placed and compact prior to additional lifts are placed.

Alternative Concept

Utilize geofoam or styrene as backfill materials.

Advantages

- Reduce construction time; estimated six (6) months schedule improvement.
- No need for compaction and test.
- Reduce the pressures applied on the foundation soils, including west abutment of bridge over I-25 and shorten or eliminate the needs for preloading.
- Reduce trucking cost.
- Reduced user impacts.

Disadvantages

- Transportation and storage of materials are critical, materials are sensitive to UV lights.
- Materials are fire hazards and vulnerable to petroleum solvents.
- Reduce earth pressure on retaining wall structures.
- Buoyancy force can create significant amount of uplift force, and damage roadway.

Discussion / Justification

The west abutments of the bridges over I-25 are expected to have consolidation settlement issue. Pre-loading, wick-drain installation, and waiting period may be required. BY utilizing the geofoam materials, the settlement will be decreased, and minimize or eliminate the needs for pre-loading, wick drains or waiting period. This would shorten the construction time, and allow the new roadway to open earlier. This can also be applied in other embankment area to shorten the construction time.

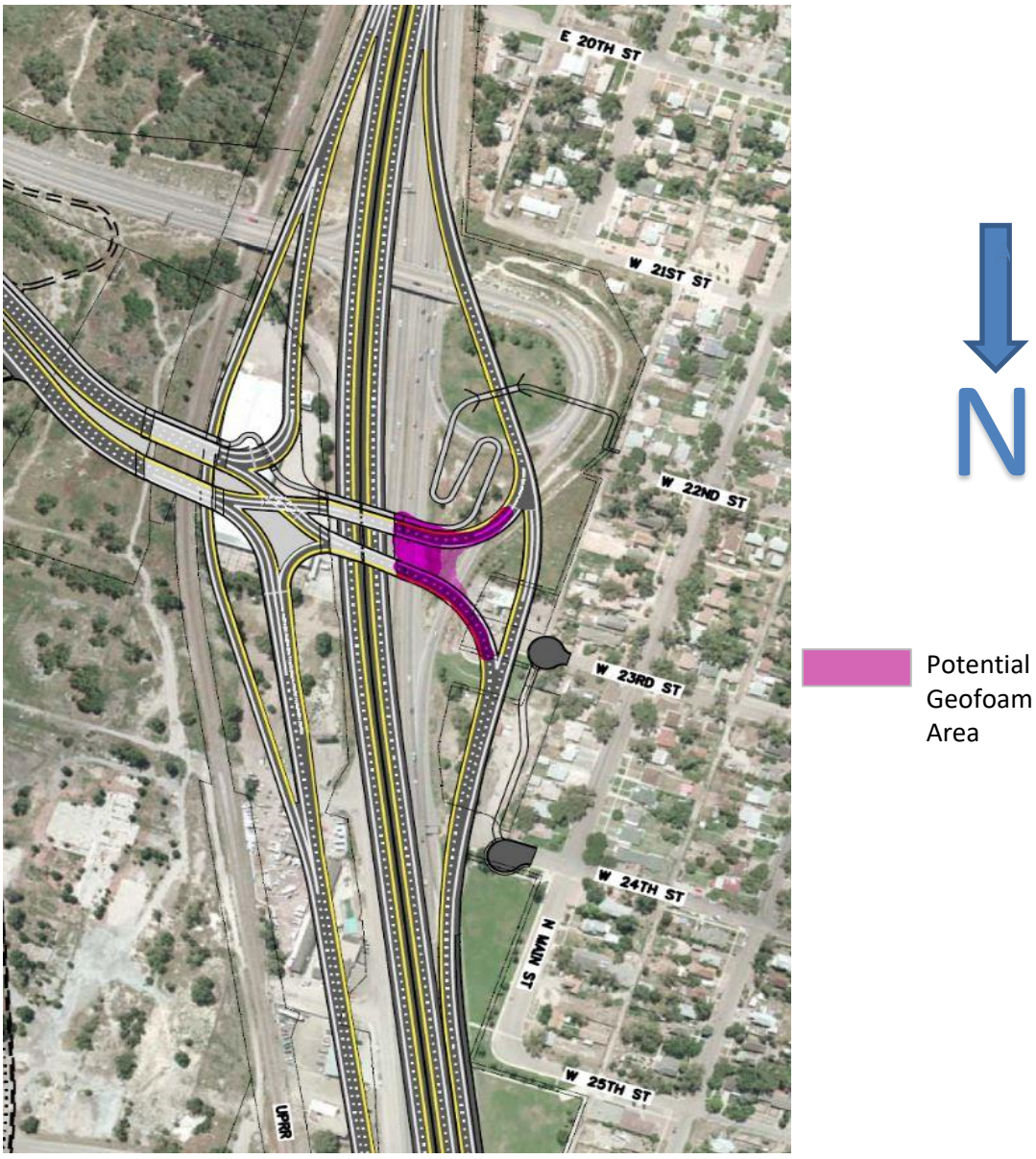
Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 3,228,900	$	$ 3,228,900
Alternative Concept	$ 5,130,500	$	$ 5,130,500
Difference	**$ (1,901,600)**	**$**	**$ (1,901,600)**

MM-07 Quantitative Value Alternative

Exhibits

Potential Location for Use of Geofoam



MM-07 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Embankment Materials	CY	28233	42.00	1,185,786
General Requirement Saving	Month	4	192,191.28	768,765

I-25/US 50 Value Engineering		
Construction Time Saving		
By General Requirements		
Construction Time=	24	months
Construction Cost=	127	million
GR=	6	%
GR/Month=	0.3175	Mil/Month
Schedule Saving=	4	months
GR Saving=	1.27	Million
GR Saving without Markup=	768765	Dollars

		Subtotal:	**$ 1,954,551**
65.2%		Markup:	$ 1,274,367
		Total Cost (Rounded):	**$ 3,228,900**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Geofoam Lightweight Fill	CY	28233	110.00	3,105,630

		Subtotal:	**$ 3,105,630**
65.2%		**Markup:**	$ 2,024,871
		Total Cost (Rounded):	**$ 5,130,500**
		Cost Difference:	**$ (1,901,600)**

PE-12 Quantitative Value Alternative

Title PE-12 **Protect Environment**

Evaluate Water Quality Opportunities on West Side of Corridor and Separate Offsite Flows

Original Concept

The Original Concept accounts for water quality in two locations, east of the BNSF Railroad and east of Fountain Creek. The specific location that will be evaluated is the east of the BNSF railroad location. The proposed concept design accounts for water quality for on I-25, north of US 50, and portions of the US 50 ramps on the east side of the BNSF railroad. These flows are seemingly accounting for offsite flow contribution.

Alternative Concept

The Alternative Concept proposes to incorporate water quality basins within the I-25 corridor and separate offsite flows from the treated areas. This will result in a localized smaller facility within the I-25 corridor, treating offsite flows, and reduction in the size of the water quality facility on the eastern side of the railroad. Depending on the adjustment of ramps in the alternative evaluations, opportunities for additional treatment to the west of the railroad tracks might be possible.

Advantages

- Reduces the construction footprint of a single water quality facility.
- Does not treat offsite flows.
- Reduces the quantities of pipes, inlets, manholes, and flared end-sections.
- The western existing ponds may be able to be relinquished the 4 ponds to the WEST of I-25 to the City.
- Realign jack and bore to narrow locations of the Railroad ROW.

Disadvantages

- Introduces an additional jack and bore under the railroad
- Does not overtreat the northern area.
- May not provide significant cost savings.
- May require additional water quality locations.

Discussion / Justification

The separation of offsite flows and onsite flows will reduce CDOT's responsibility with the drainage of the project. The facilities introduced with this suggestion will be project specific and only accounting for disturbed areas to the north of the US 50 and I-25 intersection. As a result CDOT will be able to transfer over the existing 4 ponds to the west of I-25.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 294,100	$	$ 294,100
Alternative Concept	$ 243,800	$	$ 243,800
Difference	**$ 50,300**	**$**	**$ 50,300**

PE-12 Quantitative Value Alternative

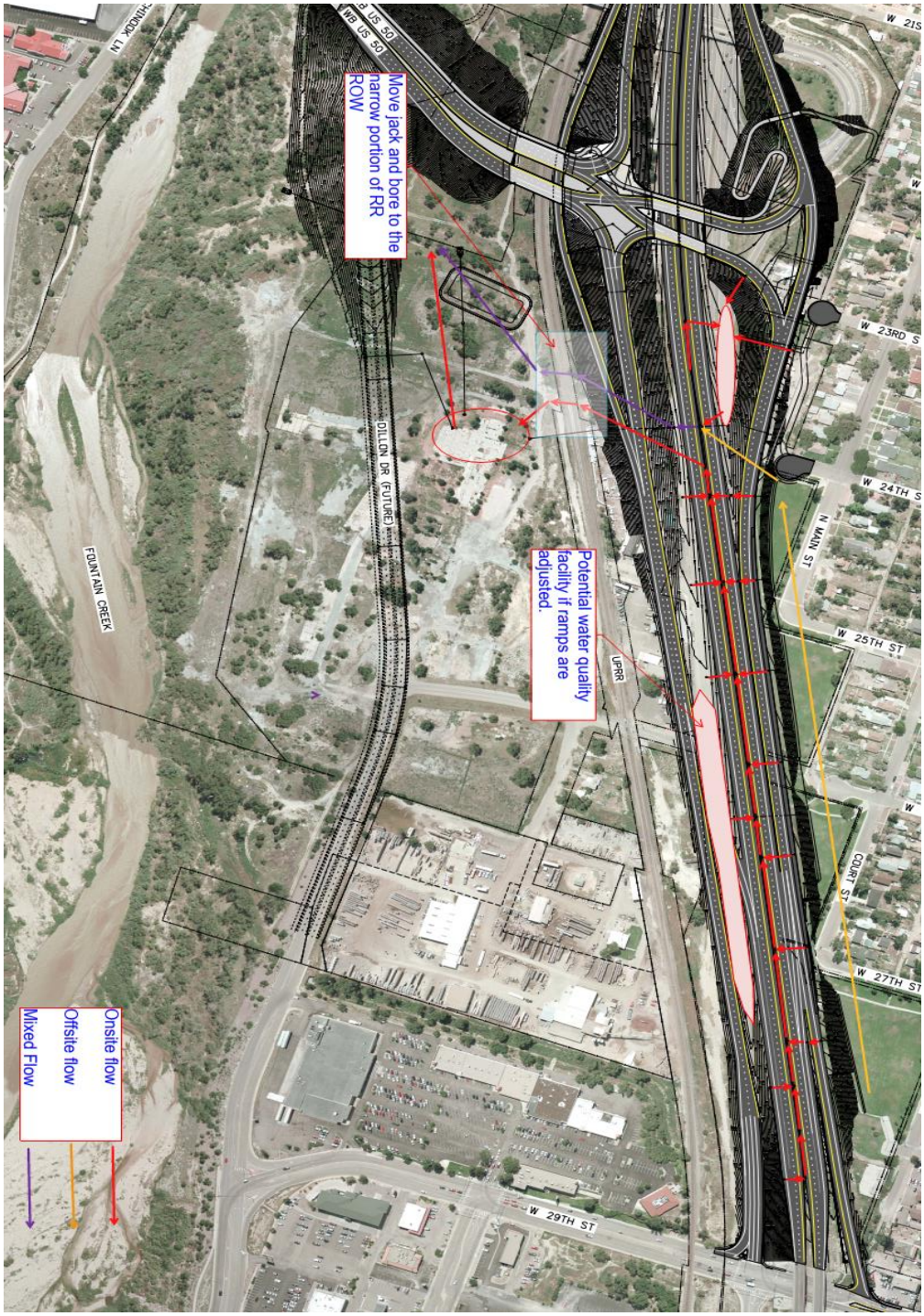
Discussion / Justification (Continued)

The quantities were roughly calculated and summarized below. The total benefit to the project financially saves the project $30,400. The reductions of the Original Concept water quality facility and the Alternative Concept water quality facility are assumed to be net neutral cost savings. However, the benefit of not treating off-site flows and allowing CDOT to transfer the four ponds on the west side of I-25 is a benefit that can't be financially quantified.

Item Description	Qtys	Unit Price	Total Price
36" FES	-1/EA	$2,700.00	$2,700.00
24" FES	-3/EA	$2,000.00	$6,000.00
18" FES	-1/EA	$1,800.00	$1,800.00
15" FES	-1/EA	$1,350.00	$1,350.00
15" RCP	-145/LF	$190.00	$27,550.00
18" RCP	-260/LF	$160.00	$41,600.00
24" RCP	-485/LF	$200.00	$97,000.00
48" RCP	311/LF	$350.00	$108,850.00
Jack and Bore 48" Steel Pipe	25/LF	$1,550.00*	$38,750.00

PE-12 Quantitative Value Alternative

Exhibits - Alternative Concept



PE-12 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
15" FES	EA	1	1,350.00	1,350
18" FES	EA	1	1,800.00	1,800
24" FES	EA	3	2,000.00	6,000
36" FES	EA	1	2,700.00	2,700
15" RCP	LF	145	190.00	27,550
18" RCP	LF	260	160.00	41,600
24" RCP	LF	485	200.00	97,000
			Subtotal:	**$ 178,000**
		65.2%	Markup:	$ 116,056
			Total Cost (Rounded):	**$ 294,100**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
48" RCP	LF	311	350.00	108,850
48" Steel Pipe (Jack and Bore)	LF	25	1,550.00	38,750
			Subtotal:	**$ 147,600**
		65.2%	**Markup:**	$ 96,235
			Total Cost (Rounded):	**$ 243,800**
			Cost Difference:	**$ 50,300**

PE-17 Quantitative Value Alternative

Title

Protect Environment

Eliminate Pier Within Fountain Creek; Provide Two-Span Bridge Structure

Original Concept

The present bridge concept provides a structure with three 135 foot spans. This configuration requires the construction of piers within the channel of Fountain Creek.

Alternative Concept

The alternative concept would reconfigure the bridge into a two-span superstructure with 202.5 foot spans. Using concrete splice girder technology.

Advantages

- Eliminates construction of piers within the channel of Fountain Creek.
- May reduce the pile scour potential within Fountain Creek.
- Improved hydraulics for Fountain Creek.

Disadvantages

- Increase superstructure costs for longer spans.
- Deeper superstructure, reduced freeboard.

Discussion / Justification

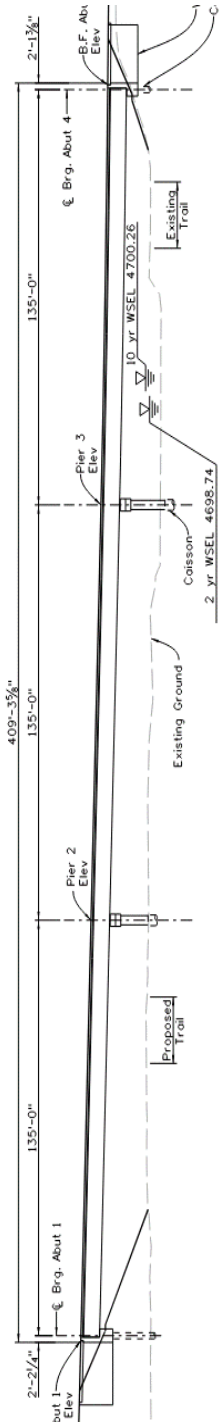
The impact of constructing a set piers in Fountain Creek is a major concern. The removal of the proposed piers from the channel of Fountain Creek will likely improve the hydraulics of the creek from the Original Concept.

Cost Summary

	Initial Costs	O&M Cost	Life Cycle Cost
Original Concept	$ 14,469,900	$	$ 14,469,900
Alternative Concept	$ 16,640,300	$	$ 16,640,300
Difference	**$ (2,170,400)**	**$**	**$ (2,170,400)**

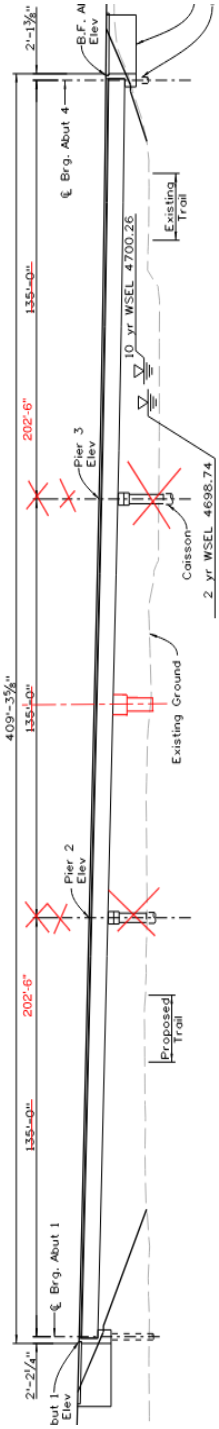
PE-17 Quantitative Value Alternative

Exhibits - Original Concept



PE-17 Quantitative Value Alternative

Exhibits - Alternative Concept



PE-17 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Three Span Superstructure	Sq Foot	43795	200.00	8,759,000

	Subtotal:	**$**	**8,759,000**
65.2%	Markup:	$	5,710,868
	Total Cost (Rounded):	**$**	**14,469,900**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Two Span Superstructure	Sq Foot	43795	230.00	10,072,850

	Subtotal:	**$**	**10,072,850**
65.2%	**Markup:**	$	6,567,498
	Total Cost (Rounded):	**$**	**16,640,300**
	Cost Difference:	**$**	**(2,170,400)**

3. Design Suggestions

The twenty-seven (27) Design Suggestions which were identified during the VE Workshop are presented in the pages following “Summary of and Design Suggestions ” table.

Summary of Design Suggestions

ID No.	Creative Idea Description	Score	Action	Comments / Notes	Cons. Dec.	Consensus Comments
CM-02	Define construction staging, laydown and field office locations	4	DS		A	
CM-04	Allow contractor use of on-site temporary crushing operations	4	DS		FS	
CM-05	Incorporate contractor incentives / disincentives	4	DS		FS	
CM-06	Contractor selection for alternative delivery; qualifications based selection	5	DS		R	DBB procurement previously selected.
CM-08	Provide construction quality control not currently included within CDOT specifications	4	DS		FS	
CM-09	Advance purchase of long lead items (i.e., girders, monotubes, traffic signals, etc.)	4	DS		FS	
CM-14	Extend trail crossing south along I-25 to Mineral Park	4	DS		FS	
CM-15	Use 65 MPH posted / 70 MPH design speed for I-25	4	DS	Requires FHWA approval for design speed.	R	Abandoned; design will honor EIS criteria.
CM-16	Eliminate tall vertical abutments and lay back slopes with rip-rap or slope paving	4	DS	To be further vetted during structures selection.	ABD	
CM-18	Reduce design speeds of west side ramps, tighten ramps closer to I-25	4	DS		FS	
CM-21	Reduce embankment fills; lower vertical profiles	5	DS	Design currently shows 25'-6" clearance at RR tracks	ABD	
ES-04	Evaluate 29th Street interchange movements	4	DS		ABD	
ES-07	Provide overhead signage including positive driver directions to reduce weaving	5	DS	Must be compatible with MUTCD	ABD	
ES-10	Use MASH Type 9 in lieu of Type 10	4	DS		FS	
ES-13	Add safety barrier between NB frontage road and RR tracks	5	DS	May be required to meet RR standards	FS	
IM-08	Provide additional permanent traffic monitoring devices	4	DS		R	Not required through traffic reevaluation process.
IM-09	Provide conduits for future uses (i.e., ramp metering, etc.)	5	DS		ABD	
IM-11	Eliminate future Dillon Drive connection; route traffic to 29th Street	5	DS	Eliminates future operational issues	R	Design will include future Dillon Drive per EIS.
MM-03	Implement focused constructability reviews by project elements to plan work	5	DS		ABD	
MM-09	Increase law enforcement presence during construction	5	DS	Project specific LE during peak construction periods.	ABD	
MM-10	Contractor provided incident management during construction	5	DS		ABD	
MM-13	Enhance public information during construction	5	DS		ABD	
PE-04	Use driven steel H piles where feasible to avoid excavation of potentially contaminated materials.	5	DS		ABD	
PE-08	Monitor water quality above and below project during construction	5	DS		FS	
PE-09	Replace east water quality pond with hydrodynamic separator	4	DS		FS	
PE-10	Modify roadway design standards to minimize impacts	4	DS	Incorporate context sensitive design (CSS)	FS	
PE-19	Separate off site versus on site storm water	4	DS		FS	

	Action
12	A - Alternative
26	DS - Design Suggestion
0	EC - Estimate Correction
20	G - Group with Other Alternative
10	ABD - Already Being Done
0	X - Dropped during Development
-	

Appendices

Appendix A. Pareto Cost Model

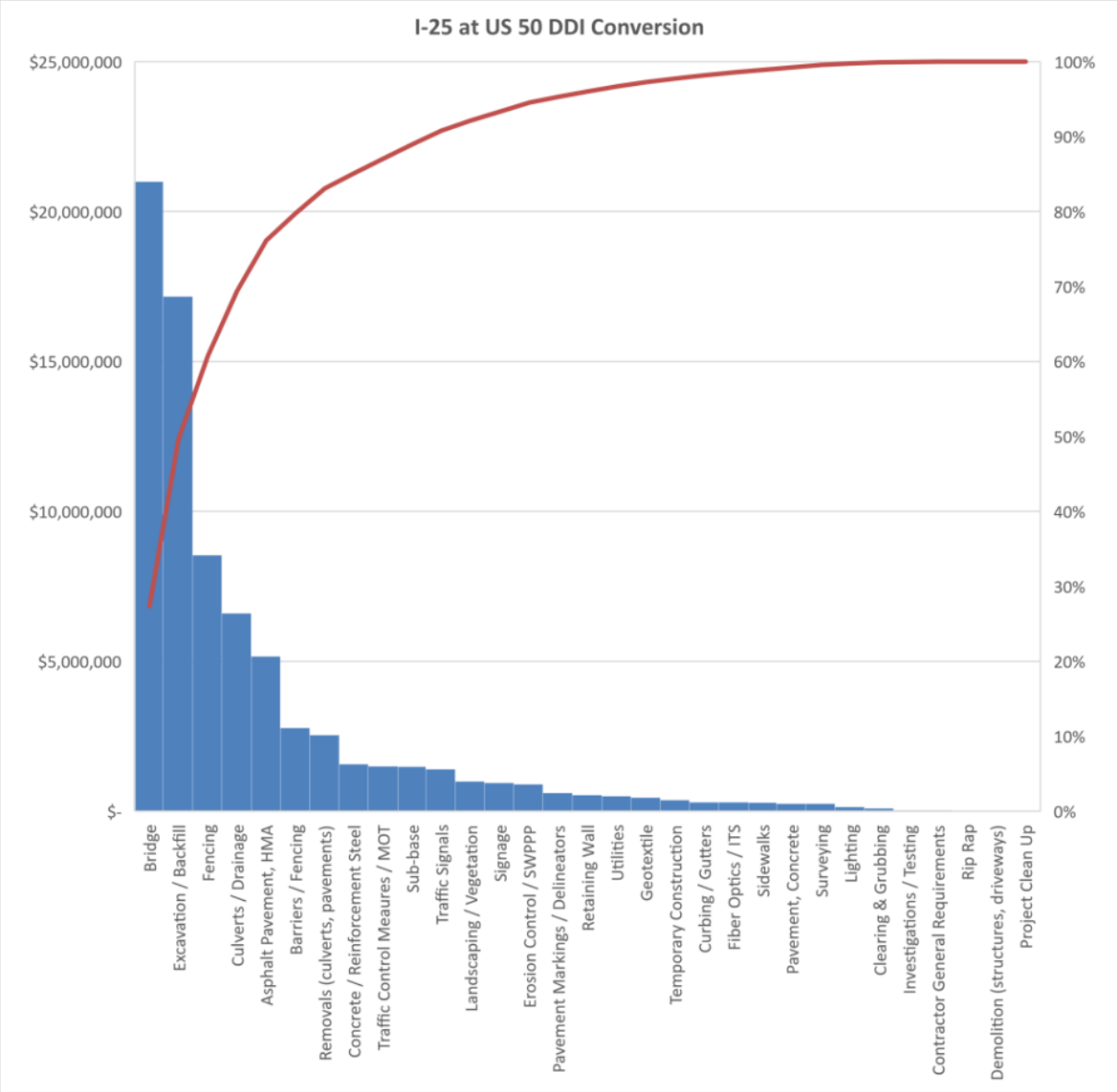
I-25 at US 50 Reconstruction || Pueblo County
Limits: Stony Creek to Ellsworth
Job No.: Multiple

Description		Cost (EOPC)	Share
Bridge	$	21,000,000	27.3%
Excavation / Backfill	$	17,163,241	22.4%
Fencing	$	8,543,492	11.1%
Culverts / Drainage	$	6,603,781	8.6%
Asphalt Pavement, HMA	$	5,159,960	6.7%
Barriers / Fencing	$	2,774,800	3.6%
Removals (culverts, pavements)	$	2,538,672	3.3%
Concrete / Reinforcement Steel	$	1,567,351	2.0%
Traffic Control Meaures / MOT	$	1,500,000	2.0%
Sub-base	$	1,485,443	1.9%
Traffic Signals	$	1,400,000	1.8%
Landscaping / Vegetation	$	1,000,000	1.3%
Signage	$	950,000	1.2%
Erosion Control / SWPPP	$	900,000	1.2%
Pavement Markings / Delineators	$	609,675	0.8%
Retaining Wall	$	540,582	0.7%
Utilities	$	500,000	0.7%
Geotextile	$	454,389	0.6%
Temporary Construction	$	370,500	0.5%
Curbing / Gutters	$	306,495	0.4%
Fiber Optics / ITS	$	300,000	0.4%
Sidewalks	$	287,727	0.4%
Pavement, Concrete	$	250,080	0.3%
Surveying	$	250,000	0.3%
Lighting	$	150,000	0.2%
Clearing & Grubbing	$	100,000	0.1%
Investigations / Testing	$	35,000	0.0%
Contractor General Requirements	$	32,500	0.0%
Rip Rap	$	15,600	0.0%
Demolition (structures, driveways)	$	-	0.0%
Project Clean Up	$	-	0.0%
Construction Only =	**$**	**76,789,289**	
Top Six =	**$**	**61,245,274**	**80%**

Contractor Allowances		Amount	Uplift
Mobilization	$	4,000,000	7.2%
Force Account Allowances	$	3,085,000	5.5%
Dispute Resolution Board	$	50,000	0.1%
Sub-total =	$	7,135,000	

CDOT Allowances		Amount	Uplift
Contingency (20%)	$	16,784,858	30.1%
Construction Engineering / Inspection (26%)	$	26,184,378	34.1%
Sub-total =	$	50,104,236	65.2%
Project Total =	**$**	**126,893,525**	

Construction Cost per Mile =	**$**	**73,810,904**



	I-25		US 50	
End STA =	310.00	81.61	834.00	70.61
Start STA =	254.00	0.00	800.00	75.00
Rods =	56.00	81.61	34.00	(4.39)
	5,682	feet	3,396	feet
	1.08	**miles**	**0.64**	**miles**

Appendix B. Project Risk Register

PROJECT RISK REGISTER

Colorado Department of Transportation
I-25 at US 50 Interchange Reconstruction **27-Sep**

Risk No.	Risk	Type (Threat or Opportunity)	Description	Risk Object	Risk Management: Threat: Accept, Avoid, Mitigate, Transfer Opportunity: Enhance, Exploit, Share
1	6 - Project Management	Threat	Railroad agreements, coordination, design and construction.	5 - Cost & Schedule	Mitigate through early and ongoing conversations / coordination to review project and determine requirements; identify points of contact (local and national). Complete and transmit concept submittal.
2	5 - External	Opportunity	Elimination of grade crossing and current flood way encroachment may benefit RR.	1 - Cost	Enhance safety by elimination of crossing. Elimination spot for potential RR ROW intrusions. Reducing maintenance costs for RR. Enhance RR operations by elimination of signal.
3	1 - Design	Threat	Constrained ROW restricts ability to phase project.	6 - Operations	Consider long term implications for alignment. How to divert traffic for mainline closure.
4	4 - Organization	Opportunity	Stakeholders acceptance of this project.	4 - Scope	Enhance through early engagement to develop collaboration with stakeholders (city, residents, businesses, etc.) to address their concerns, and to educate for DDI operations.
5	6 - Project Management	Threat	Traffic management during construction.	5 - Cost & Schedule	Mitigation by means of early definition of maintenance of traffic / traffic control plan, establish methods of handling traffic (MHT).
6	1 - Design	Threat	Accommodation future Dillon Drive extension connection to US 50.	6 - Operations	Mitigate future traffic operation challenges by incorporation of an aggreged upon design configuration for Dillon Drive connection.
7	1 - Design	Threat	Roadway and bridge construction within a floodplain.	5 - Cost & Schedule	Early conversations with floodplain administrator.
8	6 - Project Management	Threat	Existing utilities along frontage road; CDOT fiber optic along mainline; overhead power lines within vicinity of project.	5 - Cost & Schedule	Additional investigations required to identify all utilities; complete SUE process.
9	1 - Design	Threat	Potential contaminated soils within former industrial use parcels that need to be acquired to complete project.	5 - Cost & Schedule	Early identification through geotechnical and environmental investigations.
10	3 - Environment	Opportunity	Meeting requirements of SB-260, which includes green house gases reduction.	6 - Operations	1) Creation of pedestrian facility for E-W movements will reduce dependence on motor vehicles to access Mineral Palace Park. 2) Intersection conversion will enhance traffic operations and safety.
11	2 - Construction	Threat	Availability of construction materials and fabricated elements required.	5 - Cost & Schedule	Consider construction during design. Use standard shapes during design development. Allow contractor more flexibility to deliver project with alternative means and methods.

Appendix C. Function Analysis System Technique (FAST) Diagram

The Function Analysis Systems Technique (FAST) Diagram that follows documents the results of the function analysis performed for the project. Function analysis helps the VE Team clearly understand the relationships of the functions to one another, and how they work together to satisfy the requirements of the project. A FAST diagram graphically illustrates the interrelationships of the project functions and is often invaluable in accomplishing this understanding.

Guidelines for arranging functions logically into a FAST diagram are included below to assist the reader in understanding the FAST diagram which follows.

1. Two vertical dashed lines, known as Scope Lines, define the scope of the project and the VE Study. The scope lines are usually near the left and right margins.
2. The FAST diagram has a "critical path of functions" going from left to right across the scope lines. A bold line represents the critical path.
3. The critical path contains only the basic function(s) (immediately to right of left scope line) and required secondary functions. Higher order functions (related goals beyond the scope of the VE Study) are sometimes included on the critical path, left of the basic function(s). The critical path can have parallel branches.
4. Required secondary functions are to the right of the basic function.
5. All other secondary functions, which can be supporting functions, aesthetic functions, or unwanted functions, are either above or below the critical path.
6. Functions that "happen at the same time" and/or "are caused by" a function on the critical path are placed below the related critical path function.
7. Functions which happen "all the time", such as an aesthetic function, are placed above the critical path function to the extreme right of the diagram.
8. Specific "design objectives" are placed above the basic function to the extreme left.
9. Proper arrangement and relationships of the functions in the FAST diagram can be confirmed with the how-why logic test as follows:

a. Ask the question of any function, "How do I verb-noun?" The answer should be the function to the immediate right.

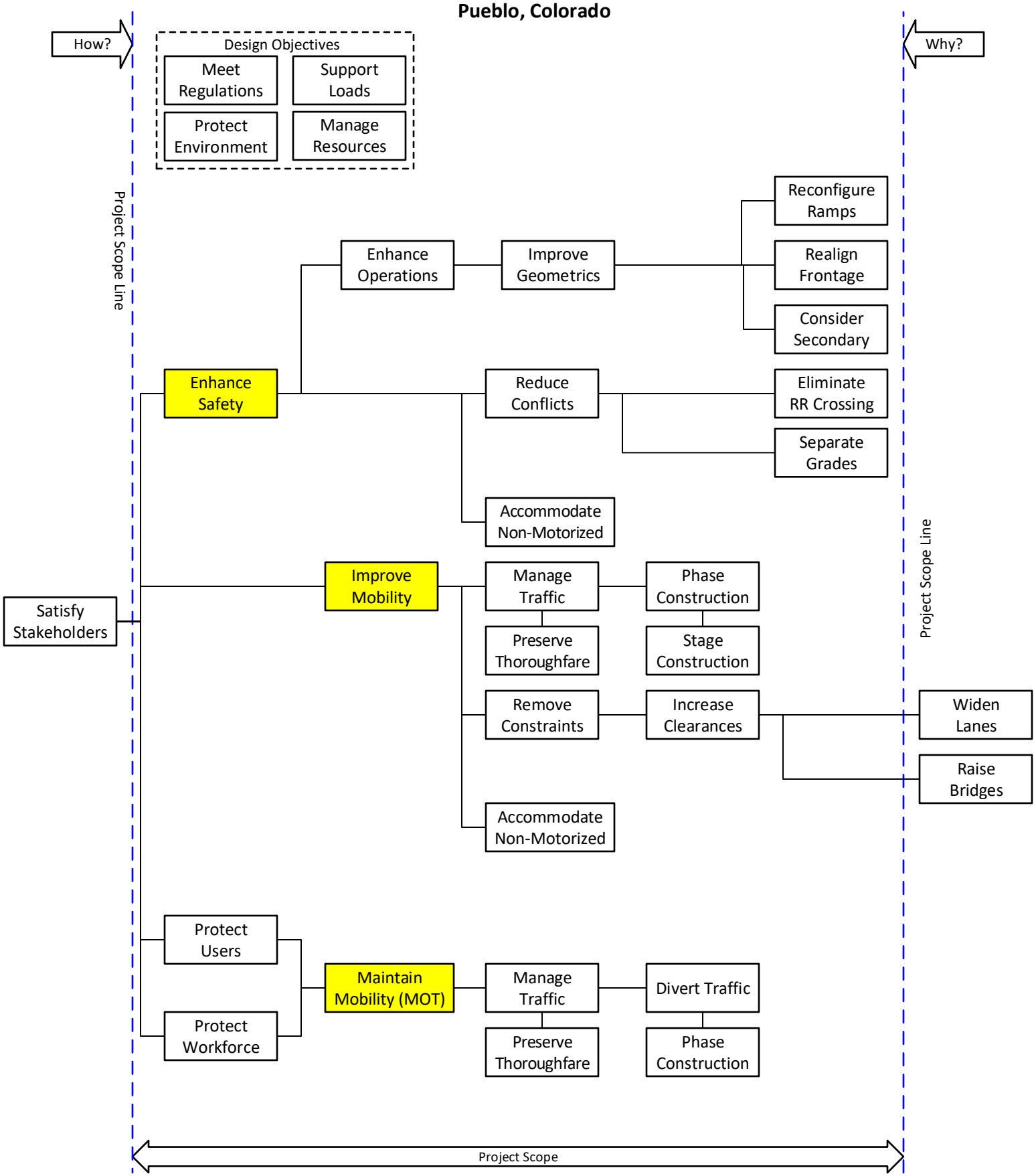
b. Ask the question "Why do I verb-noun?" The answer should be the function to the immediate left i.e., "So that I can verb-noun."

c. A function that does not pass the how-why test is either described improperly or is in the wrong place. The answer must make sense.

10. Our prime concern when constructing a FAST diagram is the essential functions. All functions on the critical path must occur to accomplish the basic function. All other functions on the FAST diagram are subordinate to the critical path function and may or may not have to take place to accomplish the basic functions. These functions are often the source for VE targets and resulting savings.

The FAST diagram for the project is presented on the following page.

FAST Diagram
I-25 at US 50 Interchange Reconstruction
Pueblo, Colorado



Appendix D. Creative Idea List with Evaluation Score and Action

List of Creative Ideas

ID No.	Creative Idea Description	Score	Action	Grouped With	Comments / Notes
CM-01	Issues tracking log for submittals, RFIs, encountered risks, etc.	5	ABD		
CM-02	Define construction staging, laydown and field office locations	4	DS		
CM-03	Allow contractor use of on-site temporary batch plants	4	G	CM-02	
CM-04	Allow contractor use of on-site temporary crushing operations	4	DS		
CM-05	Incorporate contractor incentives / disincentives	4	DS		
CM-06	Contractor selection for alternative delivery; qualifications based selection	5	DS		
CM-07	Provide stakeholders option for total US 50 closure for early completion	5	A		Further analysis required to determine potential user and
CM-08	Provide construction quality control not currently included within CDOT specifications	4	DS		
CM-09	Advance purchase of long lead items (i.e., girders, monotubes, traffic signals, etc.)	4	DS		
CM-10	Extend full ultimate typical section to limit of construction	4	A		
CM-11	Move US 50 crossing over UPRR to the north	5	A		
CM-12	Make US 50 Bridge crossings over I-25 perpendicular	4	G	CM-11	
CM-13	Grade separate Dillon Drive	1			Dillon Drive is not full movement; only right-in, right-out configuration.
CM-14	Extend trail crossing south along I-25 to Mineral Park	4	DS		
CM-15	Use 65 MPH posted / 70 MPH design speed for I-25	4	DS		Requires FHWA approval for design speed.
CM-16	Eliminate tall vertical abutments and lay back slopes with rip-rap or slope paving	4	DS		To be further vetted during structures selection.
CM-17	Postpone construction of future I-25 travel lane; use peak period shoulder lanes	3			PPSL requires FHWA approval; only approved for temporary conditions.
CM-18	Reduce design speeds of west side ramps, tighten ramps closer to I-25	4	DS		
CM-19	Modify existing interchange configuration temporarily	4	G	CM-07	
CM-20	Use new frontages for temporary through movement during mainline reconstruction	4	G	CM-07	
CM-21	Reduce embankment fills; lower vertical profiles	5	DS		Design currently shows 25'-6" clearance at RR tracks
CM-22	Steepen slopes; eliminate short retaining walls	4	A		
CM-23	Flatten slopes at sawtooth; eliminate retaining walls	4	G	CM-22	
CM-24	Use geosynthetic reinforced soil integrated bridge system	4	A		Potentially eliminates deep foundations; potential schedule reduction.
CM-25	Update unit costs based CDOT cost data book, RS Means, and Oman bid tabs	4	ABD		Required by CDOT Project Development Manual
CM-26	US 50 perpendicular to I-25, rotate interchange to create more room on west to shorten bridges	4	G	CM-11	

List of Creative Ideas

ID No.	Creative Idea Description	Score	Action	Grouped With	Comments / Notes
ES-01	Braid ramps on both frontage roads to eliminate weave	4	A		Eliminate weave
ES-02	Educate public on DDI operations	4	G	MM-13	
ES-03	Median separation on frontage road until after DDI	4	G	ES-01	Eliminate weave
ES-04	Evaluate 29th Street interchange movements	4	DS		
ES-05	Swap gore points on NB collector distributor to eliminate weave	4	G	ES-01	Eliminate weave
ES-06	Extend limits of I-25 mainline improvements north	4	G	CM-10	
ES-07	Provide overhead signage including positive driver directions to reduce weaving	5	DS		Must be compatible with MUTCD
ES-08	Provide smart work zone devices	4	G	MM-13	Provides drivers advance information during construction
ES-09	Use social media travel apps	4	G	MM-13	
ES-10	Use MASH Type 9 in lieu of Type 10	4	DS		
ES-11	Provide multi-modal facilities across / under I-25 between US 50 and 29th Street	2			
ES-12	Move bridge rail from inside sidewalk edge to outside edge of bridge; use barrier curb	4	A		Potential for some bridge construction cost savings
ES-13	Add safety barrier between NB frontage road and RR tracks	5	DS		May be required to meet RR standards
IM-01	Build Dillon Drive	1			
IM-02	Eliminate DDI, build flyovers	4	A		
IM-03	Continuous bridge from Fountain Creek to RR; eliminate fill and retaining walls	5	A		
IM-04	Build trail along Dillon Drive to Mineral Park	5	G	CM-14	
IM-05	Positive traffic control through DDI	3	ABD		
IM-06	Provide multi-use facility through the sawtooth on west side of I-25	2			Existing side streets provide multi-use connection.
IM-07	Incorporate bridge deicing systems	2			
IM-08	Provide additional permanent traffic monitoring devices	4	DS		
IM-09	Provide conduits for future uses (i.e., ramp metering, etc.)	5	DS		
IM-10	Eliminate signal at WB US 50 to SB I-25; extend SB frontage; merge traffic further south	5	G	ES-01	
IM-11	Eliminate future Dillon Drive connection; route traffic to 29th Street	5	DS		Eliminates future operational issues
IM-12	Dog-bone intersection at 29th Street	1			
IM-13	Full interchange at 29th Street	1			
MM-01	Complete frontages first	4	G	CM-07	
MM-02	Encourage contractor for early completion through A+B or early completion incentives	4	G	CM-05	
MM-03	Implement focused constructability reviews by project elements to plan work	5	DS		
MM-04	Minimize temporary drainage	5	ABD		
MM-05	Build temporary on-site detours	5	ABD		
MM-06	Utilize temporary bridging	1			
MM-07	Utilize Geofoam or styrene backfill	4	A		
MM-08	Use 2-foot temporary shoulders through construction	3			
MM-09	Increase law enforcement presence during construction	5	DS		Project specific LE during peak construction periods.

List of Creative Ideas

ID No.	Creative Idea Description	Score	Action	Grouped With	Comments / Notes
MM-10	Contractor provided incident management during construction	5	DS		
MM-11	Provide breakdown pull out areas	1			
MM-12	Provide emergency vehicle turn arounds	5	ABD		
MM-13	Enhance public information during construction	5	DS		
MM-14	Add permanent variable messaging signs ahead of the project	1			
MM-15	Perform additional Geotech investigation on west abutment of bridge over I-25	5	ABD		Preliminary geotech investigations completed; final geotech report will have additional information.
MM-16	Build full west abutment before demolition of existing bridge	4	G	MM-15	Evaluate based on settlement predictions
MM-17	Minimize MOT by identifying critical early action items	4	ABD		
MM-18	Utilize accelerated bridge construction (ABC) methodologies	4	ABD		Occurs as part of bridge type selection.
PE-01	Elevated structure from Fountain Creek to RR	4	G	IM-03	
PE-02	Construct Dillon Drive extension on structure	1			
PE-03	Realign Dillon Drive west adjacent to RR ROW	1			Exasperates weaving problems
PE-04	Use driven steel H piles where feasible to avoid excavation of potentially contaminated materials.	5	DS		
PE-05	Dredge Fountain Creek channel to accomplish No-Rise configuration	1			
PE-06	Use corridor landscape maintenance contract	1			
PE-07	Use LED roadway lighting	3	ABD		
PE-08	Monitor water quality above and below project during construction	5	DS		
PE-09	Replace east water quality pond with hydrodynamic separator	4	DS		
PE-10	Modify roadway design standards to minimize impacts	4	DS		Incorporate context sensitive design (CSS)
PE-11	Utilize non-pavement surfaces for large vehicle off-tracking	3			
PE-12	Evaluate water quality opportunities on west side of corridor	4	A		
PE-13	Create a wetlands bank on this project for rest of corridor / region	3			
PE-14	Sponsor planting new trees within corridor	1			
PE-15	Bring in CSU Extension Service to evaluate vegetation options within corridor	3			
PE-16	Utilize drought tolerant plantings	4	ABD		
PE-17	Eliminate pier within Fountain Creek; provide two-span bridge structure	5	A		
PE-18	Provide grade separation in lieu of DDI	4	G	IM-02	
PE-19	Separate off site versus on site storm water	4	DS		
PE-20	Add water quality to south end of the project	4	G	PE-19	
PE-21	Utilize sawtooth ponds for water quality	4	G	PE-12	

Action

A - Alternative
DS - Design Suggestion
EC - Estimate Correction
G - Group with Other Alternative
ABD - Already Being Done
X - Dropped during Development

Appendix E. VE Workshop Agenda

VALUE ENGINEERING WORKSHOP AGENDA

COLORADO DEPARTMENT OF TRANSPORTATION

I-25 at US 50 Interchange, Pueblo

27-29 September 2021

20-24 September Pre-Workshop Activities

- VE Team Leader prepares:
  - Draft cost model(s)
  - VE forms and templates
- VE Team Members:
  - Review all project documents.
  - Note any questions, observations.

Wednesday, 22 September [1]

8:30 – 8:45	Workshop Kick-Off / Project Orientation (Virtual) • Introductions / Check-in • Safety Moment	Tom Cotton (Atkins)

8:45 – 10:15	Project Introduction (Information Phase)
	• Presentation by Project Development Team
	  ○ Scope of Work
	  ○ Project Stakeholders
	  ○ Project Constraints / Site Specific Issues
	  ○ Anticipated Construction Costs and Schedule
	• Discussion, questions and answers
		Joe DeHeart (CDOT)

10:15 - 10:30	Recap / Adjourn	Al Adelgren (Atkins)

Monday, 27 September

8:00 – 8:05	VE Team Assembles / Check-in	
8:05 – 8:15	Overview & Instructions • Safety Moment • Ground rules • Safety Moment • Overview of the VE Process and Agenda / Workshop Goals	Al Adelgren (Atkins) [2]
8:15 – 10:30	Project Review (Information Phase) • Project Scope / Constraints Review • Project Documents Discussion - Observations • Cost Models	
10:30 – 10:45	Break (typical; times may vary)	
10:45 – 11:45	Qualitative Risk Review / Risk Register (Information Phase) • Define Project Risks (threats and opportunities) • Identify Risk Management Strategies	
11:45 – 12:45	Lunch Break (typical; times may vary daily)	
12:45 - 2:30	Function Analysis Phase	
2:30 – 2:45	Break (typical; times may vary)	
2:45 – 4:50	Creative Ideas Phase	
4:50 – 5:00	Review the Day's Work / Prepare for next day	

[1] All times are Mountain Daylight Time (MDT)

[2] Workshop facilitator; will lead discussions for all remaining topics (typical all days).

VALUE ENGINEERING WORKSHOP AGENDA

COLORADO DEPARTMENT OF TRANSPORTATION

I-25 at US 50 Interchange, Pueblo

Tuesday, 28 September

8:00 – 9:00	Creative Ideas Phase (continued)
9:00 – 11:00	Evaluation / Judgment Phase
11:00 – 12:00	Development Phase – Recommendations
	• Team Discussion – Forms
	• Recommendations Selection
	• Assignment
12:00 – 1:00	Lunch Break
1:00 – 4:50	Development Phase - Recommendations (continued)
4:50 – 5:00	Review the Day's Work / Prepare for next day

Wednesday, 29 September

8:00– 1:00	Development Phase - Finalize Recommendations / QC Review
12:00– 1:00	Lunch Break
2:00– 3:00	Preparation for Presentation
3:00– 5:00	VE Team Presentation to Stakeholders
	• Questions / Answers
	• Path Forward

Post Workshop Activities

- VE Team Leader completes FAST model, compiles alternatives, and prepares preliminary draft report.
- VE Team Members review preliminary draft report.
- Submit Draft Report to CDOT (NLT 08-October-21).
- CDOT review, provide feedback.
- TBD consensus conference call / meeting.
- Finalize report.

Alan K. Adelgren, PE, CVS-Life, LEED AP, CPP
Atkins North America, Inc.
7604 Technology Way
Suite 400
Denver, CO 80237

Tel: +1 303 221 7275
Direct: +1 303.209.2325
Alan.Adelgren@fgould.com