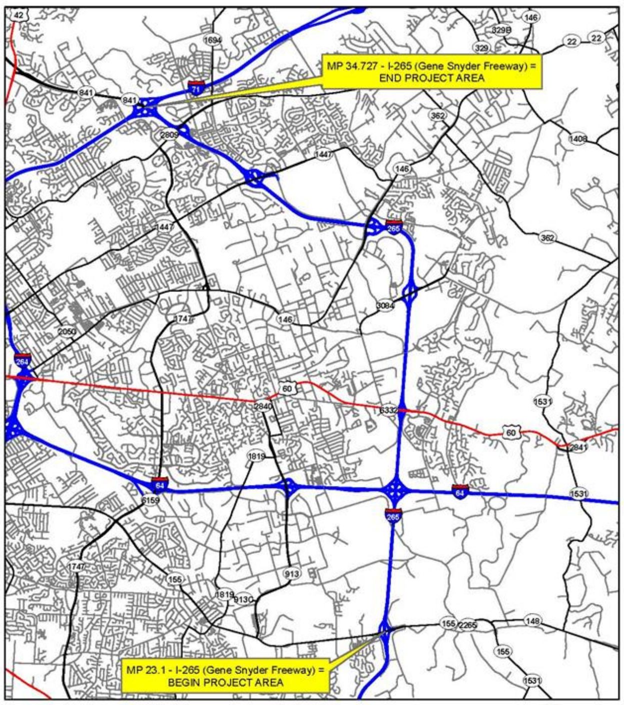

Value Engineering Study KYTC 201902 Report

I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange

KENTUCKY TRANSPORTATION CABINET

February 4–8, 2019

Prepared by:

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Disclaimer

The information contained in this report is the professional opinions of the team members during the Value Engineering study. These opinions were based on the information provided to the team at the time of the study. As the project continues to develop, recommendations and findings will need to be reevaluated as new information is received. All costs displayed in the report are based on best available information at the time of the study and, unless otherwise noted, used the estimate provided as the Basis of Estimate. Any graphics, photos, drawings, maps, etc., used in the report were supplied by the study sponsor or developed during the time of the study.

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Executive Summary

Introduction

The purpose of the Value Engineering (VE) team was to review and improve on various concepts for the widening of the current 4-lane I-265 to six lanes from the interchange with KY 155 (Taylorsville Road) to the I-71 interchange, a distance of approximately 11.6 miles. The widening will occur within the existing median. The project also includes the reconfiguration of the interchange at I-64 from its current clover-leaf configuration. Two separate projects are programmed: one to cover the widening of I-265 from KY 155 to KY 3084 (Old Henry Road), which includes the interchange at I-265 and I-64 from east of Blankenbaker Parkway to west of S. English Station Road; and another to widen from KY 3084 (Old Henry Road) to the interchange at I-71. Both projects were at different stages of the environmental clearance development phase. While both projects are treated independently from the NEPA clearance perspective, they are being considered to be let together under one contract. Coordination is ongoing to establish a scope of work for each project that optimizes sequence of construction. Performance Based Flexible Solutions (PBFS) design approach was used in their project development process.

The VE team was presented with four alternatives for the I-265 at I-64 interchange project: Alternative 1 is a spill-through flyover, Alternative 1A is a spill-through flyover with added capacity, Alternative 3 is a partial turbine interchange, and Alternative 3B is a partial turbine with braided ramp (C). The I-265 widening project presented to the VE team was the selected alternative (Alternative 2), which includes 12-foot lanes, 4-foot inside shoulders, and a varied median width. It is anticipated that right-of-way acquisition will be necessary in the vicinity of the interchange at I-64.

Seven subject-matter experts and stakeholders made up the study team.

VE Recommendations

The VE team generated 53 ideas for the project. These concepts were compared against the baseline developed by the project team. The concepts that performed the best were further developed by the VE team.

#	Description	Cost Delta (millions)	Performance Improvement
1	Steepen slopes and build retaining walls to avoid right-of-way impacts	$0.48	+6.7%
2	Use ramp metering	$0.50	+3.0%
3	Change I-64 ramp construction sequence to minimize temporary construction	($0.78)	+4.9%
4	Widen new underpasses to the outside to improve constructibility	($0.60)	+3.9%
5	Use design-build delivery method	($1.90)	+12.4%
6	Modify System Interchange Design to Separate US 60 and Mainline Traffic	($0.67)	+12.0%

#	Description	Cost Delta (millions)	Performance Improvement
7	Apply advanced signalization strategies to avoid impacts to main line	$0.24	+2.7%
8	Improve signage at approaches to interchanges	$0.05	+3.3%
9	Reduce pavement section	($2.29)	+5.4%

The individual recommendations are summarized below; the detailed information about each recommendation is included in Section 7 of this report.

1—Steepen Slopes and Build Retaining Walls to Avoid Right-of-Way Impacts – Introduces strategies to reduce or eliminate right-of-way impacts.

2—Use Ramp Metering – To improve lain line operations and safety, use ramp metering as a traffic control measure during peak traffic hours.

3— Change I-64 Ramp Construction Sequence to Minimize Temporary Construction – Scheduling ramp construction to accommodate and maintain traffic will eliminate the need for temporary loop ramps.

4—Widen New Underpasses to the Outside to Improve Constructibility – Leave existing northbound bridge and realign main line I-265 northbound to match existing bridge section, improving constructibility.

5—Use Design-Build Delivery Method – This method of delivery for the interchange and portions of the widening project will enable construction letting in 18 months.

6—Modify System Interchange Design to Separate US 60 and Mainline Traffic – This introduces a new interchange concept that allows a collector-distributor (CD) road to be constructed when impacts to the interchange are realized.

7—Apply Advanced Signalization Strategies to Avoid Impacts to Main Line – Using advanced queuing detection at interchange off-ramps allows signal prioritization, which will clear long queues.

8—Improve Signage at Approaches to Interchanges – Implement strategies to improve queuing capacity at interchanges.

9—Reduce Pavement Section – Reduce pavement thickness using Kentucky Transportation Cabinet (KYTC) pavement design tool to accommodate traffic and drain to outlet.

The VE team also recommends the design team **revisit the ultimate interchange configuration at I-64 using the revised 50 mph design speed,** which should reduce the footprint of the interchange and lower eastbound I-64 to northbound I-265 direct flyover to a third level, making it a more feasible option.

In addition, the VE team recommends that the design team **re-run traffic modeling software for the entire corridor**, including activation of all interchanges traffic, using the latest available traffic data, to validate complete system operations. An interchange to focus on is US 60, whose performance will influence the performance of the system interchange at I-64.

Implementation of Recommendations

To facilitate implementation, a Value Engineering Punch List is included as Appendix C. If the state elects to reject or modify a recommendation, please include a brief explanation of the decision.

The VE team wishes to express its appreciation to the project design managers for the excellent support they provided during the study. We hope that the recommendations and other ideas provided will assist in the management decisions necessary to move the project forward through the project delivery process.

Jose Theiler, PE, CVS®
Professional Associate
East Region Manager for
Project Risk Management and Value Engineering

1 Introduction

This VE report summarizes the events of the VE study conducted for the Kentucky Transportation Cabinet (KYTC) and facilitated by HDR. The subject of the study was the I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange project. The VE study was conducted February 4–8, 2019 while the project was in the environmental clearance phase.

1.1 Project Overview

I-265 is an urban Interstate Highway ringing Metro Louisville-Southern Indiana. Through Jefferson County, it extends from I-65 in the south to I-71 in the northeast, where it continues north as KY 841 to the Lewis and Clark Bridge over the Ohio River and into Indiana. The section of the interstate within the project limits is in the heavily developed area of eastern Jefferson County, from the Taylorsville Road (KY 155) interchange north to I-71. Through the project area, the main line is currently four 12-foot lanes (two northbound and two southbound) with three basic typical sections:

- Depressed median (60 feet) from Taylorsville Road to I-64 (2.3 miles).
- Depressed median (36 feet) from the I-64 interchange to just north of Shelbyville Road (1.3 miles).
- Depressed median (64 feet) from Shelbyville Road north to I-71 (7.9 miles).

Improvements include widening within the existing median to a 6-lane facility. The project also includes the reconfiguration of the interchange at I-64 from its current clover-leaf configuration.

1.2 Value Engineering Approach

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

The primary objective of any VE study is to improve the value of the project. A simple way to think of value in terms of an equation is shown at right.

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

While project costs are fairly easy to quantify and compare through traditional estimating techniques, performance is not so easily quantifiable.

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

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

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

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

- Main line operations
- Local operations
- Maintainability
- Construction impacts
- Environmental impacts
- Project schedule

A detailed definition of the performance attributes can be found in Section 3.5 of this report.

1.3 Scope of the Value Engineering Study

The purpose of the study, through execution of the Value Methodology Job Plan (see Appendix A), was to:

- Verify or improve on the various concepts for the identified section of I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange project.
- Conduct a thorough review and analysis of the key project functions using a multidiscipline, cross-functional team.
- Improve the value of the project through innovative measures aimed at improving the performance while reducing costs of the project.

1.4 VE Team Members

The VE team included the following. See Appendix B for details of attendees.

- Erica Albrecht, HDR
- Joe Cochran, HDR
- Will Hume, HDR
- Elizabeth Lykins, KYTC
- Brent Sweger, KYTC
- Jose Theiler, HDR
- Jonathan West, HDR

2 Project Information

The current project plan is to widen the existing 4-lane I-265 to six lanes from the interchange with KY 155 (Taylorsville Road) to the I-71 interchange, a distance of approximately 11.6 miles. The widening will occur within the existing median.

2.1 Purpose and Need

2.1.1 Purpose

The purpose of the proposed project is to decrease existing congestion on the main line of I-265 Gene Snyder Freeway between KY 155 Taylorsville Road and I-71.

2.1.2 Need

Following an extensive data collection effort in the fall of 2017, analysts used a variety of available traffic forecasting and modeling tools to simulate traffic operations along the I-265 study corridor under the 2017 conditions and build scenarios for both the current traffic with a 6-lane facility and future (2045) design year with a 6-lane facility. This analysis was intended to help define the needs of the project and understand how the proposed widening would influence traffic operations.

Carrying 65,000 to 88,000 vehicles per day (vpd) today, the existing I-265 corridor does not provide adequate capacity to serve current peak period traffic volumes. It exhibits poor level of service (LOS), inflated travel times, and ramp queue lengths that back up onto main line travel lanes in select locations.

Two separate projects were programmed: one to cover the widening of I-265 from KY 155 to KY 3084 (Old Henry Road), which includes the interchange at I-64 from East of Blankenbaker Parkway to West of S. English Station Road; and another to widen from KY 3084 (Old Henry Road) to the interchange at I-71.

After evaluating a number of configurations for the widening of the main line of I-265 and the I-64 system interchange, the design team narrowed options to the following feasible alternatives:

I-265 Widening: the project presented to the VE team was the selected alternative 2 whereby widening will occur within the existing median. No other improvements are planned for interchanges other than at I-64.

I-64 Interchange:

Alternative 1: Spill-Through Flyover

- Provides 2-lane Ramp B
- Eliminates all weaves
- Maintains all lanes on I-64/I-265
- Design speed of 30 mph on ramps A, E, G, and H
- Design speed of 50 mph on ramps B, C, D, and F
- Two new bridges over I-64
- Does not meet capacity for 2045

Alternative 1A: Spill-Through Flyover with Added Capacity

- Provides 2-lane Ramp A, B, D, and H
- Eliminates all weaves
- Reduces lanes on I-64/I-265 through interchange
- Design speed of 30 mph on ramps A, E, G, and H
- Design speed of 50 mph on ramps B, C, D, and F
- Two new bridges over I-64

Alternative 3: Partial Turbine

- Provides 2-lane Ramp A, B, D, and H
- Maintains Ramp G-E weave
- Maintains all lanes on I-64/I-265
- Design speed of 30 mph on ramps E and G
- Design speed of 40 mph on ramps A and H
- Design speed of 50 mph on ramps B, C, D, and F
- Two new bridges over I-64
- Two new structures under I-265

Alternative 3B: Partial Turbine with Braided Ramp C

- Provides 2-lane Ramp A, B, D, and H
- Maintains Ramp G-E weave
- Reduces lanes on I-64/I-265 through interchange
- Design speed of 30 mph on ramps E and G
- Design speed of 40 mph on ramps A and H
- Design speed of 50 mph on ramps B, C, D, and F
- Reduces weave of I-265 northbound traffic
- Two new bridges over I-64
- Two new structures under I-265

2.2 Project Schedule

The two projects were in the environmental clearance phase. The current schedule is shown in Table 1. While still under review, it is currently anticipated that the project will be constructed using the design bid build (DBB) delivery method.

Table 1. Project Schedule

Project Phase	I-64 Interchange	I-265 Widening
Public meeting	January 2018	Completed
Begin preliminary design	April 2018	Completed
Preferred alternative	February 2019	Completed
Environmental clearance	May 2019	May 2019
Project letting	Fall 2020	Fall 2020

While both projects are treated independently from the NEPA clearance perspective, they are being considered to be let together under one contract. Coordination is ongoing to establish a scope of work for each project that optimizes sequence of construction.

2.3 Project Cost Estimate

At the time of the study, the VE team was provided with five separate construction cost estimates: one for the I-265 widening project (Table 2) and four for the I-64 interchange project (Table 3). See Appendix D for detailed estimates by project and by alternative.

Table 2. Cost Estimate I-265 Widening

Description	Amount
Pavement	$21,880,184
Noise Walls	$9,821,310
Contingencies	$8,325,660
MOT	$7,043,864
CEI	$6,383,006
Structures	$4,681,400
Mobilization	$3,141,758
Earthwork	$2,351,635
Median Barrier	$2,257,145
Signing	$1,674,530
ITS	$1,524,000
Drainage	$1,128,573

Table 3. Cost Estimate I-64 Interchange Alternative Matrix

Cost Item	Alt 1 Base	Alt 1A Build-Out	Alt 3	Alt 3 Braided C
Earthwork	$2,234,705	$2,640,037	$5,067,244[a]	$4,622,491[b]
Pavement	$7,055,066	$10,575,258	$11,102,707	$10,345,968
Guardrail	$562,741	$793,653	$516,732	$423,969
Bridge	$6,370,000	$9,490,000	$13,845,000	$13,455,000
Culvert	$399,100	$542,100	$377,000	$208,000
Retaining Wall	$0	$0	$243,398	$113,100
Concrete Barrier	$137,137	$122,213	$19,119	$18,200
Total Construction Cost	**$16,758,750**	**$24,163,261**	**$31,171,191**	**$29,186,728**

[a] $24,255,238 with bridges expanded for future build-out
[b] $26,693,218 with bridges expanded for future build-out

2.4 Information Provided to the VE Team

Table 4 lists the project documents that were provided to the VE team for their use during the study.

Table 4. Information Provided to the VE Team

Document/Drawing/Schematic	Date
Request for Proposal for Professional Services Contract – Jefferson | I-265 (Gene Snyder Freeway) | 5-537	October 2017
Request for Proposal for Professional Services Contract – Jefferson | I-265/I-64 Interchange | 5-549	March 2018
Kentucky Transportation Cabinet Six Year Highway Plan (2 versions)	June 28, 2018
I-265 Project Coordination Meeting Minutes	May 24, 2018
5-537 | I-265 Widening	
Public Meeting Survey and Handout	Not dated
Location Map	Not dated
Preliminary Line & Grade – Alternative 2 – Section 1B	June 2018
Preliminary Line & Grade – Alternative 2 – Section 2	June 2018
Preliminary Line & Grade – Alternative 2 – Section 3	June 2018
Preliminary Line & Grade – Alternative 2 – Option B-1	June 2018
Plan Exhibit – Public Meeting	May 2018
Typical Sections – Alternatives 1 and	Not dated
Various roll plans and documents from QK4	Various
5-549 Interchange	
Existing Safety Analysis Final Revision	October 2018
Project Framework Document – Interchange Modification at I-265 and I-64	August 2018
Location Map	Not dated
Public Exhibit –Alternate 1	December 13, 2018
Public Exhibit –Alternate 2	December 13, 2018
Public Exhibit –Alternate 3	December 13, 2018
Public Exhibit –Alternate 3A	December 13, 2018
Public Exhibit –Blankenbaker	December 13, 2018
I-265 | I-64 Traffic Forecast Report – Final	October 22, 2018
Traffic Forecast Exhibits	Not dated
Ramp I-265/I-64 System Interchange Reconstruction – Component Build and Cost Estimate Matrix	January 17, 2019
Land Development Plans	Various
Meeting Minute Notes	Various

3 Project Analysis

3.1 Summary of Analysis

In addition to the project information (Section 2), the VE team used a series of tools to gain additional knowledge and a better understanding of the project. The following analysis tools were used to study the project, and are explained in greater detail in this chapter:

- Cost Model
- Function Analysis
- Function Analysis System Technique (FAST) Diagram
- Value Matrix

3.2 Cost Model

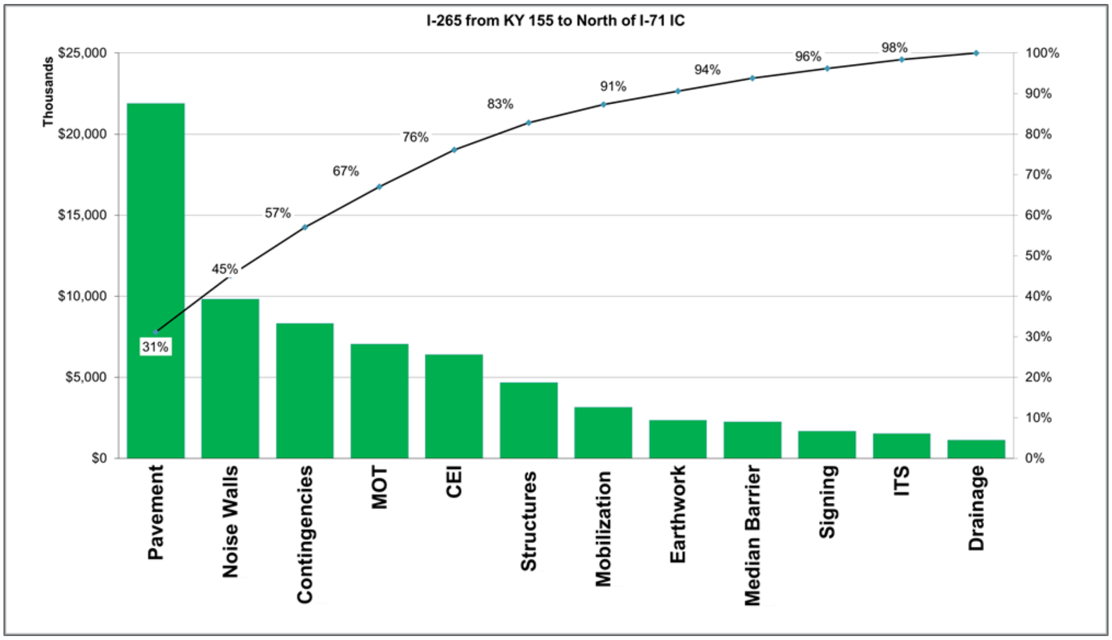
The VE team leader prepared a cost model from the cost estimate, which was provided by the project team. The model was organized to identify major construction elements or trade categories, the design team's estimated costs, and the percent of total project cost for the significant cost items (see Table 5).

The cost model for the I-265 widening project clearly showed the cost drivers and were used to guide the VE team during the VE study. In addition, the VE team understood the nature of cost of the interchange at I-64 being primarily structures.

Table 5. I-265 Widening Cost Model

Cost Item	Cost	Percent of Total	Cumulative Percentage
Pavement	$21,880,184	31.2	31
Noise Walls	9,821,310	14.0	45
Contingencies	8,325,660	11.9	57
MOT	7,043,864	10.0	67
CEI	6,383,006	9.1	76
Structures	4,681,400	6.7	83
Mobilization	3,141,758	4.5	87
Earthwork	2,351,635	3.3	91
Median Barrier	2,257,145	3.2	94
Signing	1,674,530	2.4	96
ITS	1,524,000	2.2	98
Drainage	1,128,573	1.6	100
TOTAL CONSTRUCTION COST	**$70,213,065**		

Figure 1. I-265 Widening Cost Model



3.3 Function Analysis

Function analysis results in a unique view of the study project. It transforms project elements into functions, which moves the VE team mentally away from the baseline design and takes it toward a functional concept of the project. Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level (see Table 6). Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

Table 6. Function Analysis Verb-Noun Statements

Component	Verb	Noun
Project Purpose	Alleviate Improve Improve Deliver Maintain	Congestion Mobility Operations Project Traffic
Barriers	Separate	Traffic
Clearing and Grubbing	Prepare	Site
Drainage	Collect Convey Discharge Treat Store	Water Water Water Water Water
Earthwork	Create Move Support	Profile Earth Roadway
Lighting	Illuminate	Facility

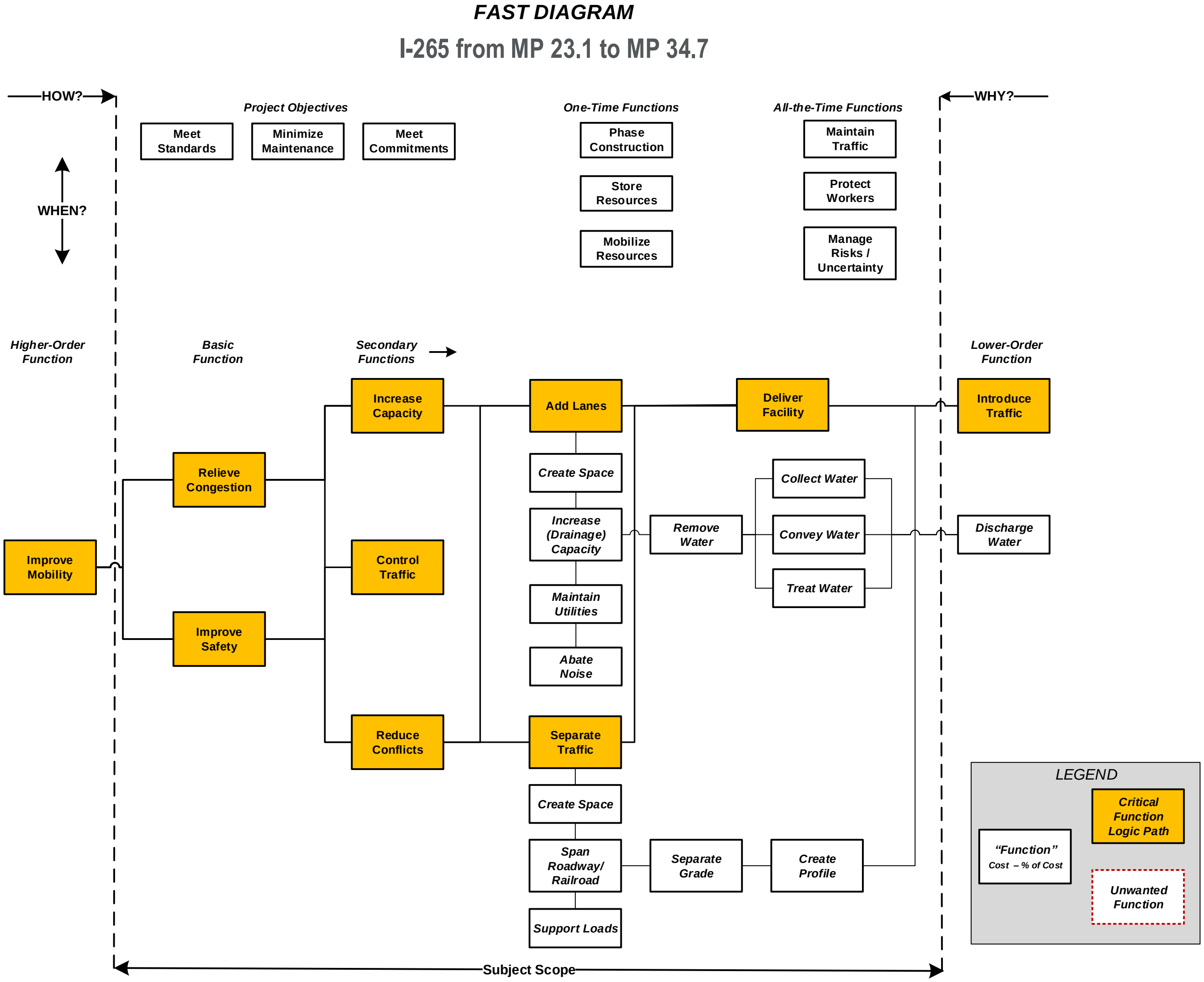
Table 6. Function Analysis Verb-Noun Statements

Component	Verb	Noun
Mobilization	Deploy	Resources
Pavement	Support Protect	Loads Base
Right-of-way	Create	Space
Signalization	Control	Traffic
Structures	Support Span Transfer Abate	Loads Distance Loads Noise
Traffic Control	Protect Protect Maintain	Highway User Highway Worker Traffic

3.4 Function Analysis System Technique Diagram

The Function Analysis System Technique or “FAST” diagram arranges the functions in logical order so that when read from left to right, the functions answer the question “How?” If the diagram is read from right to left, the functions answer the question “Why?” Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column. The FAST diagram provided the VE team with an understanding of which functions offer the best opportunity for cost or performance improvement (Figure 2).

Figure 2. FAST Diagram



3.5 Performance Attributes

Performance attributes can generally be divided between project scope components (highway operations, environmental impacts, maintainability, and system preservation) and project delivery components. It is important to make a distinction between performance *attributes* and performance *requirements*. Performance requirements are mandatory and binary in nature. All performance requirements MUST be met by any VE alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives could be acceptable that had different durations.

The vast majority of performance attributes that typically appear in transportation VE studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Typical standardized project performance attributes are shown below. Specific definitions of each attribute can be found in Table 7.

- Main line operations
- Local operations
- Maintainability
- Construction impacts
- Environmental impacts
- Project schedule

For the purposes of this VE study, Table 7 summarizes the performance attributes that were used to help the VE team evaluate idea performance. In addition, the elements that are inherent in the project design are found in the “Baseline Concept” column of the table. This baseline was used later in the evaluation process to assess the performance of new ideas developed by the VE team. The baseline concept was given a rating of 5 in each category.

Table 7. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline (5-549 Interchange)	Baseline (5-537 Main Line)
Main Line Operations	An assessment of traffic operations and safety on the main line within the project limits. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance, and lane and shoulder widths.	**I-265:** • 50 MPH • 6 each 12' lanes • 10' outside shoulders, 4' inside shoulders • LOS F by 2035 (Peak hour) **I-64:** • No impacts	**I-265:** • 50 MPH • 6 each 12' lanes • 10' outside shoulders, 4' inside shoulders • LOS F by 2035
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure. Local Operations include frontage roads as well as cross roads. Operational considerations include level of service relative to the 20-year traffic projections; geometric considerations such as design speed, sight distance, lane and shoulder widths; bicycle and pedestrian operations and access.	• Interchange works at acceptable LOS when interchange US 60 volumes are assumed handled by interchange. • When performance of US 60 interchange is considered the system interchange is assumed failing, although it's unknown the year	• No improvements to interchanges are scoped

Table 7. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline (5-549 Interchange)	Baseline (5-537 Main Line)
Maintainability	An assessment of the long-term maintainability of the facilities and equipment. Maintenance considerations include the overall durability, longevity, and maintainability of structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.	• Asphalt section to add new asphalt lane (29" total thickness) to the inside and mill 1.5", overbuild 3" existing (4.5" total) lanes.	• Concrete Pavement inside lane (new pavement). • No improvements on existing concrete pavement
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to existing utilities; impacts to businesses and residents relative to access, visual effects, noise, vibration, dust, and construction traffic; environmental impacts.	• Detours: weekend only • Lane Closures: cannot close eastbound loop ramp • Some lane closures on main line I-265 after widening. • Temporary Drainage: Some temp drainage northbound direction - maintain 2-lanes in each direction at all times	• Detours: none planned • Lane Closures: nightly closures only • Business impacts: none • Minor temporary drainage required.
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts; impacts to shore edge; impacts to cultural, recreational and historic resources.	• Right-of-way acquisition: strips around interchange. • No impacts to natural resources	• Minor Temporary Construction Easements (TCE)s
Project Schedule	An assessment of the total project delivery from the time as measured from the time of the VE Study to completion of construction.	• Fast-racked project • 18 month Design phase • 2 construction seasons	• Two phase construction: close inside lane, temp outside lane, build inside. • 2 construction seasons

3.6 Performance Attribute Matrix

The performance attribute matrix was used to determine the relative importance of the performance attributes for the project. The project owner, design team, and stakeholders evaluated the relative importance of the performance attributes that would be used to evaluate the creative ideas.

These attributes were compared in pairs, asking the question: “An improvement to which attribute will provide the greatest benefit to the project relative to need and purpose?”

The letter code (e.g., “A”) was entered into the matrix for each pair. After all pairs were discussed they were tallied (after normalizing the scores by adding a point to each attribute) and the percentages calculated (see Figure 3).

Figure 3. Performance Attribute Matrix

Performance Attributes Criteria Matrix								
Paired Comparison							Total points	% of Total
Main Line Operations	A	A/B	A	A	A	A	5.5	26.1%
Local Operations		B	B	B	B	B	5.5	26.1%
Maintainability			C	C	C	C/F	3.5	16.6%
Construction Impacts				D	E	F	1.0	4.7%
Environmental Impacts					E	F	2.0	9.9%
Project Schedule						F	3.5	16.6%
						Total	21.0	100.0%

4 Creative Phase

During the creative phase, the VE team as a group generated ideas on how to perform the various functions. The idea list was grouped by function or major project element. All of the ideas generated were recorded in Table 8, below. The final disposition of each idea is included at the end of Section 5, Idea Evaluation.

Table 8. Creative Idea List

Idea No.	Description
	Function: Abate Noise
1.	Use excess earthwork to build berm and shorten noise walls where practical
	Function: Control Traffic
2.	Use ramp metering where practical
3.	Install Variable Message Signs to inform drivers of alternative routes in case of delays on the interstate and crossing roads
4.	Build ITS infrastructure
5.	Use ITS technology to manage traffic along the corridor
6.	Use TSM&O strategies to improve local and Interchange network operations
7.	Create partnerships with Google and Waze to proactively inform users of alternative routes in case of delay
8.	Convert interchanges' signalization phasing from 3 phases to 2 phases to improve failing interchanges that spill over into the Interstate
9.	Build the backbone for smart transportation corridors
53.	Increase use of signs at interchanges and approaches to inform users
	Function: Convey Water
10.	Grade inside lane and shoulder to the outside and eliminate close drainage in the median
	Function: Create Space
11.	Steepen slopes to avoid purchasing right of way along the interchange, where feasible
12.	Use retaining wall/noise wall combination where applicable to avoid right of way impacts
13.	Use retaining walls in lieu of purchasing right of way along the interchange, where feasible
14.	Jack bridges of underpasses to obtain minimum vertical clearance
15.	Rehab bridges at underpasses to obtain minimum vertical clearance using slimmer beams
	Function: Deliver Facility
16.	Eliminate temporary construction of NE and SE loop ramps to maintain traffic by constructing ramp H and A in sections and leaving the last connection to be built in a weekend with full ramp closure and detouring off to US 60
17.	Keep bridge over I-64 as is (don't widen to inside), and realign main line over new ramps to the outside (i.e. widen to the outside in that section) of existing for constructibility purposes and keep them outside permanently.
18.	Use design-build delivery method for interchange
19.	Postpone widening of Interstate south of Rehl Rd (change southern termini)

Table 8. Creative Idea List

Idea No.	Description
20.	Phase build 3/3B system interchange
21.	Separate the northbound I-265 to I-64 movement from the joint ramp (F) and keep it at grade alongside I-265 to join I-64 at grade and reduce earthwork of the ramp (F).
22.	Bring bridges of ramps H and A closer to shorten their spans and perhaps build one wider bridge
23.	Build ramp A first before ramp H so the northbound to westbound loop ramp can be closed to build ramp H.
24.	Eliminate widening between US 60 and Old Henry and strengthen shoulder if necessary to make shoulder a peak hour lane
25.	Use Construction Management @ Risk (CM@Risk)
	Function: Improve Mobility
26.	Create a dynamic directional express lanes on I-265
27.	Separate a movement away from the system interchange
28.	Separate traffic that wants to drive through the system interchange from traffic that wants to exit the system interchange (CD lane / traffic separators)
29.	Widen to the outside
30.	Widen to the inside at underpasses and to the outside elsewhere
31.	Merge westbound to northbound I-64 with ramp H and minimize width of bridge/culvert under main line I-265. For 3, bring ramp H closer to main line sooner to reduce bridge width
	Function: Improve Safety
32.	Traffic separate eastbound I-64 to northbound traffic onto US 60 from I-265 (create a CD lane to US 60)
33.	Braid ramp northbound I-265 to US 60 under / over I-64 eastbound/westbound to northbound I-265
34.	New Interchange concept: To eliminate weave at US 60, combine I-265 northbound to I-64 westbound and US 60 traffic in ramp, then split traffic off after crossing I-64 and braid eastbound I-64 traffic onto I-265 and US 60.
35.	Split ramp F (northbound to eastbound movement) after underpass of ramp H (southern culvert); bring ramp H under ramp A and to the outside, tighten radii of ramp A at the northern underpass (culvert) and try to avoid right of way at the eastern side (north and south) quadrants.
36.	Build a modified ultimate interchange (lower design speed) in phases, eastbound to northbound and northbound to westbound first.
37.	Rerun the Vissim model to validate what year the system interchange is impacted without improvements to other interchanges, particularly US 60.
38.	Rerun the corridor-wide Vissim model once the preferred alternative is determined using consistent traffic data
39.	Create a new interchange on I-64 between I-265 and 1848 to relieve traffic from I-64/I-265 interchange
40.	Upgrade signalization of US 60 to an adaptive corridor to make the route more attractive for users and Transit operations
41.	Plan to phase in the elimination of ramp E or G to eliminate weaving : Split southbound I-265 to westbound I-64 traffic and loop ramp movement onto I-64

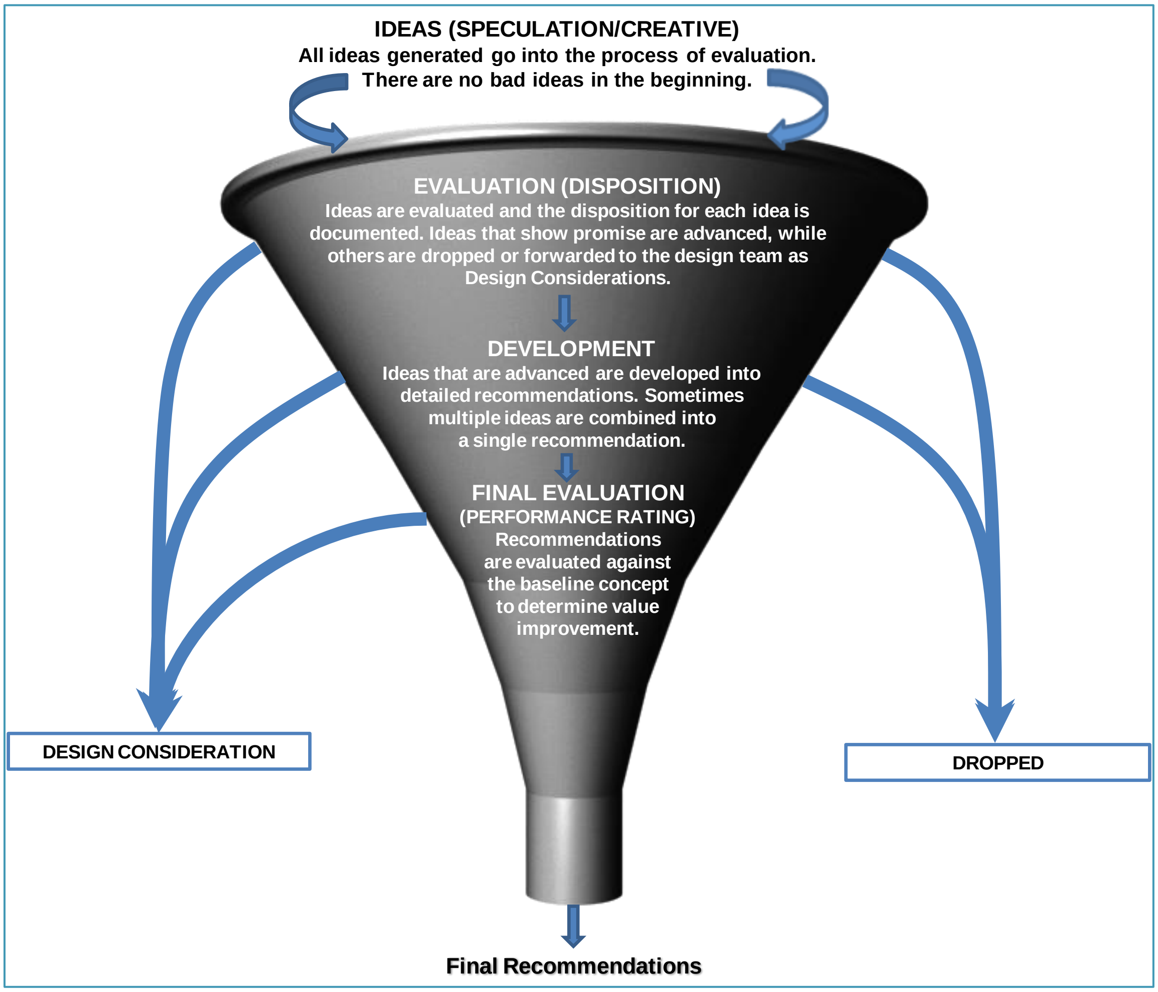
Table 8. Creative Idea List

Idea No.	Description
42.	Use 11' lanes and widen inside shoulder to 6', keep outside lane 12'
	Function: Increase Drainage Capacity
43.	Design team to look into the drainage design during PS&E to procure a more detail estimate.
	Function: Relieve Congestion
44.	Improve signal timing on local network by prioritizing ramp movement to relieve congestion on main line operations
45.	Use advanced detection at off ramps to prioritize signalization and empty queuing at interchanges.
46.	Add striping and pavement markings at interchange approaches (off-ramps) to increase queuing capacity at interchanges
	Function: Support Loads
47.	Design pavement section for cars only and restrict trucks from traveling in left lane
48.	Mill 1.5" and resurface 1.5" instead of overbuild additional 3" of structural pavement.
49.	Use ABC bridge structures in lieu of culverts in the underpasses of I-265 (loops A and H)
50.	Use asphalt to widen the concrete section of the project in lieu of concrete
51.	Include pavement alternate in the bid package
52.	Build concrete lanes on asphalt section and mill asphalt completely and overlay with concrete existing lanes

5 Idea Evaluation

Although each project is different, the evaluation process for each VE effort can be thought of in its simplest form as a way of combining, evaluating, and narrowing ideas until the VE team agrees on the recommendations to be forwarded. Figure 4 depicts the typical information flow for the VE process.

Figure 4. VE Process Information Flow



5.1 Evaluation Process

The evaluation process begins by going through the ideas brainstormed during the speculation/creative phase. Considering the information provided to the VE team at the time of the study and the constraints and controlling decisions that were also given to them, the team discussed the ideas and documented their advantages and disadvantages based on their relationship to the baseline concept.

The VE team also compared each idea with its baseline concept to determine whether the performance of the attribute (as introduced in Section 3.5) was better than, equal to, or worse than the baseline concept.

Each idea was then carefully evaluated, with the VE team reaching consensus on the overall ranking of the idea (ranking values 0 through 3, as defined below).

3 = Good Opportunity

2 = Good Idea for Design Team to Pursue

1 = Poor Opportunity

0 = Out of Scope/Fatal Flaw

This ranking resulted in the initial disposition of the idea. Those ideas ranked as a 3 were developed further; low-ranked ones (those ranked 0 or 1) were dropped from further consideration; and those that were ranked two were brought forward as ideas the design team should further pursue.

Once ideas were evaluated, the VE leader held a mid-point review with the project manager to validate the evaluation results and ensure the ideas moving forward aligned with the goals and objectives of the project.

5.2 Idea Evaluation Form

Function: Abate Noise

Idea No.	Description		
1	Use excess earthwork to build berm and shorten noise walls where practical		
	Advantages		**Disadvantages**
	• Reduce cost of noise walls • Reduce haul of excess soil • More aesthetically pleasing • May be more effective		• May not have enough room to build berm • May take longer to construct • Right of way constraints
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Function: Control Traffic

Idea No.	Description		
2	Use ramp metering where practical		
	Advantages		**Disadvantages**
	• Improved operations in main line • Improved vehicular spacing • Improved merging operations • Flexible for peak operations		• Increases cost • Increases maintenance • May impact local network operations • Driver expectation • KYTC unfamiliar with technology • May require connection with ITS network & TOC
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation.*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description		
3	Install Variable Message Signs to inform drivers of alternative routes in case of delays on the interstate and crossing roads		
	Advantages		**Disadvantages**
	• Inform users of best routes • Gives users real time traffic information • May divert traffic at peak hours • Improve traffic management of corridor		• Increases cost • Requires management from Traffic Operation Center • Requires backbone infrastructure
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
4	Build ITS infrastructure		
	Advantages		**Disadvantages**
	• Inform users of best routes • Gives users real time traffic information • May divert traffic at peak hours • Improve traffic management of corridor		• Increases cost • Requires management from Traffic Operation Center • Requires backbone infrastructure
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
5	Use ITS technology to manage traffic along the corridor		
	Advantages		**Disadvantages**
	• Inform users of best routes • Gives users real time traffic information • May divert traffic at peak hours • Improve traffic management of corridor		• Increases cost • Requires management from Traffic Operation Center • Requires backbone infrastructure
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
6	Use TSM&O strategies to improve local and Interchange network operations		
	Advantages		**Disadvantages**
	• Inform users of best routes • Gives users real time traffic information • May divert traffic at peak hours • Improve traffic management of corridor		• Increases cost • Requires management from Traffic Operation Center • Requires backbone infrastructure
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Idea No.	Description		
7	Create partnerships with Google and Waze to proactively inform users of alternative routes in case of delays		
	Advantages		**Disadvantages**
			• Partnerships already in existence or on the way
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Idea No.	Description		
8	Convert interchanges' signalization phasing from 3 phases to 2 phases to improve failing interchanges that spill over into the Interstate		
	Advantages		**Disadvantages**
	• Reduces probability of traffic spilling onto the interstate • Increases the throughput of off-ramp movements		• Out of direction travel • User confusion • Added cost • May require right of way for bulb outs (truck turning)
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
9	Build the backbone for smart transportation corridors		
	Advantages		**Disadvantages**
	• Provides options for future technologies in the corridor • Lower future costs of installation		
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Idea No.	Description		
53	Increase use of signs at interchanges and approaches to inform users		
	Advantages		**Disadvantages**
	• Increase User awareness • Reduces weaving and conflicts		• Increase cost
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Function: Convey Water

Idea No.	Description		
10	Grade inside lane and shoulder to the outside and eliminate close drainage in the median		
	Advantages		**Disadvantages**
	• May reduce drainage cost		• May introduce hydroplaning by sheetflowing three lanes
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Function: Create Space

Idea No.	Description		
11	Steepen slopes to avoid purchasing right of way along the interchange, where feasible		
	Advantages		**Disadvantages**
	• Reduces right of way cost and impacts • Reduces risk of project delays		• Increased maintenance cost • May require protection
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #11, 12, 13*	
Idea No.	**Description**		
12	Use retaining wall/noise wall combination where applicable to avoid right of way impacts		
	Advantages		**Disadvantages**
	• Reduces right of way cost and impacts • Reduces risk of project delays		• Increased maintenance cost • May require protection
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #11, 12, 13*	
Idea No.	**Description**		
13	Use retaining walls in lieu of purchasing right of way along the interchange, where feasible		
	Advantages		**Disadvantages**
	• Reduces right of way cost and impacts • Reduces risk of project delays		• Increased maintenance cost • May require protection
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #11, 12, 13*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description		
14	Jack bridges of underpasses to obtain minimum vertical clearance		
	Advantages		**Disadvantages**
			• No bridges are being replaced for vertical clearance
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
15	Rehab bridges at underpasses to obtain minimum vertical clearance using slimmer beams		
	Advantages		**Disadvantages**
			• No bridges are being replaced for vertical clearance
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
16	Eliminate temporary construction of NE and SE loop ramps to maintain traffic by constructing ramp H and A in sections and leaving the last connection to be build in a weekend with full ramp closure and detouring off to US 60		
	Advantages		**Disadvantages**
	• Reduces cost of temp construction • Maintains a higher speed loop • Less throw away cost		• Constricted space for contractor to build • Risk of not completing on time
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #16, 23*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description	
17	Keep bridge over I-64 as is (don't widen to inside), and realign main line over new ramps to the outside (i.e. widen to the outside in that section) of existing for constructibility purposes and keep them outside permanently.	
	Advantages	**Disadvantages**
	• Eliminates widening of I-265 bridge over I-64 • May reduce cost • Improves constructibility of underpasses for ramps H and A • Improves MOT	• Does not match typical section before and after the bridge • Reduced shoulder widths on bridge may require exception
	Rating:	***Justification/Comments/Disposition:***
	3	*Develop into a VE Recommendation.*

Idea No.	Description	
18	Use Design build delivery method for interchange	
	Advantages	**Disadvantages**
	• May decrease cost • Reduces Owner risk of delays • Good candidate for D/B delivery • Improved constructibility • Involves contractor early in the process and decision making • Owner receives best value option	• May lower quality/aesthetic of final product • Design decisions by contractor • Transfer risk to contractor (at a premium) • May take longer to put package together • Right of way scheduling constraints
	Rating:	***Justification/Comments/Disposition:***
	1	*Develop into a VE Recommendation.*

Idea No.	Description	
19	Postpone widening of Interstate south of Rehl Rd (change southern termini)	
	Advantages	**Disadvantages**
	• Reduces capital cost • Savings could be used on improvements elsewhere in the project	• May cause bottle neck delays • May not be able to handle traffic at Taylor and may cause back-ups onto the system interchange
	Rating:	***Justification/Comments/Disposition:***
	1	*Drop from further consideration*

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description		
20	Phase build 3/3B system interchange		
	Advantages		**Disadvantages**
	• Addresses critical movements • Reduces MOT costs • Simplifies construction • Defers right-of-way requirements		• Public perception • Impacts public multiple times
	Rating:	***Justification/Comments/Disposition:***	
	2	*Unable to test traffic model with a partial build. Design team to investigate and develop further*	
Idea No.	**Description**		
21	Separate the northbound I-265 to I-64 movement from the joint ramp (F) and keep it at grade alongside I-265 to join I-64 at grade and reduce earthwork of the ramp (F).		
	Advantages		**Disadvantages**
	• Reduce earthwork quantities • Improves geometry to reduce bridge length of ramps H and A		• May increase length of southern underpass (ramp H)
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
22	Bring bridges of ramps H and A closer to shorten their spans and perhaps build one wider bridge		
	Advantages		**Disadvantages**
	• One less structure over I-64 • Shorter structure • Shorter spans		• May require reducing design speed to achieve geometry
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
23	Build ramp A first before ramp H so the northbound to westbound loop ramp can be closed to build ramp H.		
	Advantages		**Disadvantages**
	• Reduces cost of temp construction • Maintains a higher speed loop • Less throw away cost		• Constricted space for contractor to build • Risk of not completing on time
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #16, 23*	
Idea No.	**Description**		
24	Eliminate widening between US 60 and Old Henry and strengthen shoulder if necessary to make shoulder a peak hour lane		
	Advantages		**Disadvantages**
	• Reduces cost		• Eliminates refuge on peak hours • Driver expectations • May cause operation degredation on main line
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
25	Use Construction Management @ Risk (CM@Risk)		
	Advantages		**Disadvantages**
	• May decrease cost • Shares Owner risk of delays • Good candidate for D/B delivery • Improved constructibility • Involves contractor early in the process and decision making • Owner receives best value option		• May lower quality/aesthetic of final product • KYTC is less experienced on CM@Risk • Design decisions by contractor • Shared risk with contractor • May take longer to put package together • Right of way scheduling constraints
	Rating:	***Justification/Comments/Disposition:***	
	1	*VE Team prefers D/B delivery method. Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Function: Improve Mobility

Idea No.	Description		
26	Create a dynamic directional express lanes on I-265		
	Advantages		**Disadvantages**
	• Increase throughput during peak hour		• Volumes do now warrant directional dynamic express lanes • Does not meet legislative mandate
	Rating:	***Justification/Comments/Disposition:***	
	0	*Drop from further consideration*	
Idea No.	**Description**		
27	Separate a movement away from the system interchange		
	Advantages		**Disadvantages**
			• Impractical on an interstate
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
28	Separate traffic that wants to drive through the system interchange from traffic that wants to exit the system interchange (CD lane / traffic separators)		
	Advantages		**Disadvantages**
	• Offers alternative for long distance drivers • Reduces conflicts		• Increased maintenance • May not provide significant advantage • Limited acces for emergency operations. • Limited refuge
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
29	Widen to the outside		
	Advantages	**Disadvantages**	
	• Design meets 2016 standards (10' inside shoulders) • Improved operations • Improved Driver expectations	• Increased Right of way costs • Likely requires to replace underpass bridges • Increased capital cost • Complex construction • Increased MOT • Already eliminated by Designer	
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
30	Widen to the inside at underpasses and to the outside elsewhere		
	Advantages	**Disadvantages**	
	• Design meets 2016 standards (10' inside shoulders) • Improved operations • Improved Driver expectations	• Increased Right of way costs • Increased capital cost • Complex construction • Increased MOT • Driver expectency not straight line drive)	
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
31	Merge westbound to northbound I-64 with ramp H and minimize width of bridge/culvert under main line I-265. For 3, bring ramp H closer to main line sooner to reduce bridge width		
	Advantages	**Disadvantages**	
	• Reduce structure width • Reduces cost • Reduces maintenance cost	• May be constrained geometry • May require slower design speed	
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Function: Improve Safety

Idea No.	Description		
32	Traffic separate eastbound I-64 to northbound traffic onto US 60 from I-265 (create a CD lane to US 60)		
	Advantages		**Disadvantages**
	• Reduces weaving • Creates storage for 60 • Isolates traffic onto I-265 and reduces delays onto I-265 • Will extend service life of ramps • Increased likelihood of FHWA approval		• May have right of way implications • May cost more • May be more difficult to construct • May require lowering speed • May cause a delay in re-design
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #32, 33, 34, 35*	
Idea No.	**Description**		
33	Braid ramp northbound I-265 to US 60 under / over I-64 eastbound/westbound to northbound I-265		
	Advantages		**Disadvantages**
	• Reduces weaving • Creates storage for 60 • Isolates traffic onto I-265 and reduces delays onto I-265 • Will extend service life of ramps • Increased likelihood of FHWA approval		• May have right of way implications • May cost more • May be more difficult to construct • May require lowering speed • May cause a delay in re-design
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #32, 33, 34, 35*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description		
34	New Interchange concept: To eliminate weave at US 60, combine I-265 northbound to I-64 westbound and US 60 traffic in ramp, then split traffic off after crossing I-64 and braid eastbound I-64 traffic onto I-265 and US 60.		
	Advantages		**Disadvantages**
	• Reduces weaving • Creates storage for 60 • Isolates traffic onto I-265 and reduces delays onto I-265 • Will extend service life of ramps • Increased likelihood of FHWA approval		• May have right of way implications • May cost more • May be more difficult to construct • May require lowering speed • May cause a delay in re-design
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #32, 33, 34, 35*	
Idea No.	**Description**		
35	Split ramp F (northbound to eastbound movement) after underpass of ramp H (southern culvert); bring ramp H under ramp A and to the outside, tighten radii of ramp A at the northern underpass (culvert) and try to avoid right of way at the eastern side (north and south)		
	Advantages		**Disadvantages**
	• Allows for separating traffic to US 60 • Isolates queuing delays away from main line I-265 and onto the system interchange • Improves I-265 main line operations through design year		• May require additional right-of-way • Tight geometry for ramp A • May require lowering design speed • Increases cost • May increase construction duration
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #32, 33, 34, 35*	
Idea No.	**Description**		
36	Build a modified ultimate interchange (lower design speed) in phases, eastbound to northbound and northbound to westbound first.		
	Advantages		**Disadvantages**
	• Addresses critical movements • Reduces MOT costs • Simplifies constructions • Provides for flexibility in future growth/expansion		• May have utilities constraints • Right-of-way constraints • Build a partial solution • Public perception
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

(green) = Advanced as recommendation
(yellow) = Forwarded as design consideration
(red) = Dropped from future consideration

Idea No.	Description		
37	Rerun the Vissim model to validate what year the system interchange is impacted without improvements to other interchanges, particularly US 60.		
	Advantages		**Disadvantages**
	• Plan for case scenario of system failing • Will be required for the IMR		
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
38	Rerun the corridor-wide Vissim model once the preferred alternative is determined using consistent traffic data		
	Advantages		**Disadvantages**
	• Plan for case scenario of system failing • Will be required for the IMR		
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
39	Create a new interchange on I-64 between I-265 and 1848 to relieve traffic from I-64/I-265 interchange		
	Advantages		**Disadvantages**
	• Removes traffic from I-265/I-264 interchange • Improves operations of the system interchange		• Increased cost • Requires NEPA approval • Extends schedule of project • Extensive Right of Way acquisition
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description	
40	Upgrade signalization of US 60 to an adaptive corridor to make the route more attractive for users and Transit operations	
	Advantages	**Disadvantages**
	• Improves Operations on US 60 • Reduces traffic on I-265 • Reduces probability of traffic backing up into I-265 • May increase transit ridership	• Increased cost (change in signal boxes and technology) • May be difficult to sign an MOA with operating agency • Is outside of the scope of the project
	Rating:	***Justification/Comments/Disposition:***
	2	*Design Team to investigate and develop further*

Idea No.	Description	
41	Plan to phase in the elimination of ramp E or G to eliminate weaving : Split southbound I-265 to westbound I-64 traffic and loop ramp movement onto I-64	
	Advantages	**Disadvantages**
	• Reduces conflicts • Eliminates weaving at ramps E and G • Improves main line operations	• Will require additional structures • Increases cost • Complex construction • Increases MOT • Increases maintenance • Driver expectation
	Rating:	***Justification/Comments/Disposition:***
	2	*Design Team to investigate and develop further*

Idea No.	Description	
42	Use 11' lanes and widen inside shoulder to 6', keep outside lane 12'	
	Advantages	**Disadvantages**
	• Improve refuge space • May improve shy distance	• May require exception • Driver expectation • Truck driver expectation • Trucking industry opposition
	Rating:	***Justification/Comments/Disposition:***
	1	*Drop from further consideration*

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Function: Increase Drainage Capacity

Idea No.	Description		
43	Design team to look into the drainage design during PS&E to procure a more detail estimate.		
	Advantages		**Disadvantages**
	• Identify possible ponds if needed • Identify piping network and flow • Assuring current outflow will handle new impervious		
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Function: Relieve Congestion

Idea No.	Description		
44	Improve signal timing on local network by prioritizing ramp movement to relieve congestion on main line operations		
	Advantages		**Disadvantages**
	• Improves operations of main line by clearing queues at ramps • No additional cost		• Coordination with local agency • Degrade local operation when improving ramp operations
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #44, 45*	
Idea No.	**Description**		
45	Use advanced detection at off ramps to prioritize signalization and empty queuing at interchanges.		
	Advantages		**Disadvantages**
	• Improves operations of main line by clearing queues at ramps • No additional cost		• Coordination with local agency • Degrade local operation when improving ramp operations
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation. Combine with #44, 45*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

Green = Advanced as recommendation
Yellow = Forwarded as design consideration
Red = Dropped from future consideration

Idea No.	Description		
46	Add striping and pavement markings at interchange approaches (off-ramps) to increase queuing capacity at interchanges		
	Advantages		**Disadvantages**
	• Increase User awareness • Low cost • Reduces weaving and conflicts		• Slight cost increase
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation.*	

Function: Support Loads

Idea No.	Description		
47	Design pavement section for cars only and restrict trucks from traveling in left lane		
	Advantages		**Disadvantages**
	• Reduced pavement design requirements • Reduces costs • May be quicker to construct		• Increased signage requirements • May be difficult to enforce • Lower flexibility in operations
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation.*	
Idea No.	**Description**		
48	Mill 1.5" and resurface 1.5" instead of overbuild additional 3" of structural pavement.		
	Advantages		**Disadvantages**
	• Lower initial construction cost • Reduces grade adjustments at bridges • Simpler MOT • Quicker construction (1 lift vs 2)		• Lower lifecycle • May not meet the 40-year requirement
	Rating:	***Justification/Comments/Disposition:***	
	3	*Develop into a VE Recommendation.*	

Ranking Scale: 3 = Good Opportunity; 2 = Good Idea for Design Team to Pursue; 1 = Poor Opportunity; 0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
49	Use ABC bridge structures in lieu of culverts in the underpasses of I-265 (loops A and H)		
	Advantages		**Disadvantages**
	• Easier to construct • Improved visibility • Improved sight distance • Improved lifecycle • Eliminates cost of ilumination		• May cost more • May require more maintenance
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	
Idea No.	**Description**		
50	Use asphalt to widen the concrete section of the project in lieu of concrete		
	Advantages		**Disadvantages**
	• Faster construction • Reduces cost		• Shorter lifecycle • Differential settling • Driver expectations
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	
Idea No.	**Description**		
51	Include pavement alternate in the bid package		
	Advantages		**Disadvantages**
	• Allow industry to weigh in decision • May increase competition • May decrease cost		• Inconsistency in pavement
	Rating:	***Justification/Comments/Disposition:***	
	2	*Design Team to investigate and develop further*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

Idea No.	Description		
52	Build concrete lanes on asphalt section and mill asphalt completely and overlay with concrete existing lanes		
	Advantages		**Disadvantages**
	• Increased lifecycle • Lower maintenance cost		• Increased cost • Longer to construct
	Rating:	***Justification/Comments/Disposition:***	
	1	*Drop from further consideration*	

Ranking Scale: 3 = Good Opportunity
2 = Good Idea for Design Team to Pursue
1 = Poor Opportunity
0 = Out of Scope/Fatal Flaw

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from future consideration

6 Development Phase

This phase of the process takes the concepts, or ideas, that ranked the highest in the idea evaluation phase and further develops them into full VE recommendations. In many cases, it is possible that one or more ideas were combined to form an overall recommendation, which was then evaluated further by the VE team.

In the case of this project, of the 53 ideas that were generated during the Creative Phase, 16 of those ideas were taken evaluated high enough to be taken forward, combined, and developed further. Some of the 53 ideas were deemed more appropriate as a design consideration for the project team, rather than developed into a VE recommendation (see Section 6.3). For the Development Phase, narratives, drawings, calculations, and cost estimates were prepared for each recommendation.]

6.1 Performance Assessment

As the VE team developed recommendations, the performance of each was compared to the baseline for potential value improvement. For this exercise, the baseline was given a score of 5. Table 9 shows the attribute scales used to evaluate the performance of the alternative concepts relative to the baseline concept.

Table 9. Performance Attribute Rating Scale

Rating	Performance Attribute Scales
10	Alternative concept is extremely preferred
9	Alternative concept is very strongly preferred
8	Alternative concept is strongly preferred
7	Alternative concept is moderately preferred
6	Alternative concept is slightly preferred
5	***Concepts are equally preferred***
4	Baseline concept is slightly preferred
3	Baseline concept is moderately preferred
2	Baseline concept is strongly preferred
1	Baseline concept is very strongly preferred
0	Baseline concept is extremely preferred

6.2 Performance Rating

The performance matrix permits the comparison of various recommendations against the baseline concept by organizing the data developed for the performance attributes into a matrix format to yield value indices.

The matrix is essential for understanding the performance and value of the baseline and VE concepts. Comparing the performance suggests which recommendations are potentially as good as or better than the baseline concept in terms of overall value.

Comparison at the value index level suggests which recommendations have the best functionality or provides the project with the best value.

Table 10 shows the VE team evaluation of the baseline design of both projects 5-549 Interchange and 5-537 Main Line, based on performance measures as defined in Table 7.

Table 10. Baseline Assessment

PERFORMANCE MEASURES **Attributes and Rating Rationale**	***Performance***	***Baseline***
Main Line Operations Low design speed I-64 EB backups, WB seems to free flow I-265 is similar to other segments. Ramp operations will dictate mainline operations	***Rating***	**5**
	Weight	**26.1**
	Contribution	**130.5**
Local Operations Options 1A, 3 and 3B accommodates traffic through 2045 Ramp delays due to downstream capacity constraints (SB particularly) Good operations all ramps except D (EB-SB)	***Rating***	**5.5**
	Weight	**26.1**
	Contribution	**143.55**
Maintainability New bridges are being built, including new pavement to approaches Some structures (I-265) were built in 1960's Others are slightly newer. Existing bridges may require increased maintenance over the years	***Rating***	**6.5**
	Weight	**16.6**
	Contribution	**107.9**
Construction Impacts weekend closures widening required for MOT 3/3B requires new bridges over new ramps (turbine)	***Rating***	**8.5**
	Weight	**4.7**
	Contribution	**39.95**
Environmental Impacts Right of way required Some mitigation required Noise mitigation required	***Rating***	**8**
	Weight	**9.9**
	Contribution	**79.2**
Project Schedule Complex constructibility (over traffic) Staging locations may be limited Minor utility relocations Higher risks of delays - Fast track Pursuing an Infra-Grant	***Rating***	**4**
	Weight	**16.6**
	Contribution	**66.4**

The performance rating and rationale for each alternative generated by the VE team is located on the individual recommendation forms found in Section 7.4.

Figure 5. Performance Rating Matrix

Attribute	Attribute Weight	Concept	Performance Rating	Total Performance
Main Line Operations	**26.1**	**Baseline**	**5**	**130.5**
		1	5	130.5
		2	7	182.7
		3	5	130.5
		4	5	130.5
		5	5	130.5
		6	8	208.8
		7	7.5	195.8
		8	5.5	143.6
		9	5.5	143.6
Local Operations	**26.1**	**Baseline**	**5.5**	**143.6**
		1	5.5	143.6
		2	4.5	117.5
		3	5.5	143.6
		4	5.5	143.6
		5	5.5	143.6
		6	5.5	143.6
		7	3.5	91.4
		8	5.75	150.1
		9	5.5	143.6
Maintainability	**16.6**	**Baseline**	**6.5**	**107.9**
		1	6	99.6
		2	6	99.6
		3	6.5	107.9
		4	7	116.2
		5	6.5	107.9
		6	6	99.6
		7	6.75	112.1
		8	6.5	107.9
		9	6.25	103.8
Construction Impacts	**4.7**	**Baseline**	**8.5**	**40.0**
		1	8.5	40.0
		2	8	37.6
		3	9	42.3
		4	9	42.3
		5	9.5	44.7
		6	8.5	40.0
		7	8.5	40.0
		8	8.5	40.0
		9	8.5	40.0
Environmental Impacts	**9.9**	**Baseline**	**9**	**89.1**
		1	9	89.1
		2	9.5	94.0
		3	9.5	94.0
		4	9	89.1
		5	9.5	94.0
		6	8.5	84.1
		7	9	89.1
		8	9	89.1
		9	9	89.1
Project Schedule	**16.6**	**Baseline**	**4**	**66.4**
		1	7	116.2
		2	4	66.4
		3	5	83.0
		4	4.5	74.7
		5	7	116.2
		6	4	66.4
		7	4	66.4
		8	4	66.4
		9	4.5	74.7

Understanding the relationship of cost, performance, and value of the project baseline and VE concepts is essential in evaluating VE recommendations. Comparing the performance and cost suggests which recommendations are potentially as good as or better than the project baseline concept in terms of overall value.

Figure 6. Value Matrix

Recommendation Summary											
	Recommendations	**5-537 (Main Line)**	**5-549 (Interchange)**	**Performance (P)**	**% Change Performance**	**Cost (C) $ millions**	**Cost Change $ millions**	**% Change Cost**	**Value Index**	**% Value Improvement**
	Baseline	✓	✓	577	---	$101.4	---	---	5.70	---
1	Steepen Slopes & Build Retaining Walls to Avoid ROW Impacts	✓	✓	619	+7%	$101.9	$0.48	+0.5%	6.08	+6.7%
2	Use Ramp Metering	✓		598	+4%	$101.9	$0.50	+0.5%	5.87	+3.0%
3	Change I-64 Ramp Construction Sequence to Minimize Temp Construction		✓	601	+4%	$100.6	($0.78)	-0.8%	5.98	+4.9%
4	Widen New Underpasses to the Outside to Improve Constructibility		✓	596	+3%	$100.8	($0.60)	-0.6%	5.92	+3.9%
5	Use Design Build Delivery Method		✓	637	+10%	$99.5	($1.90)	-1.9%	6.40	+12.4%
6	Modify System Interchagne to Separate US 60 and Main Line Traffic		✓	642	+11%	$100.7	($0.67)	-0.7%	6.38	+12.0%
7	Apply Advanced Signalization Strategies to Avoid Impacts to Main Line	✓		595	+3%	$101.6	$0.24	+0.2%	5.85	+2.7%
8	Improve Signage at Approaches to Interchanges	✓		597	+3%	$101.4	$0.05	+0.0%	5.89	+3.3%
9	Reduce Pavement Section	✓	✓	595	+3%	$99.1	($2.29)	-2.3%	6.00	+5.4%
	Total						($5.0)			

6.3 Design Suggestions

The VE team generated the following design suggestions for consideration by the project design team. These items represent ideas that are relatively general in nature, and are listed below in Table 11. Additional details for three of the suggestions can be found following the recommendations in Section 7.4. Advantages and disadvantages of the others are shown in Section 5.2 in the Idea Evaluation Form.

Table 11. Design Considerations

Idea No.	Description
1	Use excess earthwork to build berm and shorten noise walls where practical
3	Install Variable Message Signs to inform drivers of alternative routes in case of delays on the interstate and crossing roads
4	Build ITS infrastructure
5	Use ITS technology to manage traffic along the corridor
6	Use TSM&O strategies to improve local and Interchange network operations
9	Build the backbone for smart transportation corridors
20	Phase build 3/3B system interchange
21	Separate the northbound I-265 to I-64 movement from the joint ramp (F) and keep it at grade alongside I-265 to join I-64 at grade and reduce earthwork of the ramp (F).
22	Bring bridges of ramps H and A closer to shorten their spans and perhaps build one wider bridge
31	Merge westbound to northbound I-64 with ramp H and minimize width of bridge/culvert under main line I-265. For Alternative 3, bring ramp H closer to main line sooner to reduce bridge width
36	Build a modified ultimate interchange (lower design speed) in phases, eastbound to northbound and northbound to westbound first.
37	Rerun the Vissim model to validate what year the system interchange is impacted without improvements to other interchanges, particularly US 60.
38	Rerun the corridor-wide Vissim model once the preferred alternative is determined using consistent traffic data
40	Upgrade signalization of US 60 to an adaptive corridor to make the route more attractive for users and Transit operations
41	Plan to phase in the elimination of ramp E or G to eliminate weaving : Split southbound I-265 to westbound I-64 traffic and loop ramp movement onto I-64
43	Design team to look into the drainage design during PS&E to procure a more detail estimate.
49	Use ABC bridge structures in lieu of culverts in the underpasses of I-265 (loops A and H)
51	Include pavement alternate in the bid package

7 Recommendations

7.1 Introduction

Evaluation of the 53 ideas generated by the team resulted in 9 individual recommendations to the baseline concept. The VE recommendation documents in this section are presented as written by the team during the VE study. While they have been edited from the draft VE report to correct errors or better clarify the recommendation, they represent the VE team's findings during the VE study.

Each recommendation consists of a summary of the baseline concept, a description of the suggested change, a listing of its advantages and disadvantages, a cost comparison, change in performance, and a brief narrative comparing the baseline design with the recommendation. Sketches, calculations, and performance measure ratings are also presented. The cost comparisons reflect a comparable level of detail as in the baseline estimate.

7.2 Summary of Recommendations

Table 12. Summary of Recommendations

#	Description	Cost Delta (millions)	Performance Improvement (%)
1	Steepen slopes and build retaining walls to avoid right-of-way impacts	($0.48)	7
2	Use ramp metering	($0.50)	4
3	Change I-64 ramp construction sequence to minimize temporary construction	$0.78	4
4	Widen new underpasses to the outside to improve constructibility	$0.60	3
5	Use design-build delivery method	$1.90	10
6	Modify System Interchange Design to Separate US 60 and Mainline Traffic	$0.67	11
7	Apply advanced signalization strategies to avoid impacts to main line	($0.24)	3
8	Improve signage at approaches to interchanges	($0.05)	3
9	Reduce pavement section	$2.29	3

7.2.1 FHWA Functional Benefit Criteria

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

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

7.3 Value Engineering Punch List

The VE punch list is to aid in annual reporting of VE activities to FHWA. It is the intent that the project manager review and evaluate the VE team's alternatives included in the final report. The project manager would then complete the Value Engineering Punch List shown in Appendix C.

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

7.4 Individual Recommendations

Based on the evaluation process, individual recommendations were developed. Each recommendation consists of a summary of the baseline concept, a description of the recommendation, a listing of its advantages and disadvantages, and a brief narrative that includes justification, sketches, photos, assumptions, and calculations as developed by the VE team. Final recommendations can be found beginning on page 7-3.

VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS

Idea Nos. 11,12,13

Baseline Concept

The baseline design used for evaluation are Alternatives 3 and 3B for the I-64 at I-265 Interchange. Baseline design for both alternatives assumes acquiring right-of-way to accommodate construction limits that fall outside of existing right-of-way.

Recommendation Concept

Use three strategies to reduce or eliminate right-of-way impacts:

1. Use retaining wall/noise wall combination where applicable to avoid right-of-way impacts.
2. Use retaining walls in lieu of purchasing right-of-way along the interchange, where feasible.
3. Steepen slopes to avoid purchasing right-of-way along the interchange, where feasible.

Advantages	Disadvantages
• Reduces right-of-way cost and impacts • Reduces risk of project delays • Reduces risk of utility impacts • May reduce earthwork quantities	• Increases maintenance cost • May require protection (barrier wall/-guardrail)

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept – **Alt 3**	$22,000	$1,653,000	$1,675,000
Recommendation Concept	$2,157,000	$0	$2,157,000
Cost Avoidance/(Added Value)	($2,135,000)	$1,653,000	($481,000)
Baseline Concept – **Alt 3B**	$33,000	$1,052,000	$1,085,000
Recommendation Concept	$941,000	$0	$941,000
Cost Avoidance/(Added Value)	($908,000)	$1,052,000	$144,000

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
		✓		✓

VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS	Idea Nos. 11,12,13

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

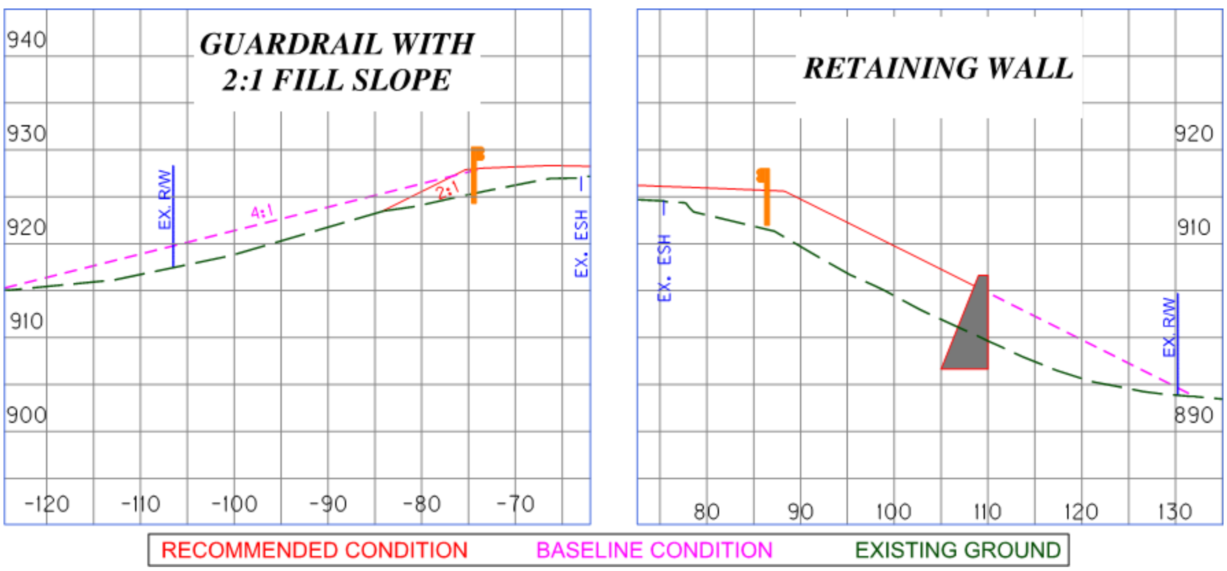
The task involved with this recommendation was to eliminate right-of-way acquisition as much as possible considering and evaluating the ideas listed below:

Idea No. 23: Use retaining walls in lieu of purchasing right-of-way along the interchange, where feasible.

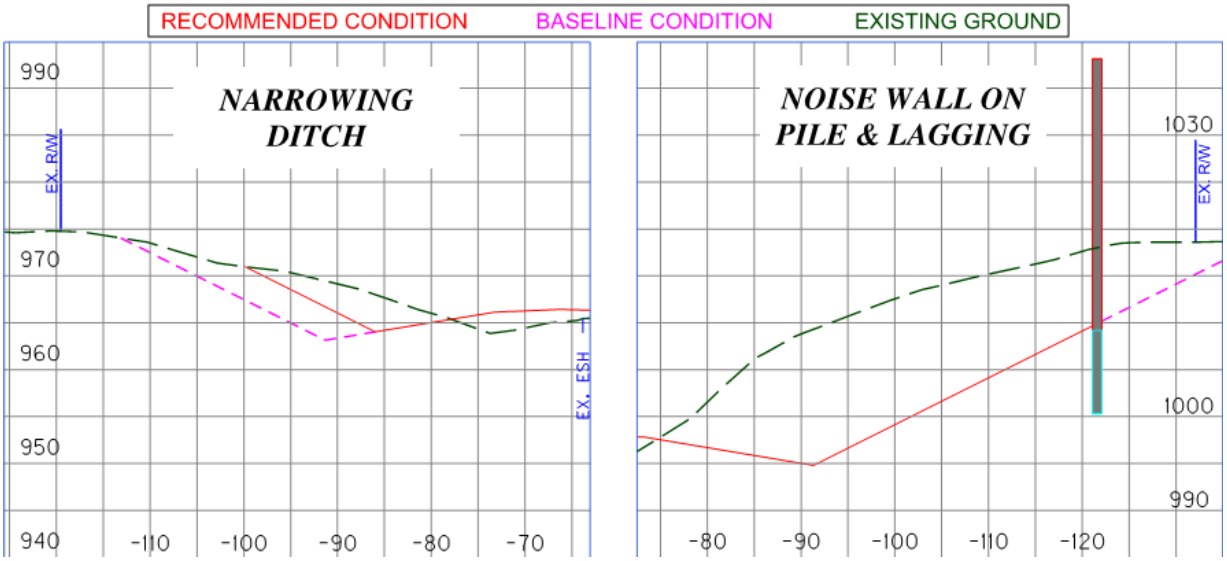
Idea No. 24: Steepen slopes to avoid purchasing right-of-way along the interchange, where feasible.

Idea No. 25: Use retaining wall/noise wall combination where applicable to avoid right-of-way impacts.

Cross sections were evaluated considering the ideas mentioned above. In addition to the above ideas, the VE team recommends refining cut and fill slopes where there is a very minor disturbance outside of the existing right-of-way line.



VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS	Idea Nos. 11,12,13



Assumptions/Calculations

An assumption and thought for consideration not reflected within the calculations and estimates made, is that the project could move along faster with reduced environmental impacts and minimal right-of-way acquisition.

The table below reflects a decrease in the number of parcels affected for each interchange alternative after applying one or more of VE Idea Nos. 11, 12, and 13. If funding through an INFRA Grant is awarded, the project could be positioned to move rapidly to construction.

	ALT 3	ALT 3B
BASELINE PARCELS	23	21
RECOMMENDED AVOIDED	22	20
RECOMMENDED REMAINING	1	1

Alternative 3 Right-of-Way Estimation:

RIGHT OF WAY				
PERM. R/W & ESMT. I-64 westbound	ACRES	-1.81	$350,000.00	($634,266.53)
PERM. R/W & ESMT. I-CHANGE	ACRES	-4.00	$200,000.00	($799,173.55)
ADDED R/W LABOR	PARCEL	-22	$10,000.00	($220,000.00)

Total Right-of-Way **($1,653,440.08)**

VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS

Idea Nos. 11,12,13

VE Study Life-Cycle Costs Calculations

I265 widening and Interchange at I-64

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Alternative 3 Scenario				$ -		$ -	$ -
Excavation	CY	1531.5	$ 11.00	$ 16,846.50		$ 11.00	$ -
Guardrail	LF		$ 16.00	$ -	1150	$ 16.00	$ 18,400.00
Asphalt Surface	TON		$ 83.00	$ -	26.4	$ 83.00	$ 2,191.20
Asphalt Base	TON		$ 67.00	$ -	126.5	$ 67.00	$ 8,475.50
MSE Wall	SF		$ 85.00	$ -	14400	$ 85.00	$ 1,224,000.00
Gravity Retaining Wall	CY		$ 375.00	$ -	1000	$ 375.00	$ 375,000.00
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
Subtotal Construction				*$ 16,846.50*			*$ 1,628,066.70*
Mark-Up (MOT, Mob., PE, CEI)	33%			$ 5,475.11			$ 529,121.68
Total Construction				**$ 22,321.61**			**$ 2,157,188.38**
Monetized Time Savings							$ -
Right of Way Costs	LS	1	$ 1,653,440.08	$ 1,653,440.08			$ -
TOTAL CAPITAL COST				***$ 1,675,761.69***			***$ 2,157,188.38***
COST CAPITAL SAVINGS / (INCREASE)							***$ (481,426.69)***

Alternative 3B Right-of-Way Estimation:

RIGHT OF WAY				
PERM. R/W & ESMT. I-64 westbound	ACRES	-1.12	$350,000.00	($390,961.89)
PERM. R/W & ESMT. I-CHANGE	ACRES	-2.30	$200,000.00	($460,789.72)
ADDED R/W LABOR	PARCEL	-20	$10,000.00	($200,000.00)

Total Right-of-Way **($1,051,751.61)**

VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS	Idea Nos. 11,12,13

VE Study Life-Cycle Costs Calculations

I265 widening and Interchange at I-64

Component	Unit	Baseline Concept Quantity	Baseline Concept Cost/Unit	Baseline Concept Total	VE Recommended Concept Quantity	VE Recommended Concept Cost/Unit	VE Recommended Concept Total
Alternative 3B				$ -		$ -	$ -
Excavation	CY	2259.3	$ 11.00	$ 24,852.30	0	$ 11.00	$ -
Guardrail	LF		$ 16.00	$ -	1150	$ 16.00	$ 18,400.00
Asphalt Surface	TON		$ 83.00	$ -	26.4	$ 83.00	$ 2,191.20
Asphalt Base	TON		$ 67.00	$ -	126.5	$ 67.00	$ 8,475.50
MSE Wall	SF		$ 85.00	$ -	3600	$ 85.00	$ 306,000.00
Gravity Retaining Wall	CY		$ 375.00	$ -	1000	$ 375.00	$ 375,000.00
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
Subtotal Construction				*$ 24,852.30*			*$ 710,066.70*
Mark-Up (MOT, Mob., PE, CEI)	33%			$ 8,077.00			$ 230,771.68
Total Construction				**$ 32,929.30**			**$ 940,838.38**
Monetized Time Savings							$ -
Right of Way Costs	LS	$ 1.00	$ 1,051,751.61	$ 1,051,751.61			$ -
TOTAL CAPITAL COST				***$ 1,084,680.91***			***$ 940,838.38***
COST CAPITAL SAVINGS / (INCREASE)							***$ 143,842.53***

Note:

Unit costs for MSE retaining wall are based on historic project data of similar items.

VE RECOMMENDATION NO. 1: STEEPEN SLOPES AND BUILD RETAINING WALLS TO AVOID RIGHT-OF-WAY IMPACTS	Idea Nos. 11,12,13

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations No Change	Rating	5	5
	Weight	26	
	Contribution	131	131
Local Operations No Change	Rating	6	6
	Weight	26	
	Contribution	144	144
Maintainability Additional walls to maintain Additional Guardrail	Rating	7	6
	Weight	17	
	Contribution	108	100
Construction Impacts No Change	Rating	9	9
	Weight	5	
	Contribution	40	40
Environmental Impacts Significantly less right of way	Rating	9	9
	Weight	10	
	Contribution	89	89
Project Schedule Reduces risk of ROW acquisition delays	Rating	4	7
	Weight	17	
	Contribution	66	116
	Total Performance	577	619
		Net Change in Performance	7%

VE RECOMMENDATION NO. 2: USE RAMP METERING	Idea No. 2

Baseline Concept

The baseline design has on-ramps that are free-flow at all interchanges with surface streets.

Recommendation Concept

Use ramp metering as a traffic control measure during peak traffic hours to improve main line operations and safety.

Advantages	Disadvantages
• Improves operations in main line • Improves merging operations by spacing vehicles • Flexible for peak operations	• Increases capital cost • Increases maintenance • May impact local network operations • Driver expectation • Need for enforcement • KYTC unfamiliar with technology

Cost Summary	Capital Cost	Right of Way Costs	Total Cost
Baseline Concept	0		0
Recommendation Concept	$500,000		$500,000
Cost Avoidance/(Added Value)	($500,000)		($500,000)

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
✓	✓			

VE RECOMMENDATION NO. 2: USE RAMP METERING	Idea No. 2

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Ramp metering works by allowing vehicles to enter the freeway at a frequency equal to the gaps on the main line. This prevents large platoons entering from the ramp when there is adequate space, thus allowing for a main line density that is stable.

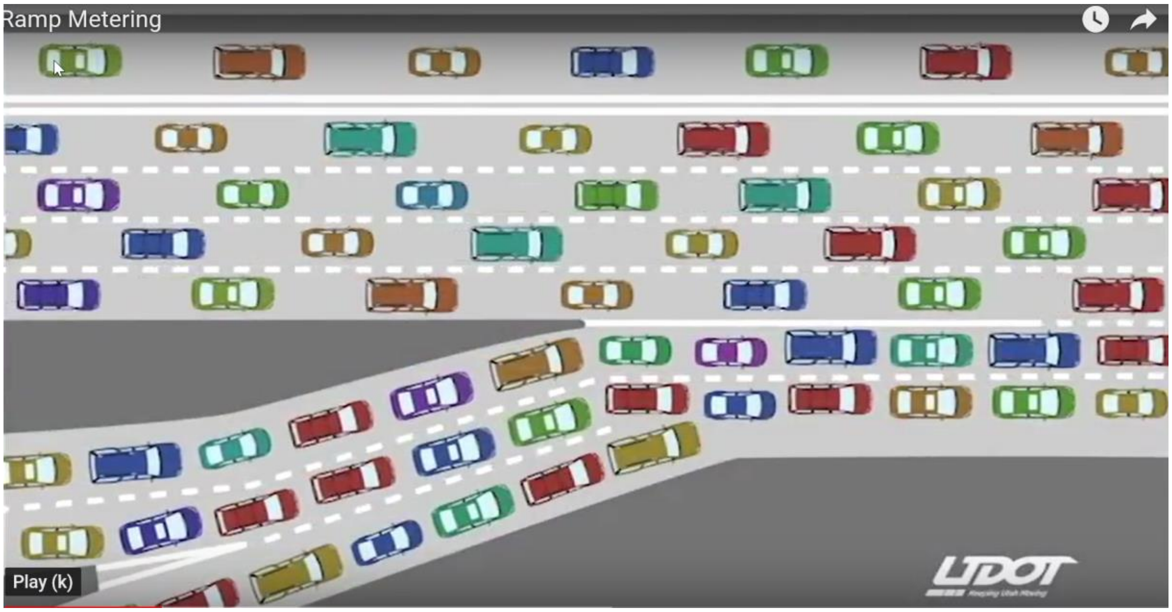
Ramp metering is a proven technology that has been used in at least 20 states. For example, the state of Ohio has used ramp metering for the last 10 years along eastbound I-74 in Cincinnati.

This technology has the potential to greatly improve traffic flow, especially in areas in and near the merge areas. Operations can be customized to activate during peak flow periods. Studies of various systems show benefits ranging from an 18 to 74 percent increase in throughput (peak volumes) and increases in average travel speed by 3 to 25 mph. Safety benefits have been measured ranging from 15 percent to 50 percent reduction in collisions.

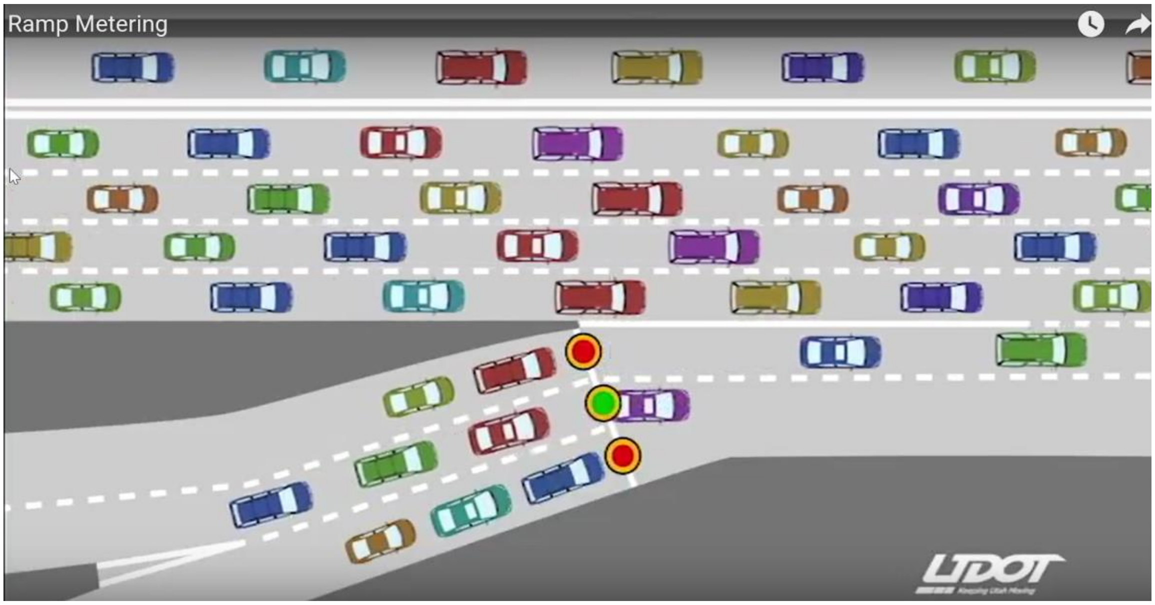
Ramp metering may prove especially critical on the US 60 (Shelbyville Rd.) ramp entering southbound I-265 and KY 22 (Brownsboro Road) ramp entering northbound I-265. This is because there is short spacing between each of these on-ramps and the adjacent system interchanges of I-64 and I-71.

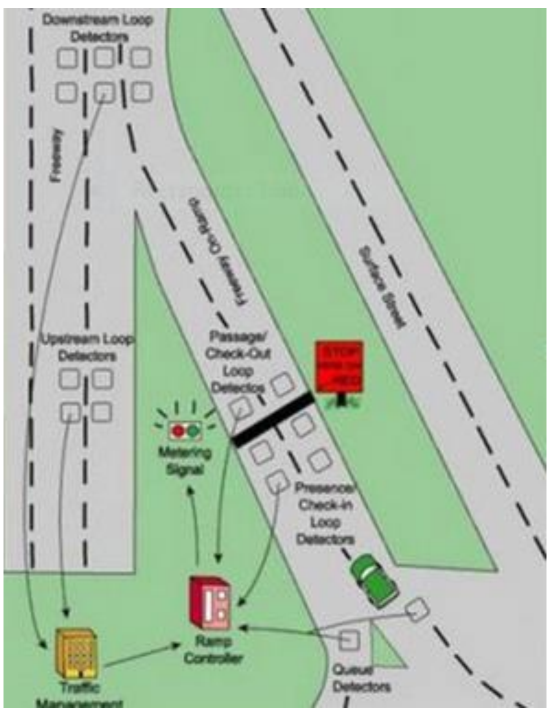
It is recommended that an abbreviated ramp metering study be conducted on the interchanges within the project corridor. This study would identify equipment needs and costs. It would also identify modifications (if any) to the ramps such as widening or lengthening to accommodate storage or ramp meter operations. The cost of this study is not included in the calculations for this recommendation.

Video on Utah DOT ramp metering implementation in 2017: https://www.youtube.com/watch?v=u-QFG1plaO8



VE RECOMMENDATION NO. 2: USE RAMP METERING	Idea No. 2





Assumptions/Calculations

The costs below assume construction cost during time of I-265 widening project.

Detection and signal equipment estimated for six ramps. Electric lines. Detection equipment on main line.

$85,000 per ramp x 6 = $510,000

VE RECOMMENDATION NO. 2: USE RAMP METERING

Idea No. 2

PERFORMANCE MEASURES / Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations — Improved mobility / Reduced congestion	*Rating*	5	7
	Weight	26	
	Contribution	131	183
Local Operations — Unlikely to cause major delays, some congestion may occur	*Rating*	6	5
	Weight	26	
	Contribution	144	117
Maintainability — More equipment to maintain and operate	*Rating*	7	6
	Weight	17	
	Contribution	108	100
Construction Impacts — Slight impact to commuter traffic, none during peak hour	*Rating*	9	8
	Weight	5	
	Contribution	40	38
Environmental Impacts — Improved air quality and user delay costs	*Rating*	9	10
	Weight	10	
	Contribution	89	94
Project Schedule — No change	*Rating*	4	4
	Weight	17	
	Contribution	66	66
	Total Performance	577	598
		Net Change in Performance	4%

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16

Baseline Concept

The baseline concept shows building two temporary loop ramps to maintain the northbound-to-westbound traffic (NE ramp) and the eastbound-to-northbound traffic to maintain traffic during the construction of Ramp A and Ramp H.

Recommendation Concept

Build ramp A first before ramp H so the northbound to westbound loop ramp can be closed to build ramp H.

Eliminate temporary construction of NE and SE loop ramps to maintain traffic by constructing ramp H and A in sections and leaving the last connection to be built in a weekend with full ramp closure

Advantages

- Reduces cost of temporary construction
- Maintains a higher speed loop during construction
- Less throwaway cost

Disadvantages

- Constricted space for contractor to build
- Risk of not completing on time

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept	$981,500		$981,500
Recommendation Concept	$200,000		$200,000
Cost Avoidance/(Added Value)	$781,500		$781,500

FHWA Function Benefit

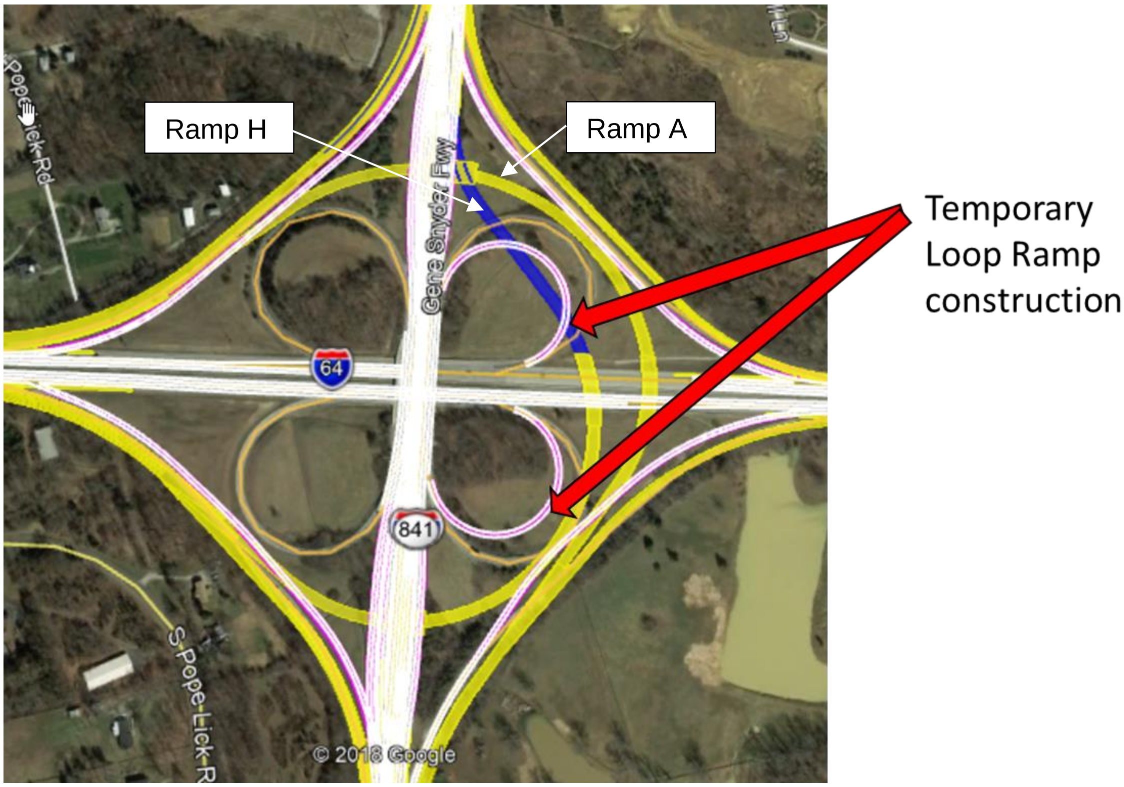
Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
			✓	

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

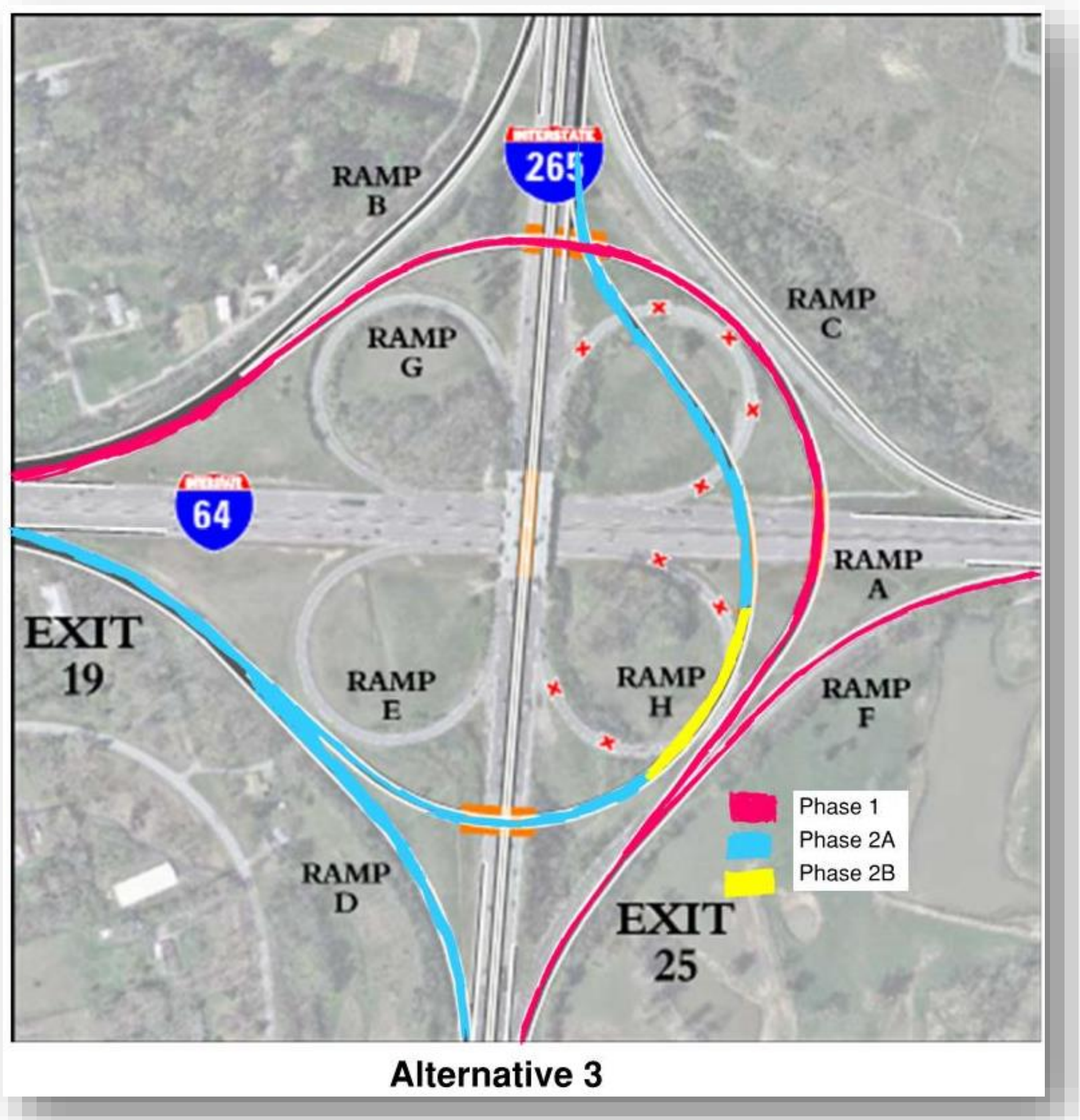
The baseline concept plans show six phases to construct ramps A and H, which requires the temporary construction of two elevated ramps, as shown in figure below:



The recommendation is to build Ramp A first while maintaining the traffic on the existing northbound-to-westbound loop ramp. Although this may require some temporary shoring near the apex of the existing loop ramp, maintaining the existing loop ramp would reduce the throwaway cost to maintain traffic. Additionally, the proposed temporary loop geometry is tighter than the existing loop and would require temporary fill embankment that may disturb existing drainage runoff conveyance. Once Ramp A is constructed, open Ramp A to traffic. This will allow the contractor more room for laydown and a larger work zone to build Ramp H.

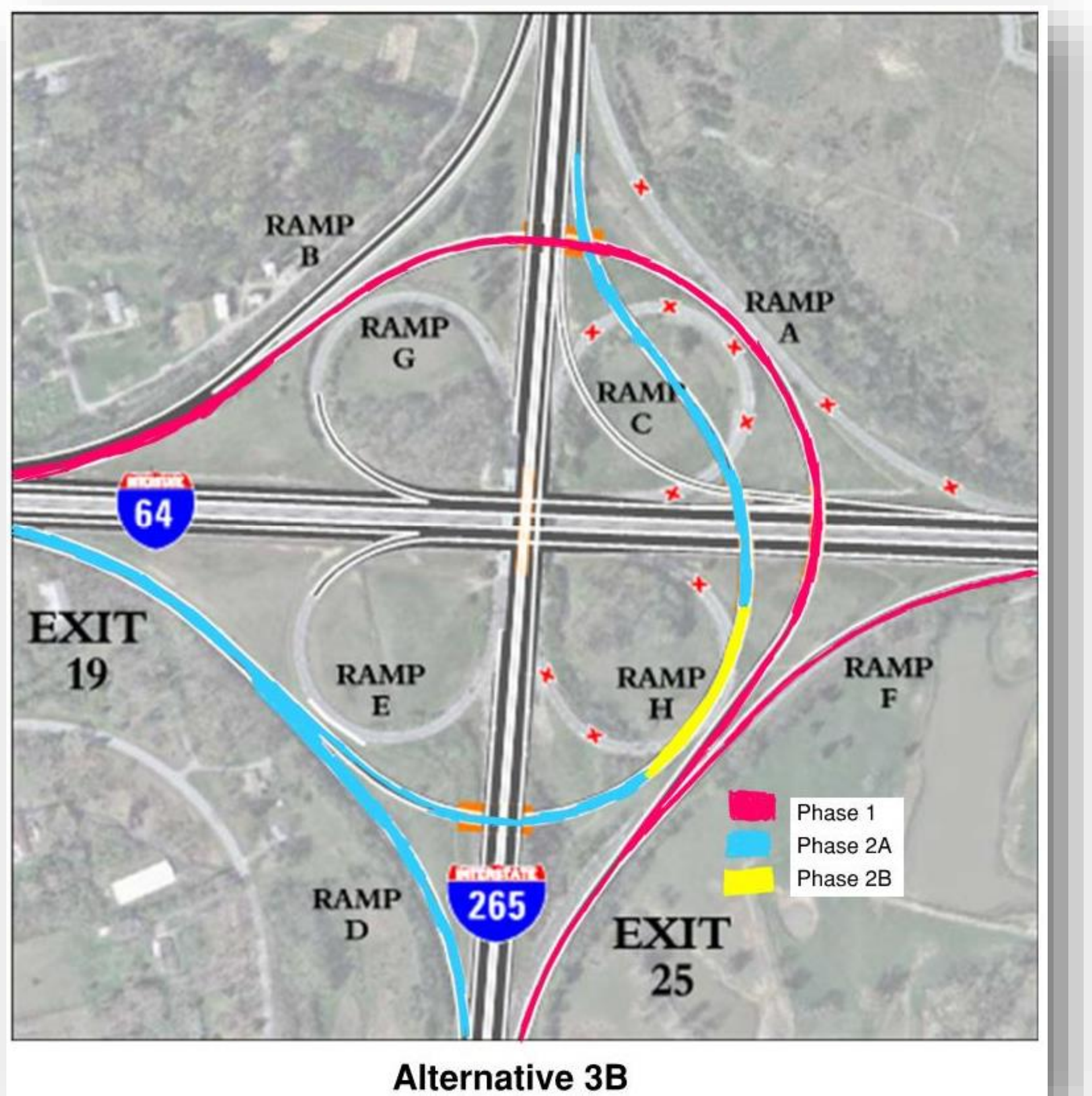
For the Ramp H construction, it is recommended to build as much of Ramp H off of the existing alignment of the eastbound-to-northbound loop ramp that is practical. This will allow traffic to be maintained on the existing loop ramp. Construction of the portion of Ramp H spanning the existing eastbound-to-northbound loop ramp would be constructed over a weekend, requiring entire closure of the existing loop ramp. Traffic would be detoured to Blankenbaker Parkway.

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16



Construction Phasing

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16



Construction Phasing

Assumptions/Calculations

- This recommendation applies to Alternative 3 and Alternative 3B.
- KYTC would be open to having weekend closure of Ramp A and Ramp H

<u>Cost for Temporary Loop Ramps A and H</u>

Ramp A and Ramp H

Length = 800 feet each

Lane width = 15 feet

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16

Shoulder width = 4 feet outside, 6 feet inside = 10 feet

Depth of asphalt surface = 1.5 inches

Depth of asphalt base = 6 inches

Depth of crushed stone base = 1 foot

Total asphalt surface = (800*2*25*1.5/12)/27 * 1.9 ton/CY = 352 tons of asphalt surface

Total asphalt base = (800*2*25*6/12)/27 * 1.9 ton/CY = 1,407 tons of asphalt base

Total crushed stone base = (800*2*25*1)/27 * 2.2 ton/CY = 3,256 tons of aggregate base

Assumed height for temporary embankment in place ranges from 16 feet to 0. Assumed average of 8 feet.

Assumed 4:1 slopes

Average cross sectional area = 32 feet * 8 feet +25*8 = 456 sq ft

Total embankment in place for ramps A and H = 456*2*800/27 = 27,022 CY temporary embankment fill

Unit price for asphalt surface= $83/ton

Unit price for asphalt base = $67/ton

Unit price for crushed stone base = $22/ton

Unit price for embankment= $10/CY

Total asphalt surface price = $29,200

Total asphalt base price = 94,300

Total crushed stone base price = $71,500

Total embankment in place = $270,000

Removal of temporary roadway = 29,000 CY * $10 = $290,000

Subtotal cost = $755,000

Reduction in contingency = Subtotal cost * 30% = $226,500

Total cost to build temporary ramps = $981,500

Assumed premium to contractor for weekend work = $200,000

VE RECOMMENDATION NO. 3: CHANGE I-64 RAMP CONSTRUCTION SEQUENCE TO MINIMIZE TEMPORARY CONSTRUCTION	Idea No. 16

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations No Change	Rating	5	5
	Weight	26	
	Contribution	131	131
Local Operations No Change	Rating	6	6
	Weight	26	
	Contribution	144	144
Maintainability No Change	Rating	7	7
	Weight	17	
	Contribution	108	108
Construction Impacts Longer construction impacts at lower speeds versus faster ramps for most of construction except for a weekend: increased preformance	Rating	9	9
	Weight	5	
	Contribution	40	42
Environmental Impacts Less user delay Improved air quality Less throw away materials	Rating	9	10
	Weight	10	
	Contribution	89	94
Project Schedule Less temporary construction (in the critical path)	Rating	4	5
	Weight	17	
	Contribution	66	83
	Total Performance	577	601
	Net Change in Performance		4%

VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY

Idea No. 17

Baseline Concept

The baseline design proposes widening the existing I-265 bridge over I-64 to the inside using precast, pre-stressed box beams to match the proposed widened roadway typical section.

Recommendation Concept

Leave existing northbound bridge over I-64 as is (don't widen). Modify roadway alignment of northbound I-265 to match existing bridge section. Widen southbound I-265 bridge to the inside, matching the design of the existing bridge.

Advantages	Disadvantages
• Eliminates widening of I-265 bridge over I-64 and associated costs • Eliminates one longitudinal joint in the bridge deck • Improves constructibility of underpasses for ramps H and A • Improves maintenance of traffic	• Would require modifications to the roadway typical section before and after the bridge • Typical section of roadway at approaches would not be symmetrical, which could make construction more complicated • Reduced shoulder widths on bridge may require exception • Roadway approaches would be more complicated due to taper

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept	$1,193,000		$1,193,000
Recommendation Concept	$596,500		$596,500
Cost Avoidance/(Added Value)	$596,500		$596,500

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
			✓	

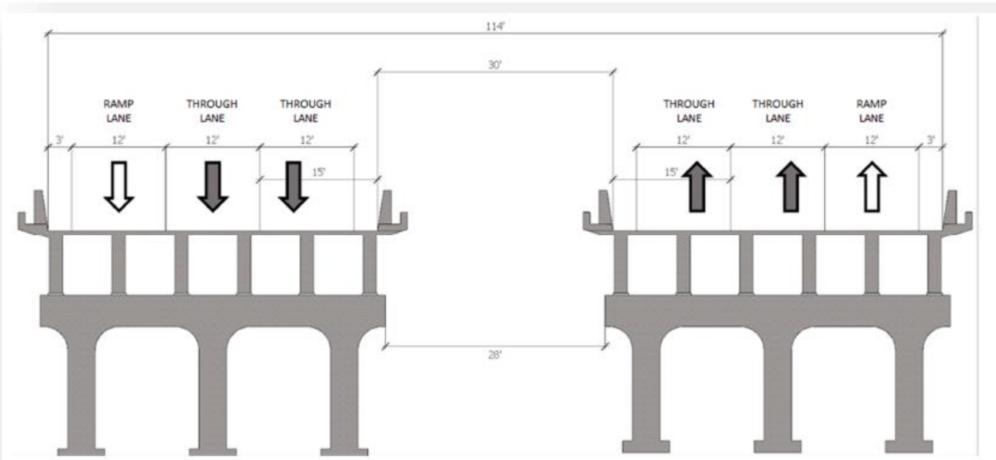
VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY	Idea No. 17

Discussion/Sketches/Photos/Calculations

Existing Bridge Location

The existing twin bridges are 42 feet wide (from gutterline to gutterline) and each carry two lanes of main line I-265 northbound and southbound traffic. The remaining third lane carried on each structure functions as lanes for the loop ramp for the movements to and from I-64. The superstructures are composed of RCDG (reinforced concrete deck girders) and the substructures are composed of conventional multicolumn reinforced concrete piers.

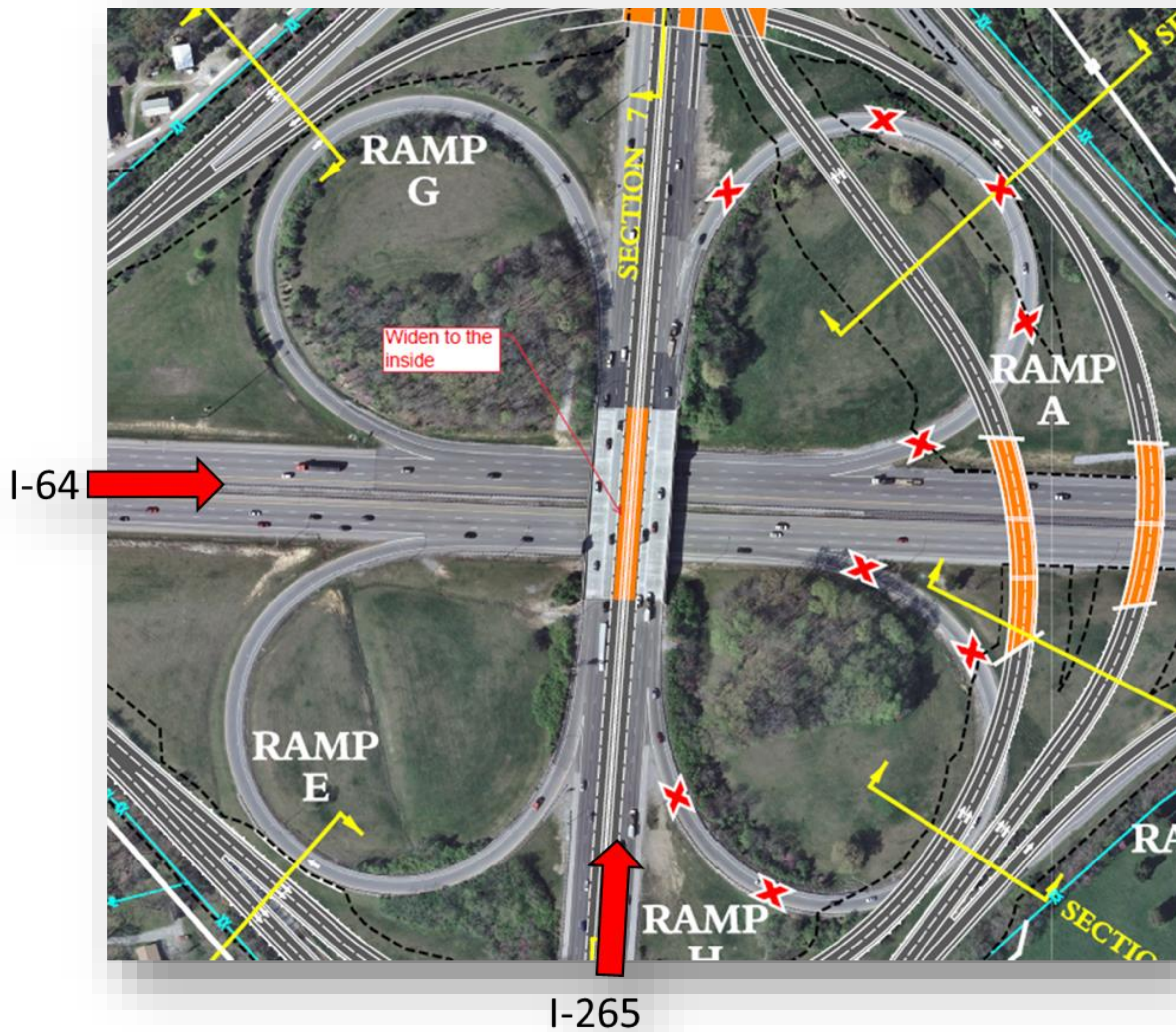
Existing Bridge Typical Section



VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY	Idea No. 17

Baseline Concept Modification to Interchange Ramps

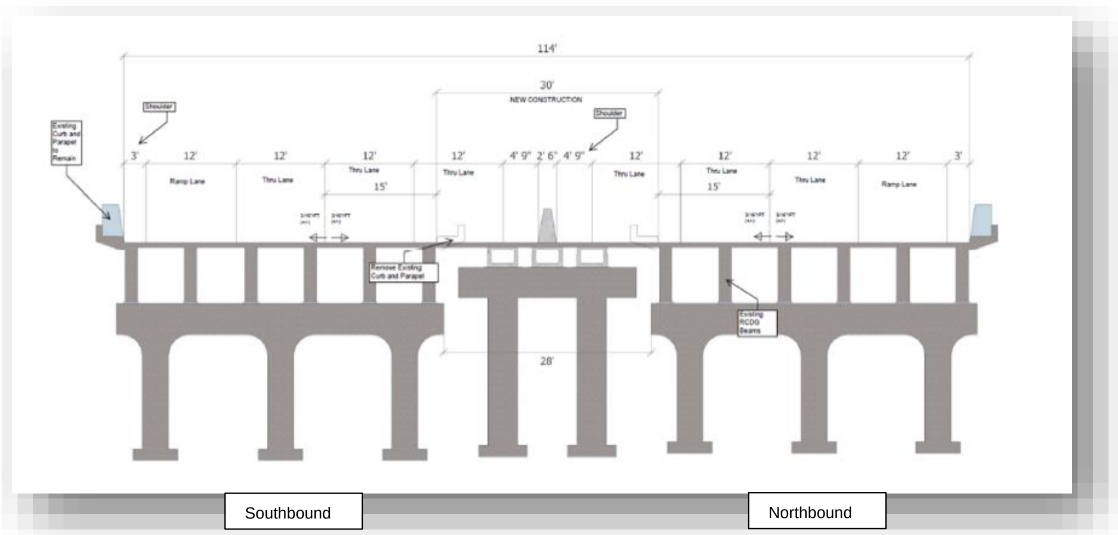
The baseline concept will widen I-265 to carry three lanes in each direction and the widening will occur to the inside. The baseline interchange concept will modify two of the four loop ramps that currently operate within the outside lane of the existing northbound bridge.



VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY	Idea No. 17

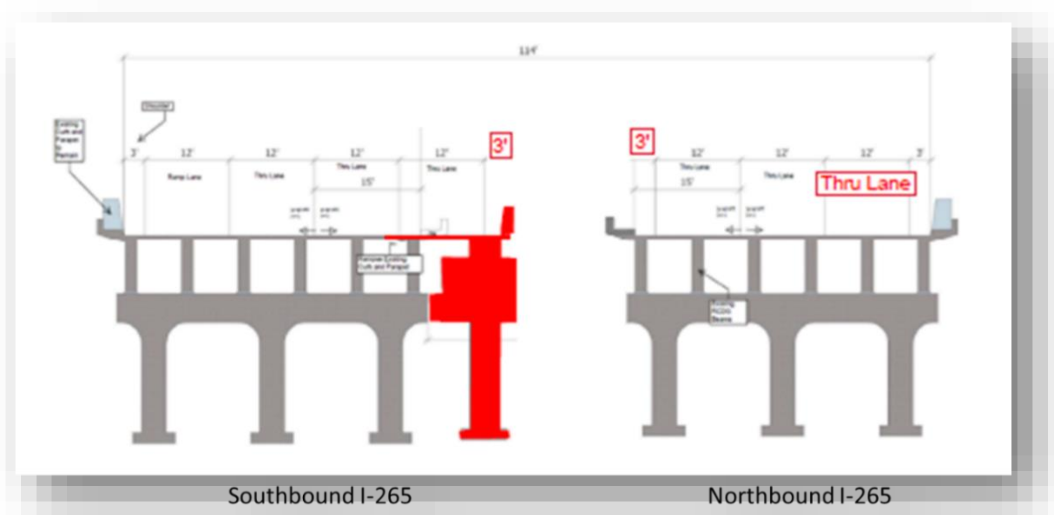
Baseline Concept I-265 Bridge over I-64 – Typical Section

The baseline concept matches the roadway typical section and proposes widening the bridge to the inside. This will be accomplished by shifting traffic to the outside and constructing a new pier and related superstructure in the middle. The three piers would not be connected; however, the superstructures would likely be connected by the concrete deck.



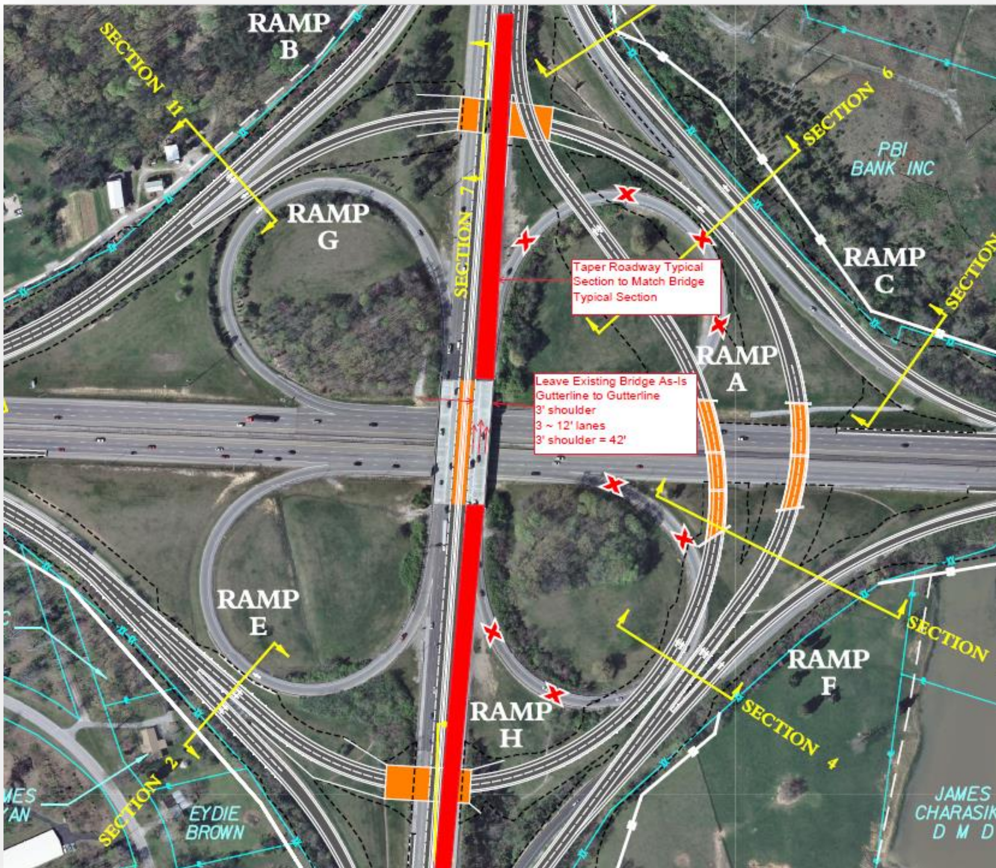
Recommendation Concept I-265 Bridge over I-64 – Typical Section

The interchange reconfiguration would eliminate the need to use the outside lane on the northbound I-265 bridge for ramp movements. The recommended concept would eliminate widening the northbound I-265 bridge and only widen the southbound I-265 bridge to match the substructure and superstructure design.



VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY	Idea No. 17

Recommended Concept I-265 Bridge over I-64 – Plan



Assumptions/Calculations

The project team has documented that there are potential vertical clearance issues with the existing bridge over I-64. This recommendation assumes that further investigation will be completed and this design will be allowed as long as the proposed clearance provided is not less than the current clearance.

The recommendation assumes that a design exception would be permitted for the 3-foot shoulder width on the I-265 northbound bridge as that is the same shoulder width that currently exists.

The recommendation assumes that the existing bridge pier carrying southbound traffic is in reasonable condition and suitable to be widened.

The base concept estimated cost of the bridge widening provided by the project team is roughly $1,400,000. Because this recommendation eliminates roughly half of the amount of bridge in the base cost, the total cost or the recommended alternative is $1,193,000 x 50 percent = $596,500

VE RECOMMENDATION NO. 4: WIDEN NEW UNDERPASSES TO THE OUTSIDE TO IMPROVE CONSTRUCTIBILITY	Idea No. 17

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Introduces a slight taper	***Rating***	**5**	**5**
	Weight	**26**	
	Contribution	**131**	**131**
Local Operations No change	***Rating***	**6**	**6**
	Weight	**26**	
	Contribution	**144**	**144**
Maintainability Less bridge to maintain One less cold joint to maintain	***Rating***	**7**	**7**
	Weight	**17**	
	Contribution	**108**	**116**
Construction Impacts Reduced phasing of construction, less impacts to users	***Rating***	**9**	**9**
	Weight	**5**	
	Contribution	**40**	**42**
Environmental Impacts No change	***Rating***	**9**	**9**
	Weight	**10**	
	Contribution	**89**	**89**
Project Schedule Slightly better, may not impact the critical path	***Rating***	**4**	**5**
	Weight	**17**	
	Contribution	**66**	**75**
	Total Performance	**577**	**596**
		Net Change in Performance	**3%**

VE RECOMMENDATION NO. 5: USE DESIGN-BUILD DELIVERY METHOD

Idea No. 18

Baseline Concept

The delivery method has not been fully determined by the Owner; however, the project team has been challenged to deliver the interchange and a portion of the widening project to a construction letting in 18 months.

Recommendation Concept

Use design-build (D/B) delivery method for the interchange and a portion of the widening project.

Advantages

- Reduces Owner risk of delays
- May decrease cost
- Good candidate for D/B delivery
- Improves constructibility
- Involves contractor early in the process and decision making
- Owner receives best value option

Disadvantages

- May lower quality/aesthetic of final product
- Design decisions by contractor
- Transfer risk to contractor (at a premium)
- Right-of-way scheduling constraints

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept **Alternative 3**	$31,171,191		$31,171,191
Recommendation Concept	$29,269,748		$29,269,748
Cost Avoidance/(Added Value)	$1,901,442		$1,901,442
Baseline Concept **Alternative 3B**	$29,186,728		$29,186,728
Recommendation Concept	$27,406,337		$27,406,337
Cost Avoidance/(Added Value)	$1,780,390		$1,780,390

FHWA Function Benefit

Safety	***Operations***	***Environment***	***Construction***	***Right-of-way***
			✓	

VE RECOMMENDATION NO. 5: USE DESIGN-BUILD DELIVERY METHOD	Idea No. 18

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Design-Build (D/B) Project Delivery

The Owner manages only one contract with a single point of responsibility. The designer and contractor work together, as a team, providing unified project recommendations to fit the Owner's design requirements, schedule, and budget. Any changes are addressed by the entire team, leading to collaborative problem-solving and innovation, not excuses or blame-shifting. While single-source contracting is the fundamental difference between design-build and traditional delivery methods, equally important is the culture of collaboration inherent in design-build.

D/B advances the project to construction when the design of the project is roughly 30 percent complete. By doing so, the contractor and its associated design firm can continue the final design process while beginning the construction process. This may include advance ordering of materials, mobilization, and even early construction such as clearing or preliminary earthwork.

This project appears to be a good candidate for the D/B process because of the limited risk expected from possible impacts such as environmental clearance, right-of-way condemnation, and utility relocations.

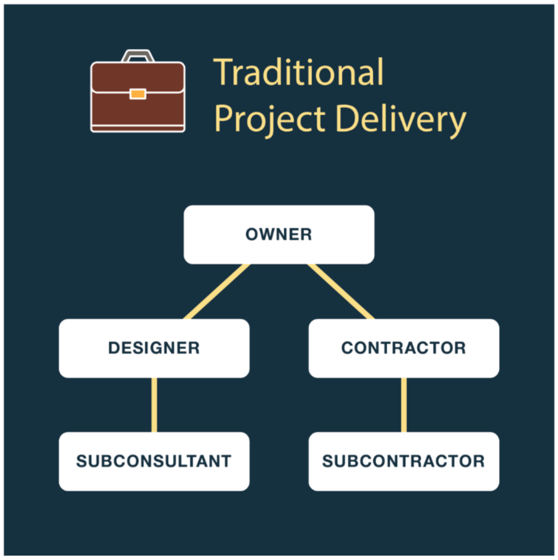
Project Complexity

Many of the brainstorming ideas that were captured during this study involved somehow altering the configuration of the interchange alternatives to provide an improvement, including construction time savings, lower overall cost, improved traffic operations, etc. Reconstructing system interchanges often involve multiple new structures and complex MOT challenges. The I-64/I-265 interchange is no exception.

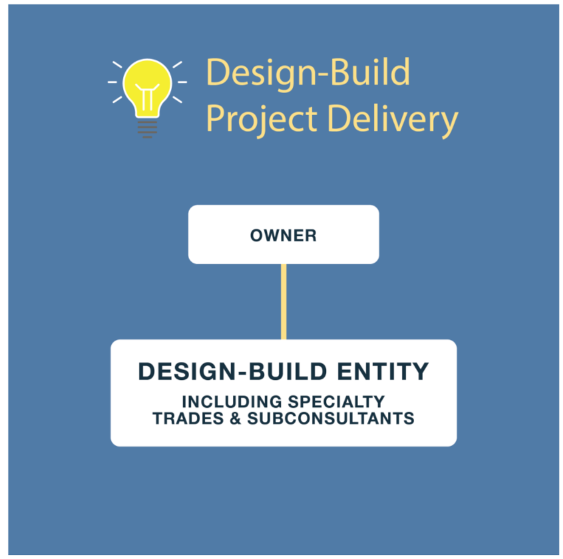
Project Schedule

The baseline assumption is the project will be let and awarded to the low bid contractor 18 months from now, with any utility and right-of-way impacts resolved and all design 100 percent complete. Using D/B, a bid package could be developed and the project could be awarded within the next 4 to 6 months to the D/B team providing the best value. Construction can begin shortly thereafter with substructure and initial earthwork prior to significantly altering traffic patterns. Also, the widening portion (if included in the D/B project) could begin relatively quickly considering the relative simplicity of the design and simpler MOT phasing. The VE team estimates that overall delivery could be shortened by one year or greater.

VE RECOMMENDATION NO. 5: USE DESIGN-BUILD DELIVERY METHOD	Idea No. 18



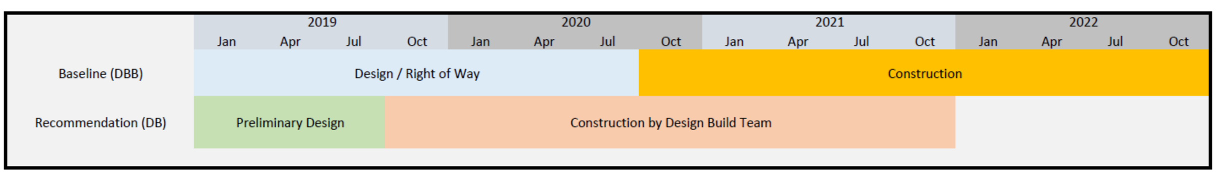
Traditional Project Delivery



Design-Build Project Delivery

Design-build saves time and money by encouraging innovation and collaboration

Once upon a time, design-build was considered an "alternative" way to deliver construction projects. Not anymore. These days, nearly half of all the nation's projects are delivered using the design-build delivery method.



Assumptions/Calculations

According to a Burns & McDonalds Report, this delivery approach has improved results in the construction industry. In a study conducted by Penn State University (that evaluated the effectiveness of multiple delivery systems, it found that D/B outperformed design-bid-build in every category. The study also found D/B had:

- Shorter construction durations (12.5 percent)
- Shorter total delivery cycle (33.5 percent)
- Lower construction costs (6.1 percent)

VE RECOMMENDATION NO. 5: USE DESIGN-BUILD DELIVERY METHOD	Idea No. 18

It is reasonable to assume a similar reduction in overall project cost and time savings based on industry experience.

Total construction cost project 5-549 Alt 3 = $31,171,191

Potential cost avoidance: $31,171,000 * 6.1% = $1,901,442

Total construction cost project 5.549 Alt 3B = $29,186,728

Potential cost avoidance: $29,187,000 * 6.1% = $1,780,390

VE RECOMMENDATION NO. 5: USE DESIGN-BUILD DELIVERY METHOD	Idea No. 18

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendatio	*Performance*	*Baseline*	*Recommendation*
Main Line Operations No Change	*Rating*	5	5
	Weight	26	
	Contribution	131	131
Local Operations No Change	*Rating*	6	6
	Weight	26	
	Contribution	144	144
Maintainability No Change	*Rating*	7	7
	Weight	17	
	Contribution	108	108
Construction Impacts Significantly less impacts to motorist due to faster construction.	*Rating*	9	10
	Weight	5	
	Contribution	40	45
Environmental Impacts DB contractor will minimize impacts to ROW	*Rating*	9	10
	Weight	10	
	Contribution	89	94
Project Schedule Significant reduction of design, permitting, construct schedule	*Rating*	4	7
	Weight	17	
	Contribution	66	116
	Total Performance	577	637
		Net Change in Performance	10%

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

Baseline Concept

Alternative 3 and Alternative 3B have Ramp A on the inside of Ramp H. This may make it difficult to allow for a future collector-distributor (CD) road to be constructed without having to build additional structures. Additionally, Ramp A carries all traffic bound for I-265 northbound and US 60.

Recommendation Concept

New interchange concept: Develop an interchange that allows for a CD road to be constructed with this project or in the future when impacts to the I-265/I-64 system interchange are realized. This will allow traffic bound for US 60 (service interchange) to be separted from the I-265/I-64 system interchange and not have to merge onto I-265. Once Ramp A merges onto I-265, there is weaving between I-265-to-US 60 and Ramp A-to-I-265 traffic. This may degrade free flow operations when future volumes are realized.

Advantages

- Eliminates weaving along I-265 between Ramp A merge and existing US 60 diverge
- Creates storage for US 60
- Isolates traffic onto I-265 and reduces delays onto I-265
- Will extend service life of I-265/I-64 ramps
- Increased likelihood of FHWA approval
- Simplifies lane development and lane drops along I-265 north of I-64
- Allows for a future CD road to be constructed if US 60 interchange operations begin to degrade I-265 main line and I-265/I-64 system interchange operations

Disadvantages

- May have right-of-way implications
- May cost more
- May be more difficult to construct
- May require lowering design speed
- May cause a delay due to additional preliminary design
- May have drainage impacts
- May require drainage easement

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept	Alt 3B $29,200,000		Alt 3B $29,200,000
Recommendation Concept	Option 1 $29,422,300 Option 2 $28,524,000		Option 1 $29,422,300 Option 2 $28,524,000
Cost Avoidance/(Added Value)	Option 1 ($222,300) Option 2 $676,000		Option 1 ($222,300) Option 2 $676,000

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
✓	✓			

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

The recommendation is to separate US 60 traffic from the mainline traffic well in advance of the US 60 interchange. This eliminates conflicts due to weaving of traffic close to the US 60 interchange. Bring Ramp A to the outside of Ramp H near the proposed Ramp A tunnel. This would require another structure to the east of the proposed southern I-265 undercrossing; however, the proposed Ramp H tunnel under I-265 to the north of the interchange would be shortened by this alternative. This would allow Ramp A traffic to diverge to either I-265 or the proposed CD road north of the I-64 overcrossing.

In addition to braiding Ramp A and Ramp H, US 60 bound traffic carried by Ramp H would diverge south of the new additional structure and tie into Ramp A. Ramp A would carry three travel lanes prior to merging back down to two lanes prior to crossing I-64. At this point, as Ramp A crosses over I-64, Ramp A would be carrying eastbound I-64 to northbound I-265, eastbound I-64 to US 60, and northbound I-265 to US 60 traffic. The inside lane would be signed for I-265, while the outside lane would be signed for US 60, eliminating a weave along Ramp A as US 60-bound traffic merges.

Westbound I-64 traffic bound for US 60 would utilize the existing I-64 to northbound I-265 on ramp. Westbound I-64 traffic bound would continue straight at the US 60 diverge, similar to Ramp C on Alternative B. US 60 traffic from Ramp A and US 60 traffic from westbound I-64 would merge together to create the 2-lane CD road. Once the CD road is constructed, the existing northbound I-265 off-ramp to US 60 would be closed.

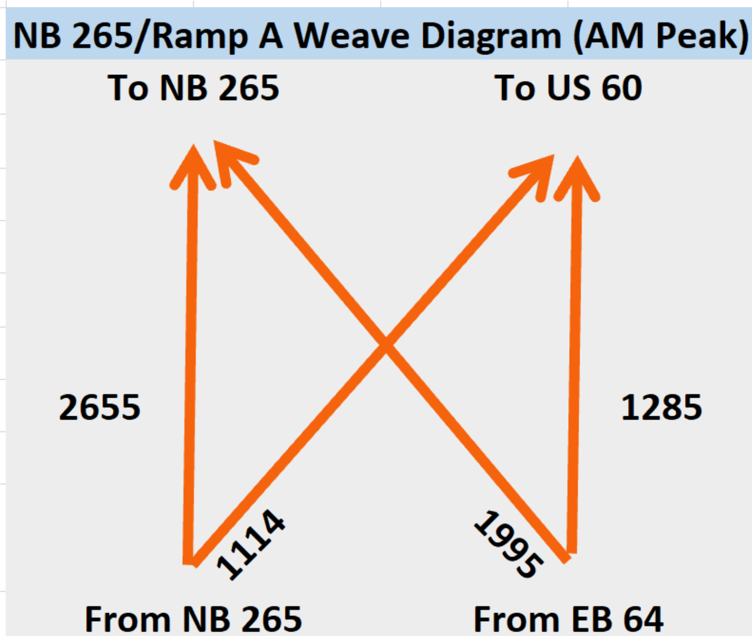
The future volumes show a potential need to split I-265 bound traffic from US 60 traffic. Below shows the design year percentage split and volumes from Ramp A, Ramp C, and northbound I-265 to northbound I-265 and US 60.

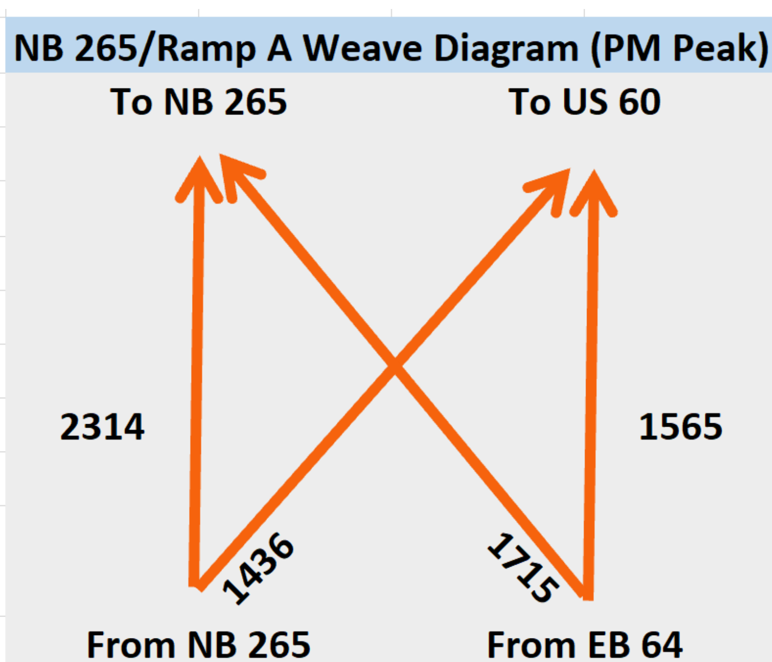
AM						
Design Year Volumes	Ramp A		Ramp C		265	
	Eastbound 64 to US 60	Eastbound I-64 to I-265	Westbound I-64 to US 60	Westbound I-64 to I-265	I-265 to US 60	I-265 to I-265
2490	1285	1995				
1150			168	978		
2620					946	1677
OD %	39%	61%	15%	85%	36%	64%

PM						
Design Year Volumes	Ramp A		Ramp C		265	
	Eastbound I-64 to US 60	Eastbound I-64 to I-265	Westbound I-64 to US 60	Westbound I-64 to I-265	I-265 to US 60	I-265 to I-265
3280	1565	1715				
1250			299	951		
2500					1137	1363
OD %	48%	52%	24%	76%	45%	55%

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

This shows that a majority of Ramp A volume in the AM and slightly more than half of the volume in the PM is bound for I-265. Northbound I-265 volume bound for US 60 is also a considerably high percentage, especially during the PM peak. Below shows a weave diagram for the AM and PM peak period.





VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

The US 60 off-ramp is approximately 4,500 feet north of the Ramp A merge onto I-265. This exceeds the 3,500 foot maximum weave distance HCS uses to analyze the weave operations, which means applying a deterministic weave analysis may not provide accurate results. Additionally, with an AM and PM peak volume of 2,399 and 3,151 vehicles, respectively, the existing lane configuration of the tight diamond interchange at US 60 is unable to process the demand being delivered from I-265 and I-64. The queue lengths on the northbound off-ramp will back up onto I-265, causing turbulence on the main line that may further degrade the weaving operations between I-265 and Ramp A.

This recommendation includes two options, described below.

Option 1

Redesign the I-265/I-64 system interchange to include a CD road and construct the CD road as part of this project. This would require modifying Alternative 3B to braid Ramp A and Ramp H or modifying the preferred alternative to incorporate a CD road.

Option 2

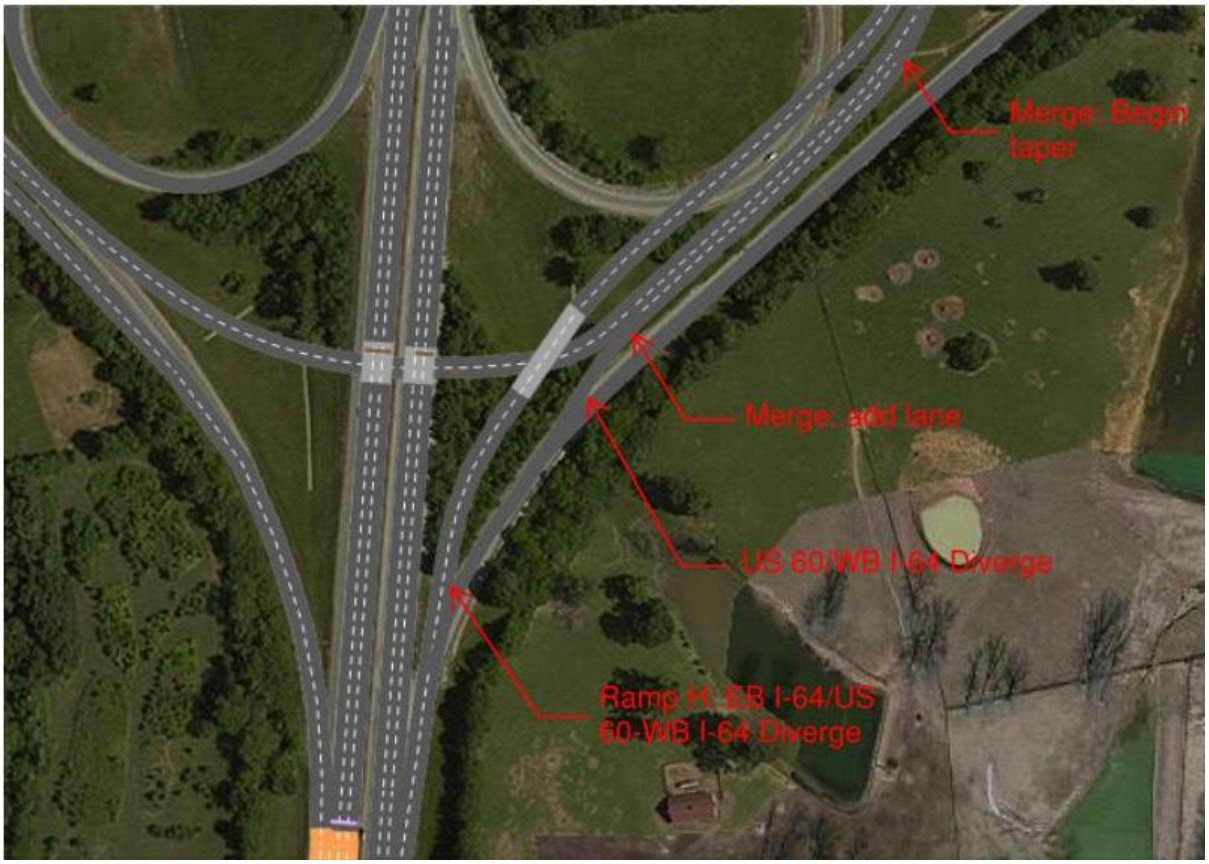
Redesign the I-265/I-64 system interchange to phase the construction of a CD road when weaving operations between I-265 and Ramp A degrade main line I-265 operations to an unacceptable threshold. With this option, it is recommended that a sensitivity analysis be completed using Vissim to determine what year the CD road would need to be constructed to ensure I-265 operations are not impacted. The CD road can then be programmed as a separate project, potentially including designing a new interchange at I-265/US 60.

Below are graphics of the proposed modifications to the I-265/I-64 system interchange that would accommodate a CD road.

(Colors have no significance. They are display settings for the Micro simulation but have no meaning of geometry or improvements.)

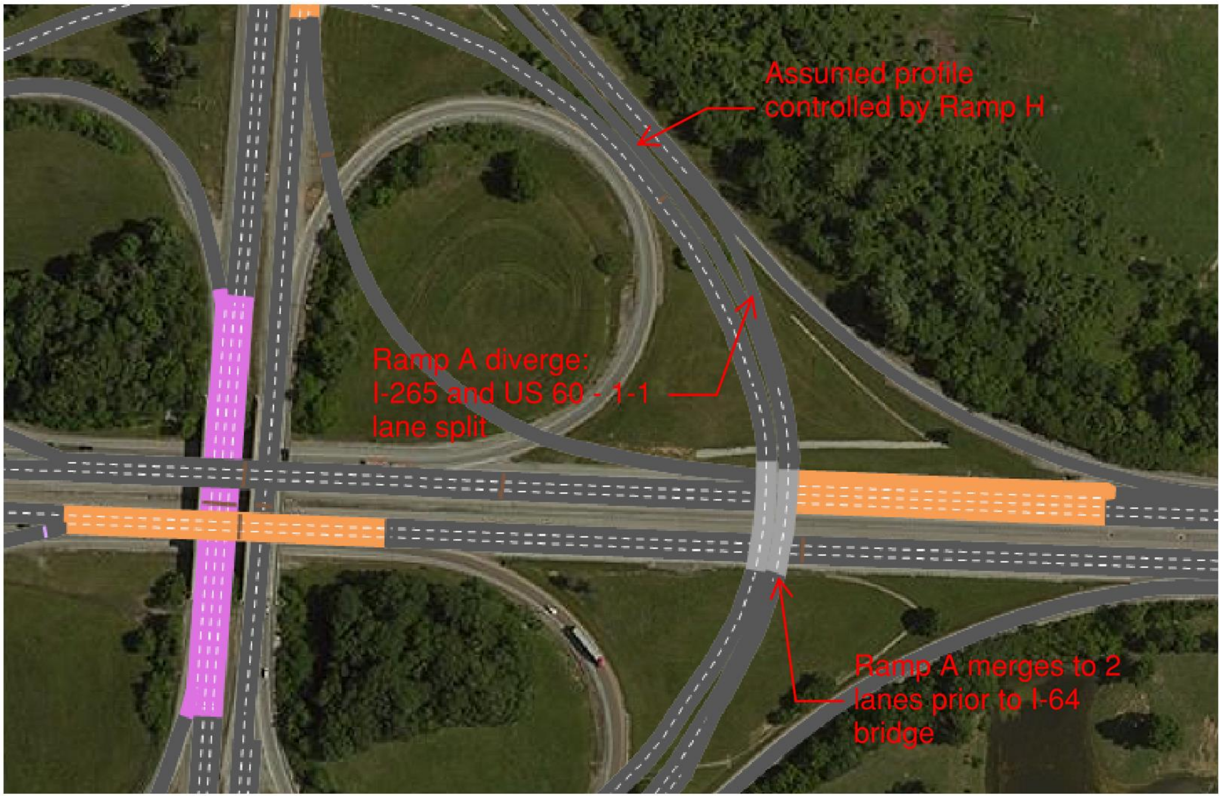
New Interchange Concept – Modified Alternative 3B with CD Road

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

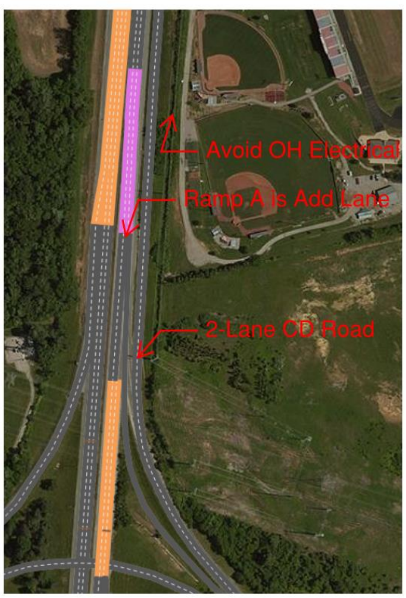


Ramp H Diverge and US 60/westbound I-64 Diverge

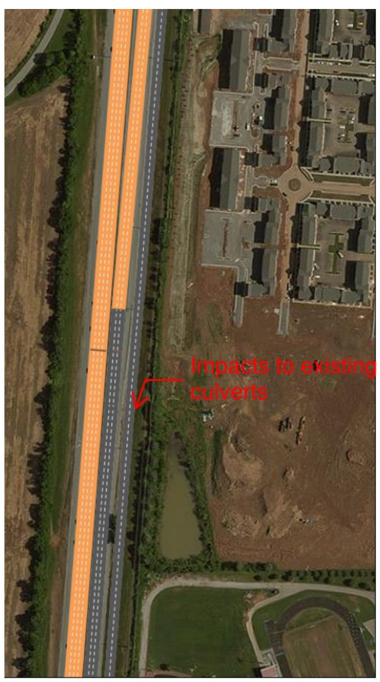
VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35



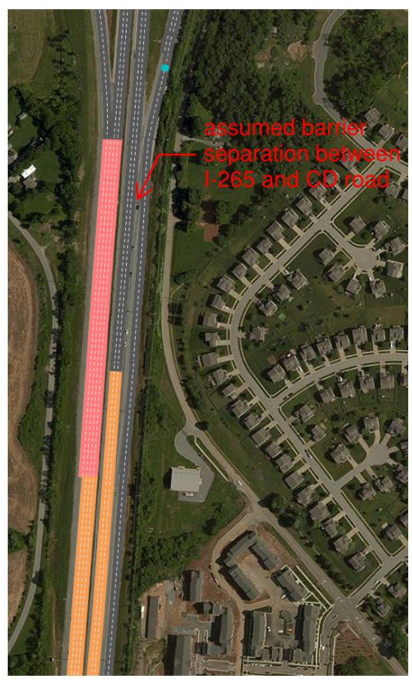
Ramp A Diverge to US 60



CD Road at Ramp A Merge



CD Road South of US 60



CD Road US 60 Ramp

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

Assumptions/Calculations

Options 1 and 2

Assumed cost for the new structure for the Ramp A and Ramp H braid is offset by the shortening the Ramp H tunnel under I-265.

Assumed profile of Ramp H could control Ramp A and CD road profile to have one structure over I-64. If this is not feasible, Ramp A horizontal alignment would need to be revised to provide more space between Ramp H.

Cost savings by putting Ramp H and Ramp A over I-265 on the same structure assumed 10 percent reduction in structures costs for a more efficient bridge. Assumed Savings = $520,000

Assumed high tension cable barrier system between I-265 and CD road. Total length of concrete barrier is estimated to be 4,000 linear feet at $15/LF = $60,000

Extending existing culverts. Total 2 culverts: Extending approximately 50 feet each. Assumed cost $300/LF plus $2,000 for each headwall.

Total Cost for extending culverts = $33,000

Option 1 Cost to Construct CD Road

Two lanes were added for CD road and I-265 was reduced from four lanes to three. Net addition of one lane plus full shoulder widths. The assumed cross-section of the CD road is 4-foot outside shoulder, 10-foot inside shoulder, and two 12-foot lane widths.

Recommendation						
ITEM DESCRIPTION	UNITS	PRICE	QUANTITY	SUBTOTAL	Depth (in)	COMMENTS
CL3 ASPH SURF 0.38A PG76-22	TON	$ 83.00	1072.5	$ 89,017.50	1.5	depth lane and shld
CL4 ASPH BASE 1.00D PG76-22	TON	$ 67.00	2155.3125	$ 144,405.94	3	depth lane and shld
CL4 ASPH BASE 1.00D PG64-22	TON	$ 65.00	2175.9375	$ 141,435.94	3	depth lane and shld
CL4 ASPH BASE 1.50D PG64-22	TON	$ 59.00	1215.15625	$ 71,694.22	3.5	depth lane only
CRUSHED STONE BASE	TON	$ 25.00	1937.5	$ 48,437.50	6	CSB mod lane
CRUSHED STONE BASE	TON	$ 25.00	3325	$ 83,125.00	9.5	CSB mod shld (full depth)
NON-PERFORATED PIPE-4 IN	LF	$ 12.00	162	$ 1,944.00		
PERFORATED PIPE EDGE DRAIN-4 IN	LF	$ 4.00	4500	$ 18,000.00		
			Total Cost	$ 598,000.00		

Total Costs for Option 1

Total Cost Savings = $520,000 + 30% = $676,000

Total Cost Increase = $691,000 + 30% = $898,300

Net Increase = ($222,300)

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

Option 2 CD Road Costs

Option 2 would not reduce the number of lanes required to build on I-265 as Ramp A is still carrying US 60-bound traffic when it merges onto I-295. There would still be initial cost savings by combining the Ramp A and Ramp H structures over I-64; however, the ultimate cost to construct the CD road in the future would be higher.

Throwaway cost for having to construct the 4th lane of I-265 from Ramp A to US 60 = $285,000

Comparing the Baseline (Alt 3B) to Option 2, however, has a net decrease of $676,000.

VE RECOMMENDATION NO. 6: MODIFY SYSTEM INTERCHANGE TO SEPARATE US 60 AND MAINLINE TRAFFIC	Idea Nos. 32, 33, 34, 35

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Reduced conflicts Reduced volumes on I-265 Eliminates weaves Significant reduction of congestion through interchange	*Rating*	5	8
	Weight	26	
	Contribution	131	209
Local Operations No Change	*Rating*	6	6
	Weight	26	
	Contribution	144	144
Maintainability More signage More pavement to maintain (additional lane) on CD lane	*Rating*	7	6
	Weight	17	
	Contribution	108	100
Construction Impacts No Change	*Rating*	9	9
	Weight	5	
	Contribution	40	40
Environmental Impacts Possible drainage easements	*Rating*	9	9
	Weight	10	
	Contribution	89	84
Project Schedule No Change	*Rating*	4	4
	Weight	17	
	Contribution	66	66
	Total Performance	577	642
		Net Change in Performance	11%

VE RECOMMENDATION NO. 7: APPLY ADVANCED SIGNALIZATION STRATEGIES TO AVOID IMPACTS TO MAIN LINE	Idea Nos. 44, 45

Baseline Concept

Signal operations at interchanges are not addressed in the baseline design.

Recommendation Concept

Use advanced queue detection at interchange off-ramps to allow signal prioritization that will clear long queues.

Advantages	Disadvantages
• Improves operations of main line by clearing queue spillback from ramps • Removes conflicts between slow or stopped exiting vehicles and main line traffic at ramp diverge points.	• Degradation of local roadway operation when clearing ramp queues.

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	0	-	0
Recommendation Concept	$240,000	-	$240,000
Cost Avoidance/(Added Value)	($240,000)	-	($240,000)

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
✓	✓			

VE RECOMMENDATION NO. 7: APPLY ADVANCED SIGNALIZATION STRATEGIES TO AVOID IMPACTS TO MAIN LINE	Idea Nos. 44, 45

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Sensing and then clearing long queues from off-ramps has potentially significant improvements to operations and safety for I-265. When queues are long, exiting vehicles may have to decelerate while still in the main line lanes. This advanced deceleration can cause the need for sudden braking, leading to rear-end crashes and slower speeds on the main line. When this occurs at multiple interchanges, overall performance of the corridor can be greatly reduced during peak traffic times.

There are various technological approaches to sense detect queues at a determined distance from the signalized intersection. Methods include traditional saw-cut electro-magnetic loops and video detectors. When a standing queue is detected, the traffic signal controller then advances the signal cycle to green for the ramp movement phase.

In addition to the installation of field equipment, signal timings will need to be developed and controllers will need reprogramming.

This approach will be most applicable at locations currently experiencing or anticipating long queues.

Another added benefit is a cost avoidance from needing to lengthen ramps for future projects to meet deceleration requirements or even the potential for major interchange reconstruction. These reduced costs are not estimated in this recommendation.

Assumptions/Calculations

It is assumed that there will be eight locations that could benefit from modifications. In the southbound direction: KY 22, KY 3084, US 60, and KY 155. In the northbound direction: US 60, KY 3084, KY 1747, and KY 22.

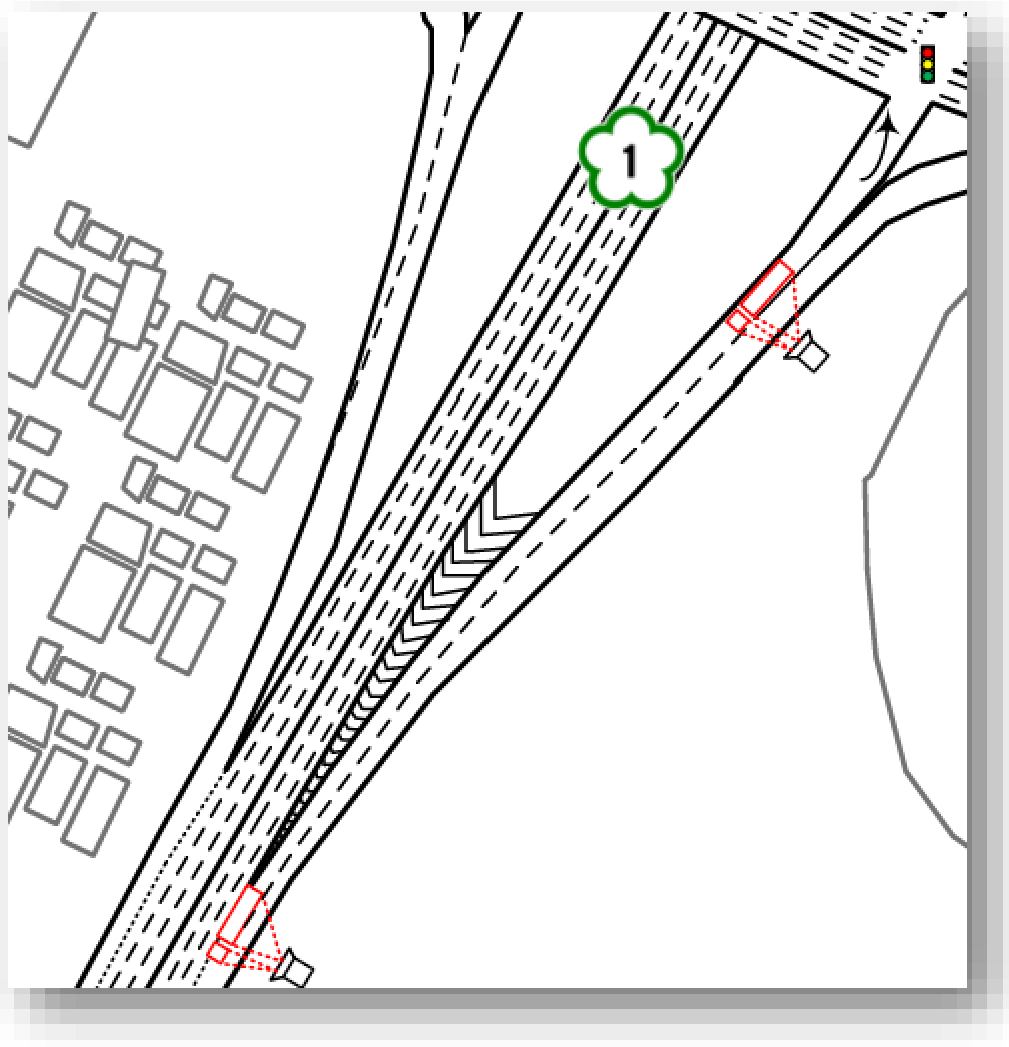
Equipment needed:

- Queue detectors on ramps
- Communications with existing signal controller
- Signal controller programming

Estimated cost per ramp: $30,000

Total project cost: $30,000 x 8 locations: $240,000

VE RECOMMENDATION NO. 7: APPLY ADVANCED SIGNALIZATION STRATEGIES TO AVOID IMPACTS TO MAIN LINE	Idea Nos. 44, 45



Typical Detection Layout

VE RECOMMENDATION NO. 7: APPLY ADVANCED SIGNALIZATION STRATEGIES TO AVOID IMPACTS TO MAIN LINE

Idea Nos. 44, 45

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations Eliminates traffic spilling into mainline I-265	*Rating*	5	8
	Weight	26	
	Contribution	131	196
Local Operations Improved ramp operations Increased delays of crossing/local traffic	*Rating*	6	4
	Weight	26	
	Contribution	144	91
Maintainability Slight increase in maintenance	*Rating*	7	7
	Weight	17	
	Contribution	108	112
Construction Impacts Negligible Change	*Rating*	9	9
	Weight	5	
	Contribution	40	40
Environmental Impacts No Change	*Rating*	9	9
	Weight	10	
	Contribution	89	89
Project Schedule No Change	*Rating*	4	4
	Weight	17	
	Contribution	66	66
	Total Performance	577	595
		Net Change in Performance	3%

VE RECOMMENDATION NO. 8: IMPROVE SIGNAGE AT APPROACHES TO INTERCHANGES	Idea No. 46

Baseline Concept

Baseline design does not account for improvements at the approaches to interchanges.

Recommendation Concept

Implement strategies to improve queuing capacity at interchanges by:

1. Adding striping and pavement markings at interchange approaches (off-ramps)
2. Adding signs to position drivers in the appropriate lanes in advance

Advantages	Disadvantages
• Increases user awareness • Low cost • Reduces weaving and conflicts	• Slight cost increase

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept			
Recommendation Concept	$50,000		$50,000
Cost Avoidance/(Added Value)	($50,000)		($50,000)

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
✓	✓			

VE RECOMMENDATION NO. 8: IMPROVE SIGNAGE AT APPROACHES TO INTERCHANGES	Idea No. 46

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Minimal pavement markings at interchange approaches often cause driver confusion, resulting in last second lane changes, increased friction, conflicts, and accidents.

Advanced warning markings give additional reaction time to the driver, potentially reducing last minute lane changes, resulting in less incidents. Providing markings on the roadway is an inexpensive way to alert drivers where to position themselves without diverting their line of sight to signage above the road or toward the shoulder.

The baseline design does not account for increased signage; currently there are no signs between interchanges informing drivers of upcoming decision points. Signage located at midpoints of the off-ramps at particularly congested interchanges such as US 60 (Shelbyville Road) could provide driver confidence to pick a turning lane in advance.

The US 60 interchange ramp descends to the interchange with a challenging line of sight; large, clearly marked turn lane designations at the driver's line of sight could help increase driver confidence, possibly reducing unnecessary last second lane changes.

In addition, signal timing improvements at the interchanges would help flush ramps that are backing up to the main line. Additional green signal phasing would allow a higher volume of vehicles to depart I-265 and flush to local roads.

Assumptions/Calculations:

Cost for additional signage at US 60 off-ramp could be assumed as follows:

Low-end Cost: Pavement markings (aka roadway tattoos): $3,000 each, two at each ramp, four ramps = $24,000

Likely Cost: Side signage and pavement markings: $50,000

High-end Cost: Truss structures signs, $90,000 each * 4 = $360,000

VE RECOMMENDATION NO. 8: IMPROVE SIGNAGE AT APPROACHES TO INTERCHANGES	Idea No. 46

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Allows for early decision	*Rating*	5	6
	Weight	26	
	Contribution	131	144
Local Operations Improved operations on local roads and at interchange	*Rating*	6	6
	Weight	26	
	Contribution	144	150
Maintainability Increased signage, negligible increase in maintenance	*Rating*	7	7
	Weight	17	
	Contribution	108	108
Construction Impacts No Change	*Rating*	9	9
	Weight	5	
	Contribution	40	40
Environmental Impacts No Change	*Rating*	9	9
	Weight	10	
	Contribution	89	89
Project Schedule No Change	*Rating*	4	4
	Weight	17	
	Contribution	66	66
	Total Performance	577	597
		Net Change in Performance	3%

VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION	Idea No. 47

Baseline Concept

Due to subgrade drainage concerns, the pavement design was 29.5 inches thick in the asphalt section to match the subgrade.

Recommendation Concept

Design left (inside) pavement section for cars only and restrict trucks from traveling in left lane. Reduce pavement thickness using KYTC pavement design tool to acccommodate the traffic at 1.8 percent growth and drain the subgrade with edge drain and perforated pipe system to outlet.

Advantages	Disadvantages
• Reduces pavement design requirements • Reduces costs • May be quicker to construct	• Increases signage requirements • May be difficult to enforce • Lower flexibility in operations • Maintenance implications of subgrade drainage

Cost Summary	Capital Cost	Right-of-Way Costs	Total Cost
Baseline Concept	$15,697,090		$15,697,090
Recommendation Concept	$13,410,796		$13,410,796
Cost Avoidance/(Added Value)	$2,286,294		$2,286,294

FHWA Function Benefit

Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
			✓	

VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION	Idea No. 47

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

The I-265 widening consists of six lanes with current AADT of 86,170 (in the highest volume section between the I-64/I-265 Interchange and US 60) and 10.1 percent truck traffic. Growth was assumed at 1.8 percent. Current design accounts for all six lanes being subject to truck traffic. Due to subgrade drainage concerns, the pavement design was 29.5 inches thick in the asphalt section to match the subgrade.

This recommendation is a combination of two ideas:

1. Trucks will only be allowed in the outside two lanes
2. Treat the subgrade drainage separate from the structural analysis of the pavement design

Many states are addressing safety concerns related to heavy commercial vehicles utilizing the left most driving lane. Several research projects have documented the benefits and resulting legislation has been passed to allow appropriate enforcement. The recommendation is reasonable with the 6-lane widening project.

The VE team developed the recommended pavement design using the KYTC Pavement Design Web App as their tool.

An independent concept is to handle the subgrade drainage separate from the pavement design thickness requirement. The team found that a significant cost savings could be realized by reducing the overall pavement section thickness by 12.5 inches. This analysis did not take into account separate truck traffic. If both parts of the recommendation were moved forward by the project team, the pavement design could be optimized further.

Current design of the proposed 12-foot interior lane are:

17-inch southbound-Mod.

4.5-inch AC Base 1.50D 64-22

3.5-inch AC Base 1.00D 64-22

3.0-inch AC Base 1.00D 76-22

1.5-inch AC Surface 0.38A 76-22

Current design of the proposed 4.5-foot interior shoulder are:

21.5-inch CSM-Mod.

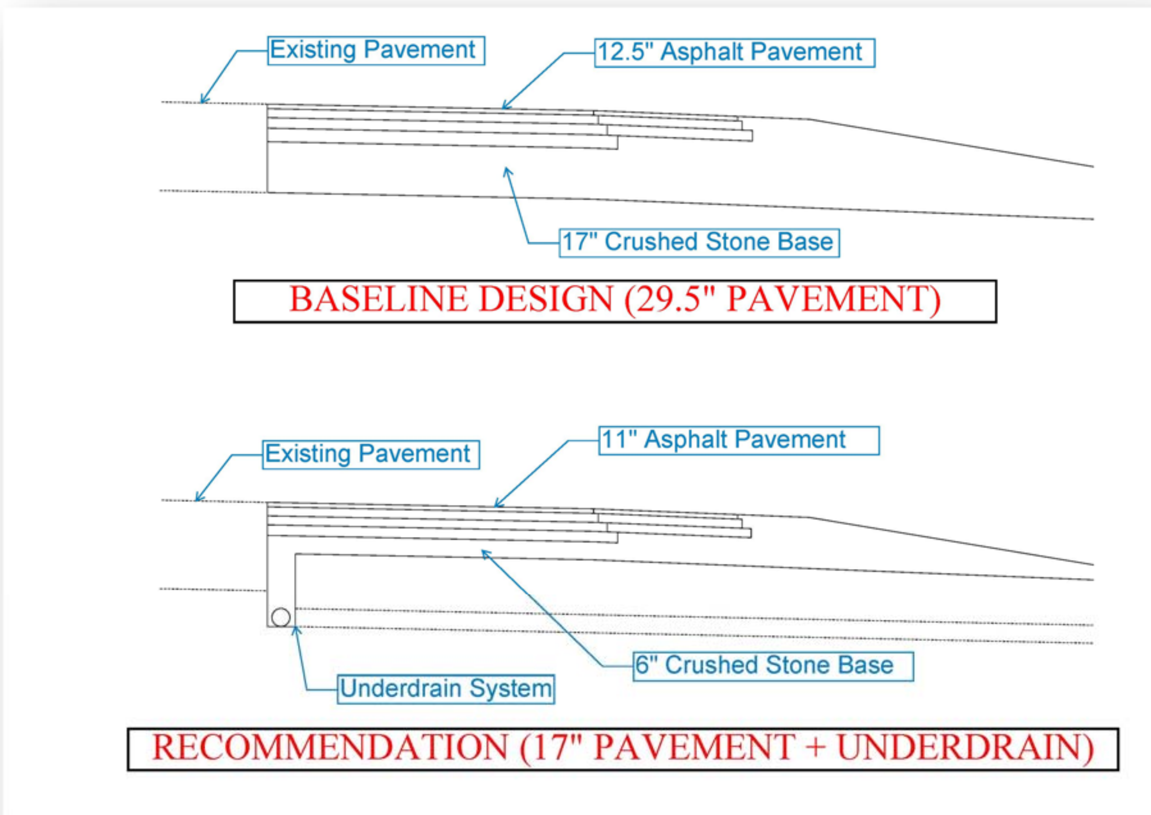
3.5-inch AC Base 1.00D 64-22

3.0-inch AC Base 1.00D 64-22

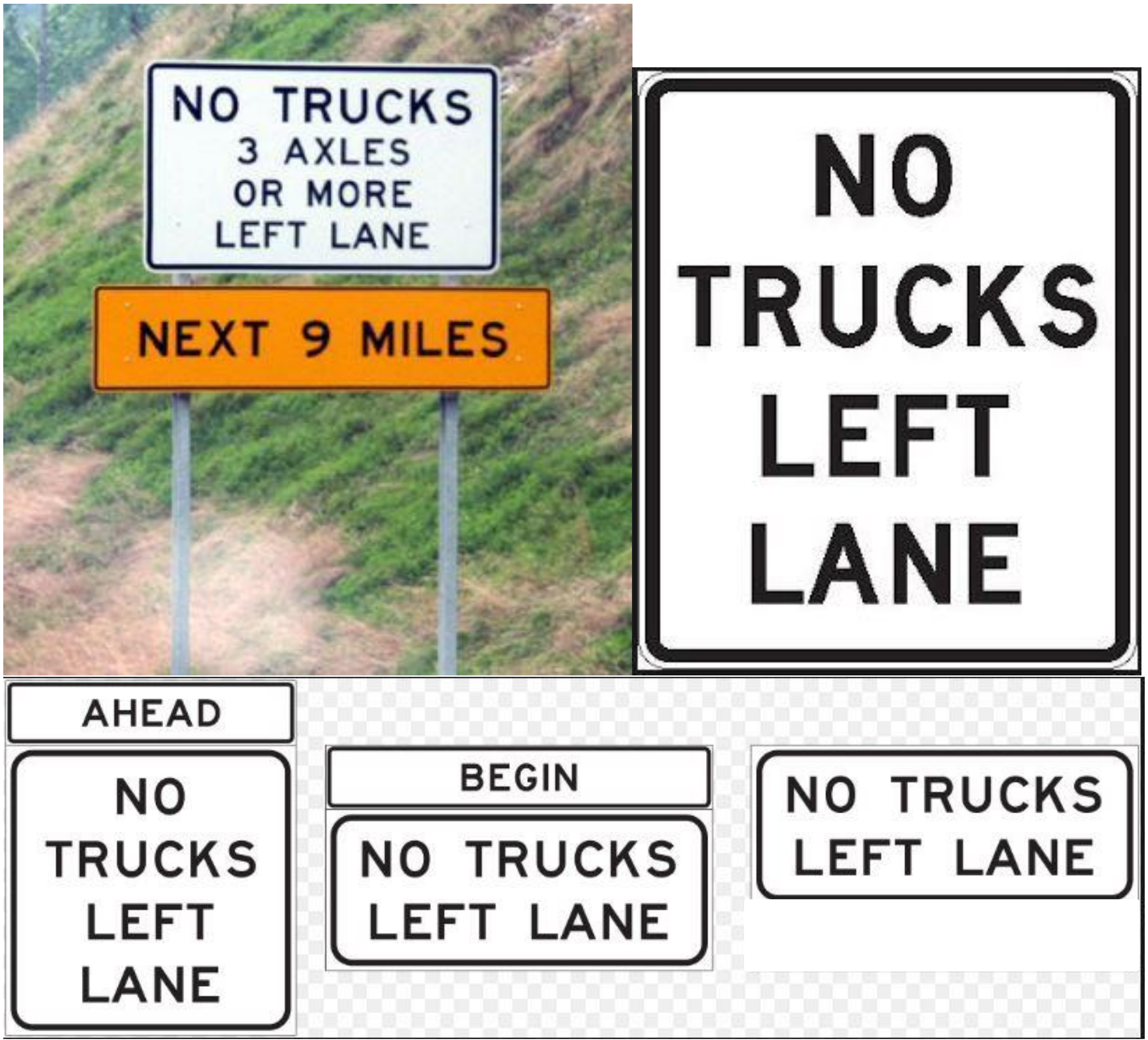
1.5-inch AC Surface 0.38D 64-22

VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION	Idea No. 47

Baseline	Item Description	Recommendation
1.5"	CL3 ASPH SURF 0.38A PG76-22	1.5"
3.0"	CL4 ASPH BASE 1.00D PG76-22	3.0"
3.5"	CL4 ASPH BASE 1.00D PG64-22	3.0"
4.5"	CL4 ASPH BASE 1.50D PG64-22	3.5"
17"	CRUSHED STONE BASE	6"
29.5"	Versus	17"



VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION	Idea No. 47



Assumptions/Calculations

Designing a travel lane designated to passenger vehicle traffic only would decrease the load the roadway would need to support, potentially providing a significant cost savings.

Per KYTC design standards, the pavement was designed for a 40-year life span.

Calculations were made using the I-265 Project Cost Line Item Excel Spreadsheet from the design team. Unit prices in that spreadsheet were used to provide a comparable estimate.

Pavement construction has the highest cost in this project. Reducing the required thickness of the additional lane reduced the estimated project cost by $2.3M.

VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION

Idea No. 47

		lane width	12	ft		
		shld width	4.5	ft		
		concrete section	43200	LF		
		asphalt section	17750	LF		
Baseline						
ITEM DESCRIPTION	**UNITS**	**PRICE**	**QUANTITY**	**SUBTOTAL**		**COMMENTS**
CL3 ASPH SURF 0.38A PG76-22	TON	$ 83.00	2684.6875	$ 222,829.06	1.5	depth lane and shld
CL4 ASPH BASE 1.00D PG76-22	TON	$ 67.00	5410.052083	$ 362,473.49	3	depth lane and shld
CL4 ASPH BASE 1.00D PG64-22	TON	$ 65.00	6406.640625	$ 416,431.64	3.5	depth lane and shld
CL4 ASPH BASE 1.50D PG64-22	TON	$ 59.00	6182.916667	$ 364,792.08	4.5	depth lane only
CRUSHED STONE BASE	TON	$ 25.00	21862.90509	$ 546,572.63	17	CSB mod lane
CRUSHED STONE BASE	TON	$ 25.00	9540.625	$ 238,515.63	21.5	CSB mod shld (full depth)
JPC PAVEMENT-13 IN	SQYD	$ 88.00	57600	$ 5,068,800.00	13	depth lane
JPC PAVEMENT-10 IN SHLD	SQYD	$ 77.00	21600	$ 1,663,200.00	10	depth shld
JPC DRAINAGE BLANKET	TON	$ 56.00	20880	$ 1,169,280.00	7.25	depth lane
JPC DRAINAGE BLANKET	TON	$ 56.00	11070	$ 619,920.00	10.25	depth shld
DGA BASE	TON	$ 25.00	23040	$ 576,000.00	8	depth lane
DGA BASE	TON	$ 25.00	8640	$ 216,000.00	8	depth shld (full depth)
ROADWAY EXCAVATION	CUYD	$ 11.00	34731.48148	$ 382,046.30		difference between baseline and recommendation = 12.5" asph section and 8" conc section
				$ 11,846,860.82		
				$ 15,697,090.59		
Recommendation						
ITEM DESCRIPTION	**UNITS**	**PRICE**	**QUANTITY**	**SUBTOTAL**		**COMMENTS**
CL3 ASPH SURF 0.38A PG76-22	TON	$ 83.00	2684.6875	$ 222,829.06	1.5	depth lane and shld
CL4 ASPH BASE 1.00D PG76-22	TON	$ 67.00	5410.052083	$ 362,473.49	3	depth lane and shld
CL4 ASPH BASE 1.00D PG64-22	TON	$ 65.00	5491.40625	$ 356,941.41	3	depth lane and shld
CL4 ASPH BASE 1.50D PG64-22	TON	$ 59.00	4793.116319	$ 282,793.86	3.5	depth lane only
CRUSHED STONE BASE	TON	$ 25.00	7642.361111	$ 191,059.03	6	CSB mod lane
CRUSHED STONE BASE	TON	$ 25.00	4215.625	$ 105,390.63	9.5	CSB mod shld (full depth)
JPC PAVEMENT-13 IN	SQYD	$ 88.00	57600	$ 5,068,800.00	13	depth lane
JPC PAVEMENT-10 IN SHLD	SQYD	$ 77.00	21600	$ 1,663,200.00	10	depth shld
JPC DRAINAGE BLANKET	TON	$ 56.00	20880	$ 1,169,280.00	7.25	depth lane
JPC DRAINAGE BLANKET	TON	$ 56.00	11070	$ 619,920.00	10.25	depth shld
NON-PERFORATED PIPE-4 IN	LF	$ 12.00	639	$ 7,668.00		
PERFORATED PIPE EDGE DRAIN-4 IN	LF	$ 4.00	17750	$ 71,000.00		
				$ 10,121,355.47		
				$ 13,410,796.00		
			Potential Savings	$ 2,286,294.59		

VE RECOMMENDATION NO. 9: REDUCE PAVEMENT SECTION	Idea No. 47

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations Improves mobility of cars by removing trucks off the new lanes Truck traffic continues to use two lanes (third lane not available)	Rating	5	6
	Weight	26	
	Contribution	131	144
Local Operations No Change	Rating	6	6
	Weight	26	
	Contribution	144	144
Maintainability Negligible lifecycle loss Marginal drainage implications	Rating	7	6
	Weight	17	
	Contribution	108	104
Construction Impacts Negligible change	Rating	9	9
	Weight	5	
	Contribution	40	40
Environmental Impacts No Change	Rating	9	9
	Weight	10	
	Contribution	89	89
Project Schedule Slightly faster to construct (less asphalt to lay down)	Rating	4	5
	Weight	17	
	Contribution	66	75
	Total Performance	577	595
	Net Change in Performance		3%

As stated in Section 6.3, of the 18 design suggestions generated, 3 were written for further consideration by the project design team. The details of the other suggestions are shown in Section 5.2 in the Idea Evaluation Form.

VE DESIGN SUGGESTION NO. 1: APPLY ABC TECHNIQUES	Idea No. 49

Baseline Concept

The baseline concept for the interchange includes alternates that have structures, including bridges and a 3 sided structure underneath I-265 at both the north and south end of the project.

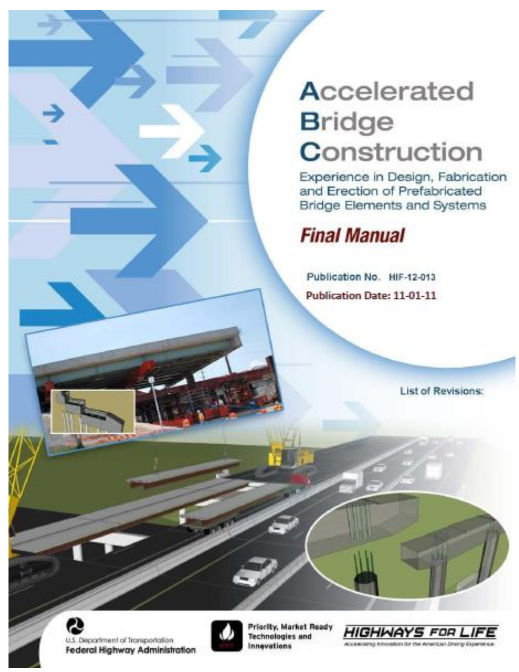
Recommendation Concept

This design suggestion includes the application of Accelerated Bridge Construction (ABC) techniques.

Advantages	Disadvantages
• Easier to construct • May decrease construction time • May improve safety of motorists and construction workers because of decreased construction time • May improve quality of materials as many are precast	• May cost more • May require approval of non-standard details • Not all contractors are familiar with and have strong experience in application of ABC techniques

Technical Discussion/Sketches

Based on FHWA's publication "Accelerated Bridge Construction Final Manual" Publication No. HIF-12-013, ABC uses innovative planning, design, materials and construction methods in a safe and cost-effective manner to reduce the onsite construction time that occurs when building new bridges or replacing and rehabilitating existing bridges. It can improve site constructibility, total project delivery time, material quality and product durability, and work-zone safety for traveling public and contractor personnel. It can also reduce traffic impacts, onsite construction time, and weather-related time delays.



The baseline project includes the widening of I-265 and the reconstruction of the I-64/I-265 interchange. This corridor and interchange carry large volumes of traffic, especially during peak hours. Constructibility and MOT will be critical issues on this project. Applying ABC techniques will reduce the duration of construction impacts.

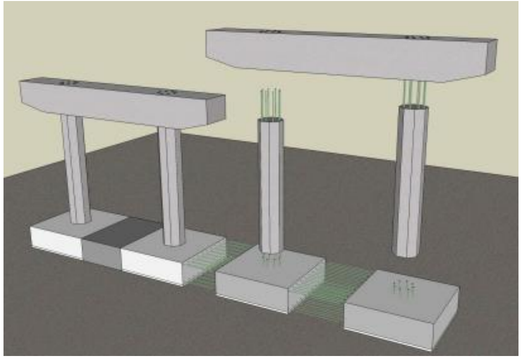
The baseline project includes several structures on the widening portion of the project. Most of the structures are being rehabilitated and ABC techniques may not be practical on those portions. However, including ABC techniques is applicable in the interchange portion of the project. Some of the specific techniques that could be considered include:

VE DESIGN SUGGESTION NO. 1: APPLY ABC TECHNIQUES

Idea No. 49

- **Precast Deck Elements:** Portions of the superstructure can be precast in segments and lifted into place, decreasing the length of time for construction by eliminating time for setting up formwork and reducing time for concrete curing. This also improves safety by reducing the length of time for contracting personnel to be on site working adjacent to live traffic when bridges are being constructed under part-width conditions.

- **Precast substructure:** Portions of the substructure can be precast in segments and lifted into place, decreasing the length of time for construction by eliminating time for setting up formwork, and reducing time for concrete curing. This also improves safety by reducing the length of time for contracting personnel to be on site working adjacent to live traffic.



- **Rapid Embankment Construction:** There are different types of lightweight fill and material that can be used for embankment. This can decrease the construction time and also reduce the construction footprint when working in tight areas.

- **Improved Quality:** Quality is always a priority during construction; however, even with controls in place and oversight, it can be challenging to construct a bridge to a high degree of quality given harsh environments. The quality of site cast concrete can be affected by temperature, humidity, rain, and wind; these factors can reduce the long-term durability of the concrete. Prefabrication can offer a number of advantages when compared to on-site construction because of the additional control of environmental conditions.
- **Reduced Cost to Motorists** (i.e., road user costs): Agencies that have completed ABS projects have seen increases in construction costs of 10 to 30 percent. The monetary cost of construction can be measured in two ways: construction cost and monetary cost to motorists associated with construction delays. Although there is a minor increase in construction cost, the goal of ABC is to decrease the length of construction and affects to the user. Reducing the duration of impacts from structure construction on I-265 is critical due to the high traffic volumes.

VE DESIGN SUGGESTION NO. 2: BUILD IN PHASES, A MODIFIED ULTIMATE INTERCHANGE WITH LOWER DESIGN SPEEDS	Idea No. 36

Baseline Concept

The baseline concept for the interchange includes alternates that were developed based on the application of "Performance-Based Flexible Solutions."

Recommendation Concept

Build in phases, a modified "ultimate" (defined below) interchange that considers:

1. Reduced design speed (40 mph directional ramps; 50+ main line).
2. Modified and/or eliminated collector distributer system to US 60.
3. Revised ramp profiles to consider alternatives that locate ramps under – rather than over.
4. Constructing first the I-64 eastbound to I-265 northbound and I-265 northbound to I-64 westbound movements while preserving the footprint for the other movements for when volumes warrant them.

Advantages	Disadvantages
• Addresses critical movements • Reduces grading, pavement, and structure costs • Reduces MOT costs • Reduces right-of-way costs • Simplifies construction • Provides flexibility for future growth/expansion	• May have utility constraints • Build a partial solution • Public perception • Could have increased structure costs for flyover ramps

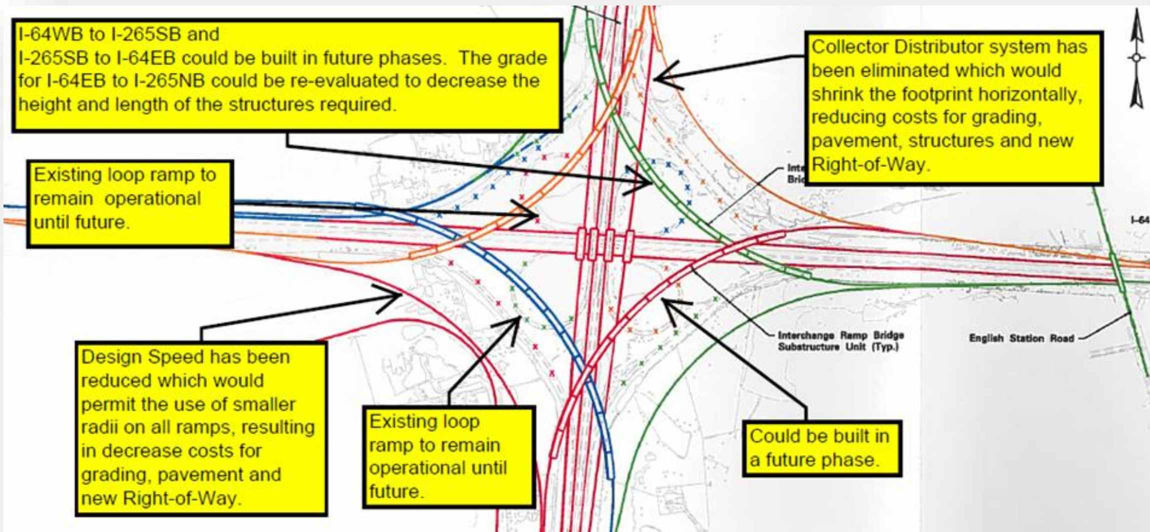
Technical Discussion/Sketches

The original "ultimate" concept (developed under Item No. 5-21 during the Alternative Selection phase) was a fully-directional interchange that accounted for several items: a collector distributor system at US 60 (Shelbyville Rd), allowing free-flow for all movements within the interchange, ideal design speeds, and all the ultimate build being constructed at one time.

The baseline concepts have accommodated different criteria, including eliminating the collector distributor system at US 60, reducing design speeds, and only the heaviest movements were designed for free-flow for the initial build. The baseline concepts do not necessarily provide flexibility to accommodate increases in traffic in some movements that are smaller in the design year.

The VE team suggests the design team revisit the ultimate concept and apply the same design criteria that is being applied to the baseline concepts. Compare a revised ultimate concept and also consider developing an ultimate solution that can be accomplished in phases so that the solution will be flexible for future conditions.

VE DESIGN SUGGESTION NO. 2: BUILD IN PHASES, A MODIFIED ULTIMATE INTERCHANGE WITH LOWER DESIGN SPEEDS	Idea No. 36



VE DESIGN SUGGESTION NO. 3: RE-RUN VISSIM MODELS	Idea Nos. 37, 38

Baseline Concept

The baseline assumes two separate traffic models that use different traffic data, and assumes traffic exiting onto US 60 disappears at the off-ramp.

Recommendation Concept

Rerun the Vissim model to validate what year the system interchange is impacted without improvements to other interchanges, particularly US 60.

Once the preferred alternative has been selected, rerun the Vissim model for both projects combined as one model, from beginning to end, including all interchanges to validate operations.

Advantages	Disadvantages
• Provides information for understanding when system may fail and require more improvements • Likely necessary as validation of the IMR	• None discussed

Technical Discussion/Sketches

The Build Alternative Vissim models were run without incorporating the signalized ramp terminal at the I-265/US 60 interchange directly north approximately 1 mile north of the I-265/I-64 system interchange. Vehicles end their routes on the US 60 exit ramp and disappear from the network. Running the Vissim model without having the signals at the US 60 ramp terminals validates that the proposed I-265/I-64 interchange can sufficiently serve the design year demand volume; however, by not incorporating the US 60 interchange, the Vissim model does not accurately reflect how the system interchange improvements may degrade I-265 main line operations and the weave between Ramp A and I-265. Based on the volume going to US 60, it is anticipated US 60 will queue back onto I-265 main line, which could further degrade the heavy weave movement between Ramp A and I-265.

The proposed improvements to the system interchange will provide increased capacity and significantly increase the throughput onto I-265, thereby delivering more of the demand volume to US 60. Rerunning the Vissim model to include the ramp signals at US 60 will ensure the proposed improvements are compatible with the adjacent interchanges. If the design year volumes are unable to be served within the network due to the bottleneck of the adjacent interchanges (specifically US 60), a sensitivity analysis should be performed to determine what year the network begins to break. This will provide KYTC the opportunity to plan and program improvements to US 60, i.e., a new interchange that can handle the increased demand, or construct a CD road to separate I-265 bound volume from US 60 bound volume from the I-265/I-64 interchange.

Appendix A

Value Engineering Process

Appendix A. Value Engineering Process

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

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

Pre-VE Study

Prior to the start of a VE study, the Project Manager and the VE Team Leader carry out the following activities:

- Initiate study – Identify study project and define study goals
- Organize study – Conduct pre-VE study meeting and select team members
- Prepare data – Collect and distribute data and prepare cost models.

All of the information gathered prior to the VE study is given to the team members for their use.

Value Methodology Job Plan

The VE team employed the six-phase Value Methodology Job Plan in analyzing the project. This process is recommended by SAVE International® and is composed of the following phases:

Information – The team reviews and defines the current conditions of the project and identifies the goals of the study.

Function Analysis – The team defines the project functions using a two-word active verb/ measurable noun context. The team reviews and analyzes these functions to determine which need improvement, elimination, or creation to meet the project's goals.

Creative – The team employs creative techniques to identify other ways to perform the project's function(s).

Evaluation – The team follows a structured evaluation process to select those ideas that offer the potential for value improvement while delivering the project's function(s) and considering performance requirements and resource limits.

Development – The team develops the selected ideas into alternatives (or proposals) with a sufficient level of documentation to allow decision makers to determine if the alternative should be implemented.

Presentation – The team leader develops a report and/or presentation that documents and conveys the adequacy of the alternative(s) developed by the team and the associated value improvement opportunity.

The following is a general discussion and overview of the Performance-Based VE process. Ideas that have been introduced and warrant further consideration, will be documented with their advantages and disadvantages; each idea will then be carefully evaluated against project-specific attributes.

Performance-Based Value Engineering

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

Introduction

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

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

Performance-based VE yields the following benefits:

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

Methodology

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

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

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

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

Assumptions

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

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between project scope components (highway operations, environmental impacts, and system preservation) and project delivery components. It is important to make a distinction between performance *attributes* and performance *requirements*. Performance requirements are mandatory and binary in nature. All performance requirements MUST be met by any VE alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge meets all current seismic design criteria. In contrast, a performance attribute might be project schedule, which means that a wide range of alternatives could be acceptable that had different durations.

The VE Team Leader will initially request representatives from project team and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually four to seven attributes are selected. It is important that all potential attributes be thoroughly discussed. The information that comes out of this discussion will be valuable to both the VE team and the project owner. It is important that each attribute be discretely defined and be quantifiable in some form. The vast majority of performance attributes that typically appear in transportation VE studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required.

Typical standardized project performance attributes are shown below. Specific definitions of each attribute can be found below.

- Main Line Operations
- Local Operations
- Maintainability
- Construction Impacts
- Environmental Impacts
- Project Schedule

PERFORMANCE ATTRIBUTE AND DEFINITIONS	
Performance Attribute	**Description of Attribute**
Main Line Operations	An assessment of traffic operations and safety on the main line. Operational considerations include level of service relative to the 20-year traffic projections as well as geometric considerations such as design speed, sight distance, and lane and shoulder widths.
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure. Operational considerations include level of service relative to the 20-year traffic projections; geometric considerations such as design speed, sight distance, lane widths; bicycle and pedestrian operations and access, including shared use path.
Maintainability	An assessment of the long-term maintainability of the transportation facility(s). Maintenance considerations include the overall durability, longevity, and maintainability of pavements, structures, and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to businesses and residents relative to access, visual, noise, vibration, dust, and construction traffic. Temporary environmental impacts related to water quality, air quality, soil erosion, and local flora and fauna.
Environmental Impacts	An assessment of the permanent impacts to the environment, including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts (i.e., environmental justice, business, residents); impacts to cultural, recreational and historic resources.
Project Schedule	An assessment of the total project delivery as measured from the time of the VE study to completion of construction.

Step 2 – Determine the Relative Importance of the Attributes

Once the group has agreed on the project's performance attributes, the next step is to determine their relative importance in relation to each other. This is accomplished through the use of an evaluative tool termed in this report as the "Performance Attribute Matrix." This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?"

A letter code (e.g., "A") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of essentially equal importance, both letters (e.g., "A/B") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed. When all pairs have been discussed, the number of “votes” for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any “votes.” If this occurs, the attribute is given a token “vote,” as it made the list in the first place and should be given some degree of importance.

An example of this exercise is shown below.

PERFORMANCE ATTRIBUTE MATRIX

[Project Name]

Which attribute is more important to the project?							**TOTAL**	**%**
Main Line Operations	A	B	A	A	A	A	5.0	**23.8%**
Local Operations		B	B	B	B	B/F	5.5	**26.2%**
Maintainability			C	C	E	F	2.0	9.5%
Construction Impacts				D	E	D/F	1.5	7.1%
Environmental Impacts					E	E	4.0	19.0%
Project Schedule						F	3.0	14.3%
Total							21.0	100%

EXAMPLE

Without emphasis on preference

A = A is of greater importance

A/B = A and B are of equal importance

For the example project above, the project owner, design team, and stakeholders determined that Main Line Operations, followed by Environmental, gave the greatest improvement relative to the projects purpose and need, while Construction Impacts and Project Schedule gave the least improvement.

Step 3 – Establish the Performance Baseline for the Original Design

The next step in the process is to document the project-specific elements for the performance attributes developed in Step 1. This step establishes a baseline against which the VE alternative concepts can be compared. An example of project-specific elements is shown below.

Evaluation of Baseline Project

Standard Performance Attribute	Description of Attribute	Baseline Design Rating Rational
Main Line Operations	An assessment of traffic operations and safety on the project. Operational considerations include level of service relative to the 20-year traffic projections as well as geometric considerations such as design speed, sight distance, lane widths, and shoulder widths.	Design Speed - __ MPH Bridge – __' Lanes, __' shoulders Roadway - __' Lanes, __' shoulders Bridge ___ Loading
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure. Operational considerations include level of service relative to the 20 year traffic projections; geometric considerations such as design speed, sight distance, lane widths; bicycle and pedestrian operations and access.	Revisions will need to be made to the existing streets and private approaches due to vertical alignment.
Maintainability	An assessment of the long-term maintainability of the transportation facility(s). Maintenance considerations include the overall durability, longevity, and maintainability of pavements, structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.	Baseline design assumes a replacement bridge Bridge design – low slump overlay on a 7" deck Steel welded plate girder 100' - 150' - 250' - 250' - 150' - 100' spans
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to businesses and residents relative to access, visual, noise, vibration, dust and construction traffic; environmental impacts.	Maintain traffic across river Noise permit required Short term detour to construct tie-ins to existing highways
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts (i.e., environmental justice, business, residents); impacts to cultural, recreational and historic resources.	In-water window Considered a navigable body of water Existing bridge is under consideration for historical significance
Project Schedule	An assessment of the total project delivery from the time as measured from the time of the study to completion of construction.	Advertisement date ____ Construction start of ____ 26-month overall construction duration

EXAMPLE

Once the baseline definitions for the various attributes have been established, their total performance should be calculated by multiplying the attribute's weight (which was developed in Step 2) by its rating. While one could assign a 0 to 10 rating for each attribute, using the definitions and scales developed in Step 1, a baseline rating of 5 is typically used as a mid-point so that alternatives can be evaluated – better than or worse than the baseline.

Total baseline performance is calculated by multiplying the attribute's weight (which was developed in Step 2) by its rating (5). The baseline design's total performance of 500 points can be calculated by adding all of the scores for the attributes. This numerical expression of the original designs performance forms the baseline against which all alternative concepts will be compared.

Step 4 – Evaluate the Performance of the VE Alternative Concepts

Once the performance of the baseline has been established for the original design concept, it can be used to help the VE team develop performance ratings for individual VE alternative concepts as they are developed during the course of the study. The Performance Measures Form is used to capture this information. This form allows a side-by-side comparison of the original design and VE alternative concepts to be performed.

It is important to consider the alternative concept's impact on the entire project (rather than on discrete components) when developing performance ratings for the alternative concept.

Proposals are evaluated against the baseline for all attributes to compare and contrast the potential for value improvement. As discussed in Step 3, the baseline is given a rating of 5. The following ratings were used to evaluate the performance of the alternative concepts relative to the baseline concept.

Rating	Performance Attribute Scale
10	Alternative concept is extremely preferred
9	Alternative concept is very strongly preferred
8	Alternative concept is strongly preferred
7	Alternative concept is moderately preferred
6	Alternative concept is slightly preferred
5	***Baseline***
4	Baseline concept is slightly preferred
3	Baseline concept is moderately preferred
2	Baseline concept is strongly preferred
1	Baseline concept is very strongly preferred
0	Baseline concept is extremely preferred

Step 5 – Compare the Performance Ratings of Alternative Concepts to the Baseline Project

As the VE team develops alternatives, the performance of each is rated against the original design concept (baseline). Changes in performance are always based on the overall impact to the total project. Once performance and cost data have been developed by the VE team, the net change in value of the VE alternatives can be compared to the baseline design concept. The resulting "Value Matrix" provides a summary of these changes and allows a way for the Project Team to assess the potential impact of the VE recommendations on total project value.

The VE team groups the VE alternatives into a strategy (or strategies) to provide the decision-makers a clear picture of how the alternatives fit together into possible solutions. At least one strategy is developed to present the VE team's consensus of what should be implemented. Additional strategies are developed as necessary to present other combinations to the decision-makers that should be considered. The strategy(s) of VE alternatives are rated and compared against the baseline concept. The performance ratings developed for the VE strategies are entered into the matrix, and the summary portion of the Value Matrix is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations:

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

The following is an example of a Value Matrix worksheet.

EXAMPLE

Performance Attribute Ratings				
Attribute	**Attribute Weight**	**Concept**	**Performance Rating**	**Total Performance**
Main Line Operations	28.9	Baseline	5	144.5
		1	7	202.3
		2	7	202.3
		3	5	144.5
Local Operations	14.2	Baseline	5	71.0
		1	5	71.0
		2	5	71.0
		3	8	113.6
Maintainability	14.2	Baseline	5	71.0
		1	3	42.6
		2	6	[illegible]5.2
		3	4.5	[illegible]
Environmental Impacts	16.6	Baseline	5	83[illegible]
		1	[illegible]	107.[illegible]
		2	[illegible]	83.0
		3	4.[illegible]	74.7
Construction Impacts	14.2	Baseline	5	71.0
		1	4	56.8
		2	[illegible]	85.2
		3	5	71.0
Project Schedule	11.[illegible]	Baselin[illegible]	5	59.5
		1	5	59.5
		2	5	59.5
		3	5	59.5

Recommendation Summary								
Recommendations		**Perform[illegible]**	**% Change Performance**	**Cost (C) $ millions**	**Cost Change $ millions**	**% Change Cost**	**Value Index**	**% Value Improvement**
	Baseline	500	---	$46.1	---	---	10.85	---
1	Recommendation No. 1 - Title	540	+8.0%	$46.6	$0.5	+1.2%	11.58	+6.8%
2	Recommendation No. 2 - Title	586	+17.2%	$46.5	$0.4	+0.9%	12.60	+16.2%
3	Recommendation No. 3 - Title	527	+5.4%	$46.1	$0.0	+0.0%	11.43	+5.4%
	Total				$3.9			

Appendix B

VE Study Memo, Agenda, and Attendees

Memo

Date:	Friday, January 18, 2019
Project:	I-265 Widening and I-64/I-265 Interchange
To:	VE Team Members
From:	Jose Theiler, PE, CVS®
Subject:	Value Engineering Study

This memo is to introduce some of the expectations for the upcoming Value Engineering (VE) study. I'm looking forward to working with you on this endeavor. My hope is that this memo will provide information to you about the project and our work together.

If you have any questions, please direct them to me, Jose Theiler, at 561-386-3879, or e-mail: jose.theiler@hdrinc.com.

Project Background

This study will cover two separate KYTC projects, Item 5-537 and Item 5-549. As stated in the original design advertisements the purpose and need for each project is as follows:

- Item 5-537 involves developing improvements on a six-lane priority section of I-265 between Taylorsville Road and I-71 "to decrease congestion and improve safety, operations and roadway traffic capacity as a result of the expected increased traffic due to major transportation and development changes in the Louisville Metro area. The need is expressed through high critical crash rate factors, continued land development, and congested traffic operations."
- Item 5-549 involves the reconstruction of the I-265/I-64 interchange "to improve operational and safety characteristics of the interchange utilizing a Performance Based Flexible Solution (PBFS). The need is to address the short weaving segments and acceleration/deceleration lengths. The short weaving segments create extreme speed differentials at the existing interchange ramps. The acceleration and deceleration lengths do not provide enough length to safely accommodate traffic movements. Goals are to improve the operational and safety characteristics within the existing interchange."

VE Study Dates and Location

The workshop will be held February 4 through February 8, 2019 at

KYTC Central Office
200 Mero Street, Room C117
Frankfort, KY 40622

What to Bring

Be sure to bring your normal tools of the trade (e.g., calculator, laptop computer, scale, etc.). Bring a creative and open mind. VE studies are a lot of work, but if you bring your sense of humor you will have a good time and a rewarding experience.

Ground Rules

A VE study follows a prescribed process that has been proven over many years to produce the best results. This process needs the team members to be fully engaged and have an open mind to "step" outside of the box throughout the week.

To maintain our schedule and provide the best results to the project team, I ask that we follow some basic ground rules:

1. **Please be prepared to attend all five days.** You were selected to assist on this team based on your expertise. If you cannot be in attendance for the entire time, then please contact me prior to the study so we can make the appropriate arrangements.
   When team members leave part way through, or come and go frequently, the VE team can lose its momentum and cohesiveness.
2. **Please turn your cell phones to vibrate mode during the study.** Unless it is information to assist the team, please try to wait until breaks to return phone calls, check on messages, or sort through e-mails.
3. **No dress code.** I want everyone to be comfortable. The first day does include a site visit, so please dress accordingly. The rest of the time the appropriate dress is what some would call business casual (no ties required).
4. **If you have a laptop please bring it.** I have found most team members are more comfortable developing their write-ups on a computer. The facilities we use don't always have network connections, so the memory stick is usually the network of choice for sharing files.
5. **Our success will be evaluated based on the level of contribution that we bring to the project.** Remember that the goal of any VE Study is to "add value" to the project and saving money is just a byproduct. We want to make recommendations based on solid engineering judgment that will result in an improved overall project.
6. **Reading Material:** Prior to the workshop I'll be sending available engineering material to get familiar with it. Please read them and be prepared to ask questions during the Design Team walkthrough of the project. You should be able to have a clear picture of the project by the noon of the first day of the workshop.

Value Engineering Job Plan

The VE team will employ the six-phase VE job plan in analyzing the project. This process is recommended by SAVE International® and AASHTO, and is composed of the following phases:

Information Phase – The objective of this phase is to obtain a thorough understanding of the project's design criteria and objectives by reviewing the project's documents and drawings, cost estimates, and schedules. Elements include:

- Overview of the Value Engineering process
- Understanding of study objectives
- Project Overview and Briefing by the Design team
  - Provide insight on project history, design concepts, environmental issues, etc.
  - Discuss any design concerns and new concepts involved with the project.
  - All appropriate project disciplines should be discussed.
  - Discuss / identify any risks or issues that the VE Team should concentrate on.
  - Provide VE Team with any specific project constraints.
  - Q&A – Presenters answers questions from the VE Team

Function Analysis Phase – Identifying each of the key functions of the project is the most important phase of value engineering, as it is the basis for unlocking the creativity of team members. As part of this phase, the team performs the following tasks with the assistance of the VE Team Leader/Facilitator:

- Defines project and risk functions and assigns them to key project components,

- Classifies functions as either “Basic” or “Secondary”,
- Sequence functions to understand their relationships using the Function Analysis System Technique (FAST),
- Establishes Performance Measures,
- Creates the project’s cost model, and
- Assigns cost and performance measures (worth) to each function.

Brainstorming/Creative Phase – During this phase the team will employ creative techniques such as team brainstorming to develop a number of alternative concepts that satisfy the project’s “basic” and “supporting” functions, and mitigate project risks.

Evaluation Phase – The purpose of this phase is to evaluate the alternative concepts developed by the VE team during the brainstorming sessions. To that purpose, the team discusses advantages and disadvantages, and uses a number of tools to determine the qualitative and quantitative merits of each concept.

Mid-Study Review With Management Team: at this point, the VE team leader holds a meeting, either privately or with the participation of the VE team, to validate the direction of the team and that ideas moving forward to the development phase do not step outside the boundaries set forth by project constraints.

Development Phase – Those concepts that ranked highest in the evaluation are further developed into VE recommendations. Recommendation narratives, further qualify advantages and disadvantages, drawings, calculations, and lifecycle cost analysis will be prepared for each recommendation.

Presentation Phase – On the last day of the study, the VE team presents their finding during an oral presentation to the owner and the project team. Following the workshop, a written report prepared by the facilitator, summarizes the study, its findings and recommendations.

I’m looking forward to working with you on this VE study and I really appreciate each of you blocking time out of your busy schedule to participate. Please don’t hesitate to call or e-mail me if you have any questions.

Sincerely,

Jose Theiler, PE, CVS®
East Region Manager of
Project Risk Management and Value Engineering

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HDR

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jose.theiler@hdrinc.com

Agenda

Day 1	Monday, February 4 Objective for the day: Learn about VE and the project	
08:30 AM	**VE Team Introductions** • Team "meet and greet" • Study kickoff • Team introductions	**All audiences:** Project owner, management, stakeholders, designers, etc.
08:45 AM *Information Phase*	**VE Process Overview** • An instructional presentation on the principles of value engineering and their application to the project	**VE facilitator:** Jose Theiler, PE, CVS
09:15 AM *Information Phase*	**Project Overview** • Purpose and Need of the project • Goals and objectives of the project • Constraints • Areas for ;discussion: o Railway/Roadway Design o Traffic Analysis o Structures o Drainage/Hydraulics o Utilities o Railroad (Third Party) o Environmental Conditions o Contamination • Questions and answers	**Project team/ designer**
10:15 AM	**Virtual Site Visit**	**All Audiences**
10:45 AM	**Break**	
11:00 AM	**Risk Elicitation Define Performance Attributes**	**All Audiences**
12:00 PM	**Lunch**	**All Audiences**
01:00 PM	**Define Performance Attributes**	**All Audiences**
02:00 PM *Information Phase*	**Project Documentation Review** • Review plans/schematics, cross sections, typical sections, traffic control plans, construction constraints • Cost estimate, including construction, right-of-way, utilities, railroad, environmental, etc. • Project schedule, including construction phasing/sequencing, work windows • Project Review Observations	**Facilitator** **VE team**
03:30 PM	**Begin Function Analysis** • Review project cost model • Define key project functions using "verb + noun" expressions	
05:00 PM	**Adjourn**	

Day 2	Tuesday February 5 Objective for the day: Function Analysis and Brainstorming Ideas	
08:30 AM *Function Analysis Phase*	**Continue Function Analysis** • Finalize definition of key project functions using "verb + noun" expressions • Build a FAST diagram	**VE team**
9:30 PM *Creative Phase*	**Begin Creative Phase** • Brainstorm alternative ways to perform key functions • Brainstorm ways to improve value of key functions	**VE team**
11:30 AM	**Lunch**	
01:00 PM *Creative Phase*	**Complete Creative Phase** • Brainstorm alternative ways to perform key functions • Brainstorm ways to improve value of key functions	**VE team**
03:00 PM *Evaluation Phase*	**Begin Evaluation of Ideas** • Discuss advantages and disadvantages for each idea • Score ideas based on predetermined criteria, to develop further into recommendations	**VE team**
05:00 PM	**Adjourn**	

Day 3	Wednesday February 6 Objective for the day: Evaluate Ideas and Begin Developing	
08:30 AM *Evaluation Phase*	**Complete Evaluation of Ideas** • Discuss advantages and disadvantages for each idea • Score ideas based on predetermined criteria, to develop further into recommendations	**VE team**
12:00 AM	**Lunch**	
01:00 PM	**Mid-point review**	**Facilitator, D4 Value Engineer, Project Managers**
01:30 PM *Development Phase*	**Develop Ideas into Recommendations** • Individual/team assignments • Development of recommendations: o Test design feasibility o Design analysis o Technical narratives o Further discussion on advantages and disadvantages o Cost analysis (life cycle cost comparison)	**VE team led by Assistant (Joe Cochran)**
05:00 PM	**Adjourn**	

Day 4	Objective for the day: Continue Development of Recommendations and Draft the Close-out Presentation	
08:30 AM *Development Phase*	**Continue Development of Recommendations** • Wrap up Recommendations write-ups **Prepare Close-out Presentation**	**VE team**
11:30 AM	**Lunch**	
01:00 PM *Development Phase*	**Finalize Recommendations** • Peer review of recommendations	**VE team**
03:30 PM *Development Phase*	**Evaluate Performance Attributes of Recommendations**	**VE team**
05:00 PM	**Adjourn**	

Day 5	Objective for the day: Deliver Close-out Presentation	
08:30 AM *Development Phase*	**Finalize Evaluation of Performance Attributes**	**VE team**
10:30 AM *Presentation Phase*	**Finalize Close-out Presentation** **Team Rehearsal**	**VE team**
11:30 AM	**Lunch**	
2:00 PM *Presentation Phase*	**Presentation of VE Findings** • Team presents recommendations to management • Questions and answers	**All Audiences:** Project owner, management, stakeholders, designers, etc.
	Adjourn	

VE Study Attendees
I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange

February 2019					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	CELL
4	5	6	7	8				E-MAIL	
✓	✓	✓	✓	✓	Erica Albrecht	HDR	Structures	502.909.32.45	
								Erica.albrecht@hdrinc.com	
				✓	Jill Asher	KYTC	Highway Design		
								Jill.asher@ky.gov	
✓				✓	Kyle Chism	Parsons	Designer	502.653.6627	
								Kyle.chism@parsons.com	
✓	✓	✓	✓	✓	Joe Cochran	HDR	Roadway	859.629.4836	
								Joe.cochran@hdrinc.com	
✓				✓	Amanda Desmond	KYTC D5	Project Manager		
								Amanda.desmond@ky.gov	
				✓	Brad Eldridge	KYTC	Location		
								Brad.eldridge@ky.gov	
✓					Larry W Ginthum	QK4	Designer		
								lginthum@qk4.com	
✓	✓	✓	✓	✓	Will Hume	HDR	Traffic Engineer	971.201.9229	
								Will.hume@hdrinc.com	
✓				✓	Taylor Kelly	QK4	Designer		
								Tkelly@qk4.com	
				✓	Michael Loyselle	FHWA	Major Project Engineer	502.223.6748	
								Michael.loyselle@dot.gov	

VE Study Attendees
I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange

February 2019										
4	5	6	7	8	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	CELL	E-MAIL
✓	✓	✓	✓	✓	Elizabeth Lykins	KYTC	Roadway			Elizabeth.Lykins@ky.gov
✓	✓			✓	Pat Matheny	KYTC D5	Project Manager			Patrick.matheny@ky.com
				✓	Steve Mills	FHWA	Asst. Div. Administrator	502.223.6723		Steve.mills@dot.gov
				✓	John Moore	KYTC				John.w.moore@ky.gov
				✓	Patrick Perry	KYTC	Location			Patrick.perry@ky.gov
✓	✓	✓	✓	✓	Brent Sweger	KYTC	State Value Engineer	502.782.4912		Brent.sweger@ky.gov
✓	✓	✓	✓	✓	Jose Theiler	HDR	Value Engineer	561.386.3879		Jose.theiler@hdrinc.com
				✓	Travis Thompson	KYTC	TEBM KYTC D5	502.210.5400		Travis.thompson@ky.gov
✓	✓	✓	✓	✓	Jonathan West	HDR	Roadway			Jonathan.west@hdrinc.com
				✓	David Whitworth	FHWA	Engineer			David.whitworth@dot.gov

VE Study Attendees
I-265 from KY 155 to North of I-71 IC and I-64/I-265 Interchange

February 2019					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	CELL
4	5	6	7	8				E-MAIL	
				✓	Tom Wright	KYTC	TEBM KYTC D5		
								Tom.wright@ky.gov	

Appendix C

Value Engineering Punch List

VALUE ENGINEERING PUNCH LIST

ITEM NO. **Appendix C** PROJECT COUNTY: **Jefferson** DATE OF STUDY: **February 4-8, 2019** **VE # _____**

VE Alternative Number	VE Team Top Pick	Description	Activity (Y,N,UC-Date)	Implemented Life Cycle Cost Savings	Original Cost ($M)	Alternative Cost ($M)	Initial Cost Saving ($M)	Life Cycle Cost Savings (Total Present Worth)	FHWA Categories	Remarks
Recommendations Grouping Title #1 (e.g. Roadway)										
VE-1		**Steepen Slopes and Build Retaining Walls to Avoid Right-of-Way Impacts** – Introduces strategies to reduce or eliminate right-of-way impacts.			$1.68	$2.16	$0.48 increase		Environmental Right-of-way	
VE-2		**Use Ramp Metering** – To improve lain line operations and safety, use ramp metering as a traffic control measure during peak traffic hours.			$0.00	$0.50	$0.5 increase		Safety Operations	
VE-3		**Change I-64 ramp construction sequence to minimize Temporary Construction** – Scheduling ramp construction to accommodate and maintain traffic will eliminate the need for temporary loop ramps			$0.98	$0.20	$0.78		Construction	
VE-4		**Widen New Underpasses to the Outside to Improve Constructibility** – Leave existing northbound bridge and realign main line I-265 northbound to match existing bridge section, improving constructibility			$1.20	$0.60	$0.60		Construction	
VE-5		**Use Design-Build Delivery Method** – This method of delivery for the interchange and portions of the widening project will enable construction letting in 18 months			$31.17	$29.27	$1.90		Construction	
VE-6		**Modify System Interchange Design to Separate US 60 and Mainline Traffic** – This introduces a new interchange concept that allows a collector-distributor (CD) road to be constructed when impacts to the interchange are realized.			$29.20	$28.53	$0.67		Safety Operations	
VE-7		**Apply Advanced Signalization Strategies to Avoid Impacts to Main Line** – Using advanced queuing detection at interchange off-ramps allows signal prioritization, which will clear long queues			$0.00	$0.24	$0.24 increase		Safety Operations	
VE-8		**Improve Signage at Approaches to Interchanges** – Implement strategies to improve queuing capacity at interchanges			$0.00	$0.05	$0.05 increase		Safety Operations	
VE-9		**Reduce Pavement Section** – Reduce pavement thickness using Kentucky Transportation Cabinet (KYTC) pavement design tool to accommodate traffic and drain to outlet			$15.70	$13.41	$2.29		Construction	
Other Design Comments and/or Design Suggestions										
DC-1 Idea 49		**Apply ABC Techniques – I**nclude the application of Accelerated Bridge Construction (ABC) techniques.			N/A	N/A	N/A	N/A	Other	
DC-2 Idea 36		**Buid in Phases** – Create a modified ultimate interchange with lower design speeds.			N/A	N/A	N/A	N/A	Other	
DC-3 Ideas 37/38		**Re-run Vissim Models** – Validate what year the system interchange is impacted without improvements to other interchanges, particularly US 60.			N/A	N/A	N/A	N/A	Other	
		Implementation Meeting:								

Appendix D

Project Estimate

ALTERNATE 2
Options B-1 & D-2
KY 155 to North of I-71 IC

DEPARTMENT OF TRANSPORTATION
Bureau of Highways
ESTIMATE SHEET

Counties: Jefferson — Item No. 5-537.00
UPN Fed No.: — Total Length: 64,000'
Road Name: I-265 Widening
From: Station 5022+00 I-265 north of KY 155
To: Station 5662+00 I-265 north of I-71 IC NB, Station 5564+42 north of Westport Road SB
Net Length, Miles 12.1, — Type of Construction: Grade, Drain & Surfacing — Class of Road: Interstate

Item #	Item	Quantity	Unit	Unit Price	Amount
1	DGA Base	66,324	TON	$ 25	$ 1,658,093
8	Cement Stablized Roadbed - 8" Depth	180,331	SQ. YD.	$ 3	$ 540,993
18	Drainage Blanket - Type II - Asph	12,687	TON	$ 45	$ 576,234
22	JPC Pavement Drainage Blanket	29,669	TON	$ 56	$ 1,661,454
208	CL4 Asphalt Base 1.50D PG64-22	15,700	TON	$ 59	$ 926,295
219	CL4 Asphalt Base 1.00D PG76-22	34,920	TON	$ 67	$ 2,347,296
342	CL4 Asphalt Surface 0.38A PG76-22	17,460	TON	$ 83	$ 1,441,482
358	Asphalt Curing Seal	170	TON	$ 857	$ 145,974
2069	JPC Pavement - 10 IN	57,981	SQ. YD.	$ 77	$ 4,445,099
2086	JPC Pavement - 13 IN	81,845	SQ. YD.	$ 88	$ 7,210,287
2542	Cement	3,516	TON	$ 172	$ 604,830
2677	Asphalt Pave Milling & Texturing	12,227	TON	$ 17	$ 201,860
2702	Sand for Blotter	451	TON	$ 45	$ 20,287
	Dual off ramp on SB I-265 at KY 155 - Ln. Ba	1	LS	$ 100,000	$ 100,000
2200	Roadway Excavation	213,785	CU. YD.	$ 11	$ 2,351,635
	Drainage - 50% of Barrier Wall/Median Cable	1	LS	$ 1,128,573	$ 1,128,573
1967	Conc. Median Barrier Type 12C-50"	15,079	L.F.	$ 110	$ 1,658,690
23147EN	Median Cable Barrier	39,897	L.F.	$ 15	$ 598,455
2650	Maintenance of Traffic	1	LS	$ 7,043,864	$ 7,043,864
	Signing	1	LS	$ 1,674,530	$ 1,674,530
	ITS	1	LS	$ 1,524,000	$ 1,524,000
21590EN	Sound Barrier Wall	327,377	SQ. FT.	$ 30	$ 9,821,310
	Structures				
	I-265 NB & SB Bridge Widening over I-64	1	LS	$ 1,193,300	$ 1,193,300
	I-265 NB & SB Bridge Widening over US 60	1	LS	$ 829,800	$ 829,800
	I-265 NB & SB Bridge Widening over Aiken	1	LS	$ 812,400	$ 812,400
	I-265 NB & SB Bridge Widening over CSX R	1	LS	$ 845,900	$ 845,900
	I-265 NB Bridge Widening over I-71	1	LS	$ 1,000,000	$ 1,000,000
2568/2569	Mobilization/Demobilization (6%)	1	LS	$ 3,141,758	$ 3,141,758
	Grade & Drain $			**Subtotal**	**$ 55,504,399**
				+ 15% Add for Misc. Quantities	$ 8,325,660
Cost per MI	G. & D. & Surf. $			+ 10% for CEI & Const. Contingencies	$ 6,383,006
				Grand Total	**$ 70,213,065**

Estimated by: Qk4 - DLZ - MBI — Date: 10/2/2018
Estimated by: — Date:

Ramp I-265/I-64 System Interchange Reconstruction - Component Build and Cost Estimate Matrix

	Alternative 1 Base	Alternative 1A Build-Out	Alternative 3	Alternative 3 Braided C	2017 Base	Future Build
Ramp A – NB to WB	1 lane / 30 MPH	2 lane / 30 MPH	2 lane/ 40 MPH	2 lane/ 40 MPH	1,450 vph - AM	2,970 vph - AM
Ramp B – SB to WB	2 lane / 50 MPH	2 lane / 50 MPH	2 lane / 50 MPH	2 lane / 50 MPH	2,320 vph - AM	3,020 vph - AM
Ramp C – WB to NB	1 lane / 50 MPH	1 lane / 50 MPH	1 lane / 50 MPH	1 lane / 50 MPH	760 vph - PM	1,250 vph - PM
Ramp D – EB to SB	1 lane / 50 MPH	2 lane / 50 MPH	2 lane / 50 MPH	2 lane / 50 MPH	1,500 vph - PM	2,600 vph - AM
Ramp E – SB to EB	1 lane / 30 MPH	1 lane / 30 MPH	1 lane / 30 MPH	1 lane / 30 MPH	600 vph - AM	930 vph - AM
Ramp F – NB to EB	1 lane / 50 MPH	1 lane / 50 MPH	1 lane / 50 MPH	1 lane / 50 MPH	530 vph - PM	770 vph - PM
Ramp G – WB to SB	1 lane / 30 MPH	1 lane / 30 MPH	1 lane / 30 MPH	1 lane / 30 MPH	570 vph - PM	820 vph - PM
Ramp H – EB to NB	1 lane / 30 MPH	2 lane / 30 MPH	2 lane / 40 MPH	2 lane / 40 MPH	2,000 vph PM	3,280 vph - PM
Earthwork Cost	$1,465,296	$1,416,534	$3,281,740	$3,165,750		
Pavement Cost	$3,467,027	$4,556,843	$4,645,437	$5,346,604		
Guardrail Cost	$281,094	$338,729	$125,120	$124,714		
Bridge Cost	$4,900,000	$5,600,000	$9,500,000	$9,500,000		
Culvert Cost	$172,000	$172,000				
Retaining Wall Cost			$187,229	$87,000		
Concrete Barrier Cost	$105,490	$94,010	$14,700	$14,000		
Contingency	1.3	1.3	1.3	1.3		
Interchange Cost	**$13,508,179**	**$15,831,551**	**$23,080,494** [a]	**$23,709,488** [b]		

Added Travel Lane Option	Alternative 1 Base	Alternative 1A Build-Out	Alternative 3	Alternative 3 Braided C	Earthwork Cost	Pavement Cost	Guardrail Cost	Bridge Cost	Culvert Cost	Contin-gency	Component Cost	Noise Wall Cost
NB I-265 Aux 1-Lane Ramp					$15,666	$262,567				1.3	**$361,703**	**(5-537 cost)**
NB I-265 Aux 2-Lane Ramp	Included	Included			$14,448	$317,832	$10,164			1.3	**$445,177**	**(5-537 cost)**
NB I-265 Aux 3-Lane Ramp			Included		$33,236	$625,075	$41,250			1.3	**$909,429**	**(5-537 cost)**
SB I-265 2-Lane Entr. Ramp	Included	Included	Included	Included	$40,292	$412,464	$36,300			1.3	**$635,773**	**None**
WB I-64 2-Lane Ramp Entr.					$47,768	$412,449	$33,000		$25,000	1.3	**$673,682**	**TBD**
WB I-64 3-Lane Ramp Entr.	Included				$178,934	$930,495	$76,725		$135,000	1.3	**$1,717,500**	**$2,429,700**
WB I-64 Aux 3-Lane Ramp		Included		Included	$261,660	$1,157,330	$103,125	$850,000	$135,000	1.3	**$3,259,250**	**$3,794,700**
WB I-64 Aux 4-Lane Ramp			Included		$404,166	$1,540,130	$103,125	$1,150,000	$240,000	1.3	**$4,468,647**	**$3,794,700**
Blankenbaker 2-Lane Exit Ramp		Included	Included	Included	$26,698	$536,379	$34,601			1.3	**$776,981**	**Included in Aux Lanes**
EB I-64 Auxiliary Lane		Included		Included	$61,362	$505,660	$27,390		$25,000	1.3	**$805,236**	**Included in WB**
EB I-64 Aux 2-Lane Ramp			Included		$111,748	$781,059	$57,090		$50,000	1.3	**$1,299,866**	**Included in WB**
EB I-64 Auxiliary to Blankenbaker		Included			$189,770	$349,150	$31,598	$850,000	$85,000	1.3	**$1,957,173**	**Included in WB**
EB I-64 2-Lane Entr. Ramp	Included	Included			$20,034	$299,156	$28,595			1.3	**$452,121**	**Included in WB**
Added Travel Lane Cost	**$3,250,571**	**$8,331,710**	**$8,090,697**	**$5,477,239**								Noise Wall cost not included in Total Construction
Total Earthwork Cost	$2,234,705	$2,640,037	$5,067,244	$4,622,491								
Total Pavement Cost	$7,055,066	$10,575,258	$11,102,707	$10,345,968								
Total Guardrail Cost	$562,741	$793,653	$516,732	$423,969								
Total Bridge Cost	$6,370,000	$9,490,000	$13,845,000	$13,455,000								
Total Culvert Cost	$399,100	$542,100	$377,000	$208,000								
Total Retaining Wall Cost	$0	$0	$243,398	$113,100								
Total Concrete Barrier Cost	$137,137	$122,213	$19,110	$18,200								
Total Construction Cost	**$16,758,750**	**$24,163,261**	**$31,171,191**	**$29,186,728**								
			$1,901,442.63	$1,780,390								
			$29,269,748	$27,406,337								

Note: Green text is 2 lane ramp configurations with 12' lanes, shoulder width will be determined by sight c

Note: Red text utilizes existing loop ramps.

[a] $24,255,238 with Bridges Expanded for future build out

[b] $26,693,218 with Bridges Expanded for future build out