FINAL REPORT
VALUE ENGINEERING STUDY

CDOT REGION 6

I-225/Mississippi to Parker Road
Widening Project
Including RTD's Iliff Extension

February 2011

BY SOLUTIONS ENGINEERING & FACILITATING, INC.

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SECTION 1 – SUMMARY

This report contains the results of the Value Engineering Study of the I-225/Mississippi to Parker Road Widening Project. The report is organized in a drill down format, that is, all items are presented first in summary format with increasing levels of detail as one delves (drills down) further into the report. This will allow the reader to easily obtain only the information he or she desires.

The first section of the report contains an executive summary of all the value engineering proposals, their estimated savings, and their ultimate disposition. The second section of the report contains a brief project background, the VE Study Team Members, a listing of the Executive Review Board Members, and a brief description of the methodology used. The third section of the report contains detailed information about each VE Proposal. These individual proposal analyses are also organized in a drill down manner. Section Four of the report contains supplemental recommendations, i.e., ideas that the VE Team thought would add value to the project but do not necessarily reduce life-cycle costs. Section Five of the report contains ideas analyzed by the VE Team but either failed because they were thought to not be technically viable and/or did not save life-cycle costs. Section Six of the report contains functions analyzed by the VE Team. Section Seven of the report contains all of the ideas ideated by the VE Team both prior to and during the workshop. Section Eight of the report documents the ultimate disposition of the VE Team's Proposals and Supplemental Recommendations as made by the decision making board.

SUMMARY

This Value Engineering (VE) Study generated nine (9) proposals and ten (10) supplemental recommendations.

Caveats:

- The cost savings shown for each proposal are measured against the 1/11/2011 estimate made from the 16147 unit add costs. This estimate's cost numbers do not include preliminary engineering, construction engineering, incentives, and maintenance of traffic.
- All savings have been rounded to reflect the level of accuracy of the VE Proposals.
- Most of the savings are measured against the full build, i.e., Mississippi Ave. to Parker Rd. plus the I-225 Light Rail extension to Iliff Ave. scenario while a few, e.g., construction phasing are only measured against the Mississippi Ave. to Iliff Ave. plus the I-225 Light Rail extension to Iliff Ave. scenario. Therefore, if the full project is not built in one contract the potential savings will be reduced proportionately.
- Cost estimates made by the VE Team are intended to reflect relative values between alternatives. The estimated savings identified within each proposal are based upon comparison of the proposal to the preliminary design basis. Therefore, as is true with all cost estimates, the savings indicated are only an opinion of probable construction cost.
- Only potential savings are shown. As the proposals are implemented, additional costs or savings may result from redesign or modification.
- Some VE Proposals are mutually exclusive; a few are synergistic and could result in greater cost savings if implemented together. Therefore, the potential savings are not the simple sum of all the VE Proposals presented.

VE PROPOSAL SUMMARY TABLE

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
CONSTRUCTION PHASING			
P03-005	Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase. *Initial Est. Savings: $650,000* *Future Est. Savings: $0,000* *Total Est. Savings: $650,000*	**Accept.** See Section 8 for explanation.	3-1
P04-001	Utilize construction clear zone requirements during construction to conform with Chapter 9 of the Roadside Design Guide, specifically referring to Section 9.1, The Clear Zone Concept in Work Zones, reducing the quantity of Temporary Type 7 barrier. *Initial Est. Savings: $244,000* *Future Est. Savings: $0,000* *Total Est. Savings: $244,000*	**Accept with Modifications.** See Section 8 for explanation.	3-4
P01-008	Configure maintenance of traffic such that the TL-5 barrier isn't required for protection of falsework required for construction of the the light rail straddle bents. *Initial Est. Savings: $30,000* *Future Est. Savings: $0,000* *Total Est. Savings: $30,000*	**Accept with Modifications.** See Section 8 for explanation.	3-6
P04-003	Protect LRT falsework for median structure by implementing a phasing scheme whereby TL-5 barriers are not required by placing NB I-225 traffic temporarily on the subexcavated area under the structure. *Initial Est. Savings: $35,000* *Future Est. Savings: $0,000* *Total Est. Savings: $35,000*	**Decline.** See Section 8 for explanation.	3-10
P01-006	Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project. *Initial Est. Savings: Not Quantified* *Future Est. Savings: Not Quantified* *Total Est. Savings: Not Quantified*	**Accept with Modifications.** See Section 8 for explanation.	3-12
PLAN and PROFILE CHANGES			
P01-005	Modify the typical section to eliminate and/or reduce some retaining walls. *Initial Est. Savings: $90,000* *Future Est. Savings: $0,000* *Total Est. Savings: $90,000*	**Accept with Modifications.** See Section 8 for explanation.	3-14

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
P02-006	Adjust I-225 profiles where slopes are less than 0.50% to improve drainage and minimize the number of inlets. *Initial Est. Savings: $12,000* *Future Est. Savings: $0,000* *Total Est. Savings: $12,000*	**Accept.** See Section 8 for explanation.	3-17
SUBGRADE			
P01-002	Allow alternative soil stabilization techniques in the contract such as EN 1 resin, rubbelization, stabilize to a lower depth, or the no treatment option. *Initial Est. Savings: $800,000* *Future Est. Savings: $0,000* *Total Est. Savings: $800,000*	**Decline.** See Section 8 for explanation.	3-20
DRAINAGE			
P03-009	Place storm drain inlets at the future 8-lane locations, but use area inlets until the ultimate configuration. *Initial Est. Savings: $80,000* *Future Est. Savings: $21,000* *Total Est. Savings: $101,000*	**Accept with Modifications.** See Section 8 for explanation.	3-23

The estimated construction cost at the time of the VE Study was $24,000,000 for the CDOT I-225 widening from Mississippi Ave. to Iliff Ave., $26,000,000 for the CDOT I-225 widening from Iliff Ave. to Parker Rd., plus $65,000,000 for the I-225 Light Rail extension to Iliff Ave.

The Review Board's estimate of savings from the accepted VE Proposals is $662,000 with a maximum potential savings of $465,000 from modified proposals.

SECTION 2 – INTRODUCTION

INTRODUCTION

Value Engineering (VE) analysis identifies the high cost areas of a project during the early design stages. The VE Study then determines less expensive alternative designs that can still be incorporated into the final design drawings and specifications without incurring large costs for redesign or major project delay. These VE proposals are substantiated with technical and economic analyses.

A subsequent *Final Report* will include:

- A list of the Review Board members.
- A summary of cost savings as a result of the VE study.
- A summary of accepted proposals.
- The documentation of the Review Board's reasoning.
- A summary of the rejected VE proposals will also be included in the Final VE Report and will include the reason(s) for their rejection. The reasons may include cost-effectiveness, reliability concerns, unusual operation and maintenance problems, or project delays.
- The contents of the *Preliminary Report*.

PROJECT DESCRIPTION

Expectations/Goals

The study should meet the FHWA requirements and provide cost effective and sustainable recommendations for the project.

Focus Areas

- Future expansion accommodations (6 lanes to 8 lanes)
- Earthwork balancing and cost effectiveness
- Culvert replacement considerations
- Stormwater treatment options
- Safety considerations
- Construction Phasing and Sequencing
- RTD FasTracks Compatibility
- Drainage design for 6 lanes that minimizes future modifications for 8 lanes
- What to do with the future 8-lane shoulder space during the interim period between 6-lane and 8-lane construction
- Construction of LRT concurrently with the highway widening

"Sacred Cows"

- Project must be authorized by NEPA clearance
- Project may not preclude RTD Light Rail project
- Must accommodate future 8-lane design
- Must satisfy all regulatory requirements (e.g. MS-4)
- Must satisfy all AASHTO and CDOT design criteria and full interstate standards
- LRT alignment, structures, track, and Iliff Station have been designed to the 95% level. This VE Study should not re-examine these areas.

Project Description

The subject of this Value Engineering Study is, in part, a joint CDOT/RTD I-225 construction project that will consist of highway widening and extension of the RTD I-225 Light Rail Transit facility, similar to what was done through the TREX project along I-25 and I-225. The limits of this joint project will be from Parker Road to Iliff Avenue. Additionally, this study will examine additional I-225 highway widening from Iliff Avenue to Mississippi Avenue.

RTD will be involved in the VE Study process as a result of this planned joint project.

The I-225 Widening from Mississippi to Parker Project will complete the widening of I-225 to 6 lanes, three lanes in each direction, with auxiliary lanes from I-25 to I-70. This project was approved in the 2001 FONSI for the I-225 widening between Parker Road and 6th Avenue. The project will relieve congestion on I-225 by adding a third through lane and an auxiliary lane between interchanges from Mississippi Avenue to Parker Road and through Traffic Demand Management measures such as VMS signs, corridor cameras linked to CDOT's Transportation Management Center, and automatic traffic counters. The project will construct a sound wall along the west side of the highway, between Yale Avenue and Iliff Avenue.

Although the EA and FONSI for the corridor envisioned a 36-foot transit envelope being provided in the median, since then RTD has identified the transit corridor transitioning from the median to the east side of the highway within the project corridor, north of the Nine Mile Station at Parker Avenue. Not precluding the light rail transit is an important element of the highway widening design. In addition, the environmental documents identify a possible future 4th lane along the highway. This project is being designed to accommodate the future widening with minimal impacts; this includes building retaining walls for the future eight-lane improvements.

The current vision is to widen the highway to six-lanes by widening to the inside. A thorough analysis was conducted to reach that decision by CDOT to ease construction and meet conventional design standards.

There is a dual 3' by 8' concrete box culvert that crosses I-225 diagonally north of Iliff Avenue interchange that has been in place since 1971. The culvert will be inspected to determine its condition and if it can sustain the design life of the project enduring the increased traffic loading anticipated with the additional lanes.

Water quality has become an important aspect of highway design. A variety of water quality treatment facilities has been investigated for the corridor to treat the stormwater runoff from the highway. South of Yale Avenue, the water quality facilities will consist mainly of porous landscape detention basins. Between Yale Avenue and Florida Avenue, a combination of water quality ponds and stormceptors will be used to treat the stormwater.

With respect to the RTD LRT component of this project, it will extend the existing system from its current termination at the Parker Road Nine-Mile Park-N-Ride Station, to a new Park-N-Ride Station that will be constructed at Iliff Avenue.

The entire RTD I-225 FasTracks LRT project has been previously studied in a formal Value Engineering Study, and the current Parker Road to Iliff Avenue segment has been designed to the 95% level incorporating the accepted recommendations of that VE Study.

It is expected that this VE Study will examine construction phasing and efficiencies that might be realized now that both the CDOT and RTD projects are planned to be constructed concurrently.

ORGANIZATION

VE STUDY TEAM

The following individuals were members of the VE Team:

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THE REVIEW BOARD

The Review Board is comprised of the following representatives.

A. REVIEW BOARD

REVIEW BOARD MEMBER	FIRM	TELEPHONE/E-MAIL
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The reviewers decide upon the status of the VE proposals in one of four ways:

1. Accept the proposed alternative as it stands. This will require the design team to implement the accepted proposed alternative. Those individuals comprising the Review Board are expected to have this authority for their respective organization.

2. Accept the proposed alternative with modifications. This disposition is similar to item 1 but with some changes imposed by the Review Board.

3. Decline the proposed alternative altogether. This disposition is obvious, but proper reasoning must be given for the *Final Report.*

4. Table (defer) the proposed alternative for further study or information gathering. If a proposed alternative is tabled, it is wise to assign responsibilities to resolve the issue(s), assign a schedule for resolution, and design a decision tree.

METHOD OF THE VE STUDY

VE ANALYTICAL PROCESS

1. Information Phase

Each VE Team Member was given the plans, specifications, and cost estimate information for the project prior to the workshop. They were given instructions to familiarize themselves with the project prior to an oral briefing to be given by the owner and the designer. The facilitator asked that the design team start with a very broad overview of the project (the exact phrase used was "satellite view") of the project with concentration on purpose and need for the project. The facilitator then asked the design team to start to gradually cover the project in increasing detail (the phrase used was "airplane view" down to "feet on the ground" view). Emphasis was made as to how the project fit into scheme of things and especially the interface points at the project ends. The facilitator encouraged the other VE Team members to ask very open ended questions.

2. Function Analysis Phase

The next activity done by the VE Team was to review previous Function Analysis Technique (FAST) Diagrams. This tool (borrowed from Value Engineering Studies) forces an analytical team to look at a project with a fresh outlook. For example, if a technical group was given the assignment to improve a heating/ventilating/air conditioning system (HVAC) system for an office building they could ideate the numerous common systems, e.g., dual duct, variable air volume, multi-zone, etc. However, the phraseology of the problem has already limited the group's thinking to a mechanical system.

By using function analysis to analyze the HVAC system the CR/VE Team would brainstorm the function "control temperature". This forces the team to broaden the number of possible solutions thus increasing the odds of achieving an improved solution. For example, by brainstorming the function "control temperature" the study team can look at insulation levels, fenestration schemes, thermal storage, reflective roofing, building axis orientation, landscaping, etc. By using the FAST Diagram the study team has been forced to abandon the paradigm of solely using a mechanical system to control temperature.

This VE Team then generated six functions that it felt covered 80% of the project cost. These functions are listed in Sections 6 & 7 of this report.

3. Creative Phase

The VE Team selected the functions for brainstorming per Pareto's Law, i.e., the 20% of the functions that drive 80% of the project. The formal brainstorming session generated as many alternative methods as possible for achieving the selected functions. These were then segregated by three categories, Constructability Review Comments (default case), Value Engineering Proposals (ideas that have the potential to save life-cycle costs), and Supplement Recommendations (ideas that would improve the project but don't easily fit into either of the previous two categories).

4. Analysis Phase

A rough analysis was performed by first passing or failing the brainstormed ideas, then combining or grouping similar ideas. The VE Team as a whole then discussed and recorded the relative advantages of the original concept versus the advantages of the alternative plus the risks of implementing the alternative concept. The ideas surviving these discussions were selected as candidates for further development by individual team members.

5. Development Phase

A cursory technical examination followed the analysis phase. The purpose of this examination was to see it the alternative was indeed technically viable and to better explain the alternative to the design team. An order of magnitude economic analysis of technically feasible alternatives was also made. The economic analysis was done on a life-cycle basis where appropriate. The VE Team tried to use the same base cost data as that used by the design team so that proper comparison could be made with the original concepts(s). Ideas that passed these technical and economical analyses and, in the opinion of the VE Team should be incorporated into the design, were prepared as formal proposals.

The VE Team also prepared Supplemental Recommendations. These recommendations are ideas that the VE Team thought would add worth to the project but would not necessarily save capital or future costs. The Supplemental Recommendations were not necessarily priced.

6. Presentation & Report

All proposals, supplemental recommendations, and ideas analyzed but not proposed were recorded during the VE Study and were compiled to in a *Preliminary Report* to be presented to the Review Board for their consideration. Once the Review Board has decided on the proposals' and supplemental recommendations' dispositions the *Final Report* will be prepared.

SECTION 3 – PROPOSALS

VALUE ENGINEERING PROPOSAL NO. 03-005

SUMMARY PROPOSAL DESCRIPTION:

Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.

Estimated potential savings:

Initial:	$ 650,000
Future:	$ 0,000
Total:	$ 650,000

Discussion:

This idea has traffic cross over to the opposite direction of travel in order to complete the full width of each direction of travel in two phases. A smaller, third phase is needed to complete the south end tie-ins for both directions and the median abutment and piers to the light rail structure. The north crossover would be north of Iliff eliminating a median phase on the north end.

This construction method was used successfully on the I-225/Mississippi to 2nd Ave. reconstruction.

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-006 - Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project.

P01-008 - Configure maintenance of traffic such that the TL-5 barrier isn't required for protection of falsework required for construction of the the light rail straddle bents.

P04-003 - Protect LRT falsework for median structure by implementing a phasing scheme whereby TL-5 barriers are not required by placing NB I-225 traffic temporarily on the subexcavated area under the structure.

SR03-001 - Use the NB on/off ramp at Parker Road for a nighttime construction detour.

SR07-001 - Use the A + B type of bid:

- 07-001A: Bid as one construction contract with lowest cost, plus schedule incentives winning the bid.
- 07-001B: Bid as two separate projects with the same advertisement and award date.

EVALUATION
Idea Number: 03-005 Idea Description: Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.
Advantages of alternative concept: 1. Reduces contract time 2. Increases work area and eliminates construction joints 3. Reduces the construction time needed to complete a dangerous center phase.
Advantages of original concept: 1. Smaller crossovers
Risks of implementing alternative concept: 1. Creates larger cross-over areas

Calculations and/or Discussion:

Phase 1

- Construct the temporary widening necessary to carry two-way traffic on existing southbound lanes.
- Construct the crossover near Parker Rd. that will carry northbound traffic to two-way traffic on southbound lanes.
- Construct the crossover near Iliff that will allow northbound traffic on southbound lanes to utilize the Iliff interchange.
- Construct the majority of NB I-225 and the majority of the light rail bridge structure not in conflict with the crossover near Parker Road, including two straddle bents and two hammerhead piers near Parker Road.
- Construct the eastern half of the Yale bridge over the northbound lanes.

Phase 2

- Construct a crossover north of Iliff that will carry traffic on southbound lanes to two-way traffic on newly constructed northbound lanes.
- Construct a crossover north of Parker Road that will allow southbound traffic on northbound lanes to use the Parker interchange.
- Construct a majority of southbound I-225 lanes, complete the western half of the Yale bridge over the southbound lanes, and any remaining light rail not in conflict with the crossover near Parker.

Phase 3

- Open traffic to newly constructed northbound and southbound I-225.
- Remove crossovers.
- Use the 60' width of both I-225 bridges over Parker Rd. to build the south segment of northbound and southbound I-225 construction 1/2 at a time simultaneously.
- Construct the remaining south portion of the light rail previously in conflict with the south crossover in the median area.

It is estimated that 3 to 4 months are needed to complete one phase of construction if phasing is done based on plan phasing. Based on a 24-month project at a $26,000,000 estimate and a conservative 15% overhead cost to the contractor, the following cost savings would be:

3.5/24 x 26,000,000 x 17% = $644,583.33 or $650,000

VALUE ENGINEERING PROPOSAL NO. 04-001

SUMMARY PROPOSAL DESCRIPTION:

Utilize construction clear zone requirements during construction to conform with Chapter 9 of the Roadside Design Guide, specifically referring to Section 9.1, The Clear Zone Concept in Work Zones, reducing the quantity of Temporary Type 7 barrier.

Estimated potential savings:

Initial:	$ 244,000
Future:	$ 0,000
Total:	$ 244,000

Discussion:

This proposal incorporates a lesson learned from a previous I-225 project.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 04-001 Idea Description: Utilize construction clear zone requirements during construction to conform with Chapter 9 of the Roadside Design Guide, specifically referring to Section 9.1, The Clear Zone Concept in Work Zones, reducing the quantity of Temporary Type 7 barrier.
Advantages of alternative concept: 1. Reduced use of Type 7 Temporary Barrier reduces both time and construction cost. 2. May preclude a contractor submitted VECP. 3. The construction zone speed limit is less than ultimate design speed, so clear zone requirements are reduced anyway.
Advantages of original concept: 1. Overestimates Temporary Type 7 Barrier in the event the Contractors Method of handling Traffic is less than the proposed phasing presented in the plans.
Risks of implementing alternative concept: 1. Possible non- recoverable slopes are introduced to the design in the temporary condition.

Calculations and/or Discussion:

Clear zone requirements in work zones are less than clear zone requirements for final design. Clear zone is the total roadside border area, starting from the edge of the traveled way available for safe use by errant vehicles. The width commonly used for work zones is 12-18 ft. Permanent clear zone requirements for Design ADT fitting I-225 is 30 feet. In previous I-225 design phases, permanent clear zone requirements were used in determining temporary roadside barrier use. As a cost saving measure, it is proposed that the less stringent 12-18 ft. be used as allowed by the Roadside Design Guide and the quantity for Type 7 barrier be reduced accordingly.

	Estimated Cost of Roadside Barrier utilizing 30 ft clear zone width					
Pay Item	Quantity	Unit	Unit Cost		Total	
Type 7 Temporary Barrier	54780		$15.00		$821,700.00	
					$821,700.00	Total
	Estimated Cost of Roadside Barrier utilizing 12-18 ft clear zone width					
Pay Item	Quantity	Unit	Unit Cost		Total	Total
Type 7 Temporary Barrier	38520		$15.00		$577,800.00	
Potential Savings					$243,900.00	
				round to $244,000		

VALUE ENGINEERING PROPOSAL NO. 01-008

SUMMARY PROPOSAL DESCRIPTION:

Configure maintenance of traffic such that the TL-5 barrier isn't required for protection of falsework required for construction of the the light rail straddle bents.

Estimated potential savings:

Initial:	$ 30,000
Future:	$ 0,000
Total:	$ 30,000

Discussion:

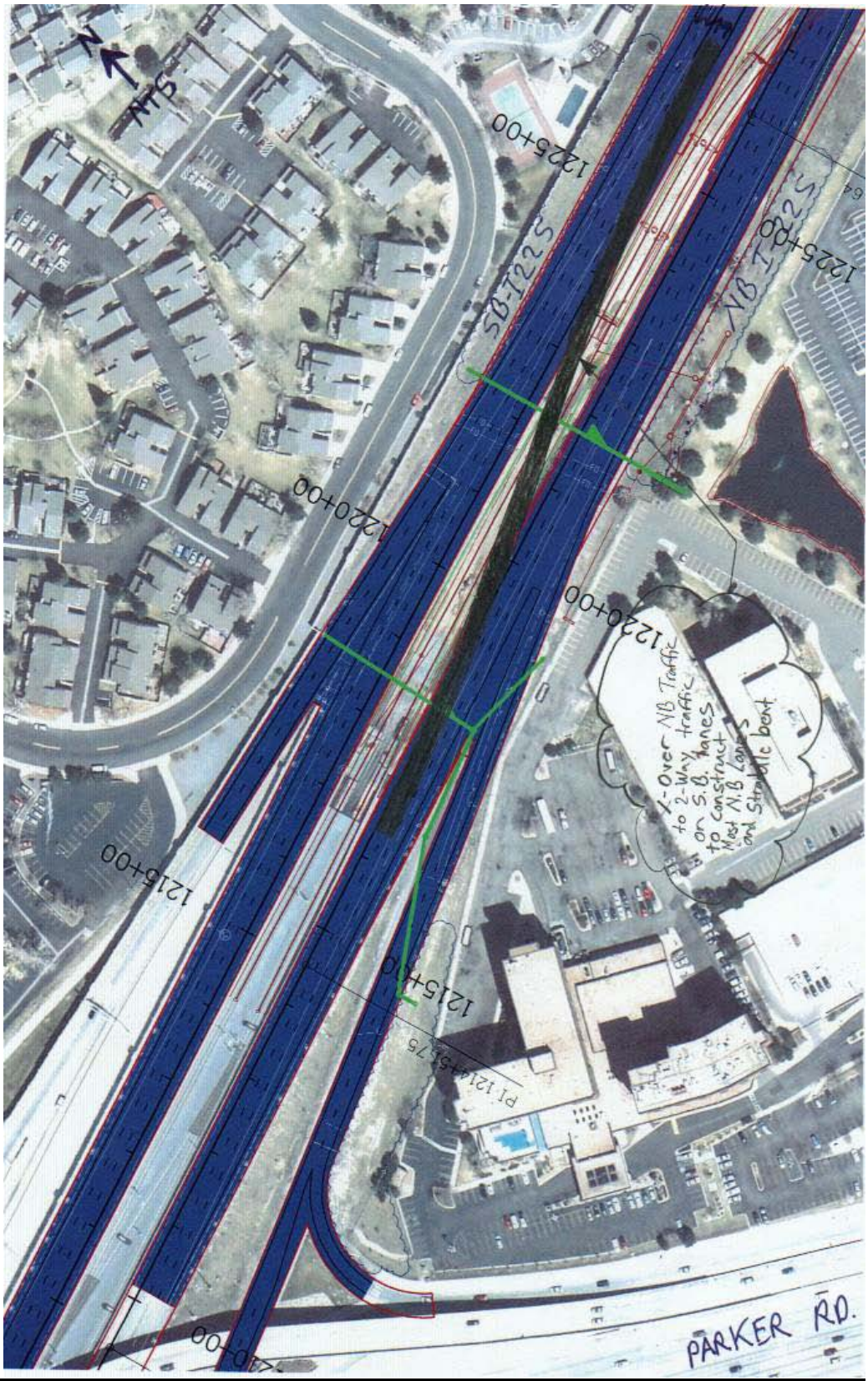
Related Value Engineering Proposals and/or Supplemental Recommendations:

P03-005 - Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.

EVALUATION
Idea Number: 01-008 Idea Description: Configure maintenance of traffic such that the TL-5 barrier isn't required for protection of falsework required for construction of the the light rail straddle bents.
Advantages of alternative concept: 1. Cast in place straddle bent over northbound I-225 can be constructed while traffic is on southbound I-225. 2. This eliminates the need for TL-5 barrier and increases safety during construction by not carrying traffic under falsework.
Advantages of original concept: 1. Traffic does not need to be crossed over during construction.
Risks of implementing alternative concept: 1. Cross over just north of where existing light rail facility ends near the Parker interchange may not be geometrically possible before conflicting with straddle bents.

Calculations and/or Discussion:

After producing a rough hand sketch, it appears that a crossover that realigns north bound traffic head to head with south bound traffic is geometrically feasible. This crossover would occur south of where the two straddle bents are to be constructed. This will allow the straddle bents to be constructed along with the majority of the northbound I-225 lanes while traffic is on the southbound lanes. Further analysis is required to ensure the crossover will fit in after the end of the light rail and before the straddle bents.



Phase 1 Crossover

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	**ALTERNATIVE "A" COSTS**	**ALTERNATIVE "B" COSTS**	**ALTERNATIVE "C" COSTS**
INITIAL COSTS:				
Type TL-5 Barrier (272 Lin FT)	$30,192.00	$0.00		
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$30,192			
CAPITAL SAVINGS				
FUTURE SAVINGS				
TOTAL SAVINGS (original - alternative)	$30,192			
NOTE: Items in italics are calculated				

VALUE ENGINEERING PROPOSAL NO. 04-003

SUMMARY PROPOSAL DESCRIPTION:

Protect LRT falsework for median structure by implementing a phasing scheme whereby TL-5 barriers are not required by placing NB I-225 traffic temporarily on the subexcavated area under the structure.

Estimated potential savings:

Initial:	$ 35,000
Future:	$ 0,000
Total:	$ 35,000

Discussion:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P03-005 - Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.

EVALUATION
Idea Number: 04-003 Idea Description: Protect LRT falsework for median structure by implementing a phasing scheme whereby TL-5 barriers are not required by placing NB I-225 traffic temporarily on the subexcavated area under the structure.
Advantages of alternative concept: 1. TL-5 barriers are in-house design and are costly to design, construct and remove. 2. TL-5 barriers are replaced with Type 7 temp barrier in the 4-foot deep subexcavated area and the vertical cut earthwork is used as the buffer for the pier columns.
Advantages of original concept: 1. Construction of straddle bent is not contingent on specific phase of roadway construction.
Risks of implementing alternative concept: 1. Temporary drainage and culvert crossings will need to be designed in order to ensure that temporary pavement will remain hydraulically efficient until the straddle bent median structure is complete, and the recompaction of the subgrade is complete.

Calculations and/or Discussion:

	Cost of Type 7 Barrier Temporary			
	Length in feet	Unit Cost		Total
Type 7 Temp Barrier	272	$15.00		$4,080.00
End sections embedded in embankment				
	Cost of TL-5 Barrier			
	Length in feet	Unit Cost		Total
TL-5 Construction	272	$111.00		$30,192.00
Type 3 Flared End Sections	2	$4,000.00		$8,000.00
Potential Savings				$34,112.00
			round to $ 35,000	

VALUE ENGINEERING PROPOSAL NO. 01-006

SUMMARY PROPOSAL DESCRIPTION:

Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project.

Estimated potential savings:

Initial:	$ Not Quantified
Future:	$ Not Quantified
Total:	$ Not Quantified

Discussion:

This proposal recognizes the benefits of combining the CDOT and RTD projects and constructing at the same time. The value added may be realized with the scheduling efficiencies and minimizing impacts to the traveling public, but actual costs savings cannot be quantified.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR07-001 - Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects.
SR01-015 - Use the lessons learned from the T-REX Project when bidding the CDOT and RTD Contracts.

EVALUATION
Idea Number: 01-006 Idea Description: Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project.
Advantages of alternative concept: 1. Utilizing one contractor to construct both projects 2. Minimize impacts to the traveling public and surrounding community 3. Combine similar construction activities and phasing 4. Can utilize the RTD LRT corridor as part work area for stagging areas or as part of phasing for traffic control.
Advantages of original concept: 1. Separately track individual project quantities and payments would be provided.
Risks of implementing alternative concept: 1. Funding sources complications 2. Federal Environmental clearances 3. Multiple design standards and specifications

Calculations and/or Discussion:

The concept to coordinate the highway widening project and the light rail transit (LRT), similar to the multimodal Transportation Expansion (T-REX) Project, would have significant benefits to both CDOT and RTD. There are many challenges that would need to be overcome and project goals would need to be set to help ensure success. In addition, a significant effort for project partnering would need to be established. Once the initial coordination efforts are complete, there could be assumed significant cost savings for both RTD and CDOT during construction. Most of these costs would be realized in program management, construction scheduling, project implementation, traffic control items, and construction phasing.

The proposal acknowledges the apparent value added by combing the highway and transit construction projects, but the actual elements are not specifically definable; therefore, an actual cost savings has not been quantified.

VALUE ENGINEERING PROPOSAL NO. 01-005

SUMMARY PROPOSAL DESCRIPTION:

Modify the typical section to eliminate and/or reduce some retaining walls.

Estimated potential savings:

Initial:	$ 90,000
Future:	$ 0,000
Total:	$ 90,000

Discussion:

The original design proposes the retaining wall be tall enough for the future 8-lane with an open ditch section. By making the drainage system an enclosed system in the 8-lane, we can remove the ditch and approximately 4 feet of wall height for the entire length.

Related Value Engineering Proposals and/or Supplemental Recommendations:

P03-009 - Place storm drain inlets at the future 8-lane locations, but use area inlets until the ultimate configuration.

EVALUATION
Idea Number: 01-005 Idea Description: Modify the typical section to eliminate and/or reduce some retaining walls.
Advantages of alternative concept: 1. Will reduce the area of required retaining wall, reducing cost and construction time.
Advantages of original concept: 1. Uses standard slopes and an open ditch section. 2. Less cleaning cost than closed system.
Risks of implementing alternative concept: 1. None apparent.

Calculations and/or Discussion:

Assuming the proposed cut slope will be 3:1, pushing the open ditch section an additional 12 feet for the widening would increase the retaining wall height by 4.0 feet. The proposed solution is to overbuild the wall height this additional 4.0 feet to accommodate the future widening. If we replace this open ditch section with a closed drainage system when the 8-lane ultimate section is constructed, we could reduce the need for additional height when the ultimate 8-lane section is constructed, and save 4 feet of wall height. This concept also benefits isolating MS4 treatment area better.

Retaining Wall Savings:	4.0 ft x 1450 lf x $50/sf =	$290,000
Type 7 Barrier Cost: 1450 lf x $55/lf =		($80,000)
Drainage System:	1450 lf x $70/lf =	($102,000)
Additional Pavement Under Type 7:	2 ft x 1450 lf/9 x $45 =	($15,000)
Estimated Savings (with rounding): =		**$90,000**

Additional Combined Concepts:

01-009 “Use a Landscape Berm in lieu of soundwall”
01-014 “Subtract Berm height from soundwall”

These additional ideas were explored as a part of the typical section study. Sections were cut at 50-foot intervals along the soundwall/retaining wall area for study and consideration. The existing condition is slightly bermed already. The noise evaluation should take into account this existing berm in the determination of required wall height, and not simply take the elevation difference between roadway and receptor elevations. Doing this would likely result in a shorter soundwall, which can be perched on the existing berm.

Adding subexcavation material to this existing berm was also studied in an attempt to further improve the noise reduction by berming up available earthwork on the job. However, existing slopes are already greater than 3:1 through the area of the retaining wall. Additional soil added to the top of this slope would not catch grade, and would cause larger retaining walls than the original concept, which is counterproductive. Therefore, this concept was not taken further.

VALUE ENGINEERING PROPOSAL NO. 02-006

SUMMARY PROPOSAL DESCRIPTION:

Adjust I-225 profiles where slopes are less than 0.50% to improve drainage and minimize the number of inlets.

Estimated potential savings:

Initial:	$ 12,000
Future:	$ 0,000
Total:	$ 12,000

Discussion:

Reviewing the mainline profiles where the grade is less than 0.50%, while being mindful of the vertical constraints, resulted in a potential vertical modification. On the northbound side it appears the PVI at station 1311+50 can be eliminated. Instead of an entrance grade of 0.72% and an exit grade of 0.42% the PVI can be eliminated resulting in a uniform 0.61% slope. This will reduce the number of inlets required from 5 to 3.

Related Value Engineering Proposals and/or Supplemental Recommendations:

Modify the northbound profile as detailed in discussion.

EVALUATION
Idea Number: 02-006 Idea Description: Adjust I-225 profiles where slopes are less than 0.50% to improve drainage and minimize the number of inlets.
Advantages of alternative concept: 1. The new profiles will still match existing closely especially where matching is critical. However, grades will be steepened where practical to improve drainage.
Advantages of original concept: 1. The current profiles match existing ones more closely.
Risks of implementing alternative concept: 1. If the profile is modified only considering drainage improvement key vertical constraints could be left unmet. Major vertical constraints include: RTD braid on south end of project, Yale Ave. grade separation, CBC near Jewell Ave., high pressure gas lines on north segment, underground electric near sub-station, and many other utilities on north segment.

Calculations and/or Discussion:

Reviewing the mainline profiles where the grade is less than 0.50% while being mindful of the vertical constraints resulted in a potential vertical modification. On the northbound side it appears the PVI at station 1311+50 can be eliminated. Instead of an entrance grade of 0.72% and an exit grade of 0.42%, the PVI can be eliminated resulting in a uniform 0.61% slope. Rough order of magnitude drainage recommendations were provided by a drainage expert. These recommendations suggested that within this 2,250' run on north bound I-225 the number of inlets could be reduced from 5 to 3.

COST ANALYSIS				
PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS (5 Inlets)	**ALTERNATIVE "A" COSTS (3 Inlets)**	**ALTERNATIVE "B" COSTS**	**ALTERNATIVE "C" COSTS**
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Vane Grate Inlet (Double)(10 foot)	$30,000.00	$18,000.00		
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$30,000	$18,000		
CAPITAL SAVINGS		$12,000		
FUTURE SAVINGS		$0		
TOTAL SAVINGS (original - alternative)		$12,000		
NOTE: Items in italics are calculated				

VALUE ENGINEERING PROPOSAL NO. 01-002

SUMMARY PROPOSAL DESCRIPTION:

Allow alternative soil stabilization techniques in the contract such as EN 1 resin, rubbelization, stabilize to a lower depth, or the no treatment option.

Estimated potential savings:

Initial:	$ 800,000
Future:	$ 0,000
Total:	$ 800,000

Discussion:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-002 Idea Description: Allow alternative soil stabilization techniques in the contract such as EN 1 resin, rubbelization, stabilize to a lower depth, or the no treatment option.
Advantages of alternative concept: 1. Roadbond EN 1 has 60% savings over lime; it is placed, mixed, compacted, and finished in one operation, reduces swell potential, and is a green product as it is a by-product of the citrus industry. 2. Alternatives allow the Contractor to custom fit his construction phasing to the desired stabilization method. 3. Allowing rubbelization of existing asphalt and concrete used in combination with other soil stabilization methods magnify potential cost savings and is used as a subbase for concrete pavement where and if soil stabilization is not required. 4. Cure time for lime is temperature dependent as it cures and typically takes a minimum of 10 days. 5. Lime is caustic. 6. Requires close observation to confirm the "mixing" is adequately meeting specifications.
Advantages of original concept: 1. Lime treatment is the most common soil stabilization method and has been proven to work in the Region 6 area. 2. The construction and material requirements, and method of measurement are described in the CDOT standard specifications and construction methods are reliable and proven.
Risks of implementing alternative concept: 1. Increased risk of subgrade failure due to unproven method in Colorado may be cause our geotechnical review board to decide against alternate soil stabilation methods. 2. North of the Mississippi Bridge, lime was used as soil stabilization. The tie-in going south is proposed to be an alternative concept - the roadbed subgrade, therefore, would be a hybrid of technologies that may not function identically over time.

Calculations and/or Discussion:

In the I-225, Mississippi to 2nd Value Engineering proposal -- a similar proposal (P03-005) was reviewed by the VE team. This proposal is somewhat different.

Roadway EN 1 is a Soil Stabilization method used by Texas DOT and others to replace lime and/or other soil stabilization methods. Rubbelization would be used in lieu of ABC Class 6 where allowed. Currently there are no roadway sections using aggregate base course, so a comparative analysis was not done. Stabilization to a lower depth will be done in a separate analysis by the geotechnical committee. The no treatment option was suggested as there is no evidence of heaving in roadway sections of I-225 built without lime in the 1970's.

Possible uses of concrete rubbelization include maintenance access roads, as a Class I filler behind MSE walls, on other projects, and as a substitue for roadbase where allowed.

	Cost of Lime-treated soil stabilization					
Pay Item	Quantity	Unit	Unit Cost		Total	
Hydrated Lime	6306	Ton	$130.00		$819,780.00	
Process Subgrade 12 inch	255190	SY	$2.00		$510,380.00	
					$1,330,160.00	Total
Cost of Roadbed EN 1						
Based on advertised 60% savings	$1.330,160 x 0.40 =				$532,064.00	Total
Potential Savings					$798,096.00	
				round to $800,000		

VALUE ENGINEERING PROPOSAL NO. 03-009

SUMMARY PROPOSAL DESCRIPTION:

Place storm drain inlets at the future 8-lane locations, but use area inlets until the ultimate configuration.

Estimated potential savings:

Initial:	$ 80,000
Future:	$ 21,000
Total:	$ 101,000

Discussion:

The cost savings for the initial condition is comparing the additional cost to the throwaway costs of building drainage improvements for the interim condition. The additional upfront cost to implement this proposal during the interim 6-lane condition is the $171,000 shown in the life-cycle cost spreadsheet for the alternative plan. The savings is based on comparing the additional costs to the costs incurred to construct the interim 6-lane condition that would be throw away items.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 03-009 Idea Description: Place storm drain inlets at the future 8-lane locations, but use area inlets until the ultimate configuration.
Advantages of alternative concept: 1. Facilitates cost savings by reducing interim improvements that would need to be removed and replaced with the ultimate configuration. 2. Increases design capacity of the system during the interim condition by being sized for the ultimate 8-lane condition.
Advantages of original concept: 1. Reduces the design scope to cover a future widening that could be decades away.
Risks of implementing alternative concept: 1. The design concept for the future widening could drastically change as transportation technology evolves, and may require significant reconstruction if today's assumptions are not followed.

Calculations and/or Discussion:

The proposal is to strategically locate drainage inlets at the ultimate location for the inlets for the 8-lane construction. This proposal would save removing and reconstructing inlets along the project length by strategically placing the inlets in locations that facilitate using them for both the 6-lane configuration as well as the ultimate 8-lane configuration.

This proposal requires a complete design for the interim as well as the ultimate to determine actual locations to construct these inlets. The status of the plans to-date show utilizing ditches to convey runoff along the east side of the project.

South of Iliff, there is a ditch section shown along the west side of the roadway sections. This ditch could be utilized for the interim condition to route flows from the southbound lanes and avoid constructing inlets along this stretch until the 8-lane configuration determines that inlets are required or the ditch is reconstructed. It appears that a large cut and retaining walls are required along the west edge of the typical section for the interim condition beginning at Sta. 1249+00 and extending to section 1264+00. It appears that utilizing a ditch for the ultimate 8-lane configuration is not feasible and that utilizing inlets along the edge of shoulder and a barrier will help tie into the retaining walls required for the interim condition. It appears that there is no significant benefit to try to accommodate the ultimate configuration here.

South of Iliff, along the east side of the roadway, the current plans indicate utilizing ditches to the east of the roadway. Since a large stretch of the northbound lanes are superelevated, the runoff from the roadway area will drain toward the median barrier. It is recommended that the inlets be sized and spaced to accommodate the additional runoff from the ultimate pavement section and installed during the interim condition. This will require additional costs implemented in the near future to save significant additional costs in the future. This equates to requiring approximately 17% more drainage infrastructure

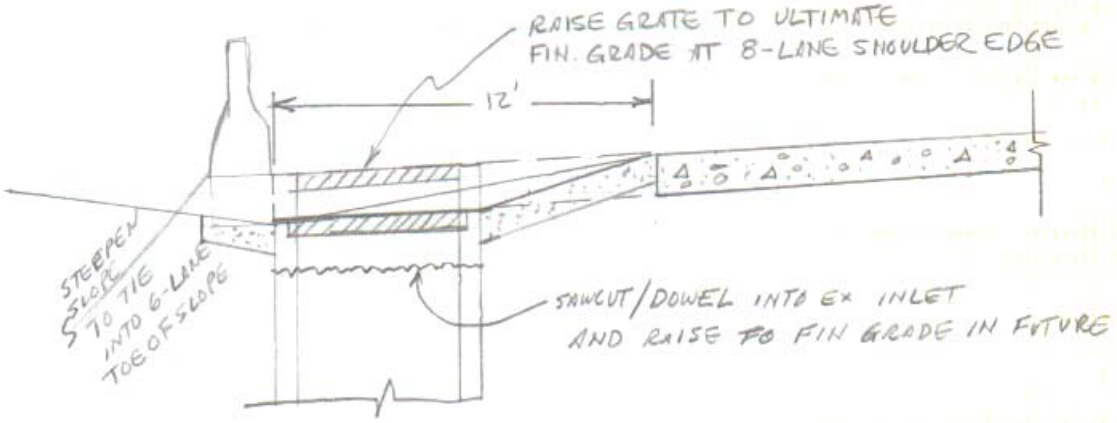
based on the ratio of the ultimate lane width versus the interim lane widths, i.e. 84/72 equates to an additional 17% more pavement.

North of Iliff, the current status of the design shows utilizing a typical ditch section with 6-to-1 side slopes off of the roadway paving and 4-to-1 side slopes with a depth of approximately one foot along the east side of the roadway with the west side draining away from the roadway. The west side needs to capture the flow from the roadway for MS4 purposes. There appears to be value in strategically placing the inlets along the east side to accommodate the future location of inlets and larger pipe sizes for the ultimate configuration and modifying the ditch alignment in the vicinity of the inlets to facilitate this by placing the inlets further east where the ultimate ditch alignment will reside. Along the west side, the use of a temporary 12-foot wide swath of hot mix asphalt ditch paving and inlets that are spaced at the ultimate location and pipe sizes increased to accommodate the additional flow will be beneficial and provide a significant project savings. This does not need to consider the benefit for this section, however the issue to capture and treat the MS4 for that section of roadway needs to be considered.

P03-009								
26-Jan-11								
ADDITIONAL Costs Required with Proposal:								
	Width	Depth	Tons / LF	Cost/Ton	Cost/LF			
HMA Temporary Ditch Routing	12	0.5	0.405	$50	20.25		Use $20 / LF	
	Cost/Inlet	Spacing	Add'l Inlets Factor					
Additional Inlets	6000	500	0.17		2.04		Use $2/LF	
Larger Pipe Required	Assume $10/LF Required to upsize pipes due to 17% increase in impervious						Use $10/LF	
Total Cost Increase			Sum of above >>>>>>>>		Use	$32/LF	<<<<<<<<<<<<<<<<<	
Throw Away Costs of Original Design:								
	Cost/Inlet	Spacing			Cost/LF			
Inlets at 500' Intervals	6000	500			$12			
					Cost/LF			
Type 7 Barrier					$35			
Additional Throw Away Unit costs			SUM>>>>>>>>>>>>>>>>		Use	$47/LF		
ADDITIONAL Costs For Ultimate Construction (Original Plan):								
	Cost/Inlet	Spacing			Cost/LF			
Inlets (1 every 427 Feet)	6000	427			$14			
Remove Inlets					$2			
Remove Barrier					$1			
Reconstruct Barrier					$35			
Total				Use	$52	per LF		
ADDITIONAL Costs For Ultimate Construction (For Proposal Alternative):								
Remove HMA Ditch Paving					$2			
Construct Type 7 Barrier					$35			
	Cost/Inlet	Spacing			Cost/LF			
Raise Inlet	1000	427			$2			
TOTAL					$39			
				Use	$39/LF			

NORTH OF ILIFF, ALONG WEST SIDE

UTILIZE VANE GRATE INLETS CONSTRUCTED LOW TO MATCH DITCH ELEVATIONS, SPACED AT INTERVALS THAT WILL INTERCEPT ULTIMATE FLOW AT SPREAD WIDTH CRITERIA AND SIZE PIPE NETWORK FOR ULTIMATE FLOW CAPTURE RATE.



ADDITIONAL COST INCURRED WITH 6-LANE PHASE IS 17% MORE INLETS WITH 17% LARGER PIPE CONDUITS REQUIRED. AVG OF 12' WIDE ADD'L HBP PAVING, PLUS MODIFY INLETS IS REQUIRED LATER.

BENEFITS: ① ALLOWS MS4 FLOWS TO BE CAPTURED AND TREATED; ESPECIALLY WHEN EDGE IS IN FILL

② DOESN'T REQUIRE CONSTRUCTION OF INLETS AT 6-LANE EDGE AND BARRIER THAT WOULD BE TEMPORARY, THROW AWAY ITEMS

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	**ALTERNATIVE "A" COSTS**	**ALTERNATIVE "B" COSTS**	**ALTERNATIVE "C" COSTS**
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Additional cost for HMA ditch paving, inlets, & pipe		$171,200.00		
Throwaway of type 7 barrier & temp. inlets	$251,450.00			
SUBTOTAL INITIAL COSTS:	$251,450.00	$171,200.00		
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):	20			
COST: replace inlets & type 7 barrier	$275,525.00			
YEAR:		20		
COST: remove HMA, add type 7, raise inlet		$208,650.00		
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:	$85,910.00	$65,058.06		
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$337,360	$236,258		
CAPITAL SAVINGS		$80,250		
FUTURE SAVINGS		$20,852		
TOTAL SAVINGS (original - alternative)		$101,102		
NOTE: Items in italics are calculated				

SECTION 4 - SUPPLEMENTAL RECOMMENDATIONS

The following ideas were generated by the VE Team and thought to have considerable merit. These ideas are thought to offer improvements, but either the economics were not calculable or the idea could not be developed because of insufficient information.

The VE Team suggests that these recommendations be carefully reviewed and given as much thought and effort as the formal VE Proposals.

SUPPLEMENTAL RECOMMENDATIONS SUMMARY TABLE

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
SR01-015	Use the lessons learned from the T-REX Project when bidding the CDOT and RTD contracts.	**Accept.** See Section 8 for explanation.	4-2
SR01-017	Build the CDOT Highway widening project without federal funding.	**Table.** See Section 8 for explanation.	4-4
SR01-020	Let Xcel Energy install their future needed electrical conduits as part of roadway construction project.	**Accept.** See Section 8 for explanation.	4-6
SR02-002	Utilize open channels and ditches to reduce the number of stormwater pipes required to route stormwater within the project area.	**Decline.** See Section 8 for explanation.	4-8
SR02-003	Put conduits and/or utilities within the zone between the ultimate roadway east edge and the light rail corridor.	**Decline.** See Section 8 for explanation.	4-10
SR03-001	Use the NB on/off ramp at Parker Road for a nighttime construction detour.	**Table.** See Section 8 for explanation.	4-12
SR03-003	Use the 60' width of both I-225 bridges over Parker to build the third phase of northbound and southbound I-225 pavement in stages while traffic is maintained on the portion not under construction.	**Accept.** See Section 8 for explanation.	4-14
SR04-004	Precast the LRT Bridge straddle bents and erect them on site.	**Accept. With Modifications.** See Section 8 for explanation.	4-19
SR06-004	Allow the contractor to submit an alternative pavement design to include a warranty that covers the original life cycle design.	**Decline.** See Section 8 for explanation.	4-21
SR07-001	Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects.	**Accept with Modifications.** See Section 8 for explanation.	4-23

SUPPLEMENTAL RECOMMENDATION NO. 01-015

SUMMARY RECOMMENDATION DESCRIPTION:

Use the lessons learned from the T-REX Project when bidding the CDOT and RTD contracts.

Discussion:

Due to the similar nature of the successful T-REX Project to the I-225 highway widening and the light rail extension projects, implementing the lessons learned may aid in the implementation of a multimodal project for the I-225 corridor.

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-006 - Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project.

SR07-001 - Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects.

EVALUATION
Idea Number: 01-015 Idea Description: Use the lessons learned from the T-REX Project when bidding the CDOT and RTD contracts.
Advantages of alternative concept: 1. Use the knowledge obtained from T-REX to coordinate and successfully build a multimodal project.
Advantages of original concept: 1. T-REX was a design-build project which have fundamental differences that may not apply to a design-bid-build project.
Risks of implementing alternative concept: 1. None noted.

DISCUSSION AND/OR CALCULATIONS:

Following the completion of the Transportation Expansion (T-REX) Project a formal document of the lessons learned on the project was compiled. *"Lessons Learned – The T-REX Mega-Project Experience": June 2007.* This document is available by request from either CDOT or RTD. Even though the T-REX project was a design-build project there are several examples that can be applied to the management of a multi-jurisdictional project. The following are a summary of these applicable lessons learned:

1. Develop a set of primary goals at the onset of the project and get "buy-in" from various stakeholders and Project participants.
2. Develop a "team approach" to project management and organization
3. Implementing a formal partnering process between the owner and contractor
    a. Commitment to mutual goals
    b. Dispute/Resolution Escalation process
    c. Accountability
    d. Consistency
4. Develop an effective Public Information program
5. Establish cost control procedures to track and manage project budget.
6. Establish a team approach to implement a Quality Assurance Program.
7. Negotiate and execute intergovernmental agreement with local governments prior to beginning construction.

SUPPLEMENTAL RECOMMENDATION NO. 01-017

SUMMARY RECOMMENDATION DESCRIPTION:

Build the CDOT Highway widening project without federal funding.

Discussion:

This idea surfaced during the project team briefing to the Value Engineering (VE) team. The VE Team decided to analyze the idea further for thoroughness.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR07-001 - Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects.

EVALUATION
Idea Number: 01-017 Idea Description: Build the CDOT Highway widening project without federal funding.
Advantages of alternative concept: 1. Removes the need to perform additional environmental analysis on the RTD light rail project. 2. Combine projects cost without the need to track separate funding sources. 3. Removes the Davis/Bacon wage requirements, which would improve bid prices.
Advantages of original concept: 1. Funding for the highway widening project has been determined and a federal funding component was anticipated.
Risks of implementing alternative concept: 1. Not being able to fully fund the highway project. 2. Potential loss of $20 million in federal funding for this project.

DISCUSSION AND/OR CALCULATIONS:

The Colorado Department of Transportation (CDOT) typically uses federal funding to supplement costs for capital construction projects around the state. The Federal Highway Administration (FHWA) is the administrative branch of the federal government that oversees the distribution and requirements of the federal dollars to CDOT. Therefore, there are specific requirements and clearances, National Environmental Policy Act (NEPA), which CDOT must follow in order to subsidize these construction projects.

Currently RTD assumed that funding for its light rail corridor project would be with local money and performed a comparative level of environmental analysis for its light rail corridor project, but without federal oversight.

If any federal money is used for a combined multimodal (highway and transit) capital project, the transit portion of the project may have to perform additional environmental analysis and obtain federal clearance. This would impact the proposed project schedule and reduce the chance for implementing the two projects together and possible increase to RTD light rail construction costs.

The other option would be to determine if sufficient state funding would be available to completely fund the highway widening project, therefore, eliminating the need for federal oversight clearance and funding.

SUPPLEMENTAL RECOMMENDATION NO. 01-020

SUMMARY RECOMMENDATION DESCRIPTION:

Let Xcel Energy install their future needed electrical conduits as part of roadway construction project.

Discussion:

The concept is to install conduits that can be utilized by XCEL Energy for crossing the roadway with additional underground electrical lines that Xcel foresees needing in the short term or long term future. This concept will provide added value by allowing Xcel to utilize these conduits for the installation of their underground electrical lines without incurring the higher cost to bore these lines in the future. CDOT may be able to recoup their costs to install these conduits and possibly share in the cost savings that Xcel would realize. The anticipated location for these crossings are located across I-225 at Sta 1311+00.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-020 Idea Description: Let Xcel Energy install their future needed electrical conduits as part of roadway construction project.
Advantages of alternative concept: 1. Saves future traffic disruption
Advantages of original concept: 1. Less complicated
Risks of implementing alternative concept: 1.

DISCUSSION AND/OR CALCULATIONS:

None

SUPPLEMENTAL RECOMMENDATION NO. 02-002

SUMMARY RECOMMENDATION DESCRIPTION:

Utilize open channels and ditches to reduce the number of stormwater pipes required to route stormwater within the project area.

Discussion:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-005 - Modify the typical section to eliminate and/or reduce some retaining walls.

EVALUATION
Idea Number: 02-002 Idea Description: Utilize open channels and ditches to reduce the number of stormwater pipes required to route stormwater within the project area.
Advantages of alternative concept: 1. Reduces initial capital costs. 2. Reduces life cycle replacement costs
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Additional flow may increase hydroplaning safety concerns. 2. Openings could be susceptible to clogging.

DISCUSSION AND/OR CALCULATIONS:

Upon review of the cross sections shown for the portion of the project located to the north of the high point of the profile at Sta. 1236+50+/-, it appears that the northbound super would require inlets along the median barrier due to the profile of the southbound lanes "trapping" runoff along the barrier. If the southbound profile could be lowered slightly by 1 foot maximum, then the use of barrier with drainage openings would allow the runoff to continue to sheet flow across the southbound lanes, thus utilizing the ditch along the west side of the roadway to reduce the storm sewer system required. This concept appears to be viable from Sta. 1236+00 to Sta. 1260+00. The ditch along the west side of the roadway is set at a nice, gentle grade of 0.5%. It should be noted that the drainage design for this section of roadway has not been fully developed yet. This alternative could save infrastructure costs for inlets and related pipe network.

It appears that a better defined ditch would be beneficial from the high point of the ditch to the east of the northbound lanes, north of Sta. 1240+00 to 1243+00 to properly route the offsite flows. North of 1243+00 a ditch is defined better all the way to Sta. 1260+00. A similar condition is evident north of Sta. 1260+00 to approximately Sta.1266+00.

SUPPLEMENTAL RECOMMENDATION NO. 02-003

SUMMARY RECOMMENDATION DESCRIPTION:

Put conduits and/or utilities within the zone between the ultimate roadway east edge and the light rail corridor.

Discussion:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 02-003 Idea Description: Put conduits and/or utilities within the zone between the ultimate roadway east edge and the light rail corridor.
Advantages of alternative concept: 1. Reduces phased construction of the numerous laterals versus a single main crossing.
Advantages of original concept: 1. Eliminates the need to have a secondary pipe system from inlet to inlet along both sides of the roadway for the section north of Iliff.
Risks of implementing alternative concept: 1. Additional flow may increase hydroplaning safety concerns. 2. Openings could be susceptible to clogging.

DISCUSSION AND/OR CALCULATIONS:

The concept to utilize the zone between the west edge of the I-225 roadway and the east edge of the light rail corridor as a utility corridor has merit because it can facilitate constructing the main storm sewer trunk line in this zone thus reducing the amount of laterals that extend across the highway. For the north section of the project, north of Iliff there are seven laterals that drain from east to west across the I-225 corridor. This requires extending each of these with each phase of roadway construction. If the main utilized the "no man's zone" then the number of crossings of I-225 can be reduced from seven laterals to one main line crossing.

This proposal does not necessarily provide a cost savings to the project that can be readily quantified since the reduction in piping for the laterals is really offset by needing a secondary system along the west edge of the roadway to facilitate routing the inlets along this shoulder, but is considered a value added proposal that may accelerate the phases of construction by reducing the phased extensions of the pipe(s) crossing I-225.

SUPPLEMENTAL RECOMMENDATION NO. 03-001

SUMMARY RECOMMENDATION DESCRIPTION:

Use the NB on/off ramp at Parker Road for a nighttime construction detour.

Discussion:

The use of full width I-225 northbound north of the Parker Rd. structure during night time operations would allow larger work areas in a confined area. This would also allow Utility crossings to be completed in 1 phase.

Related Value Engineering Proposals and/or Supplemental Recommendations:

P03-005 - Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.

EVALUATION
Idea Number: 03-001 Idea Description: Use the NB on/off ramp at Parker Road for a nighttime construction detour.
Advantages of alternative concept: 1. Allows larger areas to be constructed in this tight area north of Parker Rd.
Advantages of original concept: 1. All I-225 traffic is not required to exit at Parker Rd. and get back on.
Risks of implementing alternative concept: 1. Public disapproval- bad Media- Congestion on Parker Rd. Not meeting driver expectation resulting in rear-end collisions.

DISCUSSION AND/OR CALCULATIONS:

No cost savings noted.

Project Special Provisions should include strong language that has specific limitations and purposes for this closure with final approval required by project engineer. Contractor must submit written request for the use of this detour.

SUPPLEMENTAL RECOMMENDATION NO. 03-003

SUMMARY RECOMMENDATION DESCRIPTION:

Use the 60' width of both I-225 bridges over Parker to build the third phase of northbound and southbound I-225 pavement in stages while traffic is maintained on the portion not under construction.

Discussion:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P03-005 - Use a 3-phase construction traffic shifting scheme to move traffic to one side to complete northbound (NB) traffic lanes in one phase and southbound (SB) traffic lanes in one phase plus final tie-in phase.

EVALUATION
Idea Number: 03-003 Idea Description: Use the 60' width of both I-225 bridges over Parker to build the third phase of northbound and southbound I-225 pavement in stages while traffic is maintained on the portion not under construction.
Advantages of alternative concept: 1. Works with idea P01-008 to eliminate the need for type TL-5 barrier and construct the straddle bents without maintaining traffic under construction resulting in increased workzone safety.
Advantages of original concept: 1. The idea that the construction of the south portion of the light rail and I-225 would go together just came to light. Given the recent occurrence of this game-changing event no original construction sequencing plan has previously been developed.
Risks of implementing alternative concept: 1. Currently no other alternate is known given crossovers are not feasible within existing light rail.

DISCUSSION AND/OR CALCULATIONS:

Both northbound and south bound portions of I-225 near the Parker interchange are difficult to construct all at once especially where the light rail facility already exists. The third phase of this concept involves the recommendation. Below is a description of a potential construction sequencing concept.

Phase 1

- Construct temporary widening necessary to carry two-way traffic on existing southbound lanes.
- Construct cross-over near parker that will carry north bound traffic to two-way traffic on southbound lanes.
- Construct cross-over near Iliff that will allow north bound traffic on southbound lanes to utilize Iliff interchange.
- Construct majority of north bound I-225 and majority of light rail not in conflict with cross over near Parker including two straddle bents and two hammer head piers near Parker. Construct half of the Yale bridge over north bound lanes.

Phase 2

- Construct a crossover north of Iliff that will carry traffic on southbound lanes to two-way traffic on newly constructed northbound lanes.

- Construct crossover north of Parker that will allow southbound traffic on northbound lanes to use Parker interchange

- Construct majority of southbound I-225 lanes, complete the other half of the Yale bridge over southbound lanes, and any remaining light rail not in conflict with crossover near Parker.

Phase 3

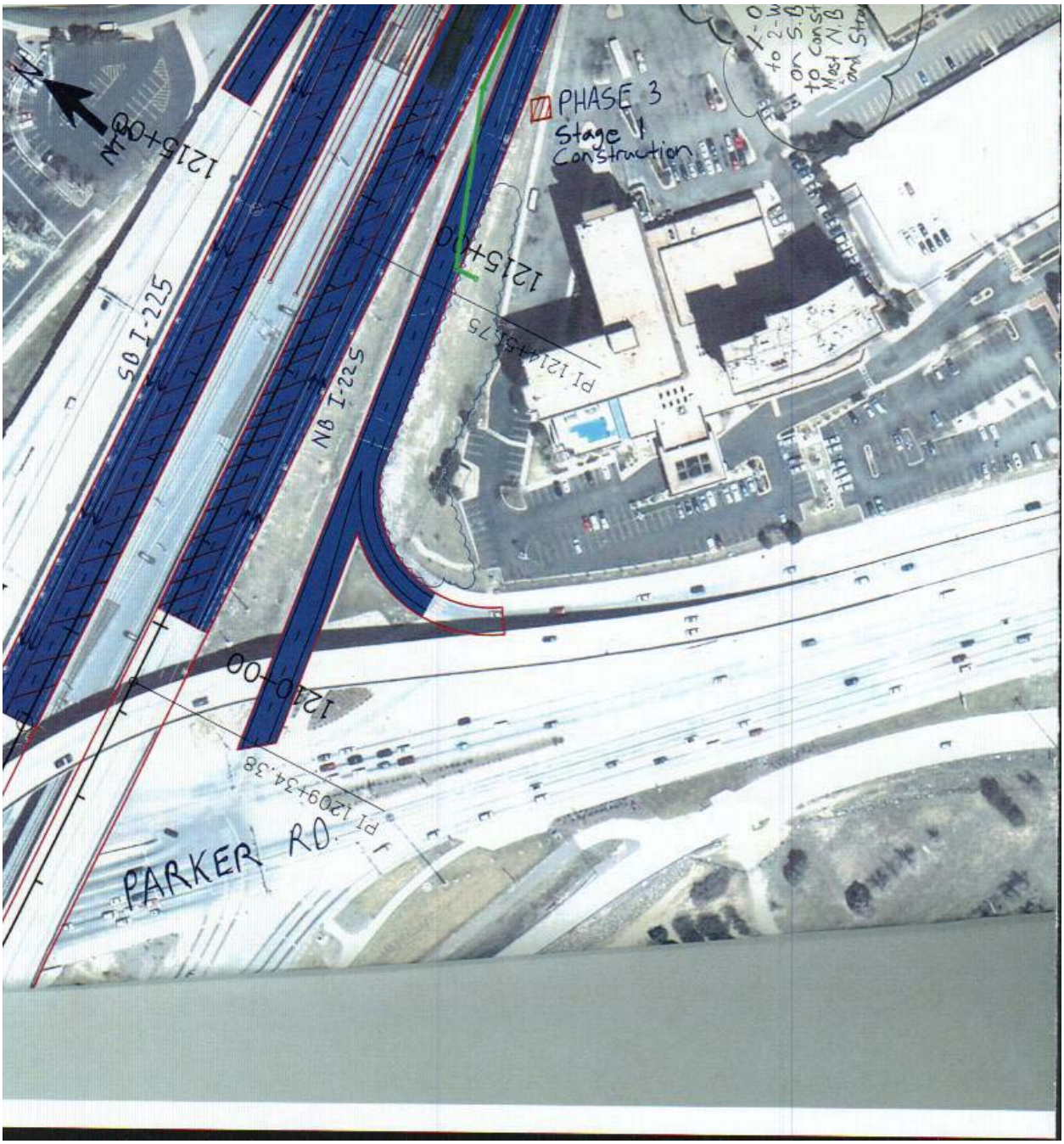
- Open traffic to newly constructed NB and SB I-225.

- Remove crossovers.

- Use the 60' width of both I-225 bridges over Parker to build the third phase of NB and SB I-225 pavement in stages while traffic is maintained on the portion not under construction.

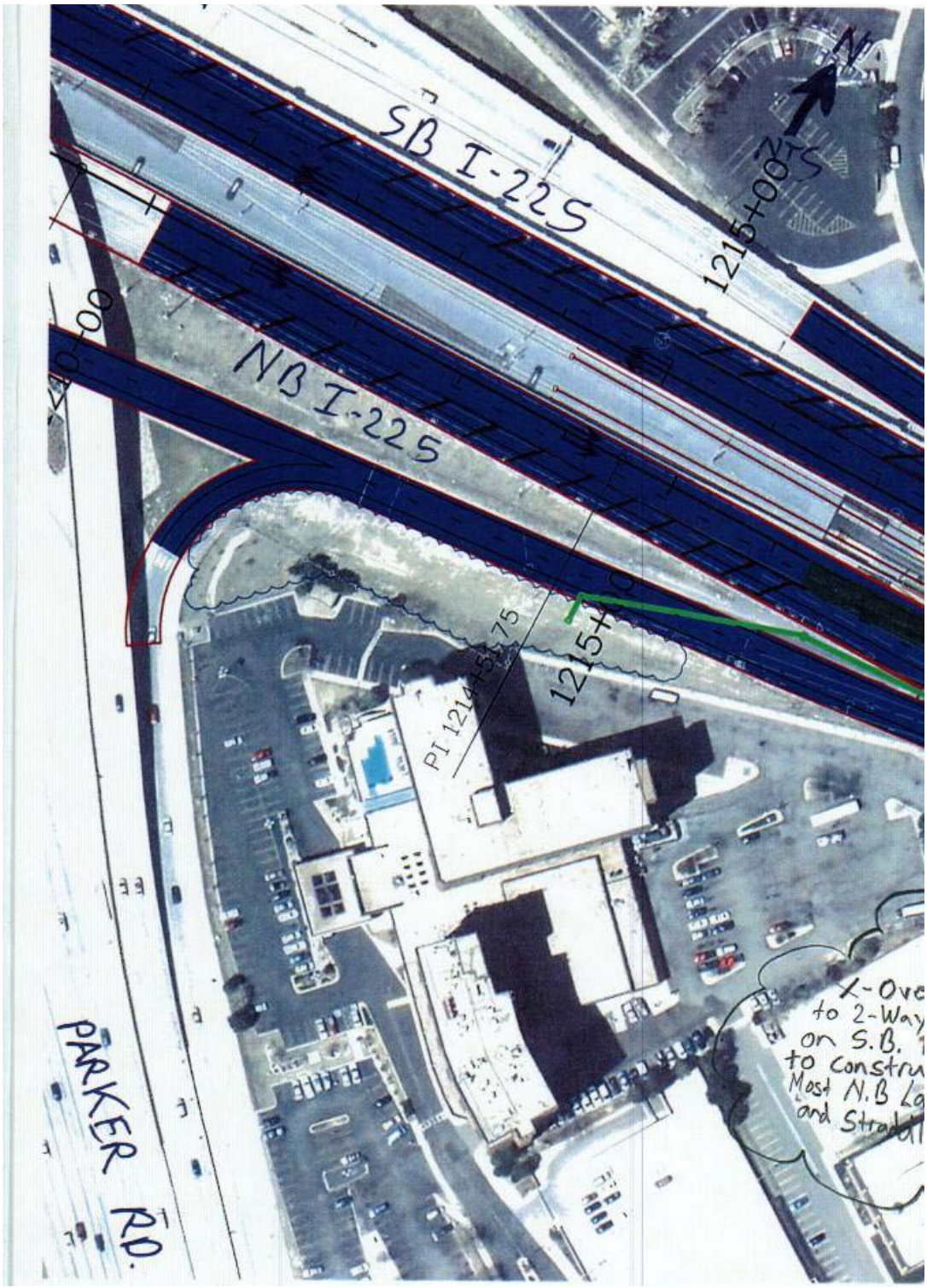
Stage 1: Maintain traffic on the outside northbound and southbound pavement while two lanes and the median shoulder are being constructed for both northbound and southbound. Construct the remaining south portion of the light rail previously in conflict with the south crossover in the median area.

Stage 2: Maintain traffic on the inside northbound and southbound pavement while the third lane and shoulder are being contructed for both northbound and southbound.



Phase 3 – Stage 1 Construction

Cross hatching = construction
Arrows = traffic direction



Phase 3 – Stage 2 Construction

Cross hatching = construction
Arrows = traffic direction

SUPPLEMENTAL RECOMMENDATION NO. 04-004

SUMMARY RECOMMENDATION DESCRIPTION:

Precast the LRT Bridge straddle bents and erect them on site.

Discussion:

Use side-by-side precast/prestressed concrete girders for the straddle bent cap.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 04-004 Idea Description: Precast the LRT Bridge straddle bents and erect them on site.
Advantages of alternative concept: 1. Prevents the need for TL-5 barrier, reduces construction time, improves safety, reduces cost.
Advantages of original concept: 1. Allows the contractor to meld his design to his phasing.
Risks of implementing alternative concept: 1. Requires significant crane operations.

DISCUSSION AND/OR CALCULATIONS:

The existing construction concept utilizes extensive falsework, including a 40-ft span of falsework over live traffic. The vicinity of falsework to live traffic requires a significant safety barrier, driving up costs further.

These 118-foot wide straddle bent caps could be precast/prestressed concrete beams in multiple sections, and erected like side-by-side bridge girders over a nightime closure. This construction concept would not require the TL-5 barrier, would prevent the need for falsework, and reduce construction time.

Built in 2 sections, these girders could be prestressed to support their own weight, with provisions for a second stage of post-tensioning following girder erection to match the design strength of the original concept.

Local precasters prefer girder weights to be under 225 ton; however, they have delivered and erected girders up to 250 ton.

If built in 2 sections: 3.75 ft wide x 6.83 ft deep x 118.25 long x 155 pcf /2000 = 235 ton

The thickened section, which supports the girders, could be cast-in-place and utilize shear stirrups in the precast girders to tie the two girders together, and insure composite action.

SUPPLEMENTAL RECOMMENDATION NO. 06-004

SUMMARY RECOMMENDATION DESCRIPTION:

Allow the contractor to submit an alternative pavement design to include a warranty that covers the original life cycle design.

Discussion:

Develop a project Special Provision which requires the contractor to agree to repair or replace damaged or failed sections of the pavement that accrue over the life cycle after project acceptance.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 06-004 Idea Description: Allow the contractor to submit an alternative pavement design to include a warranty that covers the original life cycle design.
Advantages of alternative concept: 1. Contractors would monitor their workmanship and correct problems on their own.
Advantages of original concept: 1. No warranty required which could create a lower average bid price for the related items
Risks of implementing alternative concept: 1. The pavement design in the plans could be questioned 2. There may be no way to make a bankrupt contractor fix warranty work. 3. Must keep contract open for life of warranty period.

DISCUSSION AND/OR CALCULATIONS:

Research the T-REX project and find out how that Project Special Provision reads and create a Project Special specific to this project.

SUPPLEMENTAL RECOMMENDATION NO. 07-001

SUMMARY RECOMMENDATION DESCRIPTION:

Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects.

Discussion:

In addition to the options presented and evaluated during the Value Engineering Study, any process to federalize the light rail portion of the project was not analyzed.

RTD has performed an Environmental Evaluation (EE) which included an extensive public and local agency involvement and comment period and identified specific mitigation measures. The extensive analysis completed for the EE is consistent with the Federal NEPA process but without federal oversight. Other alternatives may be presented for an expedited federal process for the LRT project that would minimize the risks for a combined project.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 07-001A Idea Description: Bid as one construction contract with lowest cost plus schedule incentives winning the bid
Advantages of alternative concept: 1. Single construction schedule 2. Can incorporate incentives for implementing and managing project schedule 3. Better construction coordination (i.e. shared traffic control and work areas). 4. Increases opportunities for obtaining qualified contractor.
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Traffic congestion impacts 2. May increase impact to traveling public 3. May reduce project quality and safety due to schedule incentives 4. May require federal clearance requirements on LRT project

Calculations and/or Discussion:

This concept would take into account innovative contracting methods that would provide incentives to the contractor for efficiently managing the multimodal project through an incentive based schedule.

Contractor incentives would be established following on time completion of major milestones.

If milestones are not met then contractor would be subject to paying liquadated damages.

EVALUATION
Idea Number: 07-001B Idea Description: Bid as two separate projects with the same advertisement and award date.
Advantages of alternative concept: 1. Segregates Federal Requirements 2. Simplifies Contract Administration 3. Opportunities for contractor to get two jobs. 4. Better alignment of contractor expertise.
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. May increase construction conflicts. 2. May increase impacts to the traveling public. 3. Potential loss of economy of scale 4. Lose single point of responsibility. 5. Potential for more claims from the contractor.

Calculations and/or Discussion:

Both CDOT and RTD would develop procurement packages and advertise separately for bid.

Each package would have the same advertise and award date.

The contractor would be encouraged to bid both projects

The expectation would be to award both projects to the same contractor.

EVALUATION
Idea Number: 07-001C Idea Description: Bid one contract with two separate bid schedules
Advantages of alternative concept: 1. Defined split of bid items between CDOT and RTD 2. Single construction schedule 3. Better construction coordination (i.e. shared traffic control and work areas). 4. Increases opportunities for obtaining qualified contractor.
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. May require federal clearance requirements on LRT project

Calculations and/or Discussion:

Contractors must bid both bid schedules with award to the overall lowest bid.

EVALUATION
Idea Number: 07-001D Idea Description: Bid as three contracts - RTD (transit), CDOT (highway), and a project management/traffic control contract.
Advantages of alternative concept: 1. Helps reduce the conflicts between contractors
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Potentially higher costs due to the additional construction management contract.

Calculations and/or Discussion:

Each agency would bid and award its separate contract

The third contract be awarded to a constrcution management firm that would coordinate work including traffic control efforts for projects.

EVALUATION
Idea Number: 01-007E Idea Description: Bid as one contract and award based on qualifications.
Advantages of alternative concept: 1. Expedite the bidding process 2. Potential for selection of a qualified contractor
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Higher probability of protest. 2. Doesn't meet the Federal requirements for funding a construction project 3. CDOT has not used this method for contractor selection

Calculations and/or Discussion:

Contract is awarded to the best value and based on cost and qualifications.

Both CDOT and RTD may have to establish or modify procurement procedures.

EVALUATION
Idea Number: 07-001F Idea Description: Bid the combined project as one design/build contract
Advantages of alternative concept: 1. Reduces the construction conflicts 2. Tighter integration of plans
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Cannot accomplish administratively within preferred time 2. May increase overall design costs 3. May lose institutional project knowledge

Calculations and/or Discussion:

The contractor would have to complete the remaining CDOT design which may delay the notice to proceed as well as the project completion date.

EVALUATION
Idea Number: 07-001G Idea Description: Bid two separate projects plus bid a combined project - lowest of each bid wins or lowest overall bid wins
Advantages of alternative concept: 1. Reduce construction conflicts 2. Increase chances for selection of single contractor. 3. Splits Federal Funding Requirements
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Potential for award to two contractors 2. Increases the probability of bid protest.

Calculations and/or Discussion:

The combination would provide an incentive to contractors bidding both projects.

EVALUATION
Idea Number: 07-001H Idea Description: Bid two separate projects with coordinated distinct milestones
Advantages of alternative concept: 1. Reduces construction conflicts 2. Complies with Federal requirements 3. Can stagger bid and award dates of the two projects 4. Simplifies project specification and plan coordination 5. Better control of schedule
Advantages of original concept: 1. None noted.
Risks of implementing alternative concept: 1. Projects may be awarded to two separate contractors.

Calculations and/or Discussion:

Similar to idea SR07-001A, but including specific milestones that would need to be established.

SECTION 5 – IDEAS ANALYZED BUT NOT PROPOSED

EVALUATION
Idea Number: 01-003 Idea Description: Overlay the whole project
Advantages of alternative concept: 1. Reduced removals and Unclassified Excavation
Advantages of original concept: 1. Consistant pavement design with other projects in the cooridor
Risks of implementing alternative concept: 1. Future failed substructure and pavement. Major drainage and clearance issues
Conclusion: Do not propose this idea because the horizontal geometry is too conflicting

Calculations and/or Discussion:

EVALUATION
Idea Number: 01-007 Idea Description: Optimize NB and SB I-225 profiles to balance earthwork using offset type CE barrier.
Advantages of alternative concept: 1. Reduction in cost resulting from reduced earthwork.
Advantages of original concept: 1. Strides were made toward balancing earthwork but the profiles could be optimized further.
Risks of implementing alternative concept: 1. If profiles vary by more than 37" in an effort to balance cut on northbound with fill on southbound type CE barrier cannot be used. 2. Extreme variation of profiles also precludes cross-over's for construction sequencing.
Conclusion: Do not propose this idea because the profiles have been recently modified to better balance earthwork. Minor adjustments are possible but final profile will not vary significantly from what is currently proposed.

Calculations and/or Discussion:

Looking at the latest cross sections versus the original cross sections the cut and fill quantities appear to be mostly evenly balanced. There are areas where the grading for the southbound side is outside of right of way. These areas will be studied further and retaining walls, steeper slopes with guardrail, and enclosed drainage versus open channel flow will be explored as design progresses. These considerations will be looked at in conjunction with any further potential profile modifications to balance earthwork.

EVALUATION
Idea Number: 01-016 Idea Description: Add Change Order to SA# 16417 to extend widening at Parker Rd. to the north
Advantages of alternative concept: 1. Would accelerate project and accomodate a 2-phase construction plan
Advantages of original concept: 1. Would eliminate a construction tie-in with the pavement limits
Risks of implementing alternative concept: 1. Continued design of drainage structures may change by the time SA#16417 is completed
Conclusion: Do not propose this idea because the cost to project SA# 16417 would exceed available funds.

Calculations and/or Discussion:

The area needing completed for this work to be effective would be 2500 lf, or 36% of the total project length. All work including drainage structures, utilities, and traffic control would need to be completed for this area. Therefore, it is estimated that 36% of the estimated cost of the project would need to be applied for a cost of $7,000,000. This exceeds the available funds of the existing project.

EVALUATION
Idea Number: 01-018 Idea Description: Utilize accelerated bridge construction for the Yale Bridge.
Advantages of alternative concept: 1. Reduce the amount of time the Yale Bridge is closed to the traveling public.
Advantages of original concept: 1. Minimizes construction cost.
Risks of implementing alternative concept: 1. Increased construction cost.
Conclusion: Do not propose this idea because this evaluation is for a bridge which is a part of the RTD project, not the CDOT project. Constructing this bridge quicker does not affect the CDOT project, which is the purpose of the study.

Calculations and/or Discussion:

A quick evaluation of Accelerated Bridge Construction (ABC) was conducted to evaluate possible advantages to the CDOT I-225 widening project. Although demolishing and reconstructing this bridge in a shorter timeframe improves traffic on Yale Ave, it has little to no impact on how the I-225 widening would be completed.

EVALUATION
Idea Number: 02-005 Idea Description: Replace the CBC with a short span bridge, and use area under it for a detention pond forebay.
Advantages of alternative concept: 1. Utilizes area under the highway for MS4
Advantages of original concept: 1. Lower cost
Risks of implementing alternative concept: 1. High cost of bridge, future maintenance of both bridge and detention pond
Conclusion: Do not propose this idea because of limited access, making maintenance and cleanout of the detention pond unaccesible.

Calculations and/or Discussion:

The proposed roadway profile allows for very little vertical clearance, on the order of 4 feet, for a bridge structure to be constructed and maintain the existing drainage profile. This limits typical cleanout equipment from accessing a detention area, requiring hand methods be used to clean out a structure that is over 400 feet long (along the skew). If this detention area backs up, impacts to local drainage are likely. It was determined that the function of this crossing, as a drainage outfall, be preserved.

The existing 2-cell box culvert is being cleaned out for inspection currently. The approved invoice was $24,000, identifying the level of effort required to clean out this small structure.

EVALUATION
Idea Number: 03-004 Idea Description: Use a whitetopping transition to full depth at Parker Rd.
Advantages of alternative concept: 1. Faster construction in congested area
Advantages of original concept: 1. Consistant pavement structure with existing pavement to the south
Risks of implementing alternative concept: 1. Different settlement between project limits. Bump/dip at tie-in.
Conclusion: Do not propose this idea because the elevation conflicts with existing tie-in.

Calculations and/or Discussion:

EVALUATION
Idea Number: 05-003 Idea Description: Use a driven sheet pile wall in lieu of soil nail retaining wall.
Advantages of alternative concept: 1. Can be constructed from back side of wall, minimizing required construction area in front of wall versus a soil nail wall.
Advantages of original concept: 1. Soil nail wall will be lower initial cost, with the same finished look.
Risks of implementing alternative concept: 1. Noise associated with installation of sheet pile to adjacent homeowners.
Conclusion: Do not propose this idea because noise associated with installation of sheet piling, in addition to higher cost and possible structure damage claims from adjacent building owners due to vibration.

Calculations and/or Discussion:

No other piling is proposed on the project. The proposed Yale Bridge is founded on caissons; therefore, the sheet pile wall would be the only operation with this associated high noise during construction. The construction can be phased such that adequate (15'+) of space is available on the front side of the wall, which will be sufficient for installation of soil nails. Therefore, there is no constructability, aesthetic, or cost benefit to using driven sheet pile.

The following ideas were dismissed during the initial idea cull. They were not analyzed to the point of listing individual advantages and disadvantages.

INITIALLY FAILED IDEAS TABLE

Idea No.	Idea Description	Reason for Failing Idea
01-004	Allow alternative pavement sections in the contract	The whole corridor is full depth concrete. Previous material analysis has shown the needed asphalt depth to be nearly 19-inches. Design costs would increase.
01-012	Increase the median width between Parker Rd. and Yale Ave.	This idea was previously analyzed by the design and they concluded there is insufficient room to accomplish the separation and it would therefore require redesigning the bridge.
02-007	Utilize the median as a conveyance	There is no median in some places. It would eliminate the center barrier.
03-002	Utilize the I-225 Bridge over Parker Rd. for 2-way traffic	Won't work - the traffic can't get back
05-004	Use a caisson wall	It is probably the most expensive wall type and is not needed

SECTION 6 - FUNCTIONS CHOSEN FOR BRAINSTORMING

Six functions were identified for brainstorming in this VE Study. The seven functions (in addition to the shotgun list) were:

1. "SHOTGUN LIST" (Not really a function)
2. CONVEY STORMWATER
3. PHASE CONSTRUCTION
4. PROTECT FALSEWORK
5. RETAIN EMBANKMENT
6. STABILIZE SUBGRADE
7. BLEND CONTRACTS

SECTION 7 – BRAINSTORMING IDEAS

The following table lists all of the ideas generated by the VE Team. They are arranged by the function from which they were generated. Shotgun list ideas are alternatives the VE Team members initially brought to the workshop as a result of their pre-study assignment.

Each idea can be traced to its ultimate disposition by crosschecking the disposition column of this table with Sections 3, 4, and 5 of this report.

Some of the ideas whose disposition is listed as "As Designed" were also assumed to be "as will be designed."

PLEASE NOTE: One of the rules for creativity exercises in a formal VE Study requires the team members to "stretch" their imaginations by generating sometimes facetious and seeming nonsensical ideas in order to ideate a possible conceptual blockbuster. These ideas, too, are recorded in this table.

Brainstorming List

Idea No.	Idea Description	Disposition	With
	SHOTGUN LIST		
01-001	Combine some MS4 sites	Pass	-
01-002	Allow alternative soil stabilization techniques in the contract	Pass	-
01-003	Overlay the whole project	Pass	-
01-004	Allow alternative pavement sections in the contract	Fail	-
01-005	Modify the typical section to eliminate and/or reduce retaining walls	Pass	-
01-006	Phase the two projects construction like T-Rex	Pass	-
01-007	Modify the NB and SB profiles to balance the earthwork using offsite barrier (CE) barrier	Pass	-
01-008	Arrange the phasing to eliminate the TL5 barrier	Pass	-
01-009	Use a landscape berm in lieu of a new soundwall	Combine	01-005
01-010	Use alternative soil stabilization methods, e.g., EN-1 glue	Combine	01-002
01-011	Make a gradual transition to soil stabilization areas	As Designed	-
01-012	Increase the median width between Parker Rd. and Yale Ave.	Fail	-
01-013	Reduce the posted speed limit during construction to eliminate the need for the TL5 barrier	Combine	01-008
01-014	Subtract the berm height from noise wall height at Yale Ave.	Combine	01-005
01-015	Use the lessons learned from T-Rex when blending the RTD and CDOT Contracts	Supplemental Recommendation	-
01-016	Blend the Mississippi Ave. to 2nd Ave. with the Mississippi Ave. to Parker Rd. project, e.g., use a change order to do the early work.	Pass	-
01-017	Build the project without federal money	Supplemental Recommendation	-

Idea No.	Idea Description	Disposition	With
01-018	Utilize accelerated bridge construction for the Yale Bridge	Pass	-
01-019	Rubbelize the existing pavement	Combine	01-002
01-020	Install the Excell conduits now	Supplemental Recommendation	-
	CONVEY STORMWATER		
02-001	Use pipes and conduits	As Designed	-
02-002	Use open channel swales and ditches	Pass	-
02-003	Put conduits under the "no mans land"	Pass	-
02-004	Combine the detention basins	Combine	01-001
02-005	Replace the CBC with a bridge and use the area under it for a detention pond forebay	Pass	-
02-006	Modify the profile to enhance the flow	Pass	-
02-007	Utilize the median as a conveyance	Fail	-
02-008		Pass	-
02-009		Pass	-
	PHASE CONSTRUCTION		
03-001	Use the ramp as a detour route during the Parker Rd. transition construction	Supplemental Recommendation	-
03-002	Utilize the I-225 Bridge over Parker Rd. for 2-way traffic	Fail	-
03-003	Use the Parker Rd. Bridge and build half and half	Supplemental Recommendation	-
03-004	Use white topping at the Parker Rd. interface and possibly use rubbelizing	Supplemental Recommendation	-
03-005	Shift all traffic to one side (using crossovers) and construct the Parker Rd. transition as a separate phase	Pass	-
03-006	Leave the median barrier out of the Mississippi Ave. to 2nd Ave. project	Combine	03-005
03-007	Coordinate closures for multiple construction activities, e.g., the RTD flyover, the Yale Br. replacement, and stormwater trunk line installation	Combine	03-005
03-008	Eliminate the temporary type 7 barrier by using clear zones and slopes	Supplemental Recommendation	-
03-009	Put drain inlets at the future 8-lane locations but use area inlets until the ultimate configuration	Pass	-
	PROTECT FALSEWORK		
04-001	Reduce the clear zone according to construction zone requirements	Pass	-
04-002	Use crossovers to avoid falsework	Combine	03-005
04-003	Temporarily drive on the subexcavation area and use the side slopes as protection	Pass	-
04-004	Precast the straddle bents and erect them on site	Supplemental Recommendation	-

Idea No.	Idea Description	Disposition	With
	RETAIN EMBANKMENT		
05-001	Use reinforced slope paving	Combine	01-005
05-002	Use terracing	Combine	01-005
05-003	Use a driven sheet pile wall	Pass	-
05-004	Use a caisson wall	Fail	-
	STABILIZE SUBGRADE		
06-001	Don't treat the subgrade since there has been no heaving problem in the last 40 years	Combine	01-002
06-002	Use a less conservative treatment, e.g., treat only two feet of material or use material import	Combine	01-002
06-003	Use rubbelized concrete for the first two feet of replaced fill	Combine	01-002
06-004	Let the contractor warranty the design life and use their design	Supplemental Recommendation	06-004
06-005	Copy the T-Rex specification for subgrade treatment	Combine	06-004
	BLEND CONTRACTS		
07-001	Use an A + B type of bid	Supplemental Recommendation	-
07-002	Bid as two separate projects with the same advertisement bid date	Combine	07-001
07-003	Bid two separate schedules but every bidder must bid both schedules with the lowest overall bid winning	Combine	07-001
07-004	Bid as three contracts - RTD, CDOT and a project management/traffic control contract	Combine	07-001
07-005	Bid as one contract based on qualifications	Combine	07-001
07-006	Bid the the combined project as one design/build contract	Combine	07-001
07-007	Bid two separate projects plus bid a combined project - lowest of each bid wins or lowest overall bid wins	Combine	07-001
07-008	Bid two separate projects with distinct milestones	Combine	07-001

SECTION 8 – REVIEW BOARD DECISIONS

REVIEW BOARD RATINGS OF VE PRPOSALS and SUPPLEMENTAL RECOMMENDATIONS

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	DISPOSITION 1 = ACCEPT 2 = ACCEPT w/ MODIFICATIONS 3 = DECLINE 4 = TABLE	Paul Jesaitis	Rick Erjavec	Rich Horstmann	Jerome Estes	Danielle Smith	Dean Bradley	Michelle Stevens
P03-005	Use a 3-Phase construction traffic shifting scheme to move traffic to one side to complete NB in one phase and SB in one phase plus final tie-in phase. *Initial Est. Savings: $650,000* *Future Est. Savings: $0,000* *Total Est. Savings: $650,000*	**1**	1	1	1	1	1	1	1
P04-001	Utilize construction clear zone requirements during construction to conform with Chapter 9 of the Roadside Design Guide, specifically referring to Section 9.1, The Clear Zone Concept in Work Zones, reducing the quantity of Temporary Type 7 barrier. *Initial Est. Savings: $244,000* *Future Est. Savings: $0,000* *Total Est. Savings: $244,000*	**2**	2	2	2	2	2	2	2
P01-008	Configure maintenance of traffic such that the TL-5 barrier isn't required for protection of falsework required for construction of the the light rail straddle bents. *Initial Est. Savings: $30,000* *Future Est. Savings: $0,000* *Total Est. Savings: $30,000*	**2**	2	2	1	2	2	1	2
P04-003	Protect LRT falsework for median structure by implementing a phasing scheme whereby TL-5 barriers are not required by placing NB I-225 traffic temporarily on the subexcavated area under the structure. *Initial Est. Savings: $35,000* *Future Est. Savings: $0,000* *Total Est. Savings: $35,000*	**3**	3	3	3	3	3	3	3

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	DISPOSITION 1 = ACCEPT 2 = ACCEPT w/ MODIFICATIONS 3 = DECLINE 4 = TABLE	Paul Jesaitis	Rick Erjavec	Rich Horstmann	Jerome Estes	Danielle Smith	Dean Bradley	Michelle Stevens
P01-006	Phase the construction of the CDOT and RTD projects like the multi-modal T-REX Project *Initial Est. Savings: Not Quantified* *Future Est. Savings: Not Quantified* *Total Est. Savings: Not Quantified*	**2**	2	2	2	2	2	2	2
P01-005	Modify the typical section to eliminate and/or reduce some retaining walls. *Initial Est. Savings: $90,000* *Future Est. Savings: $0,000* *Total Est. Savings: $90,000*	**2**	2	2	2	2	1	1	2
P02-006	Adjust I-225 profiles where slopes are less than 0.50% to improve drainage and minimize number of inlets. *Initial Est. Savings: $12,000* *Future Est. Savings: $0,000* *Total Est. Savings: $12,000*	**1**	1	1	1	1	1	1	1
P01-002	Allow alternative soil stabilization techniques in the contract such as EN 1 resin, rubbelization, stabilize to a lower depth, or the no treatment option. *Initial Est. Savings: $800,000* *Future Est. Savings: $0,000* *Total Est. Savings: $800,000*	**3**	3	3	3	3	3	2	3
P03-009	Place storm drain inlets at the future 8-Lane locations but use area inlets until the ultimate configuration. *Initial Est. Savings: $80,000* *Future Est. Savings: $21,000* *Total Est. Savings: $101,000*	**2**	2	2	2	2	2	1	2

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	DISPOSITION 1 = ACCEPT 2 = ACCEPT w/ MODIFICATIONS 3 = DECLINE 4 = TABLE	Paul Jesaitis	Rick Erjavec	Rich Horstmann	Jerome Estes	Danielle Smith	Dean Bradley	Michelle Stevens
SUPPLEMENTAL RECOMMENDATIONS									
SR01-015	Use the Lessons Learned from the T-REX Project when bidding the CDOT and RTD Contracts	**1**	1	1	1	1	1	2	1
SR01-017	Build the CDOT Highway widening project without federal funding	**4**	4	4	4	4	4	3	4
SR01-020	Let Xcel Energy install their future needed electrical conduits as part of roadway construction project.	**1**	1	1	1	1	1	1	2
SR02-002	Utilize open channels and ditches to reduce the amount of stormwater pipes required to route stormwater within the project area.	**3**	3	3	3	3	3	2	3
SR02-003	Put conduits and/ or utilities within the zone between the ultimate roadway east edge and the light rail corridor.	**3**	3	3	3	3	3	1	3
SR03-001	Use a 3-Phase construction traffic shifting scheme to move traffic to one side to complete NB in one phase and SB in one phase plus final tie-in phase.	**4**	4	4	4	4	4	1	4
SR03-003	Use the 60' width of both I-225 bridges over Parker to build 3rd phase of northbound and southbound I-225 pavement in stages while traffic is maintained on the portion not under construction.	**1**	1	1	1	1	2	1	1
SR04-004	Precast the LRT Bridge straddle bents and erect them on site.	**2**	2	2	2	2	2	2	2
SR06-004	Allow the contractor to submit an alternative pavement design to include a warranty that covers the original life cycle design.	**3**	3	3	3	3	3	2	3
07-001	Evaluate multiple construction contracting methods to combine the CDOT highway widening and RTD LRT extension projects	**2**	2	2	2	2	2	2	2

RATINGS EXPLANATIONS

DISPOSITION 1 = ACCEPT 2 = ACCEPT w/ MODIFICATIONS 3 = DECLINE 4 = TABLE	Paul Jesaitis	Rick Erjavec	Rich Horstmann	Jerome Estes	Danielle Smith	Dean Bradley	Michelle Stevens
7 - #1's	1 This idea is certainly worth developing further and this is the phasing used on the current project.	1 This has already been considered and will likely be implemented, not really a value engineering proposal but part of the actual design/phasing plan process.	1 (assuming CDOT and RTD do joint project or CDOT goes first)	1 This sequencing scenario seems the best right now. Preliminary cross-over geometrics of the critical south crossover near Park suggest this option is viable. This new sequencing scenario is a product of the new possibility of I-225 & LRT construction occurring simultaneously. This would have been suggested outside the VE study.	1 This proposal is worth looking at further, can provide benefits to the Median bridge construction also.	1	1 If the projects are combined this would be a logical and beneficial phasing method.
7 - #2's	2 This idea was recently performed on the existing project and doing this would result in more accurate plan quantity. Check Roadside design guide for viability.	2 Need more information and research regarding real construction criteria based on the Roadside Design Guide	2 The precise construction clear zone widths would need further analysis. If we use the detour design speed of 55 mph, the clear zone would drop to 24 feet, even without construction-related reduction. We probably should also treat open side-slopes, that might just be steeper than 4:1, differently than work zones where workers and construction materials and equipment will be stored.	2 This needs further evaluation. The guidance given in the Roadside Design Guide through construction zones is vague.	2 This idea could be worth looking into further, would like to make sure that all the requirements are being met from the Roadside Guide.	2 Linear corridors with adjacent construction may limit the ability to establish clear zones without barrier. Confirm with design.	2 It depends on the actual design if this concept will work and be beneficial. This is worth exploring.
5 - #2's and 2 - #1's	2 Do this if P003-005 goes forward.	2 Requires additional analysis to determine if the configuration will work with standards for highway construction and not result in increased construction costs	1 (assuming P03-005 is possible)	2 The 3-phase construction sequencing scenario eliminates the need for TL-5 because traffic is on the SB lanes while the straddle bents are being constructed.	2 This works if you go to the 3 phase construction. May want to leave it in to have it bid on, or note that if 3-phase construction is not used, CDOT requirement for falsework would apply.	1	2 If the projects are combined, this would be beneficial to the RTD project with regard to costs and construction time.
7 - #3's	3 I am concerned over providing the contractor enough details to make sure drainage can actually be accomlished during construction. While we can leave the detailed design to the contractor this must be within reason otherwise how will he bid this work?		3	3 It looks like the 3-phase construction sequencing scenario will work so this option is not needed.	3 There appears to be many questions with this section such as drainage and phasing for the amount of savings it provides.	3 Assumption is that vertical cuts associated with subexcavtions provide the protection afforded with the TL-5 barrier. Other challenges present themselves in that detour paving would need to be placed on top of excavations and maintained; crossovers may be more difficult, etc. P01-008 seems to provide a more viabe alternative.	3 There are better options available with less risks to drainage, snow removal, incident management and other similar issues
7 - #2's	2 This is already being looked into and should definitely be the goal for this project but we need more details.	2 If practical and applicable	2 This sounds ok. The details need to be worked out in construction phasing design.	2 Again, since the 3-Phase construction sequencing scenario works exactly following the sequencing involved with T-REX is not needed. However, we should take full advantage of both facilities being constructed simultaneously as TREX did.	2 This should be a goal of the projects combining, and taking past lessons learned into consideration	2 More specifics required and must be vetted with FHWA, CDOT and RTD management	2 There may be some benefit to this project in understanding the sequence of construction used on the TREX project, since this was for the most part successful and was the main requirements of the contractor for the TREX project.

Paul Jesaitis	Rick Erjavec	Rich Horstmann	Jerome Estes	Danielle Smith	Dean Bradley
1 This idea is certainly worth developing further and this is the phasing used on the current project.	1 This has already been considered and will likely be implemented, not really a value engineering proposal but part of the actual design/phasing plan process.	1 (assuming CDOT and RTD do joint project or CDOT goes first)	1 This sequencing scenario seems the best right now. Preliminary cross-over geometrics of the critical south crossover near Park suggest this option is viable. This new sequencing scenario is a product of the new possibility of I-225 & LRT construction occurring simultaneously. This would have been suggested outside the VE study.	1 This proposal is worth looking at further, can provide benefits to the Median bridge construction also.	1
2 This idea was recently performed on the existing project and doing this would result in more accurate plan quantity. Check Roadside design guide for viability.	2 Need more information and research regarding real construction criteria based on the Roadside Design Guide	2 The precise construction clear zone widths would need further analysis. If we use the detour design speed of 55 mph, the clear zone would drop to 24 feet, even without construction-related reduction. We probably should also treat open side-slopes, that might just be steeper than 4:1, differently than work zones where workers and construction materials and equipment will be stored.	2 This needs further evaluation. The guidance given in the Roadside Design Guide through construction zones is vague.	2 This idea could be worth looking into further, would like to make sure that all the requirements are being met from the Roadside Guide.	2 Linear corridors with adjacent construction may limit the ability to establish clear zones without barrier. Confirm with design.
2 Do this if P003-005 goes forward.	2 Requires additional analysis to determine if the configuration will work with standards for highway construction and not result in increased construction costs	1 (assuming P03-005 is possible)	2 The 3-phase construction sequencing scenario eliminates the need for TL-5 because traffic is on the SB lanes while the straddle bents are being constructed.	2 This works if you go to the 3 phase construction. May want to leave it in to have it bid on, or note that if 3-phase construction is not used, CDOT requirement for falsework would apply.	1
3 I am concerned over providing the contractor enough details to make sure drainage can actually be accomlished during construction. While we can leave the detailed design to the contractor this must be within reason otherwise how will he bid this work?		3	3 It looks like the 3-phase construction sequencing scenario will work so this option is not needed.	3 There appears to be many questions with this section such as drainage and phasing for the amount of savings it provides.	3 Assumption is that vertical cuts associated with subexcavtions provide the protection afforded with the TL-5 barrier. Other challenges present themselves in that detour paving would need to be placed on top of excavations and maintained; crossovers may be more difficult

1	1	1	1 Coordination with the personnel involved in formulating the TREX documents should occur.	1	2 More specifics required and must be vetted with FHWA, CDOT and RTD management.	1
4 This is being pursued, although we must go forward assuming that it is not a viable option.	4 Sufficient state funds are not available for this option	4	4 It does not seem like we are heading this direction.	4 This is a CDOT decision.	3 Feedback from CDOT implys that state funds are not available to accomplish this.	4 This may put other projects at risk at receiving funding. This project should try to advance using federal funds.
1	1 Allowable if it does not adversly affect the schedule	1	1 Makes sense but we need to coordinate with Xcel to see if this is possible.	1 Good idea to lessen future tear-up of new construction.	1	2 If Xcel is agreeable to the idea and it does not delay the CDOT project.
3 Barrier slot openings clog. Median drainage must be provided. Ditches on roadside may be appropriate however.	3 Drain slots in barrier would not be appropriate	3 Slotted barrier clogs. Open ditches may be used in some limited areas - but this was already going to be considered as part of the design process.	3 Median drainage must be accommodated. The pavement section is too large to drain everything to the west side.	3 Issues with median slots clogging and the water spreading over all lanes of traffic.	2 Confirm compatibility with future 8 lane widening.	3 There may be some MS4 issues with this concept.
3	3 If practical and applicable	3 This would only be feasible for part of the Iliff to Mississippi project - south of Florida Station. We would not want utilities underneath the future ultimate shoulder.	3 In areas where this becomes the future shoulder this doesn't seem like the a good idea.	3	1	3 There may be some competing interest for this same area. It also may be difficult for the utility to maintain without having to use traffic control each time.
4 I have this recommendation as being using the Parker Road ramps during the night time. This may or may not work related to traffic volumes.	4	4 This proposal was a mis-labeled. The phasing would need to be studed in further detail - it may not be feasible or necessary.	4 This may be acceptable for a couple hours at a time at night. However, there is a significant volume of traffic on I-225 at all hours of the day.	2 Would need to be evaluated further to make sure the phasing works.	1	4 This could be decided once more design detail has gone into the phasing plan and the projects are combined.
1	1	1	1 Yes	2 Would need to be evaluated further to make sure the phasing works.	1	1
2 The viability of this could be discussed during an industry review.	2 This would require redesign of the RTD structure.	2 RTD has done some preliminary investigation of this. Large cranes would be needed. The compartive costs and risks should be evaluated. Cast-In-Place under new construction phasing may not be a big issue.	2 RTD plans are at 100% so this probably won't materialize but has merit.	2 This should be evaluated further, it would could potentially save on the amount of falsework and protection.	2 There are implications to RTD's current plans although a specification option to allow the contractors to propose this option could be an easier solution.	2 This could be a considerable cost savings if this can be done. More research is needed to determine the feasibility of this option.
3 Warranties don't work.	3 Warranties are currently not an option for CDOT pavment	3	3 CDOT has had issues with warranties being honored in the past.	3 Warranties have been evaluated many times by CDOT and the feedback was that they do not work at this time.	2 Host of challenges in warranting work through FHWA funded projects requiring their concurrence. Pavement performance failures typically don't show in the near term and it will likley be problematic to get extended warranties.	3 There may be some risks that need to be considered that this project may not have the luxury to explore due to the tight timeframe.
2 I like the idea of one project with two separate bid schedules as perhaps a means to get one contractor and not have to Federalize the RTD project while also keeping the costs separate.	2	2	2 A unique contracting method will most likely be the best solution for this project.	2 The combination of the 2 projects will be evaluated to determine the best method to combine projects and track costs.	2 More specifics required and must be vetted with FHWA, CDOT and RTD management.	2 A contractoing method that works for both CDOT and RTD and accelerates the project would be beneficial for the agencies and the public.