Value Engineering Study No. 201905 – Report

KY 80 and KY 461 Interchange and KY 461 Widening

Pulaski County

December 16 through 19, 2019

Prepared by:
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KENTUCKY TRANSPORTATION CABINET

Disclaimer

The information contained in this report is the professional opinions of the team members as developed 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, alternatives 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. The resolution or disposition of alternatives is based on the information in this report and is independent of the proceeding of the VE study; HDR has no participation, direct or indirect, in such decisions.

Study Statistics	
Baseline Cost:	$44.2 M
Number of Recommendations:	8
Recommended Cost Savings:	$9.7 M
Recommended Value Added:	$2.8 M
Total Number of Team Members:	9
KYTC Employees:	4
Others:	5
Facilitator Consultant:	HDR

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Value Engineering Summary

Introduction

This report summarizes the events and results of the Value Engineering (VE) study conducted by HDR Engineering, Inc. for Kentucky Transportation Cabinet (KYTC) on the KY 80 and KY 461 Interchange and KY 461 Widening project in Pulaski County. The VE study consisted of a 4-day study that was conducted with a multidisipline team December 16 through 19, 2019 at the KYTC Headquarters building in Frankfort, KY.

Project Overview

The purpose of the project is to enhance regional mobility and provide a safer, free-flowing connection between I-75, Cumberland Parkway, Hal Rogers Parkway, and the future Somerset Northern Bypass in Pulaski County.

At the time of the VE study, the construction cost estimate was generic in nature and consisted of pavement, earthwork, structures, and contingencies; excluding design, right-of-way, utilities, and construction engineering. The total construction cost was $44.2 million. The required right-of-way for the project was in advanced stages of procurement.

Scope of the VE Study

The primary objectives of the team, through execution of the Value Methodology Job Plan (Appendix A), was to:

- Verify or improve on the various concepts for the identified section of the KY 80 and KY 461 Interchange and KY 461 Widening 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.

VE Recommendations

The VE team generated 33 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 and resulted in eight recommendations.

Table ES-1. Summary of Recommendations

#	Recommendation Title	Cost Savings/ (Cost Added) Millions	Performance Improvement (%)
1	Use Roundabouts at Industrial Park Bridge	$0.70	+3.1
2	Change Structure Design at System Interchange	$1.18	+4.0
3	Reduce Ramp H Radius	$1.76	+15.0
4	Create J-turns along KY 461	($2.50)	+0.2
5	Use 11-foot Lanes	$0.79	+9.7
6	Create Detention Ponds	($0.26)	+9.1
7	Reconfigure Ramp D	$5.27	+34.9
8	Mark Shopville Right-out Only at KY 461	$0.00	+2.2
	Total Savings	**$6.94**	

DC-9	Plan for a 2+1 typical section to Mount Vernon
DC-10	Utilize retaining walls to build ramp H/D to minimize stream impacts
DC-11	Reduce KY 461 by 2 feet (make median 12 feet)
DC-12	Use 2+1 lanes (directional peak) traffic control
DC-13	Use a Diamond Interchange in lieu of the system interchange with roundabouts at termini
DC-14	Create a raised or barrier median on KY 461
DC-15	Add an eastbound Barnesburg to northbound 461 acceleration lane
DC-16	Add sidewalk on north side of Coin Road and on bridge over KY 461
DC-17	Use barrier wall instead of guardrail to separate Ramps D/H and B/F
DC-18	Remove south access to Tommy Road
DC-19	Connect Parcel 38 access to Jug-handle
DC-20	Grade separate existing Ramp B alignment with Ramp F
DC-21	Reduce Coin Road bridge by 2 feet (make it 12'-12'-12')
DC-22	Improve pavement design on shoulders to use during construction

The individual recommendations are summarized below; the detailed information about each recommendation is included in Section 7.3.

1—Use Roundabouts at Industrial Park Bridge – This would reduce the width of Coin Road bridge, thus reducing costs and maintenance; it would also meet the BUILD Grant requirement.

2—Change Structure Design at System Interchange – Revising the bridge to a 5-span configuration may permit a decrease in profile as well as provide a more coventional beam type.

3—Reduce Ramp H Radius – This reduced radius would remove much of the proposed ramp embankment from the stream.

4—Create J-turns along KY 461 – Using J-turns/R-cut type crossings along KY 461 would eliminate full access points throughout the project.

5—Use 11-foot Lanes – Reducing the lane width on KY 461 would result in less pavement cost, less maintenance, and less impervious surfaces.

6—Create Detention Ponds – This recommendation suggests creating stormwater detention facilities within the interchange ramps to manage stormwater runoff.

7—Reconfigure Ramp D – Build Ramp D as a left hand movement that ties into the Ramp C as a part of initial design; plan for building a flyover when the bypass project advances.

8—Mark Shopville Right-out Only at KY 461 – Restricting movements from Mark Shopville Road would reduce conflicts and create free-flowing traffic.

In addition to the eight recommendations for the project, a total of 14 design considerations moved forward for the design team to further investigate and develop. Some of these design considerations were looked into further by the VE team and additional information can be found in Section 7.5 Design Considerations.

Implementation of Recommendations

To facilitate implementation, a Value Engineering Recommendation Approval Form 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®
VE Facilitator

1 Introduction

This VE report summarizes the events of the VE study conducted for Kentucky Transportation Cabinet and facilitated by HDR. The subject of the study was KY 80 and KY 461 Interchange and KY 461 Widening. The VE study was conducted December 16 through 19, 2019 while the project was in the 60 percent to 80 percent design phase.

1.1 Scope of the VE Study

Value is expressed as the relationship between functions and resources where function is measured by the performance requirements of the customer and resources are measured in materials, labor, price, and time required to accomplish that function. VE focuses on improving value by identifying the most resource-efficient way to reliably accomplish a function that meets the performance expectations of the customer.

The primary objectives of the team, through execution of the Value Methodology Job Plan (Appendix A), was to:

- Verify or improve on the various concepts for the identified section of the KY 80 and KY 461 Interchange and KY 461 Widening 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.

With this process, the VE team identified the essential project functions and alternative ways to achieve those functions; the team then selected the optimal recommendations to develop into workable solutions for value improvements.

1.2 VE Team Members

The VE study was facilitated by a Certified Value Specialist (CVS) from HDR. Multiple representatives and members of the KYTC project team also participated in the VE process to provide insight into the project's background and design development as well as their requirements for the project and expectations for the VE study. Their support of this study is greatly appreciated and the results provided herein are a reflection of the information they provided throughout the study.

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

- Erica Albrecht, HDR
- Joe Cochran, HDR
- Justin Harrod, KYTC
- Adam Hedges, HDR
- Scott Pennington, HDR
- Connor Schurman, KYTC
- Brent Sweger, KYTC
- Jose Theiler, HDR, CVS
- Cory Willmerdinger, KYTC

2 Information Phase

The VE team was provided with documentation and drawings as shown in Table 1 as well as an introduction to the project and its characteristics by the design team on the first day of the study. Project details and challenges as presented by the design team are summarized below.

2.1 Information Provided to the VE Team

Table 1 lists the project documents that were provided to the VE team for their use during the study.

Table 1. Information Provided to the VE Team

Document/Drawing/Schematic	Date
Drawings/Schematics	
Pulaski County KY 80/KY 461 Interchange	October 2019
Pulaski County KY 80/KY 461 Interchange	December 2019
MOT Plans	December 13, 2019
MOT Notes	December 13, 2019
Right-of-way Plans	January 29, 2019
Value Engineering Plan Set	December 13, 2019
Value Engineering Cross Sections	December 13, 2019
KMZ files	Not dated
Documents	
Pulaski BUILD Grant Agreement	Not dated
Design Executive Summary	November 2, 2016
Preferred Alignment Cost Estimate	Not dated
Categorical Exclusion, Level 3	May 17, 2019
KYTC Pavement Design	August 1, 2019
VE Study of Somerset Northern Bypass	March 15-19, 2010

2.2 Project History and Purpose and Need

The purpose of this project is to enhance regional mobility and provide a safer, free-flowing connection between I-75, Cumberland Parkway, Hal Rogers Parkway, and the future Somerset Northern Bypass in Pulaski County.

KY 80 provides the primary east-west arterial connection from Somerset in Pulaski County to London in Laurel County, linking the Cumberland Parkway in the west to I-75 and the Hal Rogers parkway in the east. The route carries between 8,000 and 19,000 vehicles per day, including as many as 2,300 trucks daily. KY 461 provides a vital north-south arterial connection linking KY 80 near Shopville in Pulaski County to I-75 near Mount Vernon in Rockcastle County. KY 461 carries approximately 11,000 vehicles per day including 2,000 trucks. The Valley Oak Industrial Complex is located along KY 461 and generates approximately 3,000 jobs for the region.

The existing KY 80/KY 461 at grade intersection near KY 80 (mile point 27.619) has experienced 74 accidents (2 fatalities, 39 injuries) from 2013 through 2018. The intersection currently has a critical rate factor (CRF) of 1.43, indicating a higher than expected crash rate than other similar intersections. The existing KY 461/Valley Oak Complex at grade intersection has experienced 16 accidents (15 injury) from 2013 through 2018. This intersection was expanded in 2012 to add left and right turn lanes; however, it continues to present safety concerns due to the sizable number of large trucks attempting left turns across opposing KY 461 traffic and high volumes generated by shift-change traffic.

These traffic concerns and their corresponding safety issues demonstrate the extreme pressure this regional roadway system is under due to the heavy traffic demand generated by intense local economic growth combined with high volumes of through traffic.

2.3 Proposed Improvements

The proposed “partial cloverleaf” KY 80/KY 461 interchange developed for Alternate 2 begins near existing KY 80 mile point 26.8. Eastbound and westbound KY 80 traffic remains along the existing roadway through the initial construction of this alternate. The proposed northbound KY 461 traffic will exit from KY 80 near mile point 26.8 then cross KY 80 (ultimate Somerset Northern Bypass) via an initial 2-lane overpass near existing KY 80 mile point 27.6. The proposed ultimate interchange is centered about KY 80 at this location.

Three of the ultimate seven ramps will be constructed during the initial project to accommodate turn movements. One northbound KY 461 lane will be provided across the proposed overpass, then widened to two through lanes further north when combined with initial Ramp “A.” Initial Ramp “A” accommodates westbound KY 80 to northbound KY 461 traffic. Southbound KY 461 to westbound KY 80 traffic will follow initial Ramp “D.” Southbound KY 461 to eastbound KY 80 traffic will use Ramp “G.”

During ultimate construction, the interchange will be modified to accommodate the Somerset Northern Bypass and a second overpass bridge will be constructed to complete four lanes of KY 461 as a through movement. The existing KY 80 roadbed will be abandoned within the footprint of the ultimate interchange.

Alternate 2 was not developed as a complete “cloverleaf” interchange to avoid impacts to Todd Truss. An ultimate loop ramp would be required in this quadrant to provide unrestricted left turns for the northbound KY 461 to westbound Somerset Northern Bypass traffic. Alternate 2 provides left turns from KY 461 onto ultimate Ramp “E” to accommodate this movement.

An additional option was presented that eliminated the ultimate southeast quadrant loop Ramp “F.” This option reduced construction costs by eliminating the earthwork required to construct the proposed loop ramp but would require an additional left turn to accommodate eastbound Somerset Northern Bypass to northbound KY 461 traffic. The project team eliminated this option due to the added at-grade left turn movement. Immediately north of the overpass, the KY 461 main line template would include four 12-foot through lanes, including 10-foot (8-foot paved) outside shoulders and 6-foot (4-foot paved) inside shoulders. This segment would include a 60-foot-wide depressed median, which would continue to the north terminus of the proposed interchange. Moving north of the interchange, the KY 461 template begins to narrow near mile point 0.15 to include four 12-foot through lanes, 14-foot flush median, and 10-foot (8-foot paved) shoulders for the remainder of the project. The proposed widening is centered along the existing alignment, shifting horizontally where necessary to minimize impacts. The vertical grade mirrors the existing roadway profile. Left turns would be indicated by pavement striping at existing access points. Right turn lanes would be constructed at major approaches. The widened segment of KY 461 tapers down to the existing roadway approximately 1,000 feet south of the existing Buck Creek Bridge at the northern terminus of this project.

Alternate 2A includes construction of a new “tight diamond” interchange providing grade separation for KY 461 and Coin Road/Valley Oak Industrial Complex near KY 461 mile point 1.25. Coin Road would be widened to provide two 12-foot through lanes, 14-foot flush median, and 4-foot (2-foot paved) shoulders. Access to and from the Valley Oak Industrial complex would be accomplished through Ramps “A-D.” Portions of Coin Road and Valley Oak Drive must be reconstructed to accommodate the proposed overpass.

Alternate 2B includes construction of a new “jug handle” interchange providing grade separation for KY 461 and Coin Road/Valley Oak Industrial Complex near KY 461 mile point 1.3. Access to and from the Valley Oak Industrial Complex would be maintained along proposed 2-way ramps located south of the proposed overpass. This option would eliminate left turns from KY 461 to Coin Road by providing right in/right out access to the proposed 2-way ramps. Alternate 1B would also widen Coin Road to provide two 12-foot through lanes, 14-foot flush median, and 4-foot (2-foot paved) shoulders. A portion of Coin Road/Valley Oak Drive must be reconstructed to accommodate the proposed overpass.

2.4 Constraints and Controlling Decisions

As part of the project briefing, the VE team was given the following project constraints and controlling factors that needed to be taken into account when considering possible alternatives:

- Must have four lanes
- Must have a grade-separated interchange at Coin Road
- Avoid Bobbitt Cemetery
- Avoid additional impacts to Toyotetsu America, Inc.

2.5 Project Schedule

The project was in design; 60 to 80 percent complete with final design expected to be completed later in 2020 (letting date of June 2020). It is currently anticipated that the project will be constructed using the design bid build (DBB) delivery method.

2.6 Project Cost Estimate

At the time of the VE study, the construction cost estimate was generic in nature and consisted of pavement, earthwork, structures, and contingencies; excluding design, right-of-way, utilities, and construction engineering. The total construction cost was $44.2 million. The required right-of-way for the project was in advanced stages of procurement. An abbreviated estimate is shown in Table 2. See Appendix D for the estimate provided by the design team.

Table 2. Cost Estimate – Baseline Concept

Cost Item	Cost	Percent of Total	Cumulative Percentage
Asphalt Pavement	$15,155,000	27.4	27
Structures	$11,683,500	21.1	49
Contingency	$10,553,550	19.1	68
Earthwork	$8,340,000	15.1	83
Mobilization	$5,030,526	9.1	92
Maintenance of Traffic	$4,573,205	8.3	100

3 Project Analysis

3.1 VE Focus Points and Observations

Prior to the VE study and during the information phase, a number of activities were conducted to better understand the baseline concept. The following summarizes key focus points and observations identified during these sessions and during the VE team's initial analysis.

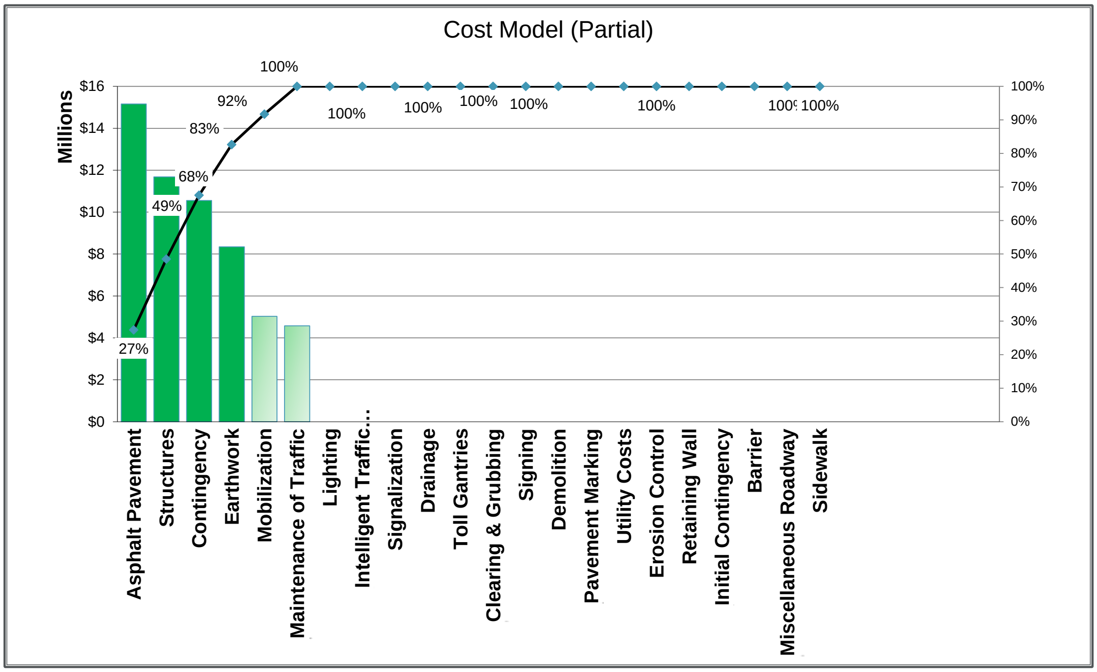
- Truck traffic: 17 to 19 percent
- There is a school zone at Coin Road, speed limit 45 mph, includes flashing lights
- Design speed is 55 mph
- Utilities: water and sewer in contract, other by owners
- Threatened fish species in Flat Lick Creek
- Design interchange to interstate standard to accommodate future I-66 (connector) west of the interchange to connect with KY 80 to the east.
- Loop ramp design speed is 40 mph
- Soil in the area contains large amounts of lime rock
- ITS network to be installed and VMS signs to control traffic through Mount Vernon
- One closure during construction is expected at Mark Shopville Road.

3.2 Cost Model

The VE facilitator 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 (Figure 1).

The cost model allows the team to focus on project elements with the highest degree of impact and utilize their time most effectively.

Figure 1. Cost Model



3.2.1 Performance Attributes

Performance attributes are an integral part of the value analysis process. The performance of each project must be properly defined and agreed on by the project team, VE team, and stakeholders at the beginning of the study. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

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 VE team, along with the project team, identified and defined the performance attributes for this project and then defined the baseline concept as it pertains to these attributes. The performance attributes shown in Table 3 were used throughout the study to identify, evaluate, and document ideas and recommendations. The baseline evaluation criteria can be found in Appendix E, and the performance measures for each recommendation can be found in Section 7.3, Individual Recommendations.

Table 3. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline Concept
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.	• Design speed: 55 mph (Bypass 70 mph - not constructed) • Four 12' Lanes, one 12' auxiliary lane, 6' inside shoulders, 10' outside shoulders (8' paved) • 48' grassy median - flush median (14') • Three 12' lane bridges, 4' inside shoulder, 6' outside • Flushed median section (4 x 12' lanes and 14' flush median)
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.	• 15' ramps, 8' outside shoulder, 4' protected inside shoulder • Local/County roads - match existing varying 11/12' • No pedestrian or bicyclist accommodations
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.	• Interchange are plate girder bridges • Industrial Park concrete bridge • Mark Shopville approach is concrete • Asphalt 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.	• No large detours, local only • One County road closure • Traffic open during construction

Table 3. Performance Attributes and Description

Performance Attribute	Description of Attribute	Baseline Concept
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.	• Stream impacts (Flat Lick Creek and Big Spring Branch) rechanneling. • Watch list endanger species (buck darter fish)
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.	• Letting 6/2020 – as late as 9/30/2020 (federal fiscal year change, needs to be authorized). • 30 month construction

3.2.2 Performance Attribute Matrix

The performance attribute matrix was used to determine the relative importance of the performance attributes for the project. The project and VE team 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: “Which one is more important to the purpose and need of the project?” 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 (Table 4). These scores were then used to calculate the value of each recommendation during the VE team’s performance evaluation scoring (Section 6).

Table 4. Performance Attribute Matrix

Paired Comparison							Total Points	% of Total
Main Line Operations	A	A	A	A	A	A	6.0	28.8
Local Operations		B	B	B	E	F	3.0	14.2
Maintainability			C	C	E	F	2.0	9.5
Construction Impacts				D	E	D	2.0	9.5
Environmental Impacts					E	F/E	4.5	21.4
Project Schedule						F	3.5	16.6
Total							**21.0**	**100.0**

4 Function Analysis Phase

4.1 Overview

Function analysis results in a unique view of the project. It transforms project elements into functions, which helps guide the VE team in considering the functional concepts of the project, independent of the current design. Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level (Table 5). Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

Table 5. Random Function Identification

Project Element	Functions
Project (Overall purpose and need)	Improve (Regional) Mobility
	Improve Operations
	Enhance Safety
	Reduce Conflicts
	Add Lanes
	Remove/Combine Movements
	Control Access
Earthwork	Create Grade
	Raise Profile
Pavement	Support Load
	Improve Ride
	Protect Base
	Increase Friction
	Protect Base
Structures	Span Road
	Separate Traffic
	Elevate Roadway
	Transfer Load
	Support Load
Culverts	Convey Water
Barrier (Median)	Separate Traffic
Lighting	Illuminate Facilities
Intelligent Traffic System (ITS)	Control Traffic
	Inform Users
	Manage Congestion

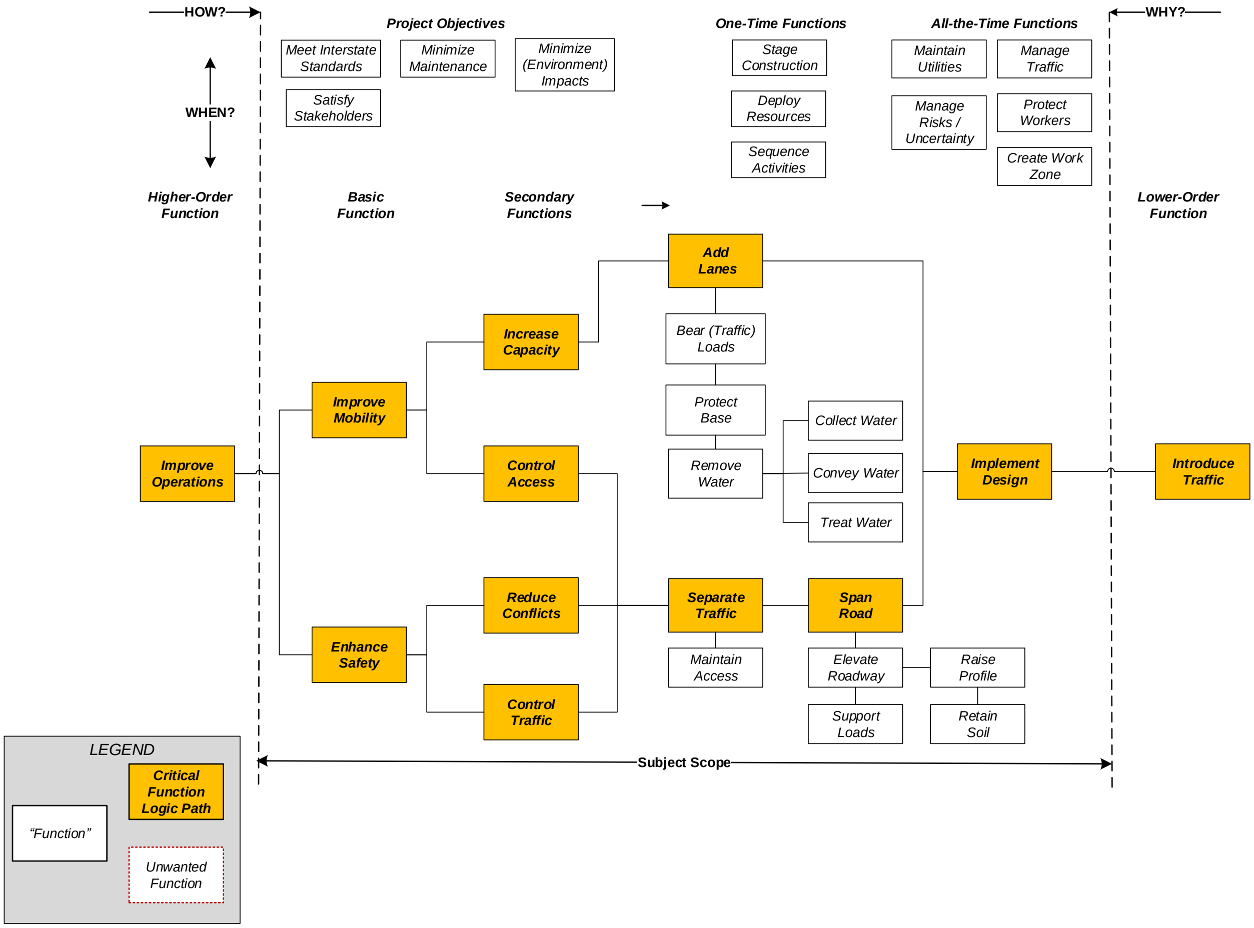
Table 5. Random Function Identification

Project Element	Functions
Drainage	Remove Stormwater
	Convey Stormwater
	Collect Stormwater
	Treat Stormwater
	Detain Stormwater
Clearing & Grubbing	Prepare Site
Signing	Inform Drivers
	Control Traffic
Pavement Marking	Delineate Roadway
	Control Traffic
Erosion Control	Prevent Erosion
Retaining Wall	Support Load
	Retain Soil
	Create Grade
	Create Space
Sidewalk	Accommodate Pedestrians
Bike Lanes	Accommodate Bicyclists
Mobilization	Deploy Resources
Maintenance of Traffic	Control Traffic
	Manage Traffic
Contingency	Manage Risks
Right of Way	Create Space

4.2 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 (Figure 2) provided the VE team with an understanding of which functions offer the best opportunity for cost or performance improvement.

Figure 2. FAST Diagram



5 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 6. The final disposition of each idea is included at the end of Section 6, Evaluation.

Table 6. Creative Idea List

Idea No.	Description
Function: Add Lanes	
1	Plan for a 2+1 to Mount Vernon
Function: Convey Water	
2	Extend triple RCBC in lieu of constructing bridge on Mark Shopville
Function: Create Grade	
3	Utilize retaining walls to build Ramp H/D to minimize stream impacts
Function: Create Space	
4	Use 11-foot lanes
5	Reduce 461 by 2-feet (make median 12 feet)
6	Reduce Ramp F radius to shift Ramp B and avoid impacts to building
Function: Detain Stormwater	
7	Create detention within project limits to manage hydraulic capacity
Function: Enhance (Regional) Mobility	
8	2+1 Lanes (Directional peak) traffic control
9	Use a Diamond Interchange in lieu of the system interchange with roundabouts at termini
10	Utilize median as a reversible lane
11	Change Ramp H to a directional flyover on a temporary basis to an at-grade basis behind Ramp G
12	Use roundabouts at Valley Oak Drive and Coin Road on both sides of bridge
13	Add diverging interchange over bridge at industrial park
Function: Enhance Safety	
14	Right-out for Mark Shopville at 461
15	Eliminate bridge at Industrial Development and use J-Turns
16	Raised or Barrier median on KY 461
17	Add an eastbound Barnesburg to northbound 461 acceleration lane
18	Add sidewalk on north side of Coin Road and on bridge over 461
19	Use barrier wall instead of guardrail to separate Ramps D/H and B/F

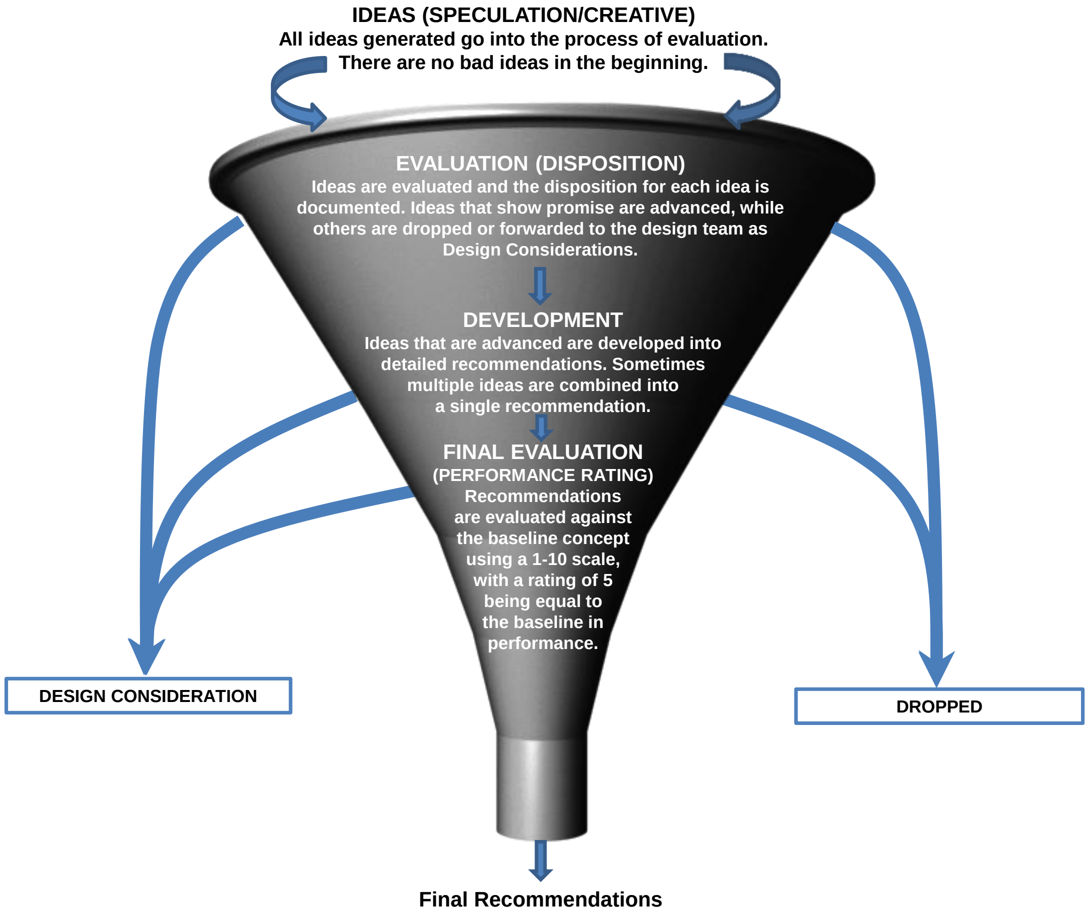
Table 6. Creative Idea List

Idea No.	Description
Function: Minimize Environmental Impacts	
20	Reduce radius of Ramp H to reduce stream impacts (Consider using walls in lieu of embankment)
21	Braid Ramp D & H to avoid stream impacts
Function: Reduce Conflicts	
22	Use J-turns/R-cut type crossings
23	Remove bridge and use a displaced left
24	Remove south access to Tommy Road
25	Connect Parcel 38 access to Jug-handle
26	Move Barnesburg intersection north 1500 feet to Parcel 34/36 access
Function: Separate Traffic	
27	Grade separate existing Ramp B alignment with Ramp F
Function: Sequence Work	
28	Build both jug-handles first making it a live intersection then build bridge
Function: Span Road	
29	Use shorter spans for interchange bridges
30	Reduce Coin Road bridge width from 3 lanes to 2 lanes
31	Use concrete beams instead of steel plate girders for bridges at system interchange
32	Reduce Coin Road bridge by 2-feet (make it 12'-12'-12')
Function: Support Load	
33	Improve pavement design on shoulders

6 Evaluation Phase

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 3 depicts the typical information flow for this part of the Value Methodology Job Plan.

Figure 3. VE Process Information Flow



6.1 Evaluation Process

The evaluation process begins by going through the ideas brainstormed during the 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 3.2.1) 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 1 through 3, as defined below).

3 = Advance for further development

2 = Design consideration; include as a comment or consideration for design team

1 = Dropped from further development

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

6.2 Evaluation Summary

All of the ideas that were generated during the creative phase using brainstorming techniques are detailed in Table 7.

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Add Lanes					
1	Plan for a 2+1 to Mount Vernon	• May avoid future costs • Sets up future widening to north	• Outside project limits	*2*	Combine Ideas 1 and 8 for design team to pursue
Function: Convey Water					
2	Extend triple RCBC in lieu of constructing bridge on Mark Shopville	• Eliminate a separate structure • Reduced construction cost • Reduced maintenance • Less community impacts • County does not inherit a bridge to maintain	• May not meet hydraulic needs	*3*	Brought forward and evaluated further, the baseline design was validated and is shown in Design Validation No. 1
Function: Create Grade					
3	Utilize retaining walls to build Ramp H/D to minimize stream impacts	• Minimize creek impacts and in lieu fees	• May increase cost • May increase maintenance	*3*	The baseline design was validated and is shown in Design Validation No. 3
Function: Create Space					
4	Use 11-foot lanes	• Lower pavement cost • Less impervious • Less maintenance	• Inconsistency in lane widths versus adjacent road segments • Increased friction between vehicles	*3*	Brought forward as Recommendation No. 5
Function: Create Space					
5	Reduce 461 by 2-feet (make median 12 feet)	• Reduced cost • Reduced impervious • Reduced maintenance	• Reduced space for turning vehicles	*2*	Design consideration for the design team to pursue

Ranking Scale: 3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Create Space					
6	Reduce Ramp F radius to shift Ramp B and avoid impacts to building	• Smaller footprint • Less earthwork • Reduces construction costs	• Right-of-way already in process	*1*	Right-of-way already in process
Function: Detain Stormwater					
7	Create detention within project limits to manage hydraulic capacity	• Prevent flooding • Eliminate hydra modification of stream • Improves water quality of stream	• Slightly more earthwork	*3*	Brought forward as Recommendation No. 6
Function: Enhance (Regional) Mobility					
8	2+1 Lanes (Directional peak) traffic control	• May meet traffic demand • Context-sensitive approach • Reduced construction cost and reduce maintenance • Reduced environmental impacts	• May not meet intent of BUILD Grant and lose funding • May require modification of document • May require sponsorship for modification	*2*	Combine Ideas 1 and 8 for design team to pursue
Function: Enhance (Regional) Mobility					
9	Use a Diamond Interchange in lieu of the system interchange with roundabouts at termini	• Smaller footprint • Introduces traffic calming • Reduced construction costs • Reduced impervious • Reduced stream impacts	• Not a 55 mph design • Slower system interchange • Differs from what was presented to public • Significant change to current design • May require public meeting/environmental reevaluation • May delay project	*2*	Design consideration for the design team to pursue

Ranking Scale:
3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Enhance (Regional) Mobility					
10	Utilize median as a reversible lane	• Increases capacity	• Introduces signal and sign costs	1	Introduces signal and sign costs
Function: Enhance (Regional) Mobility					
11	Change Ramp H to a directional flyover on a temporary basis to an at-grade basis behind Ramp G	• Less pavement • Eliminates a weave movement • Eliminates stream impacts • Reduced bridge width • Significantly reduced cost for current project	• Major redesign • Additional structures in future	3	Brought forward as Recommendation No. 7
Function: Enhance (Regional) Mobility					
12	Use roundabouts at Valley Oak Drive and Coin Road on both sides of bridge	• Narrow down bridge • Improves operation • Eliminates high speed conflicts	• Challenging geometry • Public acceptance	3	Combined ideas 12 and 30; brought forward as Recommendation No. 1
Function: Enhance (Regional) Mobility					
13	Add diverging interchange over bridge at industrial park	• None discussed	• Adds two signals with very low traffic counts	1	Adds two signals with very low traffic counts
Function: Enhance Safety					
14	Right-out for Mark Shopville at 461	• Reduced conflicts	• Inconvenient for drivers • Does not meet driver expectancy • Differs from what was presented to public	3	Brought forward as Recommendation No. 8

Ranking Scale:
3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Enhance Safety					
15	Eliminate bridge at Industrial Development and use J-Turns	• Eliminate a structure • Reduced cost • Reduced construction time	• Violates BUILD Grant	*1*	Violates BUILD Grant
Function: Enhance Safety					
16	Raised or Barrier median on KY 461	• Access management • Prevents cross overs	• Additional cost • Introducing a hazard	*3*	The baseline design was Validated shown as Design Validation no 2
Function: Enhance Safety					
17	Add an eastbound Barnesburg to northbound 461 acceleration lane	• 2 stage gap acceptance	• Requires more pavement • May require more right-of-way • Traffic volume may not warrant	*2*	Design consideration for the design team to pursue
Function: Enhance Safety					
18	Add sidewalk on north side of Coin Road and on bridge over 461	• Accommodate pedestrians • Removes conflicts between vehicles and pedestrians	• Increased cost • Increased bridge width	*2*	Design consideration for the design team to pursue
Function: Enhance Safety					
19	Use barrier wall instead of guardrail to separate Ramps D/H and B/F	• Creates visual separation between opposing movements • Wall does not deform (as opposed to GR) • Reduces headlight glare from opposite direction • Less maintenance	• More costly	*2*	Design consideration for the design team to pursue

Ranking Scale: 3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Minimize Env Impacts					
20	Reduce radius of Ramp H to reduce stream impacts (Consider using walls in lieu of embankment)	• Reduces impact to stream • Reduced pavement on Ramp D and H • Reduced in-lieu fees	• Reduced design speed • May require a design exception	*3*	Brought forward as Recommendation No. 3
Function: Minimize Env Impacts					
21	Braid Ramp D & H to avoid stream impacts	• Reduce impacts to stream • Reduce Ramp D pavement • Reduce impervious • Reduce headlight glare • Improved driver expectancy	• Added structures • Rolling grades for Ramp D	*1*	Added structures
Function: Reduce Conflicts					
22	Use J-turns/R-cut type crossings	• Reduces type/severity of conflicts • Easier driver decision making • Improves operations • Establishes consistent driver expectations • Reduces number of conflict points	• Out of direction travel • May require more right-of-way • More difficult movement for trucks • Requires acceleration lane • New concept for drivers • Potential weave conflicts with entrance traffic • Increased travel speeds	*3*	Brought forward as Recommendation No. 4
Function: Reduce Conflicts					
23	Remove bridge and use a displaced left	• Eliminate a structure • Reduced cost • Reduced construction time	• Violates BUILD Grant	*1*	Violates BUILD Grant

Ranking Scale:
3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Reduce Conflicts					
24	Remove south access to Tommy Road	• Removes one conflict • May improve operations	• Possible owner opposition	*2*	Design consideration for the design team to pursue
Function: Reduce Conflicts					
25	Connect Parcel 38 access to Jug-handle	• Less pavement • Remove one access point on 461 • Reduce pipe extension • Less overall right-of-way required	• May require right-of-way to connect to "ramp" • Access off of "ramp"	*2*	Design consideration for the design team to pursue
Function: Reduce Conflicts					
26	Move Barnesburg intersection north 1500 feet to Parcel 34/36 access	• Reduce conflict • Consolidate access point • Additional cost and impervious	• Requires additional right-of-way • May delay project letting	*1*	Requires additional right-of-way
Function: Separate Traffic					
27	Grade separate existing Ramp B alignment with Ramp F	• Reduce project footprint • Better geometry • Less pavement • Eliminates opposing traffic/headlights	• Additional structure costs • Additional embankment	*2*	Design consideration for the design team to pursue
Function: Sequence Work					
28	Build both jug-handles first making it a live intersection then build bridge	• Bridge construction in one phase	• Does not have capacity to carry all traffic across 461	*1*	Does not have capacity to carry all traffic across 461

Ranking Scale: 3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

= Advanced as recommendation
= Forwarded as design consideration
= Dropped from further development

Table 7. Idea Evaluation Summary Table

Idea #	Description	Advantages	Disadvantages	Rating	Comments
Function: Span Road					
29	Use shorter spans for interchange bridges	• Lower construction costs • More conventional beam type	• More substructure	*3*	Combined ideas 29 and 31; brought forward as Recommendation No. 2
Function: Span Road					
30	Reduce Coin Road bridge width from 3 lanes to 2 lanes	• Reduced cost • Less maintenance • Meets BUILD Grant requirement	• May not provide adequate storage	*3*	Combined ideas 12 and 30; brought forward as Recommendation No. 1
Function: Span Road					
31	Use concrete beams instead of steel plate girders for bridges at system interchange	• Lower maintenance • Lower cost	• Could require thicker profile • Span lengths may be too long	*3*	Combined ideas 29 and 31; brought forward as Recommendation No. 2
Function: Span Road					
32	Reduce Coin Road bridge by 2-feet (make it 12'-12'-12')	• Reduced cost • Reduced impervious	• Increases friction with opposing traffic	*2*	Design consideration for the design team to pursue
Function: Support Load					
33	Improve pavement design on shoulders	• Extends life of shoulder • Reduces maintenance	• Increased cost	*2*	Design consideration for the design team to pursue

Ranking Scale: 3 = Advance for further development
2 = Design consideration; include as a comment or consideration for design team
1 = Dropped from further development

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

7 Development Phase

This phase of the Value Methodology Job Plan takes the ideas that ranked the highest in the 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 33 ideas that were generated during the creative phase, 11 of those ideas were evaluated high enough to be taken forward, combined, and developed further. Some of the ideas were deemed more appropriate as a design consideration for the project team, rather than developed into a VE recommendation (Section 7.5). For the development phase, narratives, drawings, calculations, and cost estimates were prepared for each recommendation.

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, discussion of schedule and risk impacts (if applicable), 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.

7.1 Summary of Recommendations

The recommendations developed by the VE team are shown in Table 8. The table summarizes each recommendation's cost impact and performance improvement.

Table 8. Summary of Recommendations

#	Recommendation Title	Cost Savings/ (Cost Added) Millions	Performance Improvement (%)
1	Use Roundabouts at Industrial Park Bridge	$0.70	+3.1
2	Change Structure Design at System Interchange	$1.18	+4.0
3	Reduce Ramp H Radius	$1.76	+15.0
4	Create J-turns along KY 461	($2.50)	+0.2
5	Use 11-foot Lanes	$0.79	+9.7
6	Create Detention Ponds	($0.26)	+9.1
7	Reconfigure Ramp D	$5.27	+34.9
8	Mark Shopville Right-out Only at KY 461	$0.00	+2.2

Table 8. Summary of Recommendations

#	Recommendation Title	Cost Savings/ (Cost Added) Millions	Performance Improvement (%)
	Total Savings	$6.94	

7.1.1 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.

7.2 Value Engineering Recommendation Approval

The resolution or disposition of recommendations is based on the information in this report and is independent of the proceeding of the VE study. HDR has no participation, direct or indirect, in such decisions. The VE Recommendation Approval form shown in Appendix C is intended to aid the project manager in tracking and informing the state Value Engineer in annual reporting of VE activities to FHWA. Resolution and disposition of recommendations contained in Appendix C are pending.

7.3 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.

Calculations include a 30 percent markup to follow the basis of estimates provided; a 30 percent contingency was used to include mobilization, MOT, and other missing elements such as lighting, ITS, pavement markings, drainage, and others.

VE RECOMMENDATION NO. 1: USE ROUNDABOUTS AT INDUSTRIAL PARK BRIDGE	Idea Nos. 30, 12

Baseline Concept

The baseline concept is to use a jug handle configuration with 2-way stop controlled intersections along Valley Oak Drive/Coin Road. This configuration also utilizes a three lane cross section along the Coin Road bridge to allow for the left-turn storage for both jug handle intersections.

Recommendation Concept

Reduce Coin Road bridge width from three lanes to two lanes and use roundabouts at Valley Oak Drive/Coin Road on both sides of the bridge

Advantages

- Reduced cost
- Less maintenance
- Meets BUILD Grant requirement
- Narrow down bridge
- Improves operation
- Eliminates high speed conflicts

Disadvantages

- May not provide adequate storage
- Challenging geometry
- Public acceptance

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$2,106,000		$2,106,000
Recommendation Concept	$1,404,000		$1,404,000
Cost Avoidance/(Added Value)	$702,000		$702,000

FHWA Function Benefit

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

VE RECOMMENDATION NO. 1: USE ROUNDABOUTS AT INDUSTRIAL PARK BRIDGE

Idea Nos. 30, 12

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Constructing roundabouts at the jug handle intersections along Coin Road and Valley Oak Drive would allow the proposed Coin Road bridge to be reduced to two lanes as opposed to the current proposed condition of a three lane cross section. Roundabouts at either junction point would remove the need for the alternating left-turn storage across the bridge to serve the two intersections. This could reduce the width of the proposed bridge by 14 feet.

Traffic Operations

Based on the provided traffic forecasts for the 2040 AM/PM peak ultimate configuration conditions, a one lane roundabout at each intersection works with acceptable level of service (LOS), delay, and minimal approach queuing. (This includes taking into consideration a conservative truck percentage based on that discussed within the Design Executive Summary (DES) – using 15 percent for all intersection movements and providing an inflation of the peak hour traffic volumes by 20 percent). The table below shows the operational performance based on using the HCS 7 roundabout module. This analysis also indicates that the roundabouts should be able to accommodate a significant increase in volumes beyond the analysis volumes before modifications would be required.

		AM			PM		
		LOS	Delay	Queue*	LOS	Delay	Queue*
West Roundabout	**Intersection**	**A**	**8.5**	**-**	**A**	**7.4**	**-**
	EB	A	6.8	0.4	A	7.7	0.8
	WB	A	9.7	3.3	A	8.2	2.5
	NB	A	4.2	0.4	A	4.1	0.3
	SB	A	7.4	0.4	A	6.7	0.5
East Roundabout	**Intersection**	**A**	**10**	**-**	**A**	**9.7**	**-**
	EB	A	4.5	0.4	A	4.9	0.4
	WB	B	11.3	3.7	B	11.8	4.3
	NB	B	10.3	3.4	A	8.2	2.5
	SB	A	7.7	0.4	A	8	0.4

*Queue is reported as 95th percentile in vehicles.

Layout/Sizing

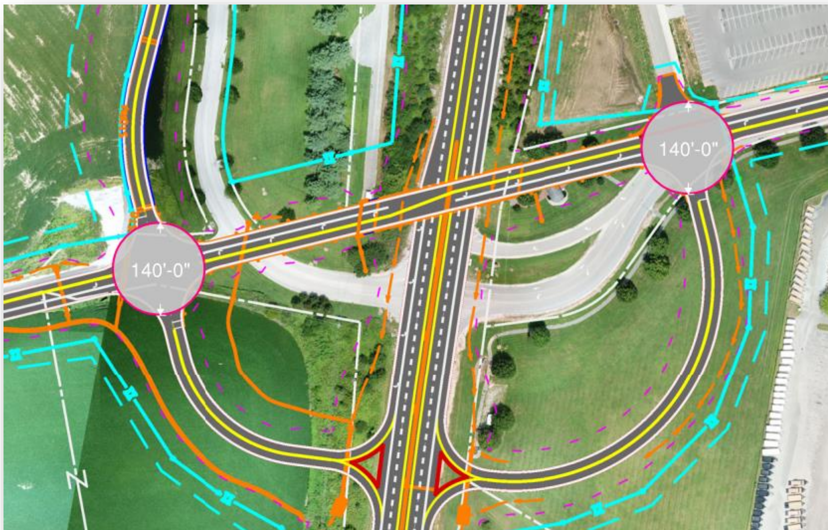
The traffic along Coin Road/Valley Oak Drive is primarily commuter and industrial/heavy vehicle traffic. For the roundabouts to function they must be able to accommodate all movements with a heavy vehicle (the controlling factor). The inscribed roundabout diameter defines the roadway width roundabout diameter. According to the KYTC Roundabout Policy, for a westbound 65, the inscribed diameter must be at least 135 feet (Table 3 – copied below).

Table 3: Single Lane Roundabout Inscribed Circle Diameter

Movement	Minimum Inscribed Diameter (ft)		
	Bus / Single Unit Truck	WB-50	WB-65
Through	75	85	90
Left Turn	90	95	120
U-Turn	90	100	135

VE RECOMMENDATION NO. 1: USE ROUNDABOUTS AT INDUSTRIAL PARK BRIDGE	Idea Nos. 30, 12

This width can be accommodated at both intersections. The sketch below shows two sample 140-foot diameters, which can fit within the project right-of-way.



Assumptions/Calculations

It was noted in the DES that one of the sub-alternatives considered included roundabouts at these intersections in the jug handle configuration, so the project team likely has already completed some level of analysis for this alternative. The goal of this recommendation was to examine the roundabouts as a method to primarily reduce the number of lanes across the bridge and introduce a savings into the project, as opposed to providing an alternative method for intersection control; therefore, they were re-analyzed.

Bridge Cost Savings

The reduction of the number of lanes across the bridge from three (two 12-foot travel lanes, one 14-foot turn lane) to two (two 12-foot travel lanes) allows for a reduction in bridge width of 14 feet. The current proposed bridge has 2-foot outside shoulders on both sides, which would also be assumed to remain with the lane reduction option. The current total usable bridge width is 42 feet to accommodate the lanes and shoulders; with the reduction of the lanes this could be decreased to 28 feet, a decrease of 33 percent (1/3 of the total width).

Based on the bridge cost provided by the design team of $1,620,000 and assuming that the reduced width bridge would be the same length, the cost savings from the bridge reduction should be approximately $540,000 (1/3 of the total bridge cost). New total bridge cost of $1,080,000.

VE RECOMMENDATION NO. 1: USE ROUNDABOUTS AT INDUSTRIAL PARK BRIDGE

Idea Nos. 30, 12

VE Study Life-Cycle Costs Calculations

KY 461 & KY 80 and KY 461 Widening

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
Coin Rd Bridge	SF	9,000	$ 180.00	$ 1,620,000.00	6,000	$ 180.00	$ 1,080,000.00
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
				$ -		$ -	$ -
Subtotal Construction				*$ 1,620,000.00*			*$ 1,080,000.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 486,000.00			$ 324,000.00
Total Construction				**$ 2,106,000.00**			**$ 1,404,000.00**
Monetized Time Savings							$ -
Right of Way Costs				$ -			$ -
TOTAL CAPITAL COST				***$ 2,106,000.00***			***$ 1,404,000.00***
COST CAPITAL SAVINGS / (INCREASE)							***$ 702,000.00***

VE RECOMMENDATION NO. 1: USE ROUNDABOUTS AT INDUSTRIAL PARK BRIDGE

Idea Nos. 30, 12

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations	*Rating*	8	8
	Weight	28.8	
	Contribution	230.4	230.4
Local Operations Improved operations at intersections	*Rating*	9	9.5
	Weight	14.2	
	Contribution	127.8	134.9
Maintainability Less bridge to maintain Slight less pavement	*Rating*	5	5.5
	Weight	9.5	
	Contribution	47.5	52.25
Construction Impacts	*Rating*	7	7
	Weight	9.5	
	Contribution	66.5	66.5
Environmental Impacts	*Rating*	4	4
	Weight	21.4	
	Contribution	85.6	85.6
Project Schedule May require public workshop	*Rating*	6	5.86
	Weight	16.6	
	Contribution	99.6	97.276
	Total Performance	657.4	666.926
		Net Change in Performance	1%

VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE	Idea Nos. 29, 31

Baseline Concept

The baseline condition proposes twin 4-span bridges that cross over three lanes in each direction. There is guardrail located behind the shoulders on each side of the traveling lanes. Each bridge has a span configuration of 90'-161'-161'-90'. The bridge superstructures will either consist of plate girder structures or hybrid concrete box beams.

Recommendation Concept

Revise the bridge to a 5-span configuration of 90'-105'-60'-105'-90'.

Advantages	Disadvantages
• Lower maintenance • Lower cost • More conventional beam type • May permit decrease in profile and embankment • Lighter weight beam permits contractor to use a smaller crane	• Additional substructure element required • Revised span configuration could yield uplift in middle span

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$10,572,000	N/A	$10,572,000
Recommendation Concept	$9,397,000	N/A	$9,397,000
Cost Avoidance/(Added Value)	$1,175,000	N/A	$1,175,000

FHWA Function Benefit

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

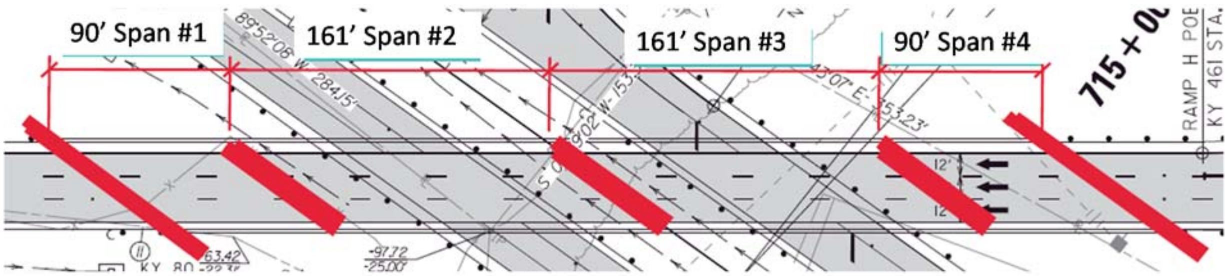
VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE	Idea Nos. 29, 31

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

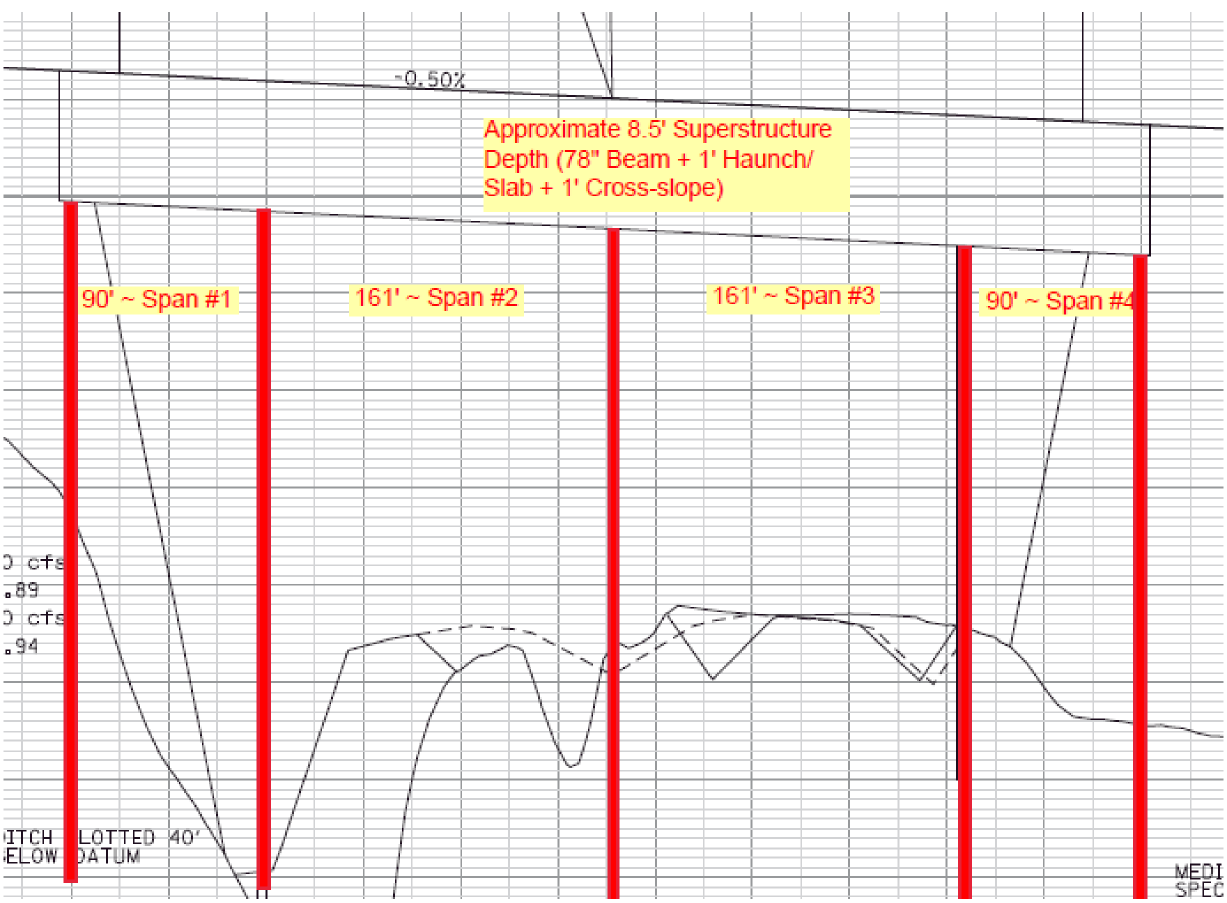
Use two piers in the median, locate each behind the proposed guardrail and modify the span configuration to a 5-span with 90'-105'-60'-105'-90'. The revised configuration would permit the use of more traditional concrete beams such as an AASHTO Type IV or AASHTO Type V Beam.

Baseline Concept–PLAN



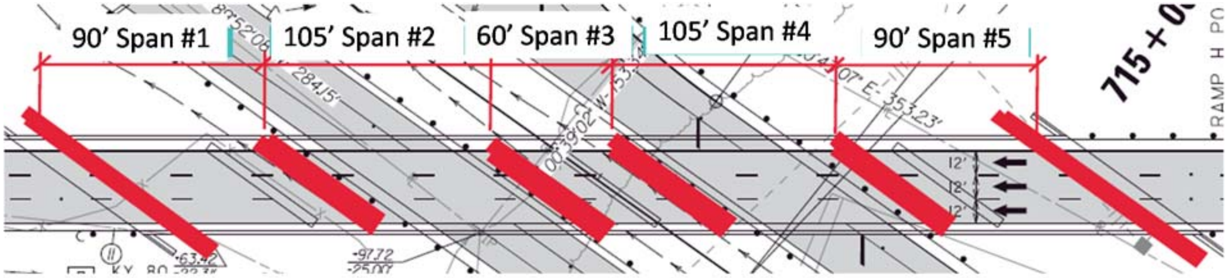
Baseline

Baseline Concept–PROFILE



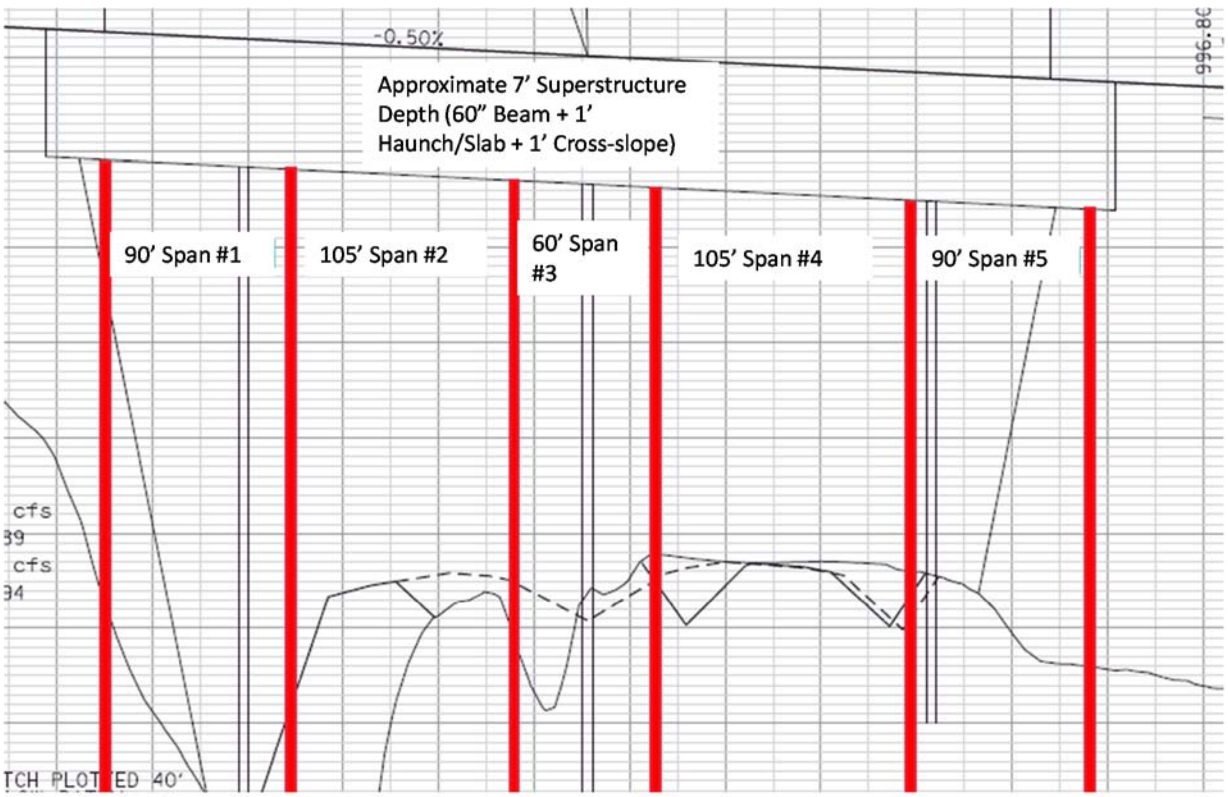
VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE	Idea Nos. 29, 31

Concept–PLAN



Recommended

Concept–PROFILE



Recommended

VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE

Idea Nos. 29, 31

Assumptions/Calculations

Dimensions:

Width = 1.5' barrier +3' shoulder + 36' lanes + 3' shoulder + 1.5' barrier = 45'

Length = 91' + 160' + 160' + 91' = 502'

Deck Area = 45' x 502' x 2 = 45,180 sq ft

Unit Cost Methodology and Assumptions:

The baseline concept proposes using either HN78-49 beams or welded steel plate girders for the superstructure with a unit cost of $180/sq ft.

KYTC Average Bid Prices for Hybrid Beams in 2018:

Beam Type	Per Lin Ft.			
	2016	2017	2018	3 year Avg
HN36-49	$380	$410	$350	$380
HN48-49	$310	-	$350	$330
HN54-49	$320	$310	$350	$327
HN60-49	$325	-	$356	$341
HN66-49	$316	-	$365	$341
HN72-49	$355	$500	$365	$407
Type 4 PCIB	$251	$278	$312	$280

For estimating purposes, the cost of an HN78-49 was assumed to be the same as a HN72-49.

Based on that assumption and 3 year averages in the table above, a Type 4 beam is generally approximately 70 percent of the cost of an HN78-49.

It is assumed that the superstructure typically accounts for approximately 65 percent of the unit cost and the substructure accounts for 35 percent of the unit cost.

Baseline Unit Costs:

- Superstructure Unit Cost = $180/sq ft x 65% = $117/sq ft
- Substructure Unit Cost = $180/sq ft x 35% = $63/sq ft
- Unit cost per Substructure Element = $63/sq ft/(5 substructure elements) = $12.60/sq ft per element

Concept Unit Cost:

- Substructure Unit Cost = $12.60/sq ft per element x 6 substructure elements = $75.60/sq ft
- Superstructure Unit Cost = $117/sq ft x 70% = $82/sq ft
- Total Unit Cost = $75.60 + $82 = $157.60/sq ft
- Use $160/sq ft as Unit Cost for Concept.

VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE	Idea Nos. 29, 31

References and Validation of Assumptions

For a welded-plate girder bridge, KYTC Division of Structural Design recommends $250/sq ft (2017 dollars) with 5 percent increase per year = $290/sq ft (2020 dollars)

For a multi-span PCIB bridge, KYTC Division of Structural Design recommends $130/sq ft (2017 dollars) with 5 percent increase per year = $150/sq ft (2020 dollars)

VE Study Costs Calculations
KY 461 & KY 80 and KY 461 Widening

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Change Structure Design at System Interchange	1	45180	$ 180.00	$ 8,132,400.00	45,180	$ 160.00	$ 7,228,800.00
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
Subtotal Construction				*$ 8,132,400.00*			*$ 7,228,800.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 2,439,720.00			$ 2,168,640.00
Total Construction				**$ 10,572,120.00**			**$ 9,397,440.00**
Monetized Time Savings							$ -
Right of Way Costs	SF			$ -			$ -
TOTAL CAPITAL COST				***$ 10,572,120.00***			***$ 9,397,440.00***
COST CAPITAL SAVINGS / (INCREASE)							***$ 1,174,680.00***

VE RECOMMENDATION NO. 2: CHANGE STRUCTURE DESIGN AT SYSTEM INTERCHANGE

Idea Nos. 29, 31

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations	*Rating*	8	8
	Weight	28.8	
	Contribution	230.4	230.4
Local Operations	*Rating*	9	9
	Weight	14.2	
	Contribution	127.8	127.8
Maintainability Concrete beams are easier to maintain than steel	*Rating*	5	6
	Weight	9.5	
	Contribution	47.5	57
Construction Impacts More piles/beams More noise/vibration	*Rating*	7	6.87
	Weight	9.5	
	Contribution	66.5	65.265
Environmental Impacts	*Rating*	4	4
	Weight	21.4	
	Contribution	85.6	85.6
Project Schedule	*Rating*	6	6
	Weight	16.6	
	Contribution	99.6	99.6
	Total Performance	657.4	665.665
	Net Change in Performance		1%

VE RECOMMENDATION NO. 3: REDUCE RAMP H RADIUS	Idea No. 20

Baseline Concept

Ramp H is designed to meet 40 mph with a radius of 444 feet. Proposed embankment between Sta. 45+00 to 60+00 Ramp H ranges in height between 60 feet to 80 feet and impacts approximately 1,800 feet of stream.

Recommendation Concept

Reduce radius of Ramp H to meet a 35 mph design using a 314-foot radius. This reduced radius would remove much of the proposed ramp embankment from the stream. Consider using retaining walls in lieu of embankment in areas that may encroach on the stream.

Advantages

- Reduces impact to stream
- Reduced pavement on ramp
- Reduced in-lieu fees
- Reduced right-of-way requirements

Disadvantages

- Reduced design speed
- May require a design exception

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$1,761,000	N/A	$1,761,000
Recommendation Concept	$0	N/A	$0
Cost Avoidance/(Added Value)	$1,761,000	N/A	$1,761,000

FHWA Function Benefit

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

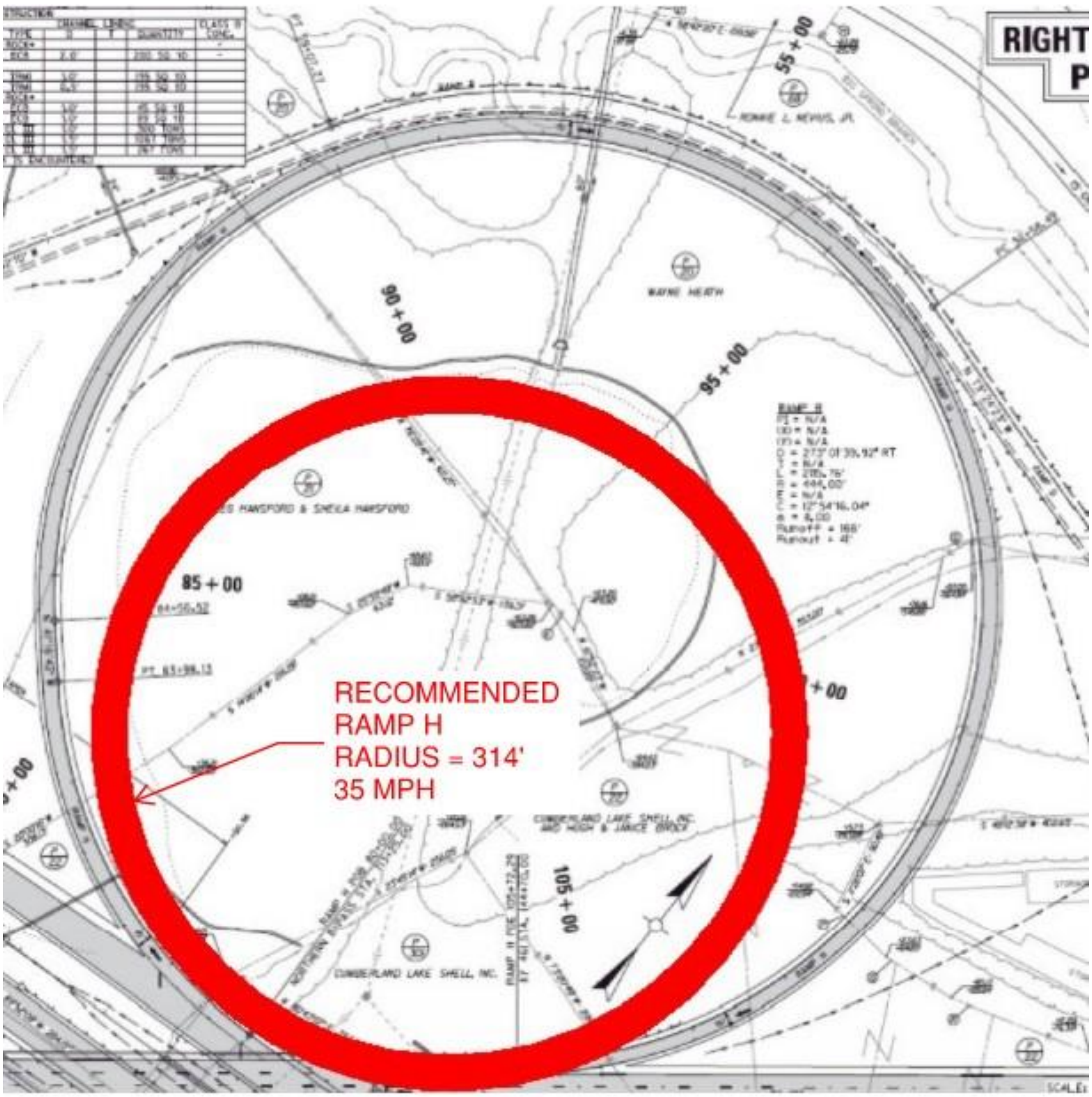
VE RECOMMENDATION NO. 3: REDUCE RAMP H RADIUS	Idea No. 20

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

The baseline design for Ramp H meets 40 mph and uses a radius of 444 feet. The proposed ramp is to be constructed on fill material, which ranges up to 80 feet in height. The proposed design utilizes 2:1 fill slopes.

The proposed recommendation is to reduce the design speed to 35 mph, which would allow a tighter radius of 314 feet. This radius significantly reduces the footprint of the ramp and shifts the embankment away from the stream. To further minimize stream impacts retaining walls could be used.



VE RECOMMENDATION NO. 3: REDUCE RAMP H RADIUS	Idea No. 20

Assumptions/Calculations

Baseline earthwork			Recommendation 3			
			0.711439271	*paved area - ratio of radius for 35 mph (314' R) versus 40 mph (444' R) quantities are reduced by a factor =50345/70765*		
STA		CY				
4500	7000					
4600	7437.5	26736.11				
4700	5780	24476.85				
4800	5950	21722.22				
4900	5600	21388.89				
5000	6400	22222.22				
5100	6000	22962.96				
5200	5200	20740.74				
5300	4200	17407.41				
5400	3600	14444.44				
5500	3480	13111.11				
5600	3335	12620.37				
5700	3335	12351.85				
5800	3300	12287.04				
5900	3120	11888.89				
6000	1800	9111.111				
CY		263472	187444	‹eduction :	76028	CY

Base Paved Area Ramp H			Recommendation 3 Paved Area Ramp H		
70765	SF		50345	SF	
7862.778	SY		5593.888889	SY	

Assumed unit costs:

Embankment = $3.50 CY (provided by design team)

Full Depth Asphalt Pavement = $52.69 SY (using KYTC average bid prices and design team pavement design)

Stream In-lieu fees = $700 per lineal foot (provided by design team)

Right-of-way is assumed already acquired for this project so no credit was calculated for this potential benefit. However, a reduced amount of right-of-way would be required for this recommendation, which would reduce overall project costs.

VE RECOMMENDATION NO. 3: REDUCE RAMP H RADIUS

Idea No. 20

HDR

VE Study Costs Calculations

KY 461 & KY 80 and KY 461 Widening

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
Full depth asphalt pavement	SY	2,269	$ 52.69	$ 119,553.61	0	$ 52.69	$ -
Embankment	CY	76028	$ 3.50	$ 266,098.00	0	$ 3.50	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
Subtotal Construction				*$ 385,651.61*			$ -
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 115,695.48			$ -
Total Construction				**$ 501,347.09**			**$ -**
Monetized Time Savings							$ -
Stream in-lieu fee	LF	1800	$ 700.00	$ 1,260,000.00	0	$ 700.00	$ -
TOTAL CAPITAL COST				***$ 1,761,347.09***			***$ -***
COST CAPITAL SAVINGS / (INCREASE)							***$ 1,761,347.09***

VE RECOMMENDATION NO. 3: REDUCE RAMP H RADIUS

Idea No. 20

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Design speed reduction by 5 MPH	*Rating*	8	7.5
	Weight	28.8	
	Contribution	230.4	216
Local Operations	*Rating*	9	9
	Weight	14.2	
	Contribution	127.8	127.8
Maintainability Slight less pavement and guardrail	*Rating*	5	5.25
	Weight	9.5	
	Contribution	47.5	49.875
Construction Impacts	*Rating*	7	7
	Weight	9.5	
	Contribution	66.5	66.5
Environmental Impacts Avoids impacts to streams and significant less excavation	*Rating*	4	7
	Weight	21.4	
	Contribution	85.6	149.8
Project Schedule Stream modifications don't need to be constructed Less earthwork (Critical Path)	*Rating*	6	7
	Weight	16.6	
	Contribution	99.6	116.2
	Total Performance	**657.4**	**726.175**
	Net Change in Performance		**10%**

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461

Idea No. 22

Baseline Concept

The baseline design for KY 461 (north of the KY 461/KY 80 interchange) is a five-lane, undivided cross section. The access points along the roadway are all full access (with the exception of the proposed jug handles serving Coin Road).

Recommendation Concept

Using J-turns/R-cut type crossings along KY 461 would eliminate full access points throughout the project.

Advantages

- Reduces type/severity of conflicts
- Easier driver decision making
- Improves operations
- Establishes consistent driver expectations
- Reduces number of conflict points
- Corridor Access Management

Disadvantages

- Out of direction travel
- May require more right-of-way
- More difficult movement for trucks
- Requires acceleration lane
- New concept for drivers
- Potential weave conflicts with entrance traffic

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$0		$0
Recommendation Concept	$2,496,000		$2,496,000
Cost Avoidance/(Added Value)	($2,496,000)		($2,496,000)

FHWA Function Benefit

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

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461	Idea No. 22

Discussion/Sketches/Photos/Calculations

Developing a J-turn/R-cut corridor requires the restricting of movements from the minor street approaches and only allowing left-turn movements from the major street (KY 461). The minor street movements are restricted to only right turns. Vehicles trying to make a left turn from the minor street must turn right onto KY 461 and then U-turn. This configuration helps improve operations, improve safety (eliminating and/or reducing conflicts to lessen severity), and introduces an access management strategy for the corridor.

To make this type of configuration work throughout the KY 461 corridor north of the interchange, several modifications to the current design must be incorporated: introduction of a median barrier throughout the corridor; curb islands to restrict movements, pavement markings, and the construction of U-turn loons.

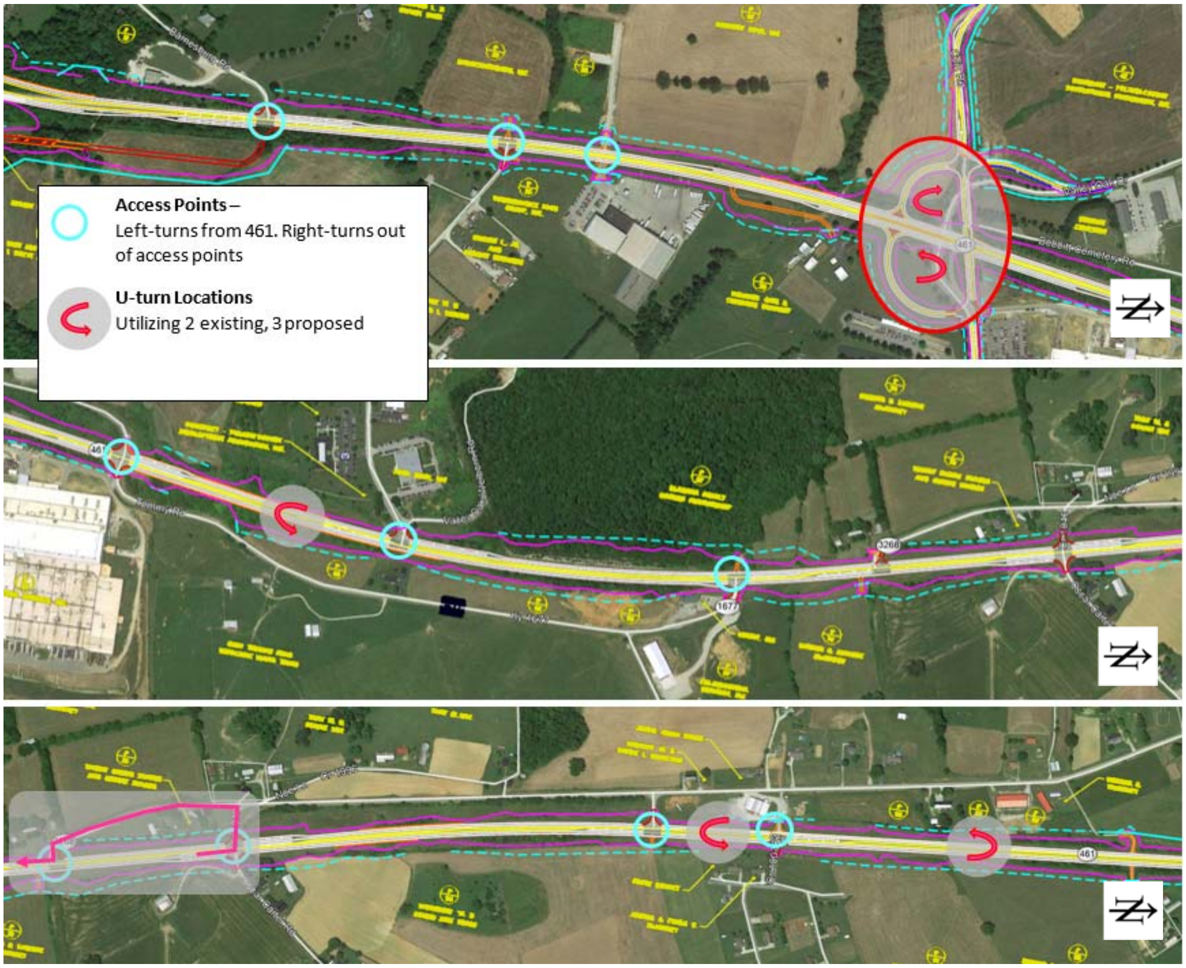
Technical Discussion/Sketches

There are ten access locations along KY 461 (excluding Coin Road) north of the interchange to the north end of the project. Each of these locations can remain to allow left-turns in from KY 461 and should have accompanying left turn lanes into the proposed median.

The baseline configuration lends itself to several locations to accommodate the U-turn movements already, not requiring the construction of a dedicated U-turn location and loon. The Coin Road interchange provides the opportunity for traffic to U-turn in either direction. In addition the CR 140/Old Mount Vernon Road loop provides a location for vehicles to make a northbound-southbound turnaround movement. In addition to these two locations, a minimum of three U-turn locations will need to be constructed throughout the project to provide options for vehicles to turn around. Each U-turn location will also require the construction of a loon to provide ample space for heavy vehicles to turn around.

The following sketch shows a simplified layout of the J-turn/R-cut corridor.

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461	Idea No. 22



The table below shows the approximate out-of-direction travel distance required for vehicles from each of the access points.

Access Point	NB to SB turnaround	SB to NB turnaround
Barnesburg/ Shopville	3500'	5000'
Performance Food Group Access	1700'	6800'
Babe Blvd	2300'	6300'
Coin Rd	N/A	N/A
Bobbitt Cemetery/ Tommy Rd S	3350'	1500'
Valley Oak Dr	-	800'
Tommy Rd	1750'	-
Old Mount Vernon Rd	-	3000'
Oscar Carter Rd	4000'	4000'
Lincoln Trail	1000'	1850'

Several of these distances are significantly longer than what is typically recommended in J-turn/R-cut corridors (400 feet to 1,000 feet); therefore, additional U-turn access points could be provided throughout the corridor if needed. The distances listed are for vehicles to turn around at a proper, designated U-turn location as this would be needed to accommodate the trucks; however, the majority of the traffic would be from passenger vehicles, which could accommodate a U-turn within the existing roadway footprint and thus could perform U-turns at the left turn locations.

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461	Idea No. 22

Minor Street Approaches

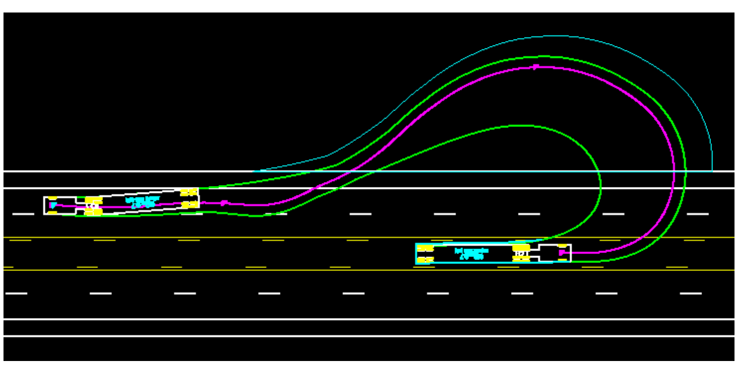
Throughout this area, the minor street/driveway approaches typically provide access to a small number of homes or businesses and thus are not anticipated to generate significant traffic volume. Thus restricting movements should not incur significant delay. Additionally, the out-of-direction travel for U-turn vehicles should only impact a limited number of vehicles. Barrier walls also deter future full-directional access points along the corridor.

Median Barrier and Curb Islands

To eliminate movements and restrict access, it is assumed that a median barrier will need to be installed throughout the corridor with openings for the left turn movements from KY 461; curb islands may also be used to help channelize and restrict movements. The assumed cost for providing median barrier throughout the entire length along KY 461 is approximately $1.7 million. (This estimate assumes a median barrier throughout the length of the project. Realistically there will be some gaps to accommodate left-turn and U-turn movements; however, this is a small portion of the total length. There will need to be some curb islands/channelization constructed in those areas to restrict movements; therefore, the total median cost was assumed to accommodate this configuration as well.)

U-turn Loons

To accommodate all vehicle types, including large vehicles, U-turns and U-turn loons will need to be constructed to provide ample turnaround space. Using a westbound-67 design vehicle each U-turn loon would need to add approximately 9,000 SF of pavement in addition to the shoulder. This pavement likely does not need to be designed for the same loads as the travel lanes. A sample image of the turnaround configuration is shown below. To be conservative, the costs were developed based on the asphalt costs provided. The U-turn locations were placed to attempt to avoid large earthwork costs (avoiding the large cut sections north of Coin Road). The required earthwork cost was estimated at $3.5/CY. An average location was used to account for a typical amount of earthwork and pavement quantities and costs. With these assumptions, the cost of each loon is approximately $74,000.



Cost estimates for the R-cut corridor, including median barrier and U-turn loons are shown on the following page.

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461

Idea No. 22

VE Study Costs Calculations

KY 461 & KY 80 and KY 461 Widening

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
Concrete median barrier wall 32"	LF	0	$ 75.00	$ -	17,500	$ 75.00	$ 1,312,500.00
Drainage box			$ -	$ -		$ -	$ -
Culvert pipe 15"	LF	0	$ 79.00	$ -	2400	$ 79.00	$ 189,600.00
Median wall drop box inlet	EA		$ 7,000.00	$ -	20	$ 7,000.00	$ 140,000.00
Culvert pipe 18"	LF		$ 85.00	$ -	500	$ 85.00	$ 42,500.00
Headwall	EA		$ 1,400.00	$ -	10	$ 1,400.00	$ 14,000.00
Loon Asphalt (3 loons)	SY		$ 52.69		3,000	$ 52.69	$ 158,070.00
Earthwork (3 loons)	CY		$ 3.50	$ -	18000	$ 3.50	$ 63,000.00
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
Subtotal Construction				$ -			*$ 1,919,670.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ -			$ 575,901.00
Total Construction				**$ -**			**$ 2,495,571.00**
Monetized Time Savings							$ -
Right of Way Costs	SF			$ -			$ -
TOTAL CAPITAL COST				***$ -***			***$ 2,495,571.00***
COST CAPITAL SAVINGS / (INCREASE)							***$ (2,495,571.00)***

VE RECOMMENDATION NO. 4: CREATE J-TURNS ALONG KY 461	Idea No. 22

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Reduce number of conflicts Eliminates crossing conflicts	***Rating***	**8**	**9.5**
	Weight	**28.8**	
	Contribution	**230.4**	**273.6**
Local Operations Driver expectations - longer drive Safer operation	***Rating***	**9**	**9**
	Weight	**14.2**	
	Contribution	**127.8**	**127.8**
Maintainability Additional median walls to maintain	***Rating***	**5**	**4.5**
	Weight	**9.5**	
	Contribution	**47.5**	**42.75**
Construction Impacts	***Rating***	**7**	**7**
	Weight	**9.5**	
	Contribution	**66.5**	**66.5**
Environmental Impacts	***Rating***	**4**	**4**
	Weight	**21.4**	
	Contribution	**85.6**	**85.6**
Project Schedule	***Rating***	**6**	**6**
	Weight	**16.6**	
	Contribution	**99.6**	**99.6**
	Total Performance	**657.4**	**695.85**
		Net Change in Performance	**6%**

VE RECOMMENDATION NO. 5: USE 11-FOOT LANES	Idea No. 4

Baseline Concept

Construct four 12-foot lanes throughout the KY 461 corridor from milepost (MP) 0.000 to MP 3.879.

Recommendation Concept

Construct 11-foot lanes throughout KY 461 corridor.

Advantages	Disadvantages
• Lower pavement cost • Less impervious • Less maintenance	• Inconsistency in lane widths versus adjacent road segments • Increased friction between vehicles

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$9,425,000		$9,425,000
Recommendation Concept	$8,640,000		$8,640,000
Cost Avoidance/(Added Value)	$785,000		$785,000

FHWA Function Benefit

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

VE RECOMMENDATION NO. 5: USE 11-FOOT LANES	Idea No. 4

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

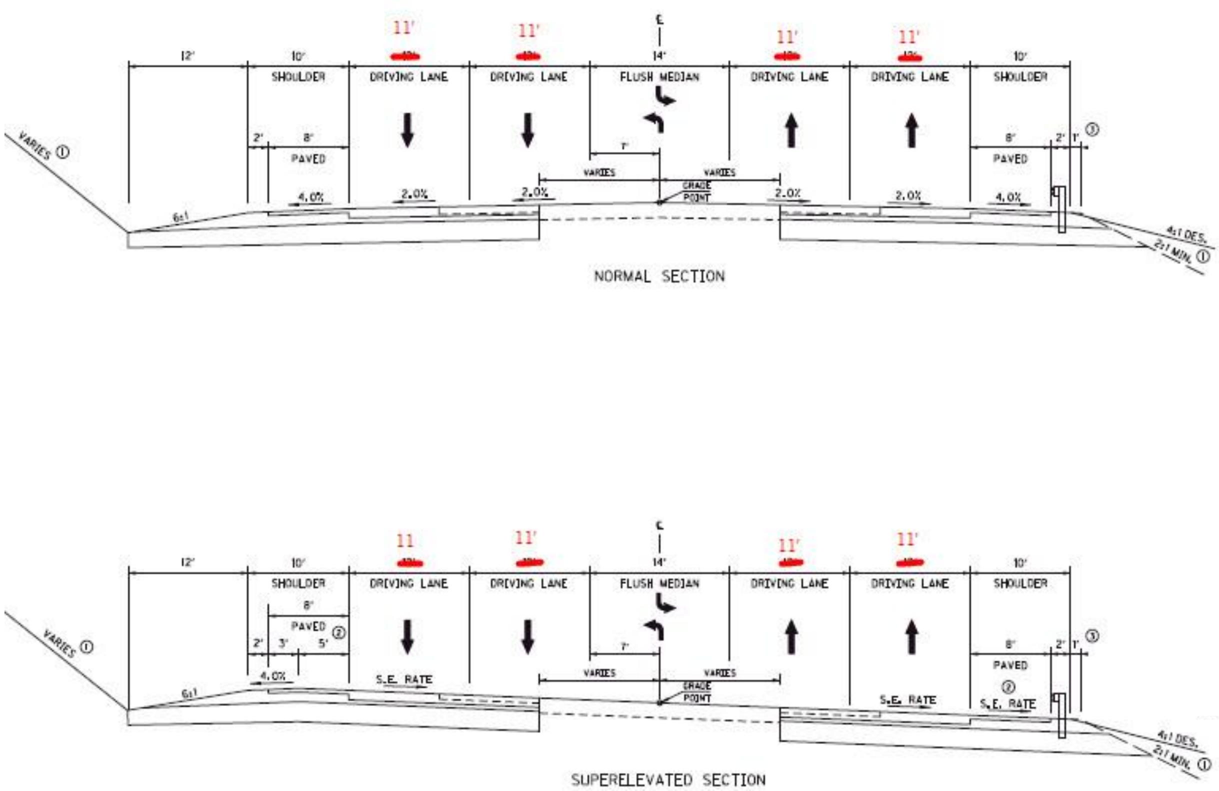
The VE team recommends using four 11-foot lanes instead of four 12-foot lanes for the entirety of the project. By using 11-foot lanes, overall pavement costs and long-term maintenance costs can be reduced due to less material used and decreased asphalt resurfacing needed.

It is the VE team's understanding that the change in lane width does not alter the scope of the project laid out in the BUILD Grant application.

There are no perceived impacts to constructability, MOT, and project schedule.

From a safety perspective, some statistics have shown that reduction in lane width can produce an increase in crashes. The CMF's for 12-foot and 11-foot lanes on an individual facility are 1.0 and 1.04, respectively. Therefore, it is anticipated that there could be a 4 percent increase in collisions.

TYPICAL SECTIONS
KY 461 – FLUSH MEDIAN



VE RECOMMENDATION NO. 5: USE 11-FOOT LANES	Idea No. 4

Assumptions/Calculations

The KY 461 Preferred Alignment Cost Estimate did not provide the level of detail needed to accurately portray this recommendation, so the following assumptions were made.

		lb	SY	Depth (IN)	Price/TON	Cost / SY
New Asphalt	Asphalt Surface	115	1	1.5	$ 72.84	$ 6.28
	Asphalt Base	110	1	9.75	$ 72.84	$ 39.06
	Crushed Stone	115	1	6	$ 21.30	$ 7.35
					Total/SY	**$ 52.69**

Baseline: 48 feet equals four 12-foot lanes for a length of 25,800 feet.

((48 ft * 25,800 ft)/9) = 137,600 SY

137,600 SY * $52.69/SY * 1.3 (contingency) = $9,425,187.20

VE Recommendation: 44 feet equals four 11-foot lanes for a length of 25,800 feet.

((44 ft * 25,800 ft)/9) = 126,133 SY

126,133 SY * $52.69/SY * 1.3 (contingency)= $8,639,732.10

Total cost reduction for new asphalt

$9,425,187.20 – $8,639,732.10 = $785,455.10

Total savings of implementing 11-foot lanes instead of 12-foot lanes is $785,455.10

VE RECOMMENDATION NO. 5: USE 11-FOOT LANES

Idea No. 4

VE Study Costs Calculations
KY 461 & KY 80 and KY 461 Widening

		Baseline Concept				VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**		**Quantity**	**Cost/Unit**	**Total**
New Asphalt	SY	137,600	$ 52.69	$ 7,250,144.00		126,133	$ 52.69	$ 6,645,947.77
				$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
Subtotal Construction				*$ 7,250,144.00*				*$ 6,645,947.77*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 2,175,043.20				$ 1,993,784.33
Total Construction				**$ 9,425,187.20**				**$ 8,639,732.10**
Monetized Time Savings								$ -
Right of Way Costs	SF			$ -				$ -
TOTAL CAPITAL COST				***$ 9,425,187.20***				***$ 8,639,732.10***
COST CAPITAL SAVINGS / (INCREASE)								***$ 785,455.10***

VE RECOMMENDATION NO. 5: USE 11-FOOT LANES	Idea No. 4

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Main Line Operations Slight decrease of shy distance	*Rating*	8	7.75
	Weight	28.8	
	Contribution	230.4	223.2
Local Operations	*Rating*	9	9
	Weight	14.2	
	Contribution	127.8	127.8
Maintainability Slight change in pavement to maintain	*Rating*	5	5.5
	Weight	9.5	
	Contribution	47.5	52.25
Construction Impacts	*Rating*	7	7
	Weight	9.5	
	Contribution	66.5	66.5
Environmental Impacts Slight less impervious	*Rating*	4	6.5
	Weight	21.4	
	Contribution	85.6	139.1
Project Schedule	*Rating*	6	6
	Weight	16.6	
	Contribution	99.6	99.6
	Total Performance	657.4	708.45
		Net Change in Performance	8%

VE RECOMMENDATION NO. 6: CREATE DETENTION PONDS	Idea No. 7

Baseline Concept

With the current design, no measures are in place to ensure the cumulative amount of post-development stormwater runoff from the project limits is less than or equal to pre-development conditions.

Recommendation Concept

Create stormwater detention facilities within the interchange ramps to manage stormwater runoff.

Advantages	Disadvantages
• Prevent flooding downstream and within project limits • Eliminate hydromodification of stream • Improves water quality of stream (preserve endangered aquatic life)	• Slightly more earthwork • Added overflow/outlet structures • Minor maintenance

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$0	N/A	$0
Recommendation Concept	$262,000	N/A	$262,000
Cost Avoidance/(Added Value)	($262,000)	N/A	($262,000)

FHWA Function Benefit

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

VE RECOMMENDATION NO. 6: CREATE DETENTION PONDS	Idea No. 7

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

With the new KY 461/KY 80/Northern Bypass interchange, existing undeveloped land will be replaced with impervious pavements. Cleared right-of-way and existing streams (Big Spring Branch and Flat Lick Creek) will be replaced with realigned channels. As a result, post-development stormwater runoff will likely exceed pre-development conditions.

Properly designed stormwater detention areas typically eliminate/minimize downstream flooding and hydromodification of the existing streams and improve water quality downstream of the project area. Per current practices, KYTC does not acquire right-of-way for stormwater detention facilities. With the drainage patterns on this project and the available land primarily within the limits of loop ramps E and H (and potentially the jug handles at the industrial park interchange), additional right-of-way acquisition would not be necessary.

Increased costs would be associated with the additional excavation for the detention basin areas and the installation of outlet/overflow structures; however, value may be found in the preservation of downstream areas and eliminating future complaints from downstream residents. This measure also mitigates the risk of higher cost of negotiation related to the acquisition of Parcel No. 27.

Figure 1. Example of a Detention Basin inside a Loop Ramp

VE RECOMMENDATION NO. 6: CREATE DETENTION PONDS	Idea No. 7

Figure 2. Example of Hydromodification of an Existing Stream

Assumptions/Calculations

Without running stormwater calculations, an assumption is made that post-development stormwater runoff from the project limits would exceed pre-development conditions with cleared right-of-way, impervious pavements, and straightened/realigned stream channels. Properly designed detention facilities typically eliminate increased post-development stormwater flows. For the purpose of quantification of the recommendation, two ponds within the two loop ramps were assumed, as follows:

Ramp H: Measured inside available area using Google Earth's KMZ file: 230,000 SF

Ramp E: Measured inside available area using Google Earth's KMZ file: 120,000 SF

Total SF: 350,000 SF

Total CY assuming a 4-foot depth: 350,000 SF * 4 LF / 27 = 52,000 CY

VE RECOMMENDATION NO. 6: CREATE DETENTION PONDS

Idea No. 7

VE Study Costs Calculations

KY 461 & KY 80 and KY 461 Widening

		Baseline Concept				VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**		**Quantity**	**Cost/Unit**	**Total**
Detention Basin Excavation	CY	0	$ 3.50	$ -		52,000	$ 3.50	$ 182,000.00
Detention Basin Outlet Structure	Each	0	$ 10,000.00	$ -		2	$ 10,000.00	$ 20,000.00
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
Subtotal Construction				*$ -*				*$ 202,000.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ -				$ 60,600.00
Total Construction				**$ -**				**$ 262,600.00**
Monetized Time Savings								$ -
Right of Way Costs	SF			$ -				$ -
TOTAL CAPITAL COST				***$ -***				***$ 262,600.00***
COST CAPITAL SAVINGS / (INCREASE)								***$ (262,600.00)***

VE RECOMMENDATION NO. 6: CREATE DETENTION PONDS	Idea No. 7

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Slight decrease of shy distance	*Rating*	8	8
	Weight	28.8	
	Contribution	230.4	230.4
Local Operations	*Rating*	9	9
	Weight	14.2	
	Contribution	127.8	127.8
Maintainability Slight increase due to weir maintainance	*Rating*	5	5
	Weight	9.5	
	Contribution	47.5	47.5
Construction Impacts	*Rating*	7	7
	Weight	9.5	
	Contribution	66.5	66.5
Environmental Impacts Prevents downstream flooding Improved water quality	*Rating*	4	7
	Weight	21.4	
	Contribution	85.6	149.8
Project Schedule	*Rating*	6	6
	Weight	16.6	
	Contribution	99.6	99.6
	Total Performance	657.4	721.6
		Net Change in Performance	10%

VE RECOMMENDATION NO. 7: RECONFIGURE RAMP D	Idea No. 11

Baseline Concept

Ramp D is a loop ramp carrying westbound KY 80 to southbound KY 80 traffic.

Recommendation Concept

As part of an initial design for this project, build Ramp D as a left hand movement that ties into Ramp C. Plan for building a Ramp D flyover when the Somerset Northern Bypass project advances.

Advantages	Disadvantages
• Significantly reduces cost for current project • Less pavement • Eliminates a weave movement at interchange • Eliminates stream impacts • Reduces bridge width • Reduces right-of-way requirement	• Significant redesign • Additional structures in future

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$7,266,000		$7,266,000
Recommendation Concept	$1,994,000		$1,994,000
Cost Avoidance/(Added Value)	$5,272,000		$5,272,000

FHWA Function Benefit

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

VE RECOMMENDATION NO. 7: RECONFIGURE RAMP D	Idea No. 11

Discussion/Sketches/Photos/Calculations

The current design calls for a loop ramp (Ramp H) for the westbound to southbound direction. To accommodate traffic merging onto the southbound 461/KY 80, a dedicated acceleration lane is designed, part of which is structure. Ramps C and D will be graded but not paved as part of this project; paving will take place. The design of Ramps H and D require construction in the location of a blue line stream, requiring a 1,700-foot channel change.

This recommendation is to build Ramp H in a new location, next to Ramp G and tie it into Ramp C alignment. By making this change, it allows Ramp D to be shifted away from the stream. These two modifications eliminate the need for a channel change, reducing construction costs and the in-lieu fees that would be charged.

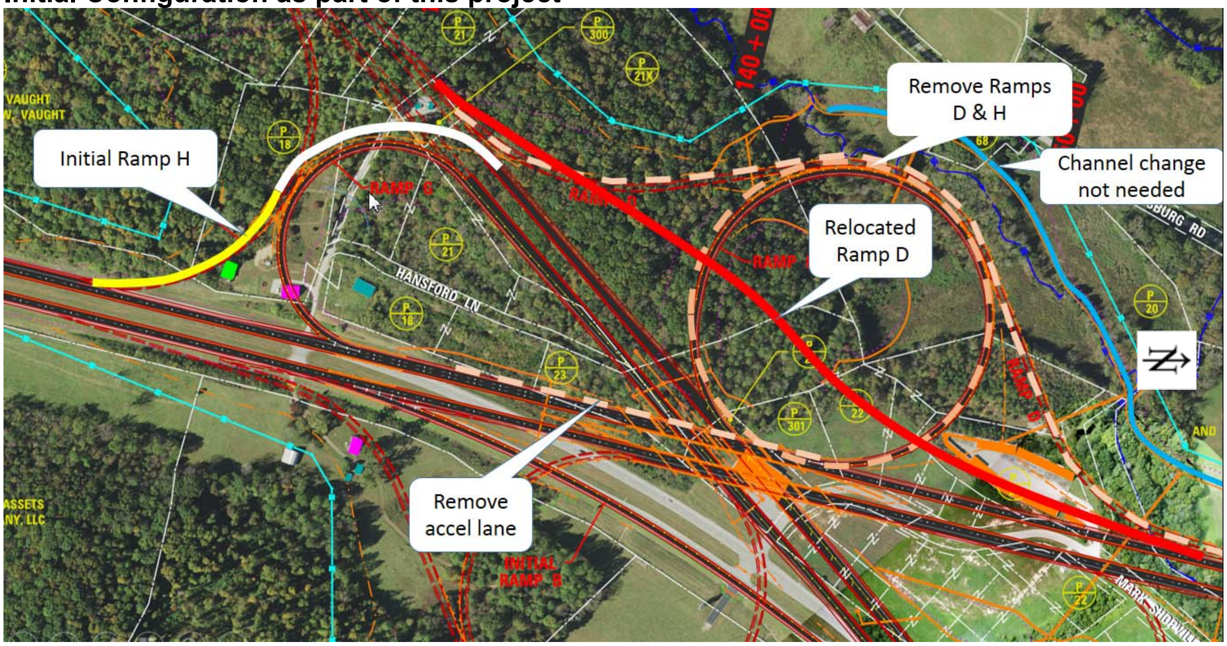
This change to the design would stay in effect until the construction of the Somerset Northern Bypass begins. At that time, a flyover ramp would be built to accommodate Ramp H movements. This ramp would tie down to the outside of the Ramp C alignment. Ramp C would then be used for the eastbound bypass to southbound KY 80 traffic movement.

Earthwork is significantly reduced; therefore, the overall construction schedule should be shortened. The environmental impacts to the stream are greatly reduced due to avoiding the channel change. By eliminating the Ramp H in its current location, the weaving movement with Ramp G is removed. Change to travel times will be slightly less for Ramp H movement; however, it would be an insignificant amount.

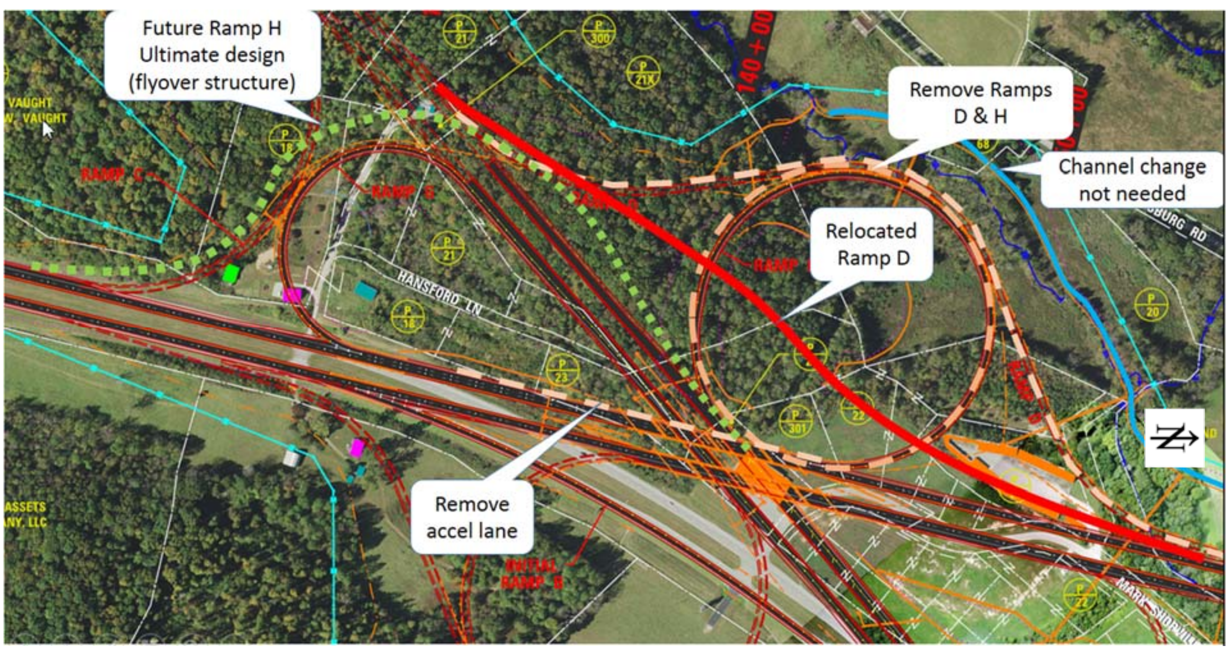
The cost estimate includes reduction of in-lieu fees and changes to pavement. Because of the large cuts and fills in this quadrant, it was assumed that 50 percent of the earthwork costs for the interchange were impacted (reduced) due to removing Ramps D and H. The earthwork of the construction of the relocated Ramp D would be much less and assumed to be 25 percent of the original quadrant's earthwork cost. There is approximately 870 feet of 60-inch pipe that would be eliminated; however, it was assumed to be included in contingency costs. The estimate provided to the VE team included a 30 percent contingency.

VE RECOMMENDATION NO. 7: RECONFIGURE RAMP D	Idea No. 11

Initial Configuration as part of this project



Ultimate Configuration as part of future bypass project



VE RECOMMENDATION NO. 7: RECONFIGURE RAMP D

Idea No. 11

VE Study Costs Calculations

KY 461 & KY 80 and KY 461 Widening

		Baseline Concept				VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**		**Quantity**	**Cost/Unit**	**Total**
Asphalt Pvmt (proposed Ramp H)	SY	2269	$ 52.69	$ 119,553.61		0	$ 52.69	$ -
Asphalt Pvmt (proposed Ramp accel/decel)	SY	533	$ 52.69	$ 28,101.33		0	$ 52.69	$ -
Bridge (proposed Ramp portion)	SF	5400	$ 180.00	$ 972,000.00		0	$ 180.00	$ -
Embankment (proposed)	CY	750000	$ -	$ -		0	$ -	$ -
Excavation (proposed)	CY	1000000	$ 3.50	$ 3,500,000.00		0	$ 3.50	$ -
Waste (proposed)	CY	250000	$ -	$ -		0	$ -	$ -
				$ -			$ -	$ -
				$ -			$ -	$ -
Asphalt Pvmt (recommended Ramp D)	SY	0	$ 52.69	$ -		8333	$ 52.69	$ 439,083.33
Asphalt Pvmt (recommended Ramp H)	SY	0	$ 52.69	$ -		4167	$ 52.69	$ 219,541.67
Embankment (recommended)	CY	0	$ -	$ -		187500	$ -	$ -
Excavation (recommended)	CY	0	$ 3.50	$ -		250000	$ 3.50	$ 875,000.00
Waste (recommended)	CY	0	$ -	$ -		62500	$ -	$ -
Subtotal Construction				*$ 4,619,654.94*				*$ 1,533,625.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 1,385,896.48				$ 460,087.50
Total Construction				**$ 6,005,551.43**				**$ 1,993,712.50**
Monetized Time Savings								$ -
Stream in-lieu fee	LF	1800	$ 700.00	$ 1,260,000.00		0	$ 700.00	$ -
TOTAL CAPITAL COST				***$ 7,265,551.43***				***$ 1,993,712.50***
COST CAPITAL SAVINGS / (INCREASE)								***$ 5,271,838.93***

VE RECOMMENDATION NO. 7: RECONFIGURE RAMP D	Idea No. 11

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Eliminates weaving at the bridge Eliminates opposing traffic glare May improve ramp design speed	***Rating***	**8**	**9**
	Weight	**28.8**	
	Contribution	**230.4**	**259.2**
Local Operations	***Rating***	**9**	**9**
	Weight	**14.2**	
	Contribution	**127.8**	**127.8**
Maintainability Less embankment Less structure	***Rating***	**5**	**6**
	Weight	**9.5**	
	Contribution	**47.5**	**57**
Construction Impacts Less excavation / embankment	***Rating***	**7**	**7.5**
	Weight	**9.5**	
	Contribution	**66.5**	**71.25**
Environmental Impacts Eliminates stream impact Less excavation / embankment	***Rating***	**4**	**7**
	Weight	**21.4**	
	Contribution	**85.6**	**149.8**
Project Schedule Eliminates the construction of the loop Eliminates the construction of the channel	***Rating***	**6**	**7**
	Weight	**16.6**	
	Contribution	**99.6**	**116.2**
	Total Performance	**657.4**	**781.25**
		Net Change in Performance	**19%**

VE RECOMMENDATION NO. 8: MARK SHOPVILLE RIGHT-OUT ONLY AT KY 461	Idea No. 14

Baseline Concept

All movements from/to Mark Shopville Road at KY 461 are allowed.

Recommendation Concept

Restrict left turn and through movements from Mark Shopville Road at KY 461 to right-out only; allow left-in from KY 461.

Advantages	Disadvantages
• Reduces conflicts • Supports purpose and need for free flow traffic	• Inconvenient for drivers • Does not meet driver expectation • Differs from what was presented to public

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept			
Recommendation Concept	Negligible		Negligible
Cost Avoidance/(Added Value)	Negligible		Negligible

FHWA Function Benefit

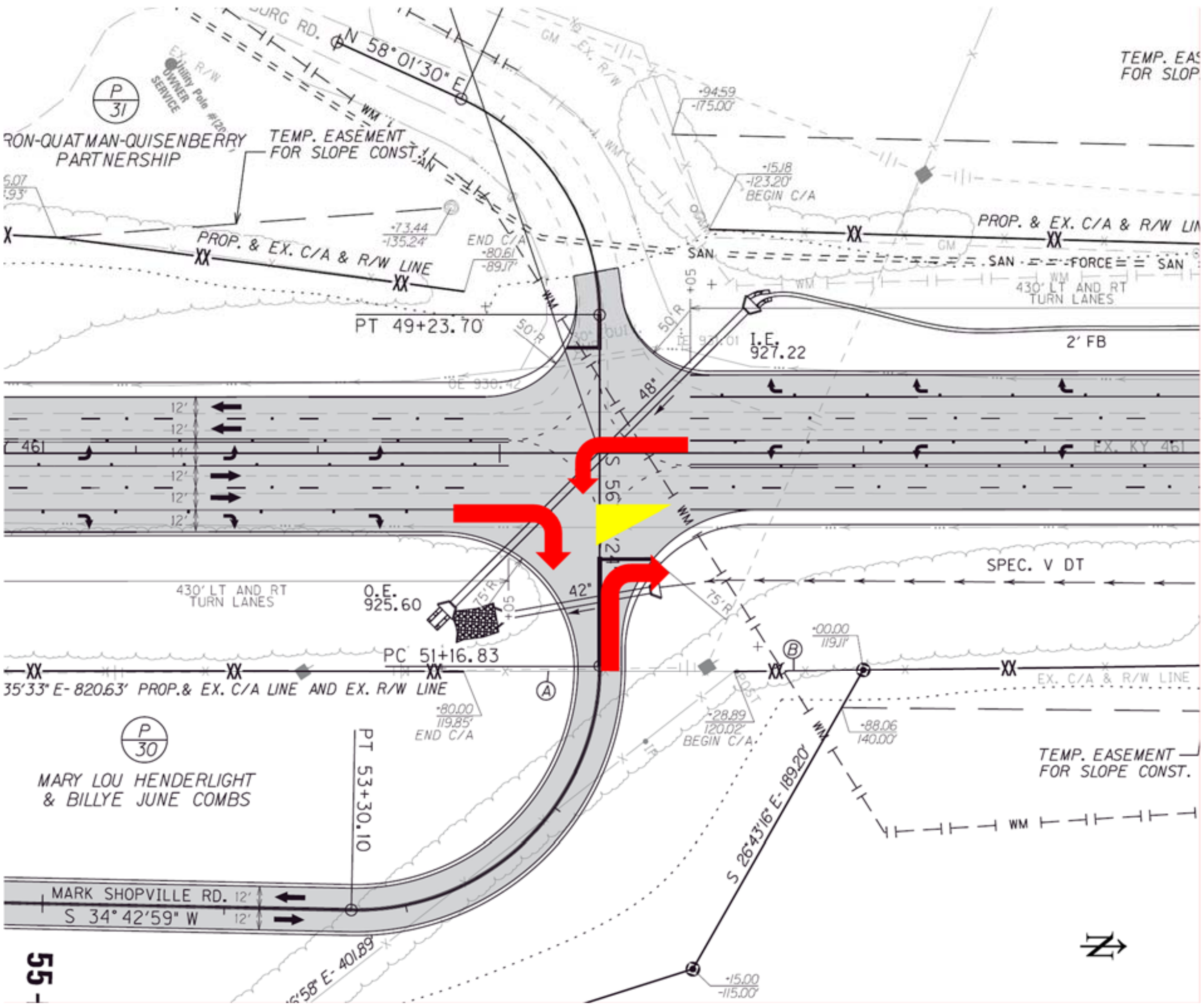
Safety	*Operations*	*Environment*	*Construction*	*Right-of-way*
✓	✓			

VE RECOMMENDATION NO. 8: MARK SHOPVILLE RIGHT-OUT ONLY AT KY 461	Idea No. 14

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

Once constructed, the baseline design allows traffic flow on Mark Shopville Road to have a left-out and right-out movement. The VE recommendation is to only allow traffic on Mark Shopville Road to have a right-out movement. Traffic on KY 461 would still have access to make a right-in and left-in. A concrete island or something similar would be implemented to constrain left-out movement.



This entrance onto Mark Shopville Road from KY 461 is currently designed to only be 1,350 feet away from the end of Ramp A and northbound through movement on KY 461. This could pose an issue for the left turn out of Mark Shopville Road onto KY 461 due to potential high speeds of vehicles on main line KY 461 and those exiting Ramp A. The vehicle must also cross three lanes of traffic with no refuge area before merging into the left lane of southbound KY 461.

VE RECOMMENDATION NO. 8: MARK SHOPVILLE RIGHT-OUT ONLY AT KY 461	Idea No. 14

With the recommendation of not allowing a left-out movement from Mark Shopville Road, the following might be used as alternatives to provide drivers access south on KY 461 toward Somerset:

1. Vehicles could use Mark Shopville Road to access KY 80 eastbound.
2. Vehicles, especially trucks, could use the Coin Road/Valley Oak Drive at KY 461 "jug handle" interchange to connect KY 461 south toward Somerset.
3. A J-turn/U-turn could be placed in the project limits north on KY 461 from the Mark Shopville Road at KY 461 intersection to provide drivers access south toward Somerset.

Accessing KY 461 Southbound using Mark Shopville Road to KY 80 west due to the prohibited left turn is 0.8 mile longer than allowing the left turn movement.

This recommendation could have a very slight impact to constructability and MOT depending on which alternative is implemented. The only new construction would be the concrete island, or similar, to prohibit left turns out of Mark Shopville Road.

Driver expectancy may be impacted due to the current layout of the intersection of Mark Shopville at KY 461. Presently, drivers can turn left onto KY 461 south. With the removal of the left-turn movement, drivers may experience confusion on selecting a different route.

Prohibiting left turns from Mark Shopville Road onto KY 461 south was not the layout presented to the public during multiple meetings, specifically the business connected to this road. This recommendation could add to driver confusion and differ from driver expectation.

The VE team does not believe the recommendation would impact the project schedule.

The VE team believes not having a left-out movement for Mark Shopville Road would reduce a conflict point, which would enhance safety for this location.

Assumptions/Calculations

Cost to implement the curbed island is negligible.

VE RECOMMENDATION NO. 8: MARK SHOPVILLE RIGHT-OUT ONLY AT KY 461	Idea No. 14

PERFORMANCE MEASURES Attributes and Rating Rationale for Recommendation	*Performance*	*Baseline*	*Recommendation*
Main Line Operations Eliminates crossing conflict	*Rating*	8	8.5
	Weight	28.8	
	Contribution	230.4	244.8
Local Operations Driver expectation for SB turn	*Rating*	9	9
	Weight	14.2	
	Contribution	127.8	127.8
Maintainability	*Rating*	5	5
	Weight	9.5	
	Contribution	47.5	47.5
Construction Impacts	*Rating*	7	7
	Weight	9.5	
	Contribution	66.5	66.5
Environmental Impacts	*Rating*	4	4
	Weight	21.4	
	Contribution	85.6	85.6
Project Schedule	*Rating*	6	6
	Weight	16.6	
	Contribution	99.6	99.6
	Total Performance	657.4	671.8
		Net Change in Performance	2%

7.4 Performance Assessment

As the VE team developed recommendations, the performance of each was compared to the baseline for potential value improvement. The baseline was evaluated and given a number based on the criteria found in Appendix E, Performance Criteria Rating.

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

7.4.1 Performance Rating

The performance matrix (Table 10) 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.

The performance rating and rationale for each alternative generated by the VE team is located on the individual recommendation forms found in Section 7.3.

Table 10. Performance Matrix

Attribute	Attribute Weight	Concept	Performance Rating	Total Performance
Main Line Operations	28.8	Baseline	8	230.4
		1	8	230.4
		2	8	230.4
		3	7.5	216.0
		4	9.5	273.6
		5	7.75	223.2
		6	8	230.4
		7	9	259.2
		8	8.5	244.8
Local Operations	14.2	Baseline	9	127.8
		1	9.5	134.9
		2	9	127.8
		3	9	127.8
		4	9	127.8
		5	9	127.8
		6	9	127.8
		7	9	127.8
		8	9	127.8
Maintainability	9.5	Baseline	5	47.5
		1	5.5	52.3
		2	6	57.0
		3	5.25	49.9
		4	4.5	42.8
		5	5.5	52.3
		6	5	47.5
		7	6	57.0
		8	5	47.5

Table 10. Performance Matrix

Attribute	Attribute Weight	Concept	Performance Rating	Total Performance
Construction Impacts	9.5	Baseline	7	66.5
		1	7	66.5
		2	6.87	65.3
		3	7	66.5
		4	7	66.5
		5	7	66.5
		6	7	66.5
		7	7.5	71.3
		8	7	66.5
Environmental Impacts	21.4	Baseline	4	85.6
		1	4	85.6
		2	4	85.6
		3	7	149.8
		4	4	85.6
		5	6.5	139.1
		6	7	149.8
		7	7	149.8
		8	4	85.6
Project Schedule	16.6	Baseline	6	99.6
		1	5.86	97.3
		2	6	99.6
		3	7	116.2
		4	6	99.6
		5	6	99.6
		6	6	99.6
		7	7	116.2
		8	6	99.6

7.4.2 Compare Value

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.

Table 11. Value Index

	Recommendations	Performance (P)	% Change Performance	Cost (C) $ millions	Cost Change $ millions	% Change Cost	Value Index	% Value Improvement
	Baseline	657	—	$44.2	—	—	14.87	—
1	Use Roundabouts at Industrial Park Bridge	667	+1.4	$43.5	($0.70)	-1.6	15.33	+3.1
2	Change Structure Design at System Interchange	666	+1.3	$43.0	($1.18)	-2.7	15.47	+4.0
3	Reduce Ramp H Radius	726	+10.5	$42.4	($1.76)	-4.0	17.11	+15.0
4	Create J-turns along KY 461	696	+5.8	$46.7	$2.50	+5.7	14.90	+0.2
5	Use 11-foot Lanes	708	+7.8	$43.4	($0.79)	-1.8	16.32	+9.7
6	Create Detention Ponds	722	+9.8	$44.5	$0.26	+0.6	16.23	+9.1
7	Reconfigure Ramp D	781	+18.8	$38.9	($5.27)	-11.9	20.07	+34.9
8	Mark Shopville Right-out Only at KY 461	672	+2.2	$44.2	$0.00	0.0	15.20	+2.2
	Total				($6.80)			

7.5 Design Considerations

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 12. Several design considerations were developed further and can be found below.

Table 12. Design Considerations

Design Cons.#	Idea No.	Description
DC-9	1	Plan for a 2+1 typical section to Mount Vernon
DC-10	3	Utilize retaining walls to build ramp H/D to minimize stream impacts
DC-11	5	Reduce KY 461 by 2 feet (make median 12 feet)
DC-12	8	Use 2+1 lanes (directional peak) traffic control
DC-13	9	Use a Diamond Interchange in lieu of the system interchange with roundabouts at termini
DC-14	16	Create a raised or barrier median on KY 461
DC-15	17	Add an eastbound Barnesburg to northbound 461 acceleration lane
DC-16	18	Add sidewalk on north side of Coin Road and on bridge over KY 461
DC-17	19	Use barrier wall instead of guardrail to separate Ramps D/H and B/F
DC-18	24	Remove south access to Tommy Road
DC-19	25	Connect Parcel 38 access to Jug-handle
DC-20	27	Grade separate existing Ramp B alignment with Ramp F
DC-21	32	Reduce Coin Road bridge by 2 feet (make it 12'-12'-12')
DC-22	33	Improve pavement design on shoulders to use during construction

DESIGN CONSIDERATION NO. 9: PLAN FOR A 2+1 TYPICAL SECTION TO MOUNT VERNON	Idea No. 1

Baseline Concept

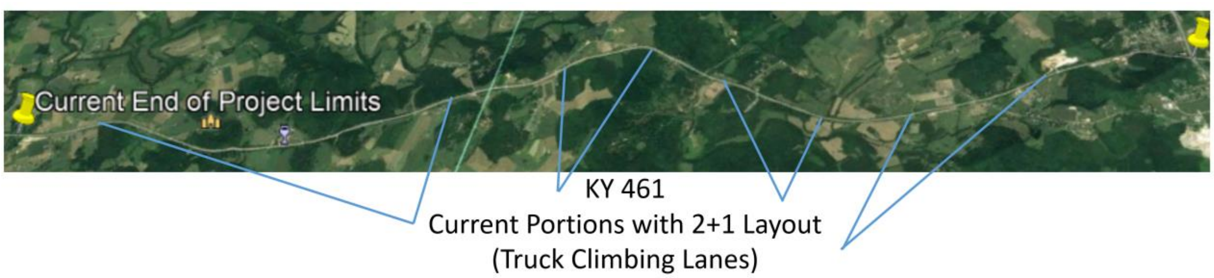
It is approximately 11.5 miles from the end of the project limits (the bridge over Buck Creek) to the City of Mount Vernon on KY 461. Currently, the typical section layout is a two-lane facility with alternating truck-climbing lanes for approximately 6 total miles throughout the section of roadway. This section of roadway is not currently part of the existing project; however, it can be considered as a project for future growth or expansion.

Suggested Concept

The suggested concept is to plan for a 2+1 from the end of the project limits (the bridge over Buck Creek) to the City of Mount Vernon along KY 461.

Advantages	Disadvantages
• May avoid future costs • Sets up future widening to north • Consistant layout of Corridor/driver expectancy	• Outside project limits

Discussion



With approximately 50 percent of the roadway between the north end of the project limit (bridge over Buck Creek) to Mount Vernon on KY 461 already in a 2+1 design, fully implementing a 2+1 template throughout the corridor would increase consistency and improve driver expectancy. This design consideration coincides with Design Consideration No. 3, implementing a 2+1 template within project limits.

This 2+1 concept can also accommodate future growth of the area. The roadway can be reconfigured through re-striping or construction of an additional lane.

The total width of the roadway would only be affected in the current portions of the roadway where there are no truck climbing lanes present.

DESIGN CONSIDERATION NO. 11: REDUCE 461 BY 2-FEET (MAKE MEDIAN 12 FEET)	Idea No. 5

Baseline Concept

The designed typical section for KY 461 is four, 12-foot driving lanes with 10-foot shoulders and a 14-foot flush median.

Suggested Concept

The recommended concept is to reduce KY 461 by 2 feet through reducing the median from 14 feet to 12 feet.

Advantages	Disadvantages
• Reduced cost • Reduced impervious • Reduced maintenance	• Reduced space for turning vehicles • Reduced driver comfort

Discussion

Reducing the width of the flush median on KY 461 from 14 feet to 12 feet would reduce the amount of pavement needed by approximately 5,350 square yards (2-feet x 5,280 feet/mi x 4.56 mi/9 SF/SY= 5,350 square yards). Assuming a unit price of $52.69/SY, this would reduce construction cost by approximately $280,000, and reduce the cost of future maintenance and resurfacing. With the reduction of width of the median, drivers may feel less comfortable when in the 2-way left turn lane and dedicated left turn lanes. Reducing the median width would allow for some widening of the shoulders or main line in the future if necessary.

DESIGN CONSIDERATION NO. 12: USE 2+1 LANES (DIRECTIONAL PEAK) TRAFFIC CONTROL	Idea No. 8

Baseline Concept

The current typical section layout design on KY 461 from Valley Oak Drive to the north end of the project utilizes four, 12-foot driving lanes with 10-foot shoulders (8-foot paved), and a 14-foot flush median for left turns. For six of the eight entrances on this portion of roadway, dedicated left turn lanes are employed.

Suggested Concept

The recommended concept is to utilize 2+1 lanes (directional peak) traffic control on KY 461 from Valley Oak Drive to the north end of the project. The typical section layout would become three, 12-foot lanes with 10-foot shoulders (8–foot paved) with a 3-foot flush median to separate traffic.

Advantages	Disadvantages
• May meet traffic demand • Context-sensitive approach • Reduced construction cost and reduce maintenance • Reduced environmental impacts	• May not meet intent of BUILD Grant • May require modification of document • May require sponsorship for modification • Eight entrances with left-turn access within approximately 1.95 miles

Discussion

Utilizing 2+1 lanes is an attractive alternative to four-lane roads where environmental and/or fiscal constraints make provision of a four-lane facility impractical. A 2+1 facility should also only be used in level or rolling terrain, and this project location has rolling terrain. However, the location of major intersections and high volume driveways should be a key consideration when selecting passing lanes. Proper placement of passing lanes and transition sections with respect to higher volume intersections will minimize the number of turning movements within the passing lane sections. Major intersections should be located in the transition area between opposing passing lanes and the conventional left-turn lanes provided at the intersection (*A Policy on Geometric Design of Highways and Streets,* 3-149 to 3-152).

With eight entrances on this section of KY 461, rear-end accidents of left-turning vehicles from passing lanes is of concern. To accommodate this, appropriate placement of passing lanes and transitions can be employed. J-turns and U-turn movements could also be implemented to restrict left turn movements. In this roadway section of approximately 1.95 miles, two passing lane sections could be constructed, considering taper lengths, lane drop lengths, and passing lengths.

This 2+1 concept can also accommodate future growth of the area. The roadway can be reconfigured through re-striping or construction of an additional lane.

The total width of the roadway would also be reduced from 82 feet to 59 feet, reducing cost, maintenance, and environmental impacts.

DESIGN CONSIDERATION NO. 13: USE A DIAMOND INTERCHANGE IN LIEU OF THE SYSTEM INTERCHANGE WITH ROUNDABOUTS AT TERMINI	Idea No. 9

Baseline Concept

The baseline concept is a full cloverleaf interchange that employs loop ramps to accommodate left-turning movement in all four quadrants.

Suggested Concept

The suggested concept is to utilize a diamond interchange with roundabouts at termini in lieu of the system interchange.

Advantages	Disadvantages
• Smaller footprint • Introduces traffic calming • Reduced construction costs • Reduced impervious • Reduced stream impacts	• Not a 55 mph design • Slower system interchange • Differs from what was presented to public • Significant change to current design • May require public meeting/environmental reevaluation • May delay project

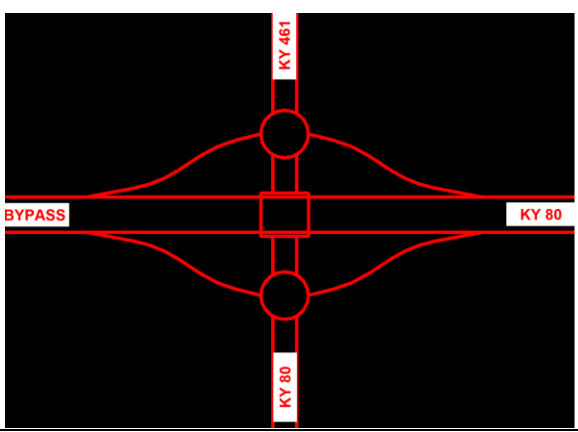
Discussion

With this suggested concept, all through and turning movements on the cross streets and ramps are accommodated using multilane roundabouts (which would contain mountable truck aprons to accommodate the expected volume of trucks and trailers with boats). The design provides continuous flow of traffic within a smaller construction footprint, a narrower bridge (no auxiliary ramp lanes), and the elimination of proposed signal control at the interchange.

This type of design provides a smaller footprint versus the cloverleaf because of smaller radii of the roundabouts compared to the radii of the ramps (444 feet versus at-most 300 feet). It also introduces traffic calming, or the intentional slowing of traffic, which would encourage slower traveling speeds when exiting the ramps. Reduced construction costs, impervious area, and stream impacts are also expected. Construction costs and impervious area would decrease due to the lesser amount of pavement from the smaller radii and more direct ramps. The stream would also not be impacted as greatly due to the smaller footprint. Ramp H would not exist and the proposed roundabout would have a smaller radii.

However, this design differs greatly from the proposed design presented at public meetings. Altering the design at this stage may require further environmental evaluation, more public meetings, and delay the project due to the need of further analysis and re-configuration.

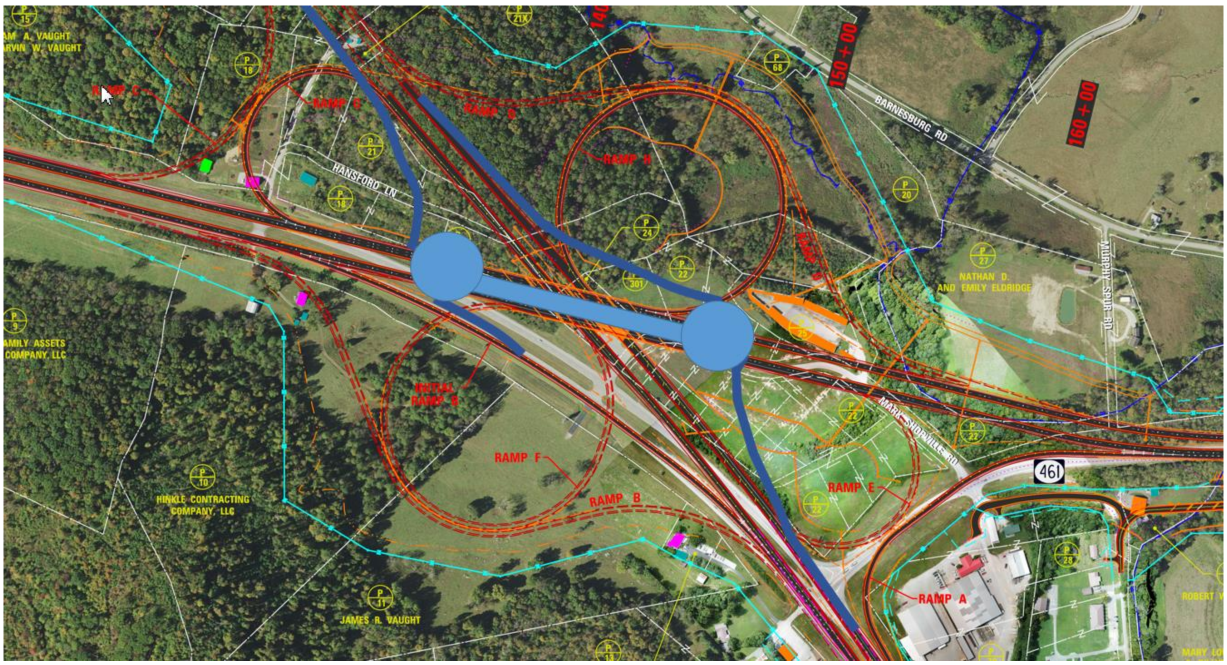
Below is a graphic depicting the suggested concept:



DESIGN CONSIDERATION NO. 13: USE A DIAMOND INTERCHANGE IN LIEU OF THE SYSTEM INTERCHANGE WITH ROUNDABOUTS AT TERMINI	Idea No. 9

HCS 7 Roundabouts

	AM	PM
North Roundabout	B 13.2	D 33.2
South Roundabout	C 24.5	A 9.1



DESIGN CONSIDERATION NO. 15: ADD AN EASTBOUND BARNESBURG TO NORTHBOUND 461 ACCELERATION LANE	Idea No. 17

Baseline Concept

As designed, to make a left turn from Barnesburg Road onto KY 461 vehicles must cross a right-turn lane, two through-lanes, and a left-turn lane. Vehicles will have no refuge area and must make the complete turn onto the left-most northbound KY 461 lane.

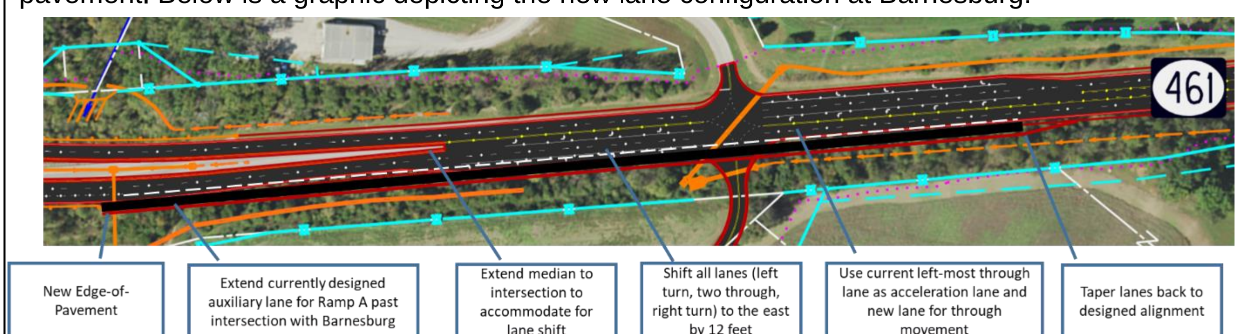
Suggested Concept

The recommended concept is to add an eastbound Barnesburg to northbound KY 461 acceleration lane.

Advantages	Disadvantages
• 2 stage gap acceptance	• Requires more pavement • Traffic volume may not warrant

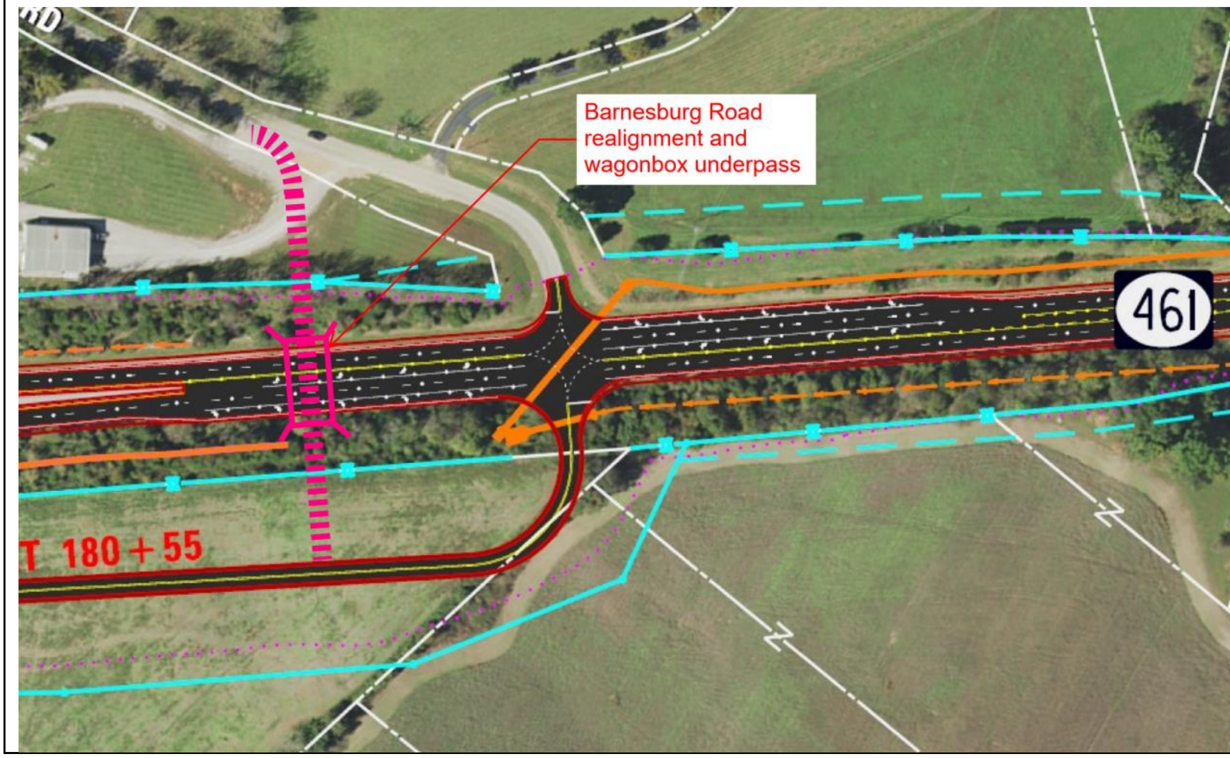
Discussion

Adding an acceleration lane for vehicles turning left from Barnesburg Road onto KY 461 would give these vehicles distance and time to fully accelerate to the speed of main line traffic. With the current design, left-turning vehicles from Barnesburg onto KY 461 would need a 9 second time gap to safely perform the turn (per the *Policy of Geometric Design for Highways and Streets*). Along with this, drivers must judge the time needed to not only cross traffic, but safely turn into free-flow traffic in one stage. Adding an acceleration lane would break this process into two stages, which gives vehicles turning extra time to reach free-flow speeds and safely merge into traffic. Adding an acceleration lane could require more right-of-way acquisition because a portion of the road would need to be widened 12 additional feet. Cost would be increased slightly with the addition of pavement. Below is a graphic depicting the new lane configuration at Barnesburg:



Another alternative to an acceleration lane, which would also aid in the difficult left-turn movement, would be to construct a culvert under KY 461 and re-route Barnesburg Road under KY 461 onto the newly proposed section of Mark Shopville Road. The underpass may need to be located further to the west due to grades. On the following page is a graphic depicting this design layout:

DESIGN CONSIDERATION NO. 15: ADD AN EASTBOUND BARNESBURG TO NORTHBOUND 461 ACCELERATION LANE	Idea No. 17



DESIGN CONSIDERATION NO. 16: ADD SIDEWALK ON NORTH SIDE OF COIN ROAD AND ON BRIDGE OVER 461	Idea No. 18

Baseline Concept

No pedestrian facilities along Coin Road and Valley Oak Drive.

Suggested Concept

Add a sidewalk on the north side of Coin Road and Valley Oak Drive, including on the bridge over KY 461.

Advantages	Disadvantages
• Accommodate pedestrians including ADA accessibility throughout the industrial part • Removes conflicts between vehicles and pedestrians	• Increased cost • Increased bridge width

Discussion

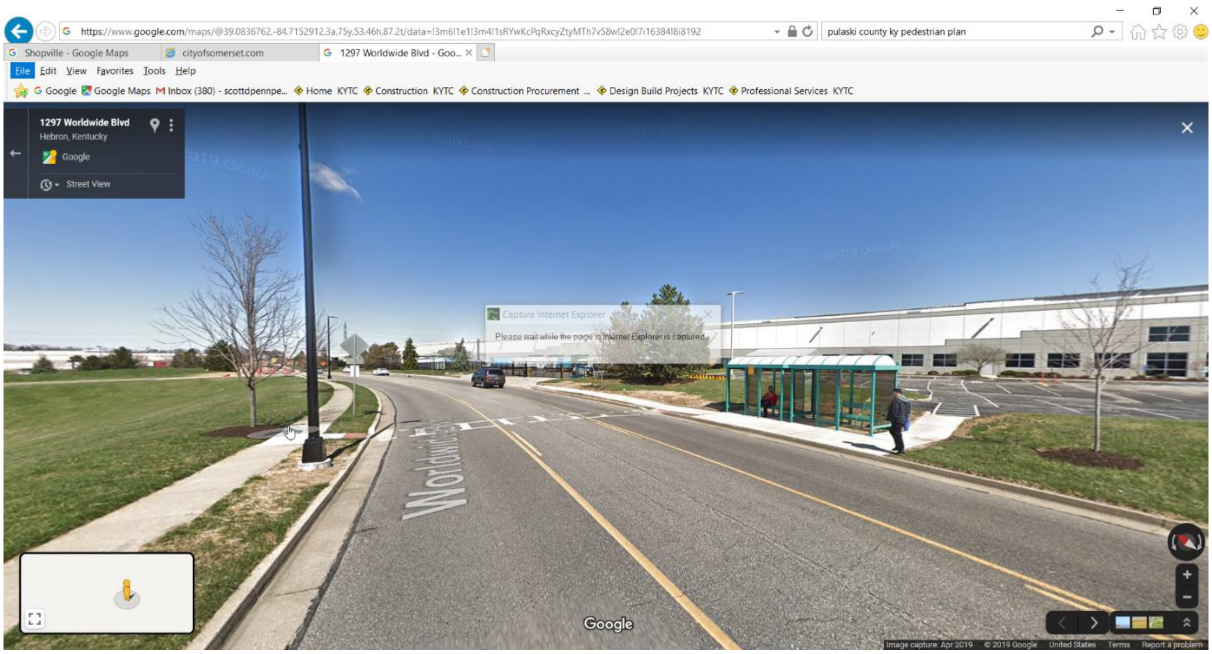
As designed, no pedestrian facilities are included in the project plans. With the large workforce and the number of businesses along the Coin Road/Valley Oak Drive corridor, the construction of a 5-foot ADA-accessible sidewalk along the north side of the roadway would provide the first piece of a larger pedestrian-friendly network that could accommodate pedestrians and remove conflicts between vehicles and pedestrians in this expanding industrial area.

The sidewalk would provide pedestrian connectivity between the businesses in the area (possibly reducing vehicle emissions) and promote healthier lifestyles for employees by providing facilities for walking during break times. As the industrial park expands (including Valley Oak Drive), other businesses could tie to the pedestrian network.

Should public transit in this area develop in the future, sidewalks could accommodate those employees dropped off by those entities. Though outside the city limits of Somerset, a pedestrian network in this area would align with Somerset's Bicycle and Pedestrian Master Plan. The addition of a sidewalk would increase the cost of this project, particularly with the corresponding increased width of the bridge over KY 461.

DESIGN CONSIDERATION NO. 16: ADD SIDEWALK ON NORTH SIDE OF COIN ROAD AND ON BRIDGE OVER 461	Idea No. 18

Example of a Pedestrian Network in an Industrial Area



Cost Estimate for Sidewalk

Sidewalk: 2000' x 5'/9 = 1100 SY x $75/SY = $82,500

ADA Ramps: 5 Ea x $1000/Ea = $5000

Thermo Markings: $1000

Earthwork: 10,000 CY x $3.50/CY = $35,000

Bridge (5' Additional Width on 200' Length Bridge): 5' x $36,0000/LF = $180,000

Bridge Fence: 200 LF x $75/LF = $15,000

Total Cost: $317,500

Final Cost with 30 percent Contingency: $318,500 x 1.3 = $412,750

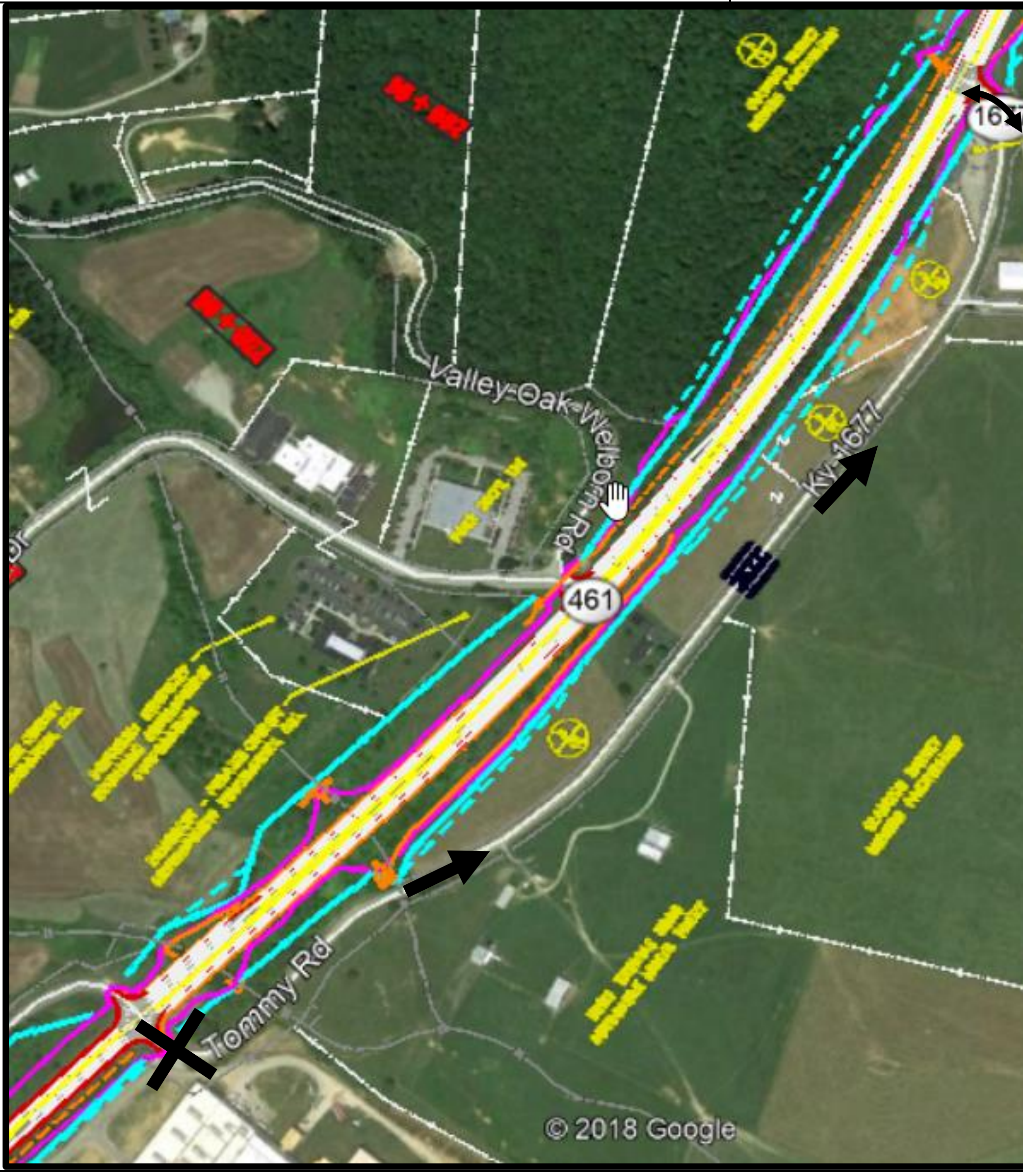
DESIGN CONSIDERATION NO. : 17 USE BARRIER WALL INSTEAD OF GUARDRAIL TO SEPARATE RAMPS D/H AND B/F	Idea No. 19
Baseline Concept	
Use guardrail to separate Ramps D/H and B/F	
Suggested Concept	
Use a 50-inch barrier wall instead of guardrail to separate Ramps D/H and B/F	
Advantages	**Disadvantages**
• Creates visual separation between opposing movements • Wall does not deform (as opposed to GR) • Reduces headlight glare from opposite direction • Less maintenance	• More costly
Discussion	
The VE team recommends using a 50-inch barrier wall to separate Ramps D/H and B/F in lieu of a guardrail. Given the proximity of the ramps to each other, the VE team believes having a visual separation could be beneficial to the driver. A barrier wall could help opposing movements by reducing headlight glare and potentially decreasing severity of crashes versus ramps being separated by a guardrail. Having a barrier wall would require less maintenance and would not deform as a guardrail might if hit by a vehicle. A barrier wall would initially be more costly than using guardrail as proposed in current plans.	

DESIGN CONSIDERATION NO. 18: REMOVE SOUTH ACCESS TO TOMMY ROAD	Idea No. 24
Baseline Concept	
Tommy Road has two separate accesses to KY 461.	
Suggested Concept	
Remove south access to Tommy Road	

Advantages	Disadvantages
• Removes one conflict point on KY 461 • May improve operations	• Possible owner opposition

Discussion
The purpose and need of the project is to enhance safety, enhance mobility, and build a free flow facility on KY 461. Through the function analysis phase of the VE study, one way to enhance safety and enhance mobility is to reduce conflict points. By removing the southern access to Tommy Road, multiple conflict points would be eliminated (right-in, right-out, southbound left-in, and left-out). Those movements could be done more safely at Flat Lick Road, which is further away from the Coin Road interchange. No access is being removed; homes would maintain access via the other location (see graphic on the following page).

DESIGN CONSIDERATION NO. 18: REMOVE SOUTH ACCESS TO TOMMY ROAD	Idea No. 24



DESIGN CONSIDERATION NO. 19: CONNECT PARCEL 38 ACCESS TO JUG-HANDLE	Idea No. 25

Baseline Concept

KY 461 access to/from Parcel 38 is achieved at the south end of the property.

Suggested Concept

Access Parcel 38 to/from the jug handle adjacent to the property.

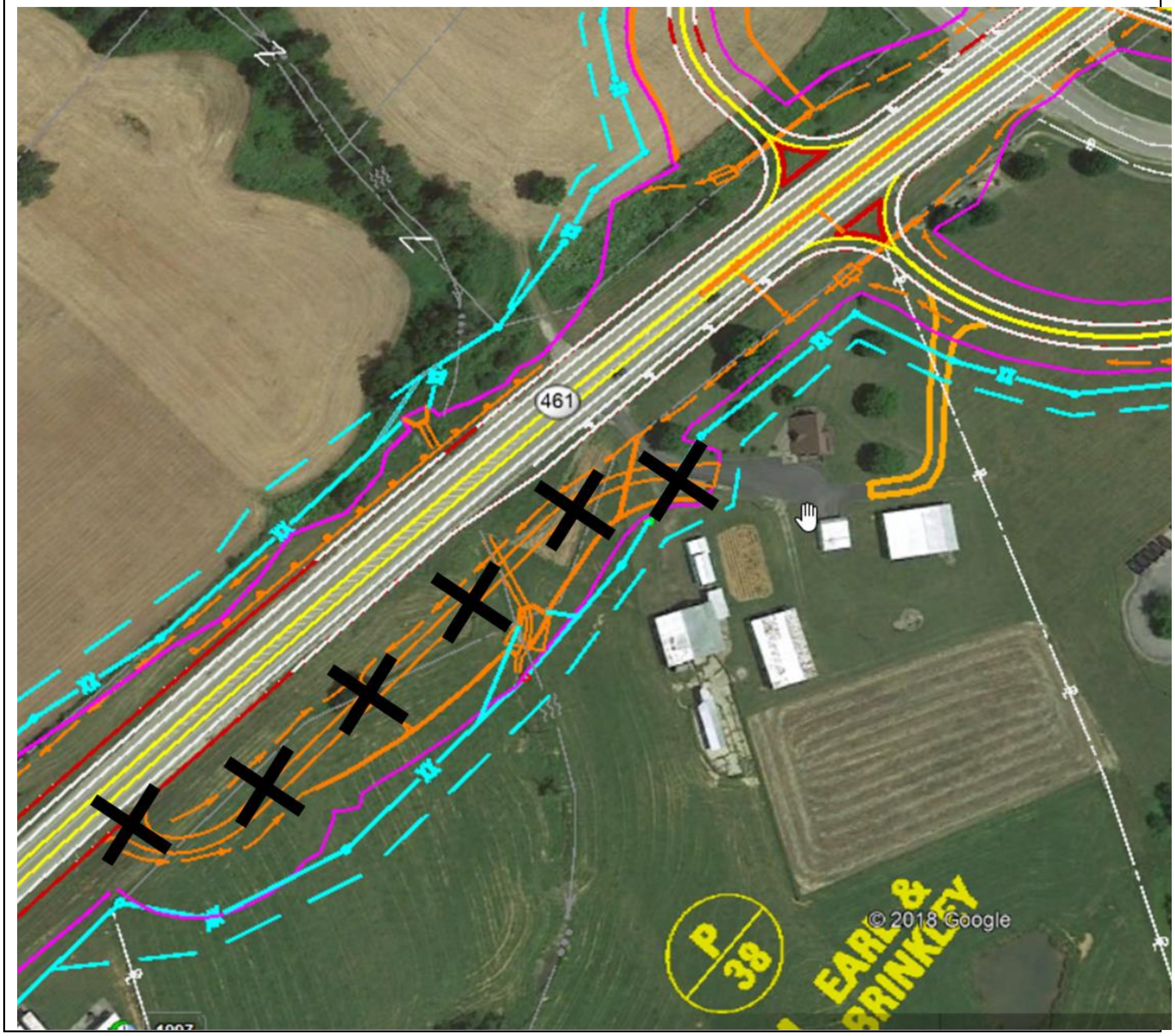
Advantages	Disadvantages
• Less pavement • Remove one access point on KY 461 • Reduce pipe extension • Reduces overall right-of-way required	• May require small acount of right-of-way to connect to “ramp” • Access off of “ramp”

Discussion

The purpose and need of the project is to enhance safety, enhance mobility, and build a free flow facility on KY 461. Through the function analysis phase of the VE study, one way to enhance safety and enhance mobility is to reduce conflict points.

Relocating this access point to the jug handle removes multiple conflict points on KY 461 (see graphic on the following page).

DESIGN CONSIDERATION NO. 19: CONNECT PARCEL 38 ACCESS TO JUG-HANDLE	Idea No. 25



DESIGN CONSIDERATION NO. 20: GRADE SEPARATE EXISTING RAMP B ALIGNMENT WITH RAMP F	Idea No. 27

Baseline Concept

Use initial ramp B; when ramp F is built, construct ramp B ultimate condition.

Suggested Concept

Grade separate Initial Ramp B alignment with Ramp F, eliminating future Ramp B

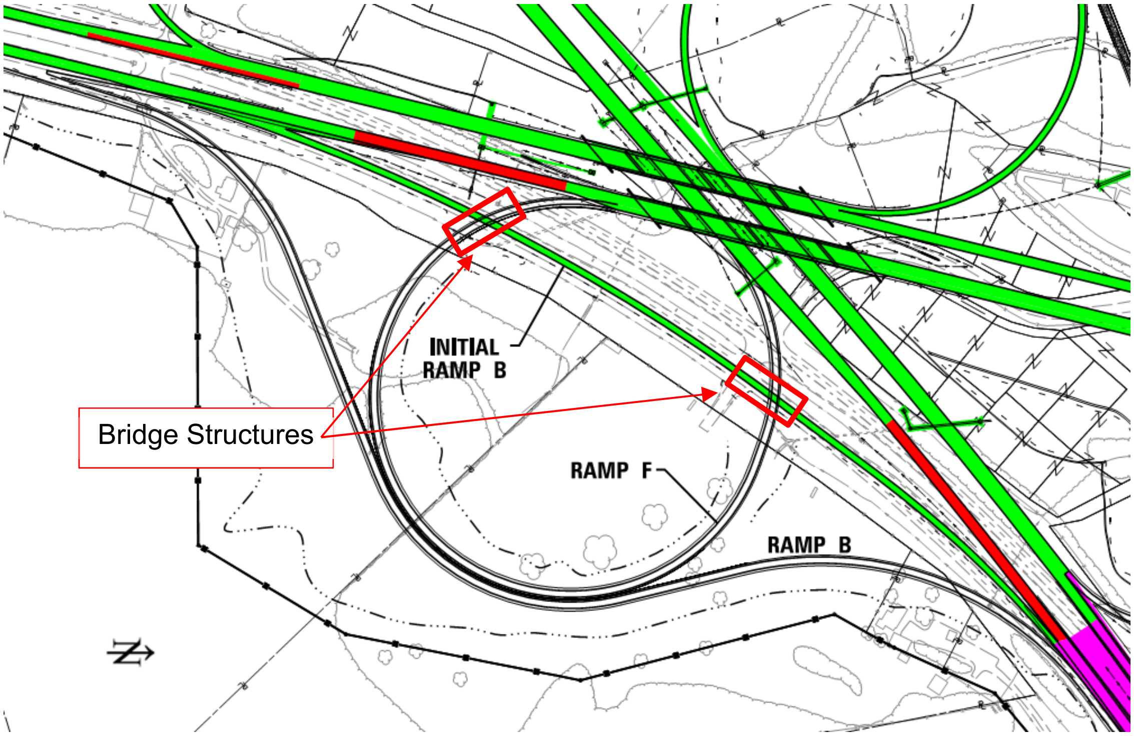
Advantages	Disadvantages
• Reduce project footprint (earthwork) • Better geometry • Less pavement when tied in with Northern Bypass • Eliminates opposing traffic/headlights	• Additional structure costs • Additional embankment

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$1,137,000		$1,137,000
Recommendation Concept	$1,290,000		$1,290,000
Cost Avoidance/(Added Value)	$(152,000)		$(152,000)

The VE team recommends using the Initial Ramp B and incorporate a grade separation with ramp F, which would allow eliminating future ramp B. The VE team believes this option would allow the overall footprint of the project to be reduced because Ramp B would not need to be built. An initial rough measurement of the plans showed that a 3 to 4 percent grade would be implemented to get the grade separation of initial ramp B over ramp F. Another benefit would be the overall reduction in earthwork for not having to construct ramp B. This would reduce pavement costs in any future projects of tying in the Northern Bypass. The downside is that cost in savings of pavement could disappear because additional structures would be needed to implement the grade separation of initial ramp B over ramp F.

The following image helps illustrate the location of the structures in this configuration.

DESIGN CONSIDERATION NO. 20: GRADE SEPARATE EXISTING RAMP B ALIGNMENT WITH RAMP F	Idea No. 27



Calculations:

Bridge Ramp F over Ramp B						Bridge Ramp B over Ramp F					
1.5	barrier					1.5	barrier				
4	shoulder					6	shoulder				
15	lane					15	lane				
2	shoulder					4	shoulder				
1.5	barrier					1.5	barrier				
24	width					28	width				
100	length					75	length				
2400	sq ft	$ 180	per sq ft	$ 432,000		2100	sq ft	$ 180	per sq ft	$ 378,000	

The total cost of structures were adjusted by 30 percent for contingency and complete cost assessment is in the table below.

Earthwork for the total KY 461/KY 80 interchange is 2,000,000 CY. Assuming this section (Ramps B/F) accounts for 25 percent of the total earthwork.

2,000,000 CY * 0.25 = 500,000 CY

For ramp B in this section, we are assuming earthwork to be 50 percent

500,000 CY * 0.50 = 250,000 CY.

Total earthwork for having to implement this recommendation is 10 percent.

500,000 CY * 0.10 = 50,000 CY.

Asphalt for implementing recommendation is roughly 1,200 ft for initial ramp B. Assuming cost of asphalt is $52.69/SY

(1,200 ft/9) = 133.33 SY

DESIGN CONSIDERATION NO. 20: GRADE SEPARATE EXISTING RAMP B ALIGNMENT WITH RAMP F

Idea No. 27

VE Study Costs Calculations

KY 461 & KY 80 and KY 461 Widening

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Bridge Ramp F over Ramp B	Sq Ft		$ 180.00	$ -	2,400	$ 180.00	$ 432,000.00
Bridge Ramp B over Ramp F	Sq Ft		$ 180.00	$ -	2100	$ 180.00	$ 378,000.00
Earthwork for getting rid of Ramp B	CY	250,000	$ 3.50	$ 875,000.00	50,000	$ 3.50	$ 175,000.00
Asphalt for Initial Ramp B	SY		$ 52.69	$ -	133.33	$ 52.69	$ 7,025.16
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
Subtotal Construction				*$ 875,000.00*			*$ 992,025.16*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 262,500.00			$ 297,607.55
Total Construction				**$ 1,137,500.00**			**$ 1,289,632.71**
Monetized Time Savings							$ -
Right of Way Costs	SF			$ -			$ -
TOTAL CAPITAL COST				***$ 1,137,500.00***			***$ 1,289,632.71***
COST CAPITAL SAVINGS / (INCREASE)							***$ (152,132.71)***

DESIGN CONSIDERATION NO. 21: REDUCE COIN ROAD BRIDGE BY 2-FEET (MAKE IT 12'-12'-12')	Idea No. 32

Baseline Concept

Proposed Coin Road bridge has a total width of 45' = 1.5' barrier + 2' shoulder + 12' lane + 14' median + 12' lane + 2' shoulder + 1.5' barrier

Suggested Concept

Reduce Coin Road bridge by 2-feet for a new total width of 43' = 1.5' barrier + 2' shoulder + 12' lane + 12' median + 12' lane + 2' shoulder + 1.5' barrier

Advantages	Disadvantages
• Reduced cost • Reduced impervious surface runoff	• Increases friction with opposing traffic

Discussion

Baseline Concept Deck Area = 9,000 sq ft = 45' wide x 200' long

Suggested Concept Deck Area = 8,600 sq ft = 43' wide x 200' long

Baseline Concept Cost = 9,000 sq ft x $180/sq ft = $1,620,000

Suggested Concept Cost = 8,600 sq ft x $180/sq ft = $1,548,000

Cost Savings = $72,000 * 1.30 markup = $93,600

7.6 Design Validation

Several ideas the VE team initially brought forward as recommendations were dropped from consideration after it was determined the baseline design was more economical and feasible. This design validations can be found in Appendix F.

Appendix A

Value Methodology Process

Appendix A. The Value Methodology 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, constructability, 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 facilitator 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

The VE team employed the six-phase Value Methodology 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 facilitator 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 facilitator 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 facilitator 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 was 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

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.

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]
		3	4.5	[illegible]
Environmental Impacts	16.6	Baseline	5	[illegible]
		1	[illegible]	[illegible]
		2	[illegible]	83.0
		3	[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	[illegible]	Baseline	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

HDR

Memo

Date:	Thursday, October 24, 2019
Project:	Pulaski County KY 461 Widening Including Interchange at KY 80–Items 8-59.25 & 8-59.26
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 KYTC project Item 8-59.25 & 8-59.26. As stated in the Design Executive Summary the purpose and need is as follows:

The purpose of this project is to *enhance regional mobility and provide a safer, free flowing connection* between I-75, Cumberland Lake Parkway, Hal Rogers Parkway, and the future Somerset Northern Bypass in Pulaski County.

KY 80 provides the primary east-west arterial connection from Somerset in Pulaski County to London in Laurel County, linking the Cumberland Parkway in the west to I-75 and the Hal Rogers parkway in the east. The route carries between 8,000 and 19,000 vehicles per day, including as many as 2,300 trucks daily. KY 461 provides a vital north-south arterial connection linking KY 80 near Shopville in Pulaski County to I-75 near Mount Vernon in Rockcastle County. KY 461 carries approximately 11,000 vehicles per day including 2,000 trucks. The Valley Oak Industrial Complex is located along KY 461 and generates approximately 3,000 jobs for the region.

The existing KY 80 / KY 461 at grade intersection near KY 80 mile point 27.619 has experienced 74 accidents (2-Fatalities, 39-Injuries) from 2013 through 2018. The intersection currently has a critical rate factor (CRF) of 1.43, indicating a higher than expected crash rate than other similar intersections. The existing KY 461 / Valley Oak Complex at grade intersection has experienced 16 accidents (15 injury) from 2013 through 2018. This intersection was expanded in 2012 to add left and right turn lanes but continues to present safety concerns due to the large number of large trucks attempting left turns across opposing KY 461 traffic and high volumes generated by shift-change traffic. These traffic concerns and their corresponding safety issues demonstrate the extreme pressure this regional roadway system is under due to the heavy traffic demand generated by intense local economic growth combined with high volumes of through traffic

VE Study Dates and Location

The workshop will be held December 16 through December 19, 2019 at

KYTC Central Office
200 Mero Street, Room C118
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 four 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 appropriate dress is what some would call business casual (no ties required).
4. **If you have a laptop <u>please bring it</u>.** 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.
- Establishes Performance Measures,
- Q&A – Presenters answer 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,
- Sequence functions to understand their relationships using the Function Analysis System Technique (FAST),

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, 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
M 561.386.3879
HDR
440 S. Church Street, Suite 1000
Charlotte, NC 28202-2075
D 704.338.6845 **M** 561.386.3879
jose.theiler@hdrinc.com

Agenda

Day 1	Monday, December 16 Objective for the day: Learn about VE and the project	
08:15 AM	**VE Team Introductions** • Team "meet and greet" • Study kickoff and agenda review • Team introductions	**All audiences:** Project owner, management, stakeholders, designers, etc.
09:00 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**
9:30 AM	**Virtual Site Visit**	**All Audiences**
10:15 AM	**Break**	
10:30 AM	**Risk Elicitation** **Define Performance Attributes** **Project Review Observations**	**All Audiences**
12:00 PM	**Lunch**	**All Audiences**
01:00 PM *Information Phase*	**Begin Function Analysis** • Review project cost model • Define key project functions using "verb + noun" expressions • Build FAST Diagram	**Facilitator** **VE team**
2:00 PM	**Break**	
02:15 PM	**Begin Creative Phase** • Brainstorm alternative ways to perform key functions • Brainstorm ways to improve value of key functions	**VE team**
04:30 PM	**Begin Evaluation Phase** • 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 2	Tuesday, December 17 Objective for the day: Function Analysis, Brainstorming Ideas and Begin Developing	
08:00 AM *Creative Phase*	**Complete Creative Phase** • Last minute ideas	**VE team**
8:15 AM *Evaluation Phase*	**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 PM	**Lunch**	
01:00 PM	**Mid-point review**	**Facilitator, D8 Value Engineer, Project Managers**
1:00 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 3	Wednesday, December 18 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**
12:00 PM	**Lunch**	
1:00 PM *Development Phase*	**Continue Development of Recommendations** • Wrap up Recommendations write-ups **Prepare Close-out Presentation**	**VE team**
3:00 PM *Development Phase*	**Finalize Recommendations** • Peer review of recommendations	**VE team**
05:00 PM	**Adjourn**	

Day 4	**Thursday, December 19** **Objective for the day: Deliver Close-out Presentation**	
08:00 AM *Development Phase*	**Evaluation of Performance Attributes**	**VE team**
11:00 AM *Presentation Phase*	**Finalize Close-out Presentation** **Team Rehearsal**	**VE team**
12:00 PM	**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 201904 - Study Attendees
KY 80 and KY 461 Interchange and KY 461 Widening

December 2019				NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	CELL	E-MAIL
16	17	18	19						
✓	✓	✓	✓	Albrecht, Erica	HDR	Structures		502.235.6813	Erica.Albrecht@hdrinc.com
✓			✓	Asher, Jill	KYTC	Director, Division of Highway Design	502.564.3280		Jill.asher@ky.gov
✓	✓	✓	✓	Cochran, Joe	HDR	Team Assistant	859.629.4836		Joe.Cochran@hdrinc.com
✓			✓	Gossage, Joseph	KYTC	District 8 Branch Manager – Project Development	606.677.4018		Joseph.gossage@ky.gov
✓	✓	✓	✓	Harrod, Justin D	KYTC	Quality Assurance	502.782.5059		Justin.Harrod@ky.gov
✓	✓	✓	✓	Hedges, Adam	HDR	Traffic/Safety	859.629.4872		Adam.Hedges@hdrinc.com
✓			✓	Moore, John	KYTC	Assistant State Highway Engineer (Project Development)	502.564.3730		John.w.moore@ky.gov
✓			✓	Mosley, Joseph	HMB	Highway Div. Mgr.	502.695.9800		jmosley@hmbpe.com
✓	✓	✓	✓	Pennington, Scott	HDR	Construction/Constructibility	859.227.2452		Scott.pennington@hdrinc.com
✓		✓	✓	Schurman, Connor	KYTC	Highway Design			Connor.schurman@ky.gov

VE 201904 - Study Attendees
KY 80 and KY 461 Interchange and KY 461 Widening

December 2019				NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	CELL
16	17	18	19				E-MAIL	
✓	✓	✓	✓	Sweger, Brent A	KYTC	State Value Engineer	502.782.4912 Brent.Sweger@ky.gov	
✓	✓	✓	✓	Theiler, Jose	HDR	VE Facilitator (CVS)	704.338.6845 jose.theiler@hdrinc.com	561.386.3879
			✓	Turner, Randy	KYTC	Location Engineer	Randy.turner@ky.gov	
			✓	Vaughan, Eileen	FHWA		Eileen.vaughan@dot.gov	
✓		✓	✓	Willmerdinger, Corinne	KYTC	Highway Design	cwillmerdinger@ky.gov	
✓			✓	Young, Clint	HMB	Design Engineer	502.695.9800 cyoung@hmbpe.com	

Appendix C

VE Recommendation Approval Form

Appendix C. VE Recommendation Approval Form

Project: KY 80 and KY 461 Interchange and KY 461 Widening
VE Study Date: December 16 through 19, 2019

	Recommendation	Approved Y/N	FHWA Functional Benefit: Safety	Operations	Environment	Construction	Right-of-way	VE Team Estimated Cost Avoidance or (Cost Added)	Actual Estimated Cost Avoidance or Cost Added
1	Use Roundabouts at Industrial Park Bridge			✓	✓			$0.70	
2	Change Structure Design at System Interchange					✓		$1.18	
3	Reduce Ramp H Radius				✓	✓	✓	$1.76	
4	Create J-turns along KY 461		✓	✓				($2.50)	
5	Use 11-foot Lanes				✓	✓		$0.79	
6	Create Detention Ponds				✓			($0.26)	
7	Reconfigure Ramp D		✓	✓	✓	✓		$5.27	
8	Mark Shopville Right-out Only at KY 461		✓	✓				$0.00	
	TOTALS							**$6.94**	

Please provide justification if the value engineering study recommendations are **not** approved or are implemented in a modified form.

KYTC is required to report Value Engineering results annually to FHWA. To facilitate this reporting requirement, the Value Engineering Recommendation Approval Form is included herein. If the Cabinet elects to reject or modify a recommendation, please include a brief explanation of why.

____________________________ ________________________

Signature – Project Manager   Date

____

Name (please print)

FHWA Functional Benefit Criteria

Each year, State DOTs are required to report on VE recommendations to FHWA. In addition to cost implications, FHWA requires the DOTs 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*.

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.

Appendix D

Project Estimate

Appendix D. Project Estimate

PULASKI COUNTY KY 461 & KY 80 INTERCHANGE ITEM NO. 08-59.10				
	Build Grant Estimate	PREFERRED		
		KY 461 / KY 80 Interchange	KY 461 Widening	Coin Rd Interchange
Project Length		31,000 ft	25,800 ft	7,500 ft
PRELIMINARY CONSTRUCTION COST ESTIMATE				
Construction Total (30% Contingency)	**$ 52,796,000**	**$ 27,800,000**	**$ 12,200,000**	**$ 4,200,000**
		Preferred Construction Total = $44,200,000		
EARTHWORK				
Embankment		1,500,000 CY	50,000 CY	75,000 CY
Excavation		2,000,000 CY	300,000 CY	80,000 CY
Waste		500,000 CY	250,000 CY	5,000 CY
EARTHWORK SUBTOTAL ($3.50 / CY)		**$ 7,000,000**	**$ 1,060,000**	**$ 280,000**
PAVEMENT / MISC				
Asphalt ($90/TON)		$ 3,600,000	$ 6,030,000	$ 1,800,000
Aggregate ($25/TON)		$ 1,450,000	$ 1,575,000	$ 700,000
PAVEMENT / MISC SUBTOTAL		**$ 5,050,000**	**$ 7,605,000**	**$ 2,500,000**
PRELIMINARY STRUCTURES				
Bridge ($180 / SQFT)		$ 8,650,000		$ 1,620,000
Culverts ($300 / FT)		$ 664,000	$ 749,500	
PRELIMINARY STRUCTURES SUBTOTAL		**$ 9,314,000**	**$ 749,500**	**$ 1,620,000**

Appendix E

Performance Criteria Rating

Appendix E. Performance Criteria Rating

Criteria	Definition	Rating Scale	Unit of Measure/Quantification	Base Evaluation
Main Line Operations	An assessment of traffic operations and safety on the main line facility(s), including off-ramps, and collector-distributor roads. 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.	10	Free flow – excellent operation	8
		9	Full Design standards	
		8	Stable flow – very good operation	
		7	Minor design exceptions	
		6	Stable flow – good operation	
		5	Approaching unstable flow – fair operation	
		4	Design exceptions (geometry, sight distance)	
		3	Unstable flow – poor operation	
		2	Major Design exceptions (weaving and merging)	
		1	Traffic congestion	
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure, including on-ramps and frontage roads. 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.	10	Free flow – excellent operation	9
		9	Full Design standards	
		8	Stable flow – very good operation	
		7	Minor design exceptions	
		6	Stable flow – good operation	
		5	Approaching unstable flow – fair operation	
		4	Design exceptions (geometry, sight distance)	
		3	Unstable flow – poor operation	
		2	Major Design exceptions (weaving and merging)	
		1	Traffic congestion	
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.	10		5
		9	Very low maintenance	
		8		
		7	Similar maintenance to the existing facility when it was in like new condition	
		6		
		5	Similar maintenance to the existing facility in existing condition	
		4		
		3	Maintainability is significantly increased over the existing facility when it was in like new condition	
		2		
		1		

Criteria	Definition	Rating Scale	Unit of Measure/Quantification	Base Evaluation
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.	10	No impacts	7
		9	Minor impacts (i.e., noise, vibration, dust, or visual, requiring limited mitigation effort)	
		8		
		7	Minor impacts (i.e., minor traffic delays, occasional temporary nighttime lane closures, etc.)	
		6	Ramp closures of up to 30 days with acceptable detours	
		5	Moderate impacts (i.e., noise, vibration, dust, or visual, requiring significant mitigation efforts and/or inconveniences to the public)	
		4	Moderate impacts (i.e., multiple minor traffic delays, lengthy detours for ramp closures up to 45 days, extended temporary night closures, etc.)	
		3	Major impacts (i.e., noise, vibration, dust, or visual, requiring substantial mitigation efforts and/or inconveniences to the public with lengthy detours for ramp closures up to 60 days	
		2	Major impacts (i.e., noise, vibration, dust, or visual, requiring substantial mitigation efforts and/or inconveniences to the public with lengthy detours for ramp closures up to 90 days	
		1	Major impacts (i.e., noise, vibration, dust, or visual, requiring substantial mitigation efforts and/or inconveniences to the public with lengthy detours for ramp closures up to 120 days	
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.	10	Major improvement upon existing environmental conditions	4
		9		
		8	Minor improvement upon existing environmental conditions	
		7		
		6	No environmental impacts	
		5	Negligible degradation - does not require mitigation	
		4	Minor degradation - requires some mitigation	
		3	Moderate degradation - requires significant on-site mitigation	
		2		
		1	Severe degradation - requires significant off-site mitigation	

Criteria	Definition	Rating Scale	Unit of Measure/Quantification	Base Evaluation
Schedule	An assessment of whether the schedule of the project, from the time of the study through open to traffic, is conservative or has no remaining positive float and activities are already critical. Consideration should be given to whether the project is a critical component of program of projects or a corridor and its implementation may impact the network operations performance.	10	No dependencies and ample positive float	6
		9		
		8	Moderate float available	
		7		
		6	Little (under 30 days) or no float remaining	
		5		
		4	Project is super critical. Other projects depend on the implementation of this project	
		3		
		2	Significant risks threaten the ability to deliver the project on time, schedule is too aggressive and is unlikely to be met.	
		1	Network Operations are severely threaten if project is not delivered on time. Commitments are broken.	

Appendix F

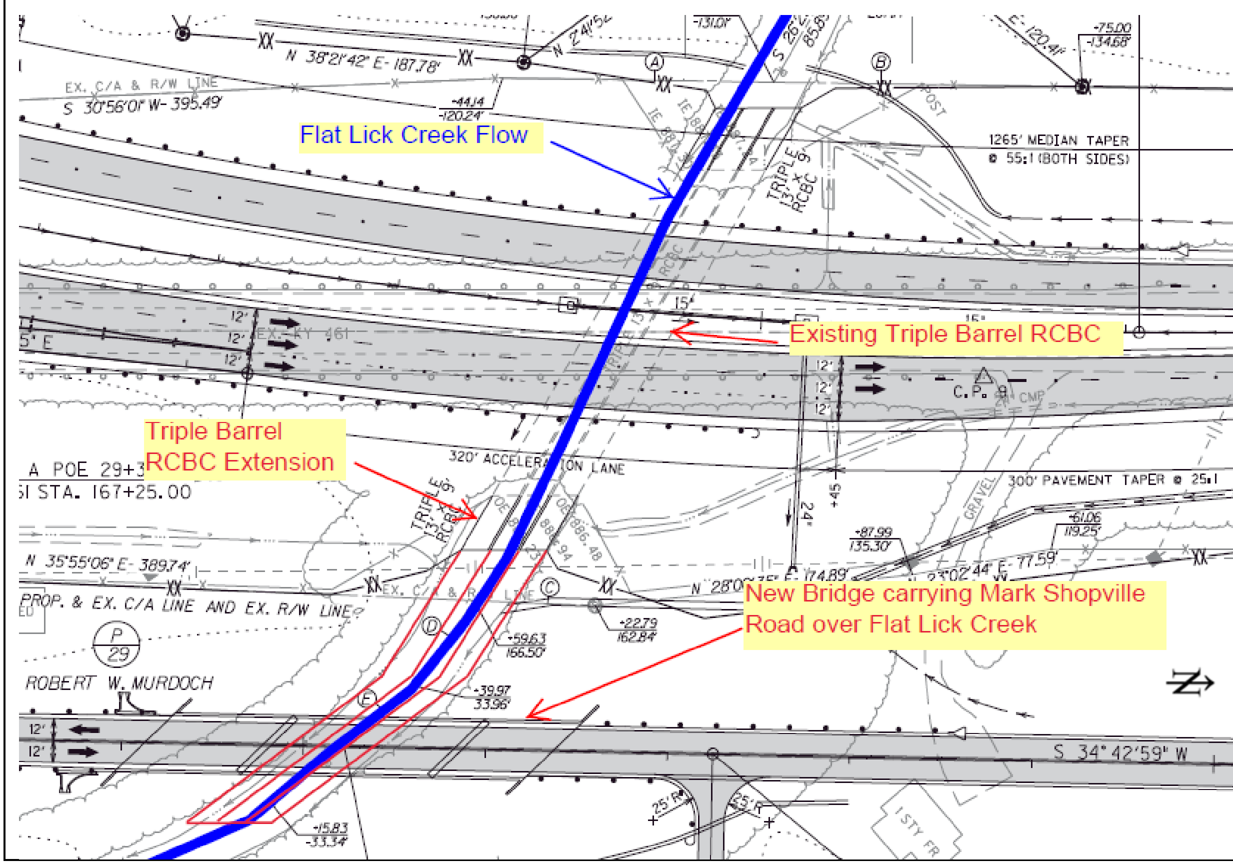
Design Validations

Appendix F. Design Validations

<table>
<tr><th colspan="2">VE DESIGN VALIDATION NO. 1:
EXTEND CULVERT IN LIEU OF BRIDGE</th><th>Idea No.
2</th></tr>
<tr><td colspan="3">Baseline Concept</td></tr>
<tr><td colspan="3">The baseline concept proposes to construct a new bridge over Flat Lick Creek to accommodate the new alignment of Mark Shopville Road.</td></tr>
<tr><td colspan="3">Recommendation Concept</td></tr>
<tr><td colspan="3">Extend triple RCBC in lieu of constructing new bridge carrying Mark Shopville Road over Flat Lick Creek.</td></tr>
<tr><td>Advantages</td><td colspan="2">Disadvantages</td></tr>
<tr><td>• Eliminate a separate structure
• Reduced construction cost
• Reduced maintenance
• Less community impacts
• County does not inherit a bridge to maintain</td><td colspan="2">• May not meet hydraulic capacity requirements</td></tr>
<tr><td colspan="3">Discussion/Sketches/Photos/Calculations</td></tr>
<tr><td colspan="3">The new bridge over Flat Lick Creek is approximately $1.6M in project cost. The VE team discussed extending the existing Triple Barrel RCBC further in lieu of constructing a new bridge.

After reviewing the site, the team concluded that it is not likely feasible to extend the culvert farther because the skew of the stream downstream presents an issue. In addition, it is unlikely that hydraulic conveyance requirements downstream of the culvert could be met. Therefore, this recommendation resulted in a design validation.</td></tr>
</table>

VE DESIGN VALIDATION NO. 1: EXTEND CULVERT IN LIEU OF BRIDGE	Idea No. 2



DESIGN VALIDATION NO. 2: BARRIER SEPARATE KY 461	Idea No. 16

Baseline Concept

On KY 461, beginning north of the system interchange bridge until the end of project, there is a 14-foot flush median.

Recommendation Concept

Install a barrier median.

Advantages	Disadvantages
• Access management • Prevents cross-over, head-on crashes	• Additional cost • Reduction of median clear zone

Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$0		$0
Recommendation Concept	$2,208,000		$2,208,000
Cost Avoidance/(Added Value)	($2,208,000)		($2,208,000)

Discussion/Sketches/Photos/Calculations

Technical Discussion/Sketches

The interchange between KY 461 and KY 80 was designed as a system-to-system interchange. Although one other interchange is planned on KY 461, the majority of the roadway has many uncontrolled access points. These access points in the current design allow for full directional movements. This type of condition is more typical of a minor arterial rather than a major arterial or controlled access facility. There is also risk that some of the very minor access points will change to higher intensity uses over time and therefore will increase turning movements and overall conflicts.

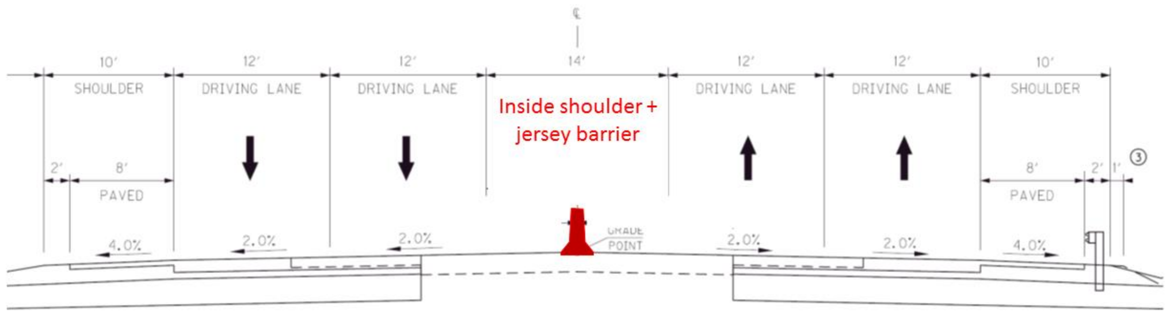
To better control access, a median barrier is proposed for the entire length of KY 461. This can take several forms; however, the VE team recommends a concrete jersey barrier median wall. This will prevent crossover crashes on the high speed facility and deter future access points.

This option would require no additional right-of-way and would not change the cross sectional width. There may be some locations that superelevation sloping toward the median may be required; in those instances a drainage box and culvert would be required to remove water from the median.

This option should be considered with Recommendation No. 4, which would refine the access control at the access points.

Example of Barrier-separated Roadway

DESIGN VALIDATION NO. 2: BARRIER SEPARATE KY 461	Idea No. 16



NORMAL SECTION

Assumptions/Calculations

Assumption of drop boxes and inlets in superelevated sections – approximately 4900 feet in length. Drop box inlet spacing of 250 feet.

Note: These pay items would be part of the 30 percent contingency, calculations only include a mark-up for MOT and Mobilization (20.8 percent).

VE Study Costs Calculations
KY 461 & KY 80 and KY 461 Widening

		Baseline Concept			VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Concrete median barrier wall 32"	LF	0	$ 75.00	$ -	17,500	$ 75.00	$ 1,312,500.00
Culvert pipe 15"	LF	0	$ 79.00	$ -	2400	$ 79.00	$ 189,600.00
Median wall drop box inlet	EA		$ 7,000.00	$ -	20	$ 7,000.00	$ 140,000.00
Culvert pipe 18"	LF		$ 85.00	$ -	500	$ 85.00	$ 42,500.00
Headwall	EA		$ 1,400.00	$ -	10	$ 1,400.00	$ 14,000.00
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
			$ -	$ -		$ -	$ -
Subtotal Construction				$ -			*$ 1,698,600.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ -			$ 509,580.00
Total Construction				**$ -**			**$ 2,208,180.00**
Monetized Time Savings							$ -
Right of Way Costs	SF			$ -			$ -
TOTAL CAPITAL COST				***$ -***			***$ 2,208,180.00***
COST CAPITAL SAVINGS / (INCREASE)							***$ (2,208,180.00)***

DESIGN VALIDATION NO. 3: USE RETAINING WALLS IN LIEU OF EMBANKMENT IN LOOP RAMPS	Idea No. 3

Baseline Concept

Ramp D and ramp H are designed to meet 40 mph with approximate radii of 444 feet. Proposed embankment between Sta. 45+00 to 60+00 ramp D ranges in height between 60 feet to 70 feet and impacts approximately 1,800 feet of stream.

Recommendation Concept

Utilize a mechanically stabilized earth (MSE) retaining wall with ramp H/D to minimize stream impacts. The proposed wall would reduce the amount of fill spilling into Big Stream Branch. The proposed wall would be placed at 70 feet right of ramp baseline, which is at approximately mid fill height.

Advantages	Disadvantages
• Minimize creek impacts and in lieu fees • Requires less right-of-way acquisition	• May increase cost • May increase maintenance

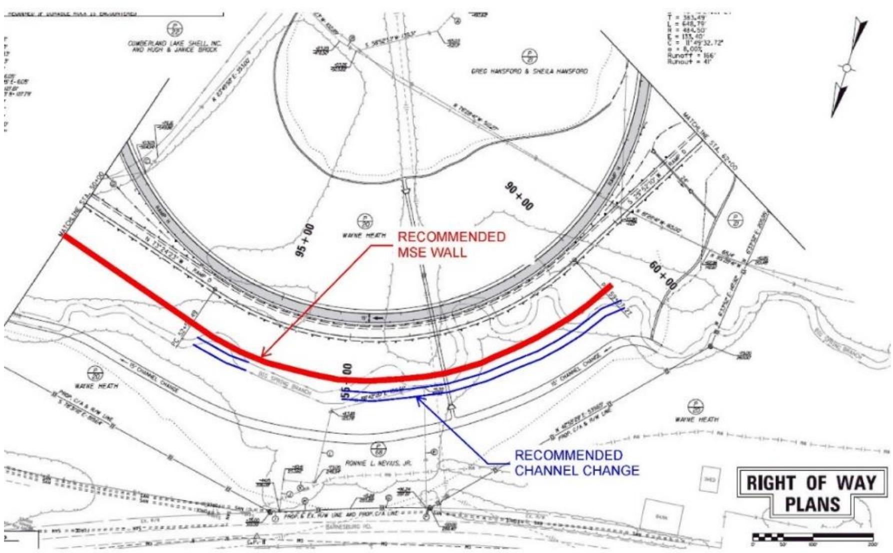
Cost Summary	Capital Cost	Life Cycle Costs	Total Cost
Baseline Concept	$1,364,000	N/A	$1,364,000
Recommendation Concept	$5,466,000	N/A	$5,466,000
Cost Avoidance/(Added Value)	$(4,102,000)	N/A	$(4,102,000)

Discussion/Sketches/Photos/Calculations

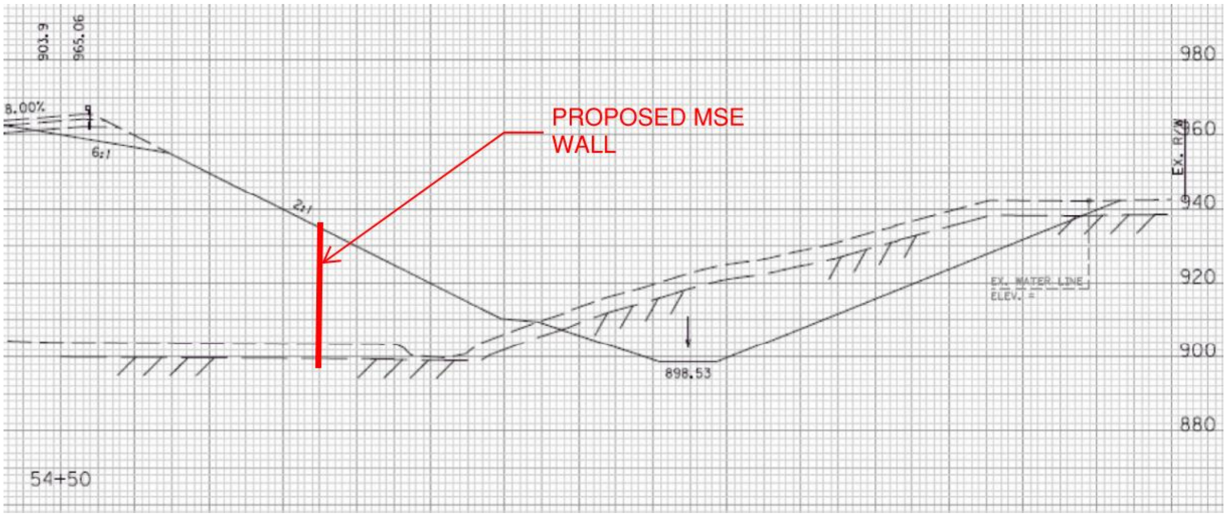
Technical Discussion/Sketches

The proposed loop ramps D and H with the system interchange at KY 461 and KY 80 include fill heights ranging between approximately 60 feet and 70 feet. Proposed fill slopes are 2:1, which extend out far enough to impact the Big Stream Branch. A channel change was proposed to relocate this section of stream that totals approximately 1,800 linear feet.

The VE team examined utilizing an MSE wall between Rt. Sta. 45+00 to Sta. 60+00 ramp D to support the roadway fill and minimize impacts to the stream. This solution would remove approximately 1,000 linear feet (as measured along the stream centerline) of stream impacts. The proposed MSE wall would range between approximately 40 to 45 feet in height.



DESIGN VALIDATION NO. 3: USE RETAINING WALLS IN LIEU OF EMBANKMENT IN LOOP RAMPS	Idea No. 3



Assumptions/Calculations

Assumed unit costs:

Embankment = $3.50 CY (provided by design team)

Stream In-lieu fees = $700 per linear foot (provided by design team)
MSE Wall = $60 SF (KYTC Division of Structural Design Website -> Structural Resources -> CloseOutFormsV33 -> Retaining Wall)

Length of MSE Wall = 1480 linear feet Assume average 42.5 feet tall = 62,900 SF

Right-of-way is assumed already acquired for this project so no credit was calculated for this potential benefit; however, a reduced amount of right-of-way would be required for this recommendation, which would reduce project costs.

VE Study Costs Calculations
KY 461 & KY 80 and KY 461 Widening

		Baseline Concept				VE Recommended Concept		
Component	**Unit**	**Quantity**	**Cost/Unit**	**Total**		**Quantity**	**Cost/Unit**	**Total**
Embankment	CY	0	$ 3.50	80,055			$ 3.50	$ -
MSE Wall	SF	0	$ 60.00	$ -		62900	$ 60.00	$ 3,774,000.00
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
			$ -	$ -			$ -	$ -
Subtotal Construction				*$ 80,055.00*				*$ 3,774,000.00*
Mark-Up (MOT, Mob., PE, CEI)	30%			$ 24,016.50				$ 1,132,200.00
Total Construction				**$ 104,071.50**				**$ 4,906,200.00**
Monetized Time Savings								$ -
Stream In-lieu fee	LF	1800	$ 700.00	$ 1,260,000.00		800	$ 700.00	$ 560,000.00
TOTAL CAPITAL COST				***$ 1,364,071.50***				***$ 5,466,200.00***
COST CAPITAL SAVINGS / (INCREASE)								***$ (4,102,128.50)***

Appendix G

Closing Presentation

VALUE ENGINEERING STUDY

KENTUCKY TRANSPORTATION CABINET

KY 80 / KY 461 Interchange and Widening
December 16, 2019

SAFETY FIRST

- Emergency exits
- Muster point
- CPR
- The number for "911"

Value Engineering Team

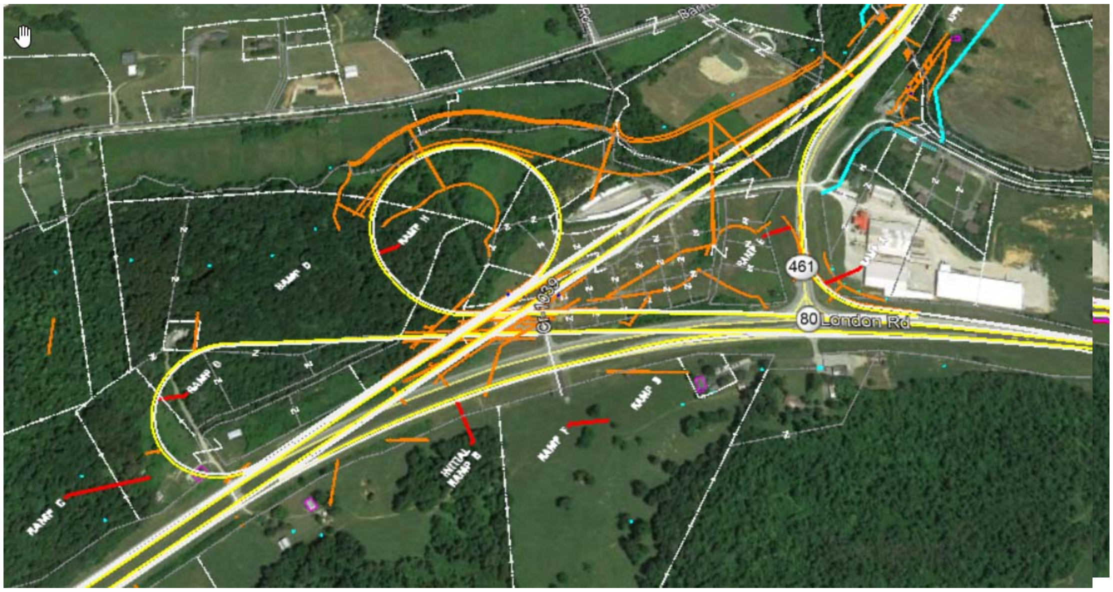
- Adam Hedges, HDR
- Brent Sweger, KYTC
- Connor Schurman, KYTC
- Cory Willmerdinger, KYTC
- Erica Albrecht, HDR
- Joe Cochran, HDR
- Jose Theiler, HDR
- Justin Harrod, KYTC
- Scott Pennington, HDR

Project Information

Purpose & Need:
Enhance mobility & provide a safer, free flowing connection

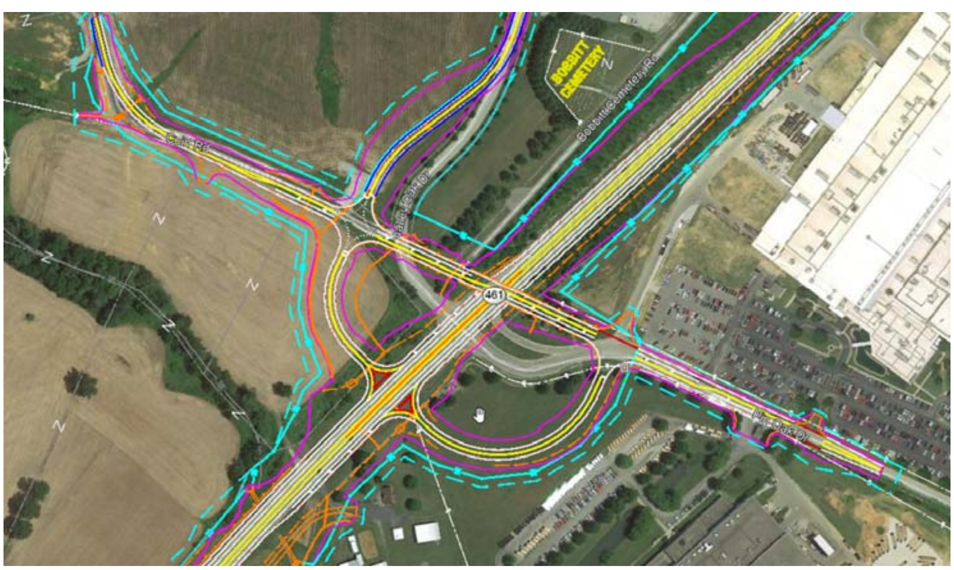
- KY 80 / KY 461 Interchange to Buck Creek Bridge
- Grade Separate KY 80 and KY 461
- Widen 461 from 2 to 4 lanes
- 12’ lanes
- 8’ outside paved shoulder
- 4’ inside paved shoulder
- Grade separate Coin Rd/Pin Oak Dr over KY 461
- Realign Flat Lick Creek

Project Information



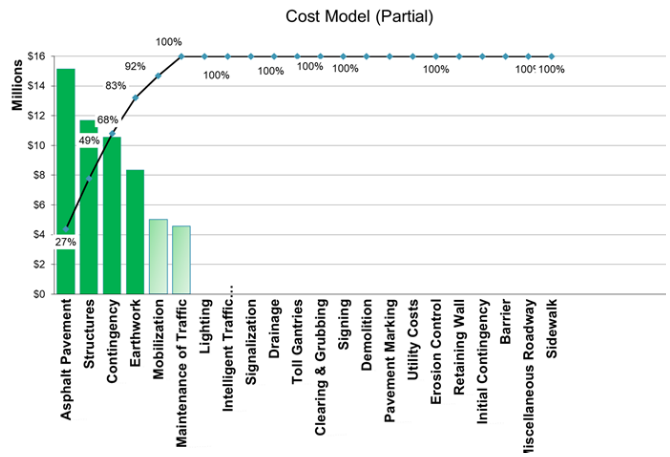
Project Information

Coin Rd / Pin Oak Dr:



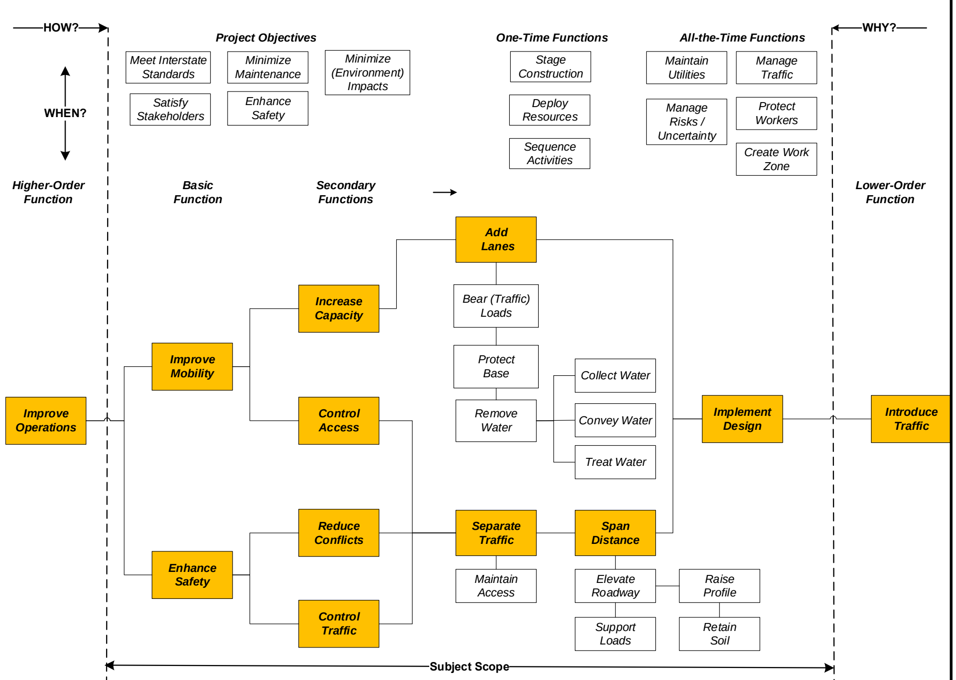
PROJECT ESTIMATE

PULASKI COUNTY KY 461 & KY 80 INTERCHANGE ITEM NO. 08-59.10				
		PREFERRED		
	Build Grant Estimate	KY 461 / KY 80 Interchange **Initial**	KY 461 Widening	Coin Rd Interchange (Jughandle)
Project Length		31,000 ft	25,800 ft	7,500 ft
PRELIMINARY CONSTRUCTION COST ESTIMATE				
Construction Total (30% Contingency)	**$52,796,000**	**$ 27,800,000**	**$ 12,200,000**	**$ 4,200,000**
		Preferred Construction Total = $44,200,000		
EARTHWORK				
Embankment		1,500,000 CY	50,000 CY	75,000 CY
Excavation		2,000,000 CY	300,000 CY	80,000 CY
Waste		500,000 CY	250,000 CY	5,000 CY
EARTHWORK SUBTOTAL ($3.50 / CY)		**$ 7,000,000**	**$ 1,060,000**	**$ 280,000**
PAVEMENT / MISC				
Asphalt ($90/TON)		$ 3,600,000	$ 6,030,000	$ 1,800,000
Aggregate ($25/TON)		$ 1,450,000	$ 1,575,000	$ 700,000
PAVEMENT / MISC SUBTOTAL		**$ 5,050,000**	**$ 7,605,000**	**$ 2,500,000**
PRELIMINARY STRUCTURES				
Bridge ($180 / SQFT)		$ 8,650,000		$ 1,620,000
Culverts ($300 / FT)		$ 664,000	$ 749,500	
PRELIMINARY STRUCTURES SUBTOTAL		**$ 9,314,000**	**$ 749,500**	**$ 1,620,000**



Function Analysis

The VE Team identified and defined relevant project functions using a **two-word active verb / measurable noun** context.

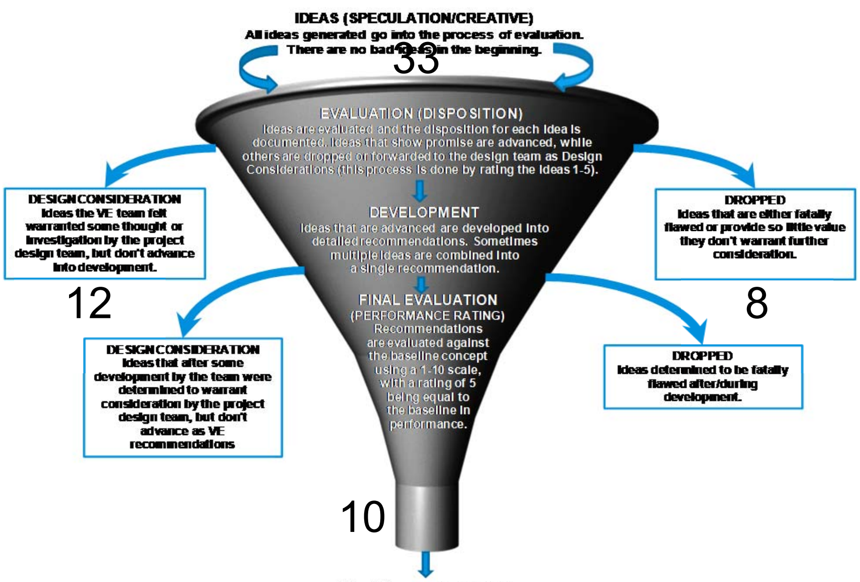


Objectives of the Study

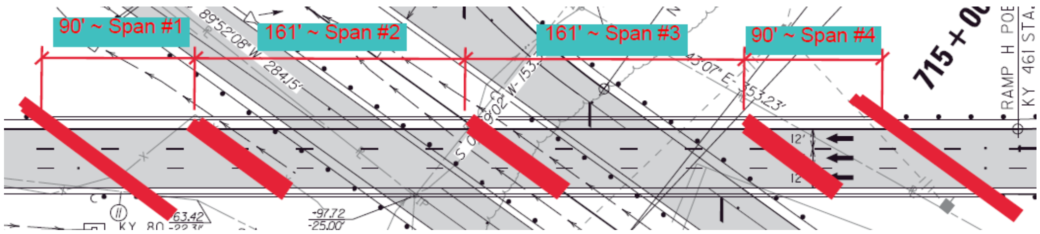
Through application of the VE job plan the objective of the VE study was to **validate or improve** on the various concepts of the project.

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

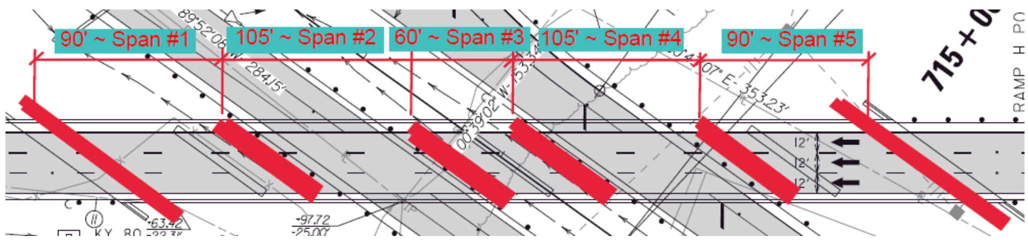
Evaluation Process – Tiered Approach



Change Structure Design at System Interchange

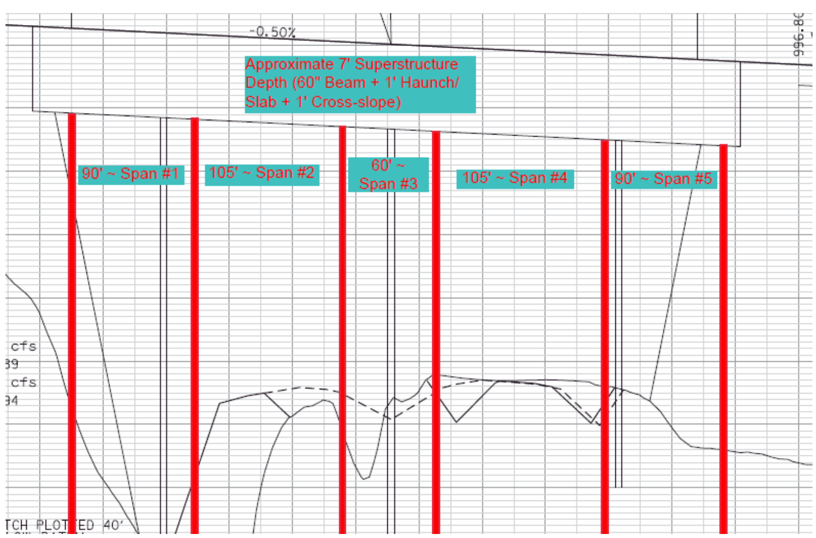


Baseline



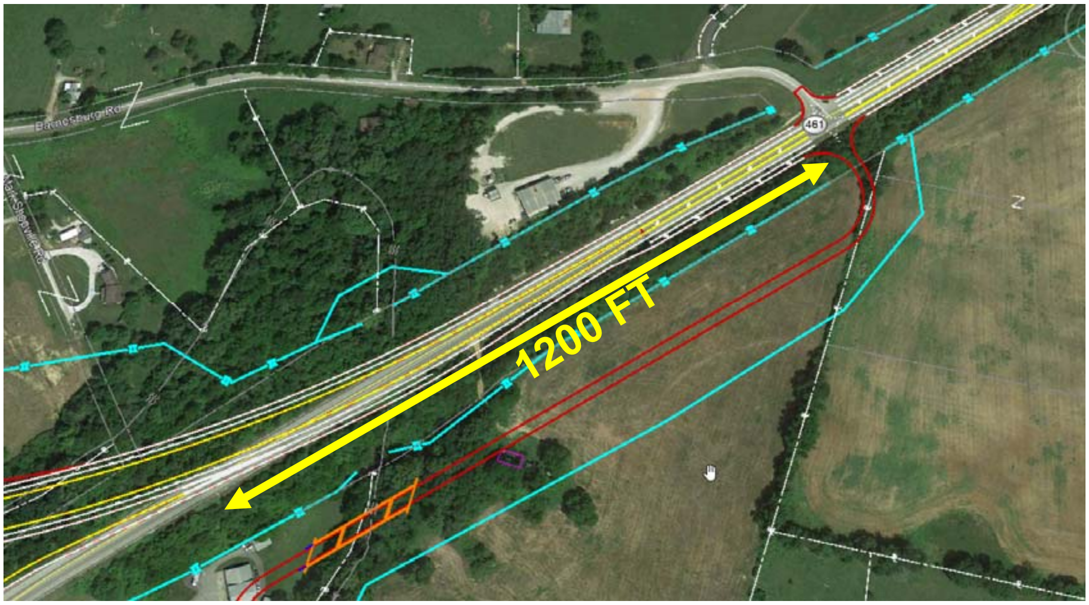
Recommended

Change Structure Design at System Interchange

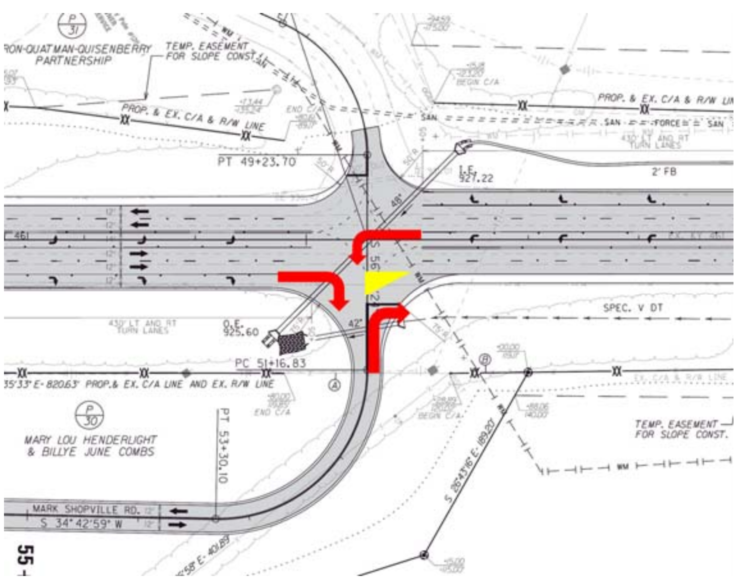


Recommended

Mark Shopville Rd Right-out Only at KY 461

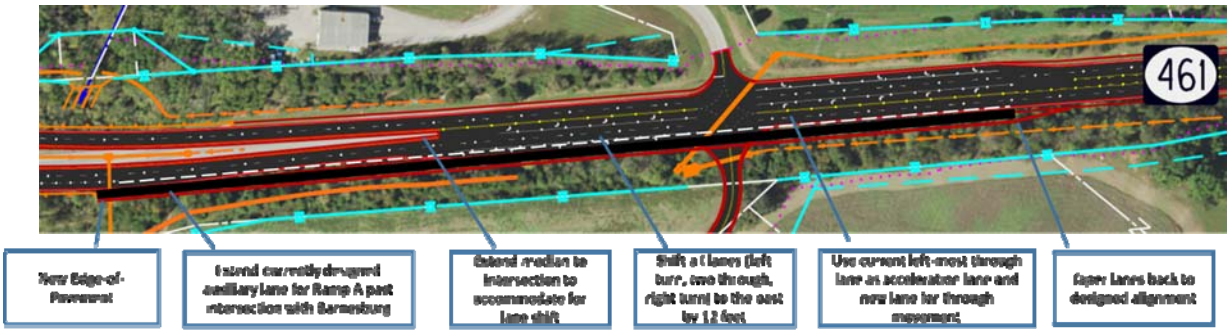


Mark Shopville Rd Right-out Only at KY 461

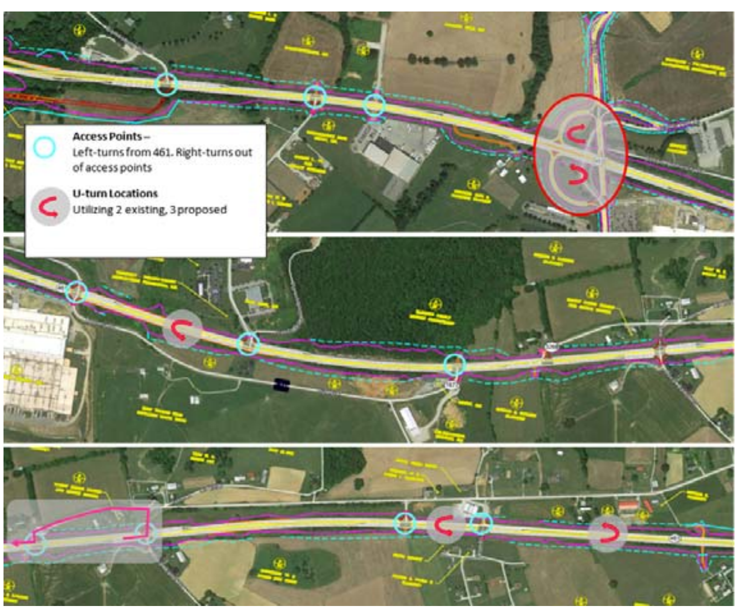


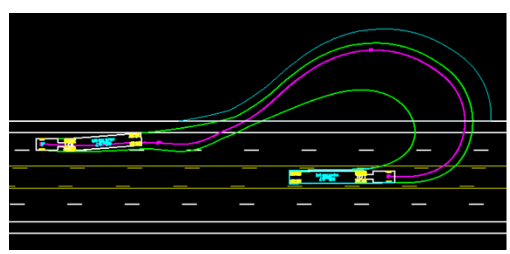
Design Consideration

Add an Eastbound Barnesburg to NB 461 Acceleration Lane



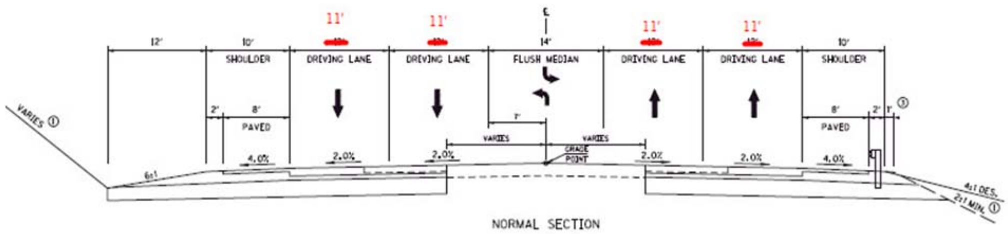
Construct J-Turns along KY 461





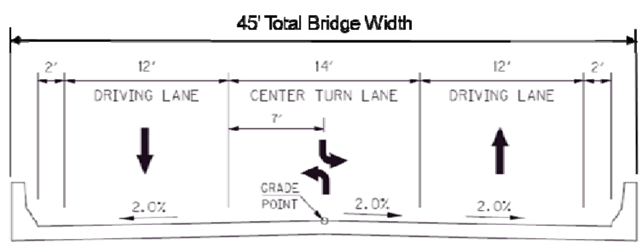
Construct 11-ft Lanes

TYPICAL SECTIONS
KY 461 – FLUSH MEDIAN

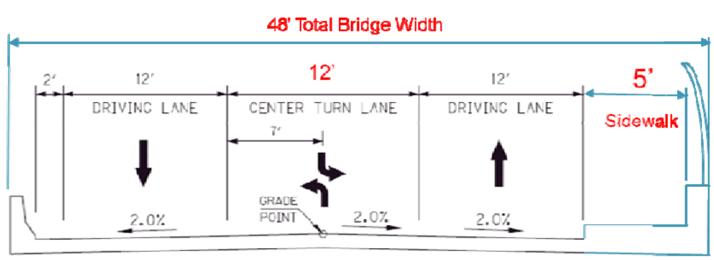


Design Consideration

Change Typical of Bridge at Industrial Park

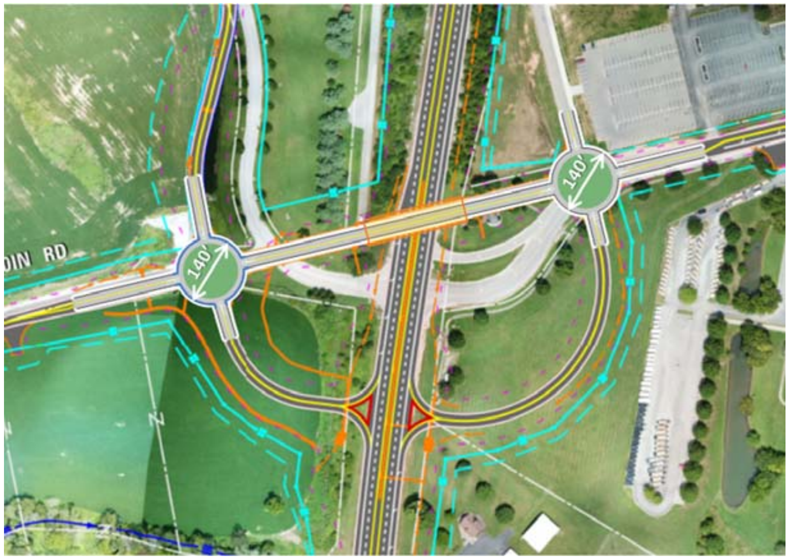


Baseline



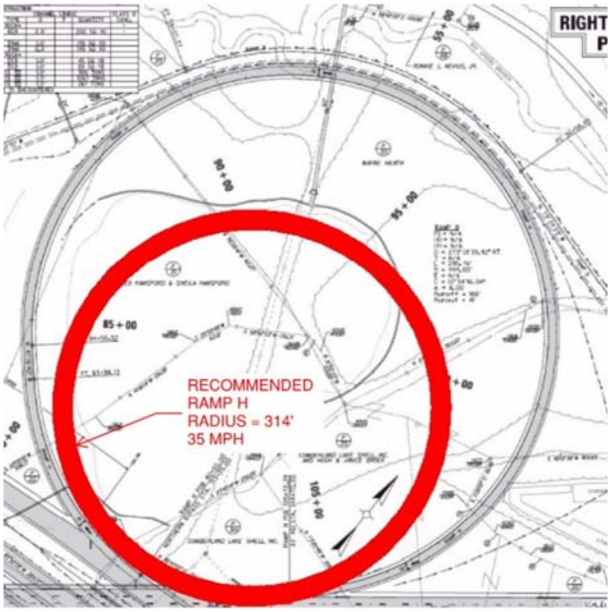
Recommended

Construct Roundabouts at Coin Rd / Pin Oak Dr



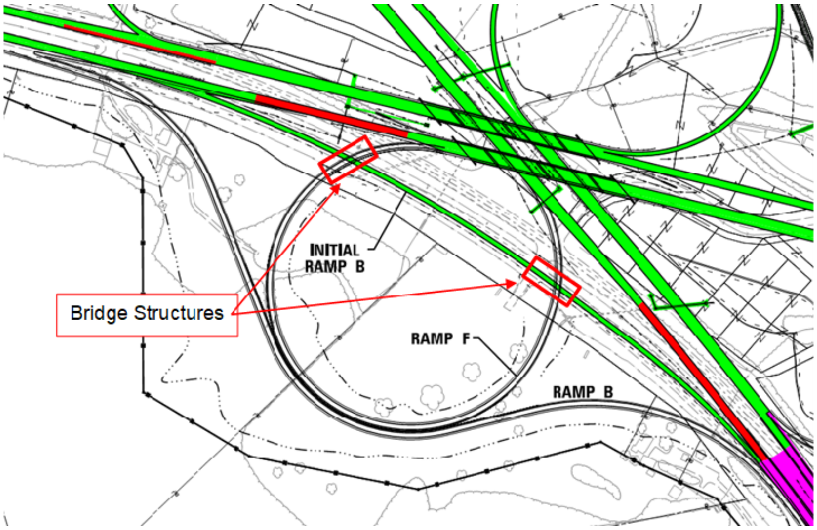
Create Detention Ponds

Reduce Ramp H Radius and Use Retaining Walls

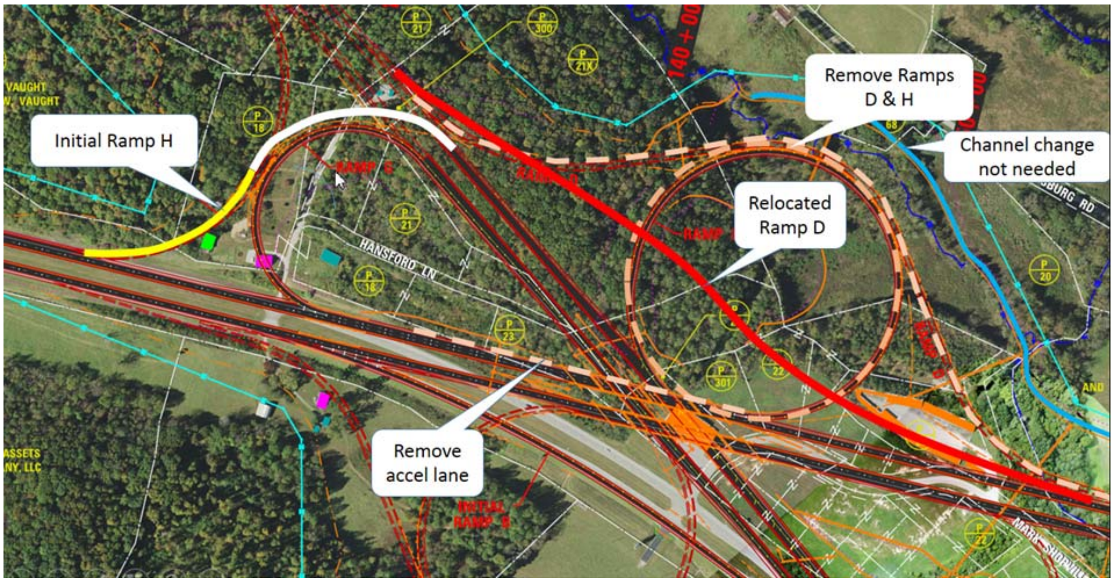


Design Consideration

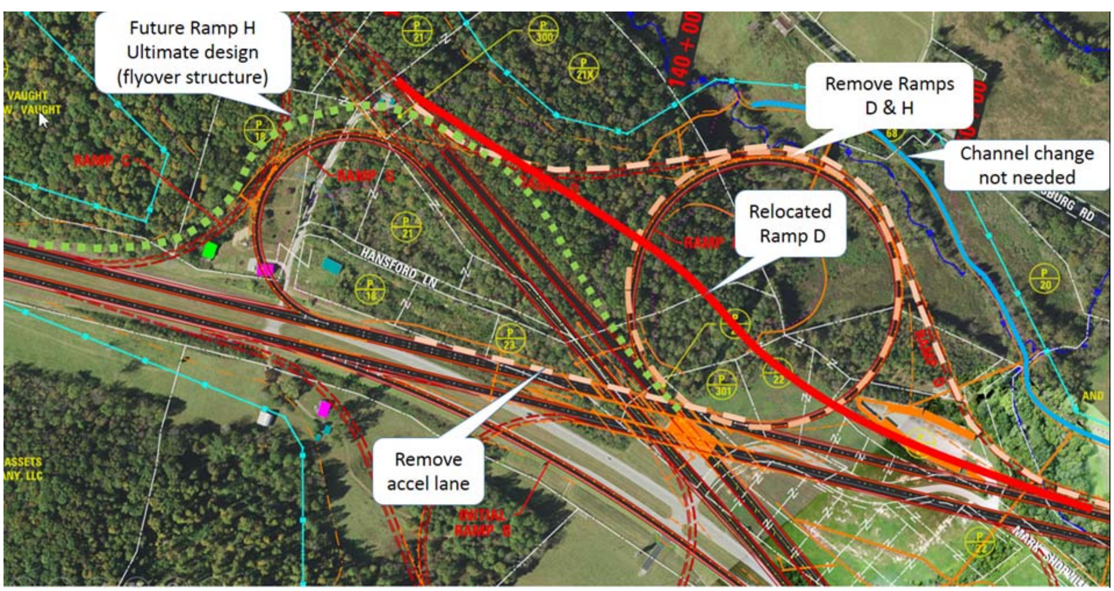
Grade Separate Existing Ramp B and Ramp F



Reconfigure Ramp "D"

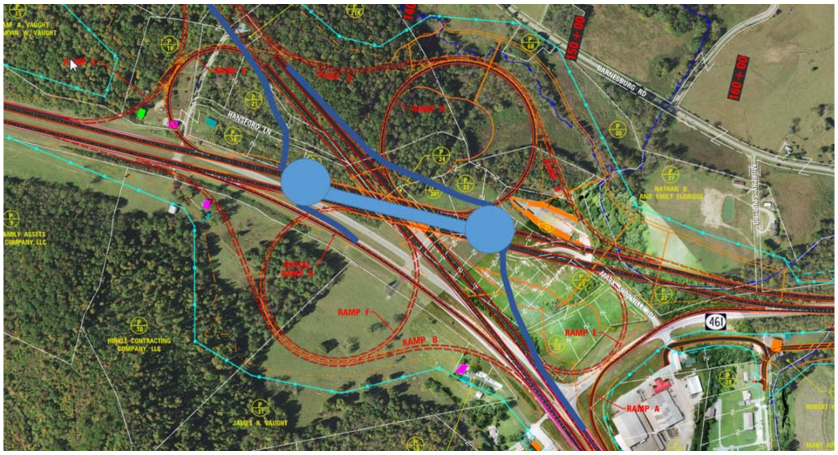


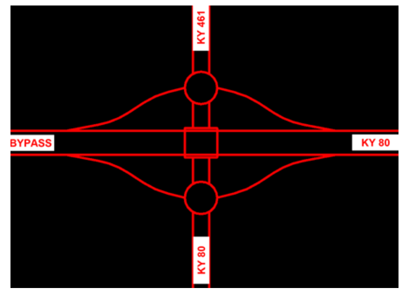
Reconfigure Ramp "D"



Design Consideration

Construct a Diamond Interchange





Design Consideration

2+1 Typical along KY 461

Design Suggestions

Idea #	Idea Description
1	Plan for a 2+1 to Mt Vernon
5	Reduce 461 by 2-feet (make median 12')
8	2+1 Lanes (Directional peak) traffic control
9	Use a Diamond Interchange with roundabouts at termini
17	Add an eastbound Barnesburg to NB 461 acceleration lane
18	Add sidewalk on north side of Coin Road and on bridge over 461
19	Use barrier wall instead of guardrail to separate Ramps D/H and B/F
24	Remove south access to Tommy Road
25	Connect Parcel 38 access to Jug-handle
27	Grade separate existing Ramp B alignment with Ramp F
32	Reduce Coin Road bridge by 2-feet (make it 12'-12'-12')
33	Improve pavement design on shoulders

Performance Attributes – Paired Comparison

Performance Attributes Criteria Matrix

Paired Comparison

							Total points	% of Total
Main Line Operations	A	A	A	A	A	A	6.0	28.8%
Local Operations		B	B	B	E	F	3.0	14.2%
Maintainability			C	C	E	F	2.0	9.5%
Construction Impacts				D	E	D	2.0	9.5%
Environmental Impacts					E	F/E	4.5	21.4%
Project Schedule						F	3.5	16.6%
						Total	21.0	100.0%

Recommendation Summary								
Value Index								
	Recommendations	Performance (P)	% Change Performance	Cost (C) $ millions	Cost Change $ millions	% Change Cost	Value Index	% Value Improvement
	Baseline	657	---	$44.2	---	---	14.87	---
1	Use Roundabouts at Industrial Park Bridge	667	+1.4%	$43.5	($0.70)	-1.6%	15.33	+3.1%
2	Change Structure Design at System Interchange	666	+1.3%	$43.0	($1.18)	-2.7%	15.47	+4.0%
3	Reduce Ramp H Radius and Use Retaining Walls	726	+10.5%	$42.4	($1.76)	-4.0%	17.11	+15.0%
4	Create J-Turns along KY 461	696	+5.8%	$46.7	$2.50	+5.7%	14.90	+0.2%
5	Use 11 ft Lanes	708	+7.8%	$43.4	($0.79)	-1.8%	16.32	+9.7%
6	Create Detention Ponds	722	+9.8%	$44.5	$0.26	+0.6%	16.23	+9.1%
7	Reconfigure Ramp H	781	+18.8%	$38.9	($5.27)	-11.9%	20.07	+34.9%
8	Mark Shopville Right-out Only at KY 461	672	+2.2%	$44.2	$0.00	0.0%	15.20	+2.2%
	Total				($6.8)			

QUESTIONS

Jose Theiler, PE, CVS