Value Engineering Study Report

VE Study Number 201401
KY-15 Improvements
Perry County, Kentucky
Item No. 10-158.00
VE Study - April 21-25, 2014
Final Report

KENTUCKY TRANSPORTATION CABINET

HDR

Disclaimer:

The information contained in this report is the professional opinions of the team members during the Value Engineering Study. These opinions were based on the information provided to the team at the time of the study. As the project continues to develop, new information will become available, and this information will need to be evaluated on how it may affect the recommendations and findings in this report. All costs displayed in the report are based on best available information at the time of the study and unless otherwise noted are in 2014 dollars.

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Executive Summary

Introduction

This value engineering (VE) report summarizes the events of the study conducted for the Kentucky Transportation Cabinet (KTC) and facilitated by HDR Engineering, Inc.

The subject of the VE Study was KY-15 Improvements project in Perry County, Item #10-158.00. The study was conducted April 21-25, 2014 with the presentation of findings held on April 25, 2014.

Value Summary for VE # 201401

Project Cost: $57.7 million

Number of Recommendations: 5

Number of Recommendations Accepted or Under Further Consideration: 2

Number of Design Considerations Accepted or Under Further Consideration: 2

Recommended Cost Savings: $24.75 million

Accepted Cost Savings: $8.81 million

Total Number of Team Members: 12

KTC Employees: 7

FHWA Employees: 0

Others: 5

Estimated cost of VE study:

$49,300 consulting fee

$9,800 KTC Fee

Recommended Rate of Return = $149:1

Project Description

This project plans to reconstruct and widen KY 15 from MP 13.27 near the northern end of the Hazard Bypass to MP 14.51 north of the intersection with Morton Boulevard. The project consists of reconstructing KY 15 to improve the alignment, to enhance safety, and to meet future traffic demands.

Major project improvements include:

- Adding a third northbound lane between KY 550 and the crest of the hill
- Removing the at-grade intersections at Perry Park Road and Morton Boulevard
- Constructing a new river bridge

The current total project cost estimate is $57.69 million. This includes construction costs of $51.49 million, right-of-way impacts of $2.93 million, utility impacts at $2.10 million and stream impacts of $1.17 million.

VE Study

A total of 27 ideas were evaluated of which 9 were developed into 5 recommendations and 7 were determined to be design comments.

Table 1 - Summary of Recommendations

#	Description	Cost Savings	Performance	Value
VE-1	River Bridge	$5.43M	+5%	+16%
VE-2	Median Width	$0.60M	0%	+1%
VE-3	Roadway Section	$2.41M	-1%	+3%
VE-4	Perry Park	$18.35M	-10%	+35%
VE-5	Morton Blvd.	$3.39M	+1%	+8%

From the 5 recommendations the VE Team created 2 scenarios to illustrate the potential combinations that may be chosen for implementation. Recommendations VE-1 and VE-4 are mutually exclusive and cannot both be implemented. The recommendations included in these scenarios are those deemed by the team to represent the best value when considering the recommendations impact on project performance and cost.

Table 2 - Summary of Scenarios				
#	**Description**	**Cost Savings**	**Performance**	**Value**
Scenario 1	**VE-1, VE-2, VE-3, VE-5**	**$11.83M**	**+1%**	**+27%**
Scenario 2	**VE-2, VE-3, VE-4, VE-5**	**$24.75M**	**-2%**	**+71%**

Implementation

Of the 5 recommendations, VE-1 was accepted and VE-2 is under further consideration. Design Considerations DC-1 and DC-4 were are also under further consideration.

VE Team Members

The VE Team included:

- Craig Barnett — Geotechnical
- Darren Back — Design
- John Broadus — Structures
- Joe Cochran — Design
- John Edwards — Construction
- Catherine Heard — Traffic
- David Lee — Traffic Design
- Dean Loy — ROW/Utilities
- Shawn Russell — Constructability
- Ken Smith — VE Team Leader
- Mike Vaughn — VE Coordinator
- Mark Walls — Construction

This is to verify that the Value Engineering Study was conducted in accordance with standard value engineering principles and practices.

Ken L. Smith, PE, CVS®
VE Team Leader

VALUE ENGINEERING PUNCH LIST

ITEM NO. **10-158.00** PROJECT COUNTY: **Perry** DATE OF STUDY: **04/21/2014 to 04/25/2014** **VE # xxxxx**

VE Alternative Number	VE Team Top Pick	Description	Activity (Y,N,UC-Date)	Implemented Life Cycle Cost Savings	Original Cost	Alternative Cost	Initial Cost Saving	Life Cycle Cost Savings (Total Present Worth)	FHWA Categories	Remarks
Recommendations Grouping Title #1										
VE-1		**River Bridge** - Limit span lengths such that pre-stressed girders (simple for dead load and continuous for live load) may be used in the new structure. It looks like a 150' span would allow piers to be placed at each edge of the river.	Y / UC - 6/9/14	$6,028,956	$19,001,346	$13,572,390	$5,428,956	$600,000	Other	It is likely that 150' or shorter span lengths can be achieved and therefore the beams of the proposed bridge will likely be pre-stressed concrete I beams. To be conservative, preliminary design estimates assumed "worst case scenario" of using steel beams. Steel beams will only be used if PCI beams are not feasible.
VE-2	✓	**Median Width** - Reduce the median width to 4 foot inside shoulders with a concrete barrier wall.	UC - 6/9/14		$16,718,128	$16,109,855	$608,274		Construction	The Project team will consider using 4' inside shoulders as the project moves forward. The Project Team will also explore using 4' inside shoulders in the 2 lane sections along proposed KY 15, and using 8' inside shoulders in the 3 lane sections along proposed KY 15. In these areas (e.g. when there are 2 lanes SB & 3 lanes NB) there would be no change in the roadway footprint versus the baseline proposed design (both inside shoulders = 6'), so there would be no cost savings, but there would still be value added by having a 8' inside shoulder along the 3 lanes sections, due to having a shoulder with sufficient width that it could be used as an emergency lane by motorists.
VE-3	✓	**Roadway Section** - The VE Team recommends ending the acceleration ramp from KY 550 NB at the proposed right-in/right-out Willies Way southern intersection. KY 15 from the Willies Way southern intersection (Sta. 360+50) to north of Morton Boulevard (Sta. 383+00) will be two lanes northbound and southbound.	N		N/A	N/A	$2,440,807		Environment Construction Other	The Project Team does not plan to implement this VE recommendation, due to operational considerations. The third uphill lane will act as a truck climbing lane. If this lane is ended prior to the crest of the hill trucks will be forced into the second lane at a point when the trucks are traveling at a very low speed, therefore reducing capacity and potentially causing a merge problem. Also, many truck drivers familiar with the area may not even utilize the third lane if it were to end at the proposed right-in/right-out Willies Way due to merge difficulties this arrangement could have. If this happened, there would be slow moving trucks in the middle (second) lane and potentially faster moving vehicles passing on the right in the shortened third lane, causing a potential safety hazard. Lastly, the public was in favor of having three lanes uphill by a vote of 17-0 at the public meeting.
VE-4	✓	**Perry Park Road** - Maintain existing KY 15 alignment with widening to the east. Keep the existing signalized intersection for Perry Park Road, Cherokee Hills Road and the Asphalt Plant north entrance. Realign the intersection's eastbound approach to provide direct access to the Asphalt Plant and modify Cherokee Hills Road so that it "Tees" into the new Asphalt Plant access. Widen and rehabilitate the existing bridge to provide a southbound auxiliary lane, 2 southbound through lanes, and a left turn lane from KY 15 onto Perry Park Road.	N		$31,976,136	$13,624,033	$18,352,103	$43,000	Environment Construction	The Project Team does not plan to implement this VE recommendation due to the much lower level of performance along the mainline and the reduction in performance to local operations. Also, the baseline design provides better access control and hence safety by providing a frontage road for the Asphalt Plant, Cherokee Hills Rd, Shell Station, and Pawn Shop. Finally, the Project Team had some concerns that the projected $18 million in savings for this VE recommendation may not be accurate.

VE-5	✓	**Morton Blvd** - Provide signalized intersection at Morton Blvd. (similar to proposed design shown in Alternate 4) with: - dual northbound left turn lanes from KY 15 to Morton Blvd. - single eastbound left turn lane from Morton Blvd. to KY 15, utilizing “green” or “inside” left turn lane - right-in, right-out movement for westbound Willies Way approach (north end). Provide unsignalized intersection at Willies Way (south end), also utilizing “green” or “inside” left turn lane for turning movements onto KY 15.	N		$9,346,000	$5,960,000	$3,386,000	-$4,800	Construction	The Project Team does not plan to implement this VE recommendation. A very similar scenario had been previously looked at by the Project Team and was rejected. Extensive queues are anticipated along KY 15 and Morton Boulevard because of the large volumes of turning traffic. This coupled with a higher number of conflict points than the baseline proposed design may result in safety concerns at an intersection that already has a CRF of 1.58. Finally, the majority of the public supported a grade separated interchange in lieu of a "green T" intersection.
Other Design Comments and/or Design Suggestions										
DC-1		**Spliced pre-stressed girder for spans greater than 150’ on the river bridge** - If the spans need to exceed 150’ for the river bridge then consider spliced pre-stressed girders as an alternative to the baseline assumed steel girders. This can reduce cost and potentially structure depth.	UC - 6/9/14		NA	NA	NA	NA	Other	The Project Team will consider this design comment as the project moves forward. Most likely span lengths will 150’ or less and conventional pre-stressed concrete I beams will be used.
DC-2		**Only beef up two lanes on new bridge for hauling off road earth movers** - The VE Study Team's Analysis concluded that legal load trucks would most likely be used due to the current projected waste site's locations relative to the excess material. The material is coming from the south side of the river and the east side of KY 15. Even with an over designed bridge, haul trucks would still have to cross KY 15 to get to the proposed waste site on the western side. This may require additional repairs to the crossing sites and significant MOT. However, if an over designed bridge is desired, the VE Study Team's recommendation is to only over design 24' width of the proposed bridge. This width would be sufficient enough for haul trucks to cross the river.	N		NA	NA	NA	NA	Construction	The Project Team does not plan to implement this design comment. After additional project discussions, overweight/off road haulers will not be allowed across the bridge, so the structure will not need to be beefed up.
DC-3		**Consider a con-span or wagon box over Perry Park Rd and shorten the main river bridge** - Using a wagon box or con-span structure over Perry Park would allow a shortened proposed bridge structure. The shortened bridge will reduce initial structure costs and long term maintenance costs associated with the bridge. This suggestion may reduce impacts to the existing Perry Park Road alignment. Drawbacks to this design consideration includes; creating a tunnel effect on Perry Park Road and a reduction of access during construction to the river bridge from the south.	N		NA	NA	NA	NA	Other	The Project Team does not plan to implement this design comment. Using a con-span or wagon box will likely create a tunnel effect that is undesirable. Also, there is a mobile home area just to the east of this location and a con-span or wagon box could cause issues with moving mobile homes in and out of the area, with this currently being the only suitable access. Finally, the project team is not sure that a con-span or wagon box in close proximity to the proposed bridge would be very feasible constructability wise, and therefore may not have any cost benefits.
DC-4		**Eliminate end spans on River Bridge and use MSE walls** - By eliminating the end spans of the bridge and incorporating MSE walls the costs of constructing the bridge could be lowered. There will be less bridge to maintain however this could have more settlement at the bridge ends due to increased fill heights.	UC - 6/9/14		NA	NA	NA	NA	Construction Other	The Project team will consider this design comment as the project moves forward. However, the Division of Structural Design has not typically considered the use of MSE Walls a favorable approach, primarily due to concerns of approach settlement, pavement deterioration and undermining, and lateral movement.

DC-5		**Use short soil nail walls and rock bolting to reduce excavation** - Based on the bedrock type of the region, it is likely the roadway cut will consist of sandstone, shale, limestone and coal varying in thicknesses. The shale bedrock may consist of durable and nondurable shales as classified by the KYTC Geotechnical Manual.	N		NA	NA	NA	NA	Environment Construction Other	The Project Team does not plan to implement this design comment. The project team feels that this approach is more in line with repairing unstable rock slopes associated with a maintenance project. The longevity of such an approach is not well known and it is not desirable to use this method for new construction rock cuts at this point.
DC-6		**Eliminate median barrier and use narrower median with mountable median curbing** - Possibility of eliminating placing barrier wall throughout project and replace with mountable median. This could lessen earthwork and required right of way due to being able to use narrower shoulders. It would also allow better access for Emergency vehicles that could cross it for accidents in the area.	N		NA	NA	NA	NA	Environment Construction Other	The Project Team does not plan to implement this design comment. The barrier wall is needed for access control and safety reasons. High speeds combined with steep grades and high bus/truck traffic make it desirable to physically separate traffic on a highly congested, accident prone corridor with a CRF over 1 in numerous spots, including an area with a CRF over 3.
DC-7		**Re-evaluate ESALS to define the appropriate pavement section** - The ESAL forecasts provided for the project should be reviewed and verified. By re-evaluating the traffic forecasts you could find that reduction in ESALS would result in a reduction in the final pavement section over the entire project.	N		NA	NA	NA	NA	Other	The Project Team does not plan to implement this design comment. ESALs have been provided using the most current Aggregated ESAL data available. Pavement costs will be updated to reflect a pavement design approved by KYTC based on the associated ESALs.
		Implementation Meeting: 6/9/2014	4	6,028,956	(Total Recommended/Value: 4 / $8,814,956) Approved (Y or UC) Category Totals: Saf 0 Ops 0 Env 0 Con 2 Oth 3					

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Introduction

This report summarizes the events of the VE Study conducted for the Kentucky Transportation Cabinet and facilitated by HDR Engineering, Inc. The subject of the VE Study was KY-15 Improvements project in Perry County, Item #10-158.00.

VE Study Timing

The study was conducted April 21-25, 2014 with the presentation of findings held on April 25, 2014. The project was at 30% design at the time of the study.

Scope of the VE Study

The scope of the VE Study was to verify or improve concepts being proposed for the project. To accomplish this, the VE Team:

- Applied the principles and practices of the VE Job Plan
- Conducted a thorough review and analysis of the project
- Brainstormed and evaluated possible improvement opportunities
- Identified potential value added and cost saving opportunities

VE Process

Information Phase
The VE Team analyzed the project using the VE Job Plan and associated tools. The Team benefited from discussions with the Project Team.

During the project presentation by the Project Team the VE Team was presented with the following environmental concerns.

- Phase II HazMat
  - Exxon Station
- Stream Permitting
  - West Side of KY 15
- Crossroad Cluster
  - Fugate Mountain
- Noise Request
  - Raised by Resident
- Frogtown Environmental Justice
  - Alternative 3 Eliminated
- Cultural Historic
- Future Permitting
  - Asbestos
  - Potential Phase III HazMat
  - Groundwater Monitoring Wells
  - Biological Assessment – Bat Survey

The VE Team was also presented with the following comments from the public meeting.

  - Preference for 3 Lanes Uphill
    - (17 – 0 Preference for 3 vs 2 Lanes)
  - Frogtown Lane
    - Revised Ramp A / B Location

The VE Team was presented with the following final design consideration by the Project Team during the Information Phase of the workshop.

- Structures
  - Beam Depths & Final Grades
    - North Fork KY River and Perry Park Road
    - Morton Boulevard over KY 15
  - Structure Type
    - Steel vs. Concrete for KY River Bridge
- Geotechnical
  - Final Earthwork Quantities / Waste Areas
- Right of Way (Fugate Mountain)

As part of their investigation process the VE Team identified the following project risks that are associated with the project:

- Exxon Station ROW estimated at $500,000 may be under estimated.
- The ROW costs for section one may grow for residential costs due to impacts to residents on Fugate Mountain. There are 3 residents in estimate but could impact all 9 homes.
- May have claim of damages due to access to Shell station.
- Contaminated soils in the vicinity of Exxon Station ROW.
- Filling in the stream for the waste site.
- ROW needed for waste site is not included in current estimate.
- Due to minimal geotechnical information the conditions may require flatter slopes than assumed in the base which would increase earthwork and ROW requirements.
- ROW for commercial property in the vicinity of Morton Blvd could exceed the $1,000,000 in the section 3 estimate.

Functional Analysis Phase

By using functional analysis and Functional Analysis System Technique (FAST) diagramming, the Team defined the basic functions of this project as Reduce Conflicts and Improve Mobility. Key secondary functions were Span River, Realign Roadway and Separate Grade.

Analysis of the functions intended to be performed by the project helped the team focus on the purpose and need of the project and, consequently, how to craft recommended concepts that would provide the required functions.

Creative Phase

During the speculation/creative phase the VE team 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 Appendix D. This generated 27 individual ideas that were moved into the Evaluation Phase.

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.

To assist in this effort specific performance criteria were developed in cooperation with the project team. These criteria were weighted, using a paired comparison approach, and resulted in the criteria used to evaluate ideas and alternative concepts. These criteria are identified later in Appendix D.

A total of 9 ideas scored high enough to move forward into the Development Phase.

Development Phase
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 in the Recommendations and Design Comments section.

The nine ideas were combined into 5 recommendations and 2 scenarios.

Implementation Phase
The VE process is complete only when the implementation decision for every recommendation has been received from the Project Manager and documented on the Value Engineering Punch List.

Project Description

This project includes improvements to KY 15 between the KY 15 Bypass and Morton Blvd. The project corridor has a history of high crashes and congestion. Proposed improvements include:

- 2 general purpose (GP) lanes in each direction
- A third northbound GP lane along KY 15 between the KY 550 entrance ramp and the crest of the hill north of Morton Boulevard
- A third southbound GP lane along KY 15 between the KY 550 entrance ramp and the intersection with KY 15 Bypass
- 8' outside shoulders and 6' inside shoulders
- A median barrier wall will be used to separate traffic on KY 15

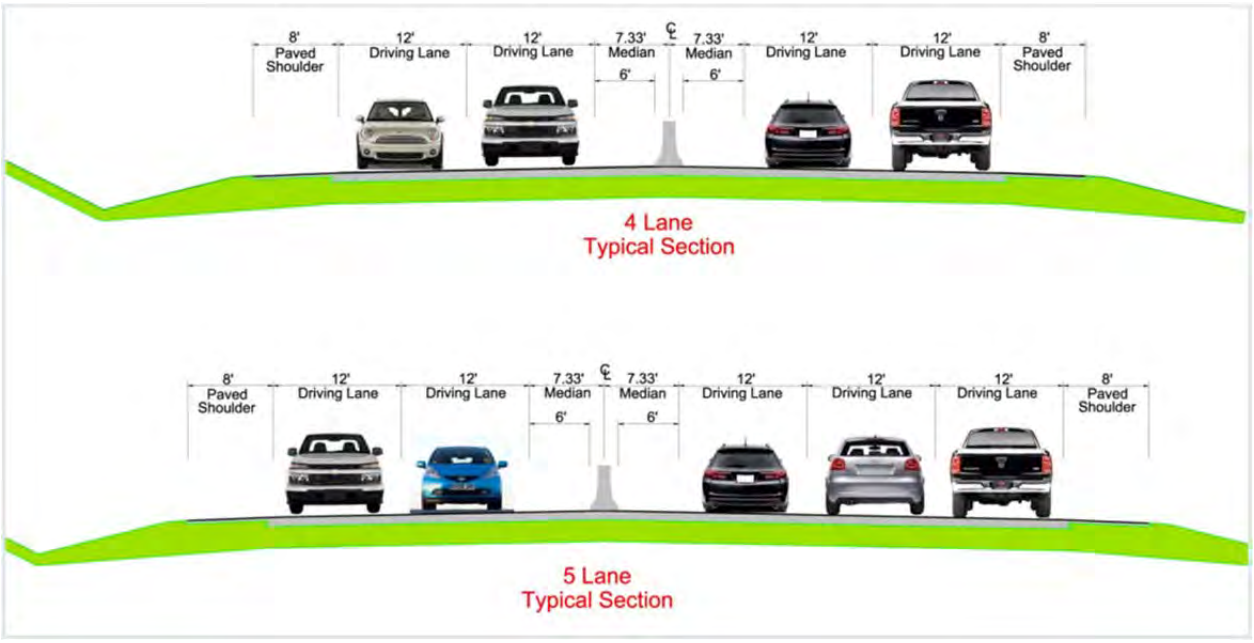

Figure 1 – Typical Sections for KY 15

Figure 2 – Alternative 6 (Preferred)

Figure 3 – Alternative 6 @ KY 15 Bypass

Beginning at the southern project limits the intersection of KY 15 and the KY 15 Bypass will utilize the existing intersection configuration. A southbound right turn lane will be added to KY 15 for traffic turning onto the Bypass.

The Exxon Station will need to be acquired to accommodate the widening of KY 15 at this location.

Figure 4 – Alternative 6 @ Perry Park

KY 15 at Perry Park Road will be realigned to the east and a new river bridge will be constructed. Right-In/Right-Out approaches will be added to KY 15 to access Perry Park Road. This configuration will eliminate the stopping & queuing that is currently occurring along KY 15 because of the existing signal at this location.

The proposed interchange will provide all movements and accommodate the ingress/egress to the asphalt plant and Fugate Mountain. The design speed of the proposed on and off ramps to connect Perry Park Boulevard with KY 15 are only 20 MPH.

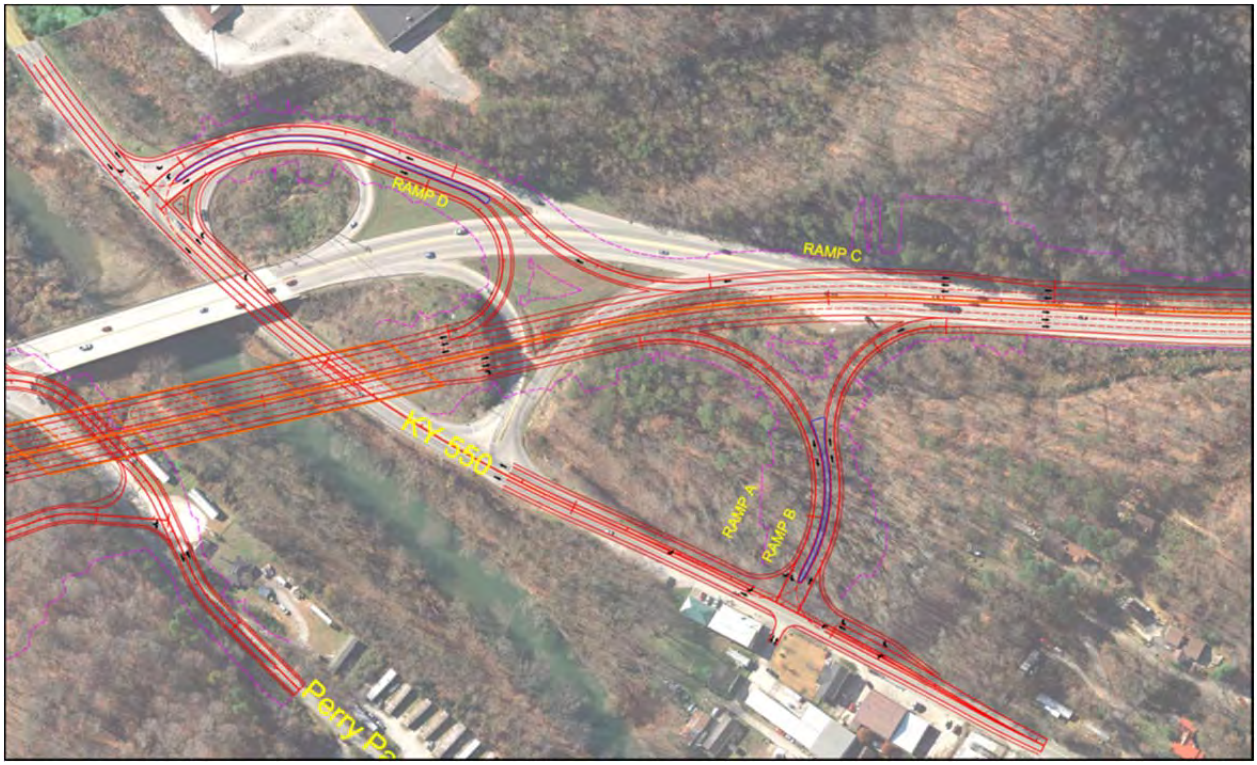

Figure 5 – Alternative 6 @ KY 550

At KY 550, Ramps A and B are shifted further to the east to align with Frogtown Lane and will have improved design speeds compared to the existing condition. The northbound on-ramp (Ramp B) will add a third northbound lane on KY 15.

Ramps C and D remain in the current location.

Because of the difference in elevation between the existing KY 15 alignment and the proposed alignment maintenance of traffic (MOT) will be difficult.

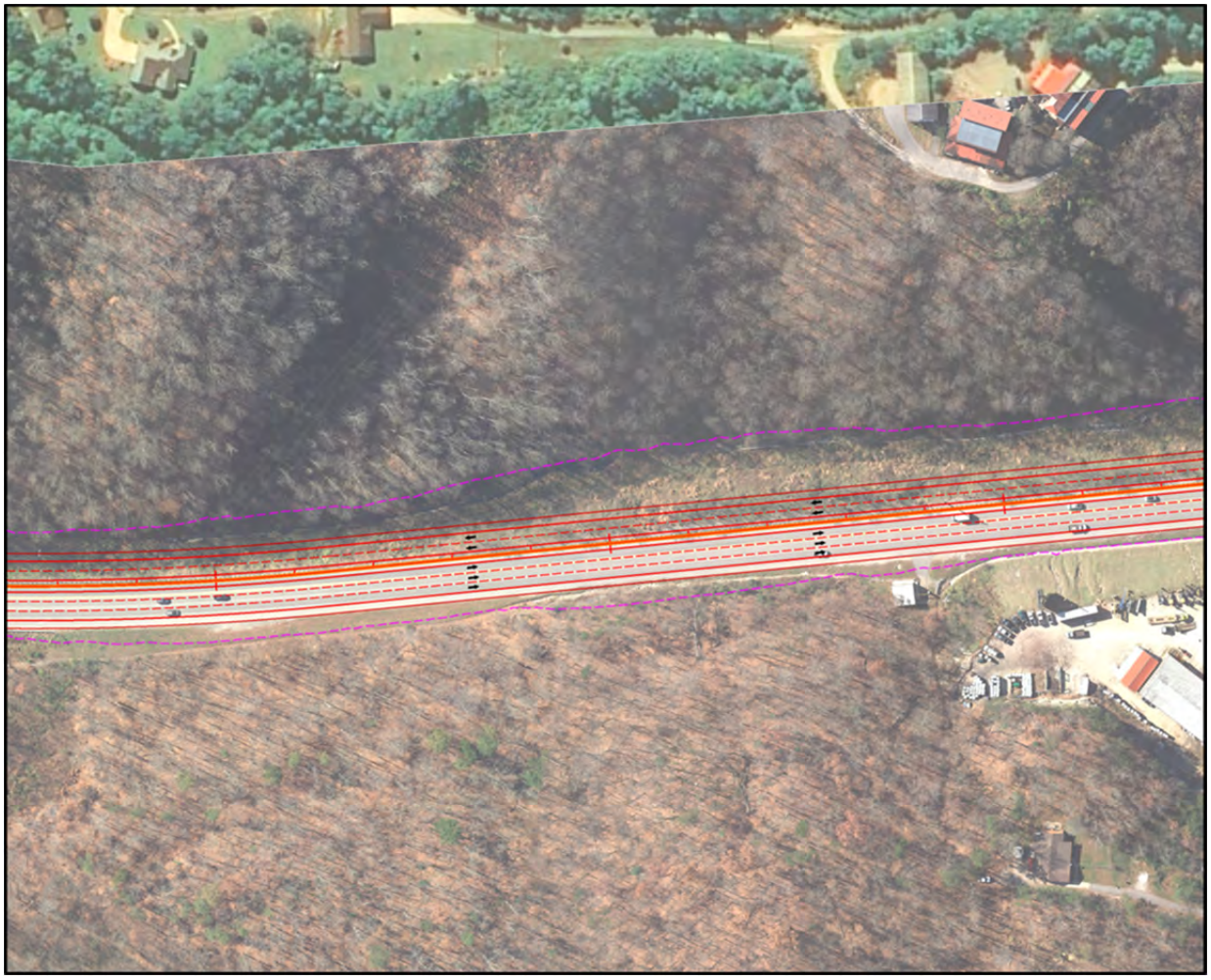

Figure 6 – Alternative 6 along KY 15

Beginning at KY 550 to the crest of the hill just north of Morton Boulevard, KY 15 has 2 general purpose (GP) lanes southbound and 3 northbound GP lanes.

KY 15 is widened to the west to accommodate the extra lanes and shoulders. Widening to the west minimizes impacts to the existing utilities, the Booster Station and impacts to Willie's Way.

Figure 7 – Alternative 6 at Morton Boulevard

The interchange configuration for Alternative 6 will eliminate the stopping and queuing that occurs along KY 15 because of the existing at-grade intersection. The design speed of the proposed on and off ramps to connect Willie's Way with KY 15 are only 20 MPH and have 6% superelevation on the horizontal curves.

VE Recommendations & Design Comments

The VE Recommendations are presented as written by the team during the VE Study. While they have been edited from the VE report to correct errors or better clarify the recommendation, they represent the VE Team's findings during the VE Study. The following table is a summary of all recommendations generated and their impact to the project.

Table 2 - Summary of Recommendations				
#	**Description**	**Cost Savings**	**Performance**	**Value**
VE-1	River Bridge	$5.43M	+5%	+16%
VE-2	Median Width	$0.60M	0%	+1%
VE-3	Roadway Section	$2.41M	-1%	+3%
VE-4	Perry Park Road	$18.35M	-10%	+35%
VE-5	Morton Blvd.	$3.39M	+1%	+8%
Scenario 1	**VE-1, VE-2, VE-3, VE-5**	**$11.83M**	**+1%**	**+27%**
Scenario 2	**VE-2, VE-3, VE-4, VE-5**	**$24.75M**	**-2%**	**+71%**

Note: VE-1 and VE-4 are mutually exclusive and cannot be implemented together.

Note: for details on performance attributes see appendix page 52 and for performance scores and value equation see page 41 of this report.

The cost comparisons reflect a difference or delta between the baseline idea and the VE Recommendation. As the project progresses, these values can be updated to reflect actual implemented results. These values shown have been adjusted by 56% to reflect the additional ***cumulative*** costs of:

Table 3 – Cost Estimate Markups	
Markup	**Percentage**
Miscellaneous Item Allowance	25%
Drainage Items	5%
Subtotal	**30%**
Mobilization	4%
Contingency	20%
Total Markup	**56%**

Individual Recommendations

Recommendation VE-1 River Bridge	IDEA NO. 3

Original Design

The current design conservatively assumed utilizing 8' deep steel girders in the superstructure. The existing structure has a center span length over the river of 178'. By holding this span length and adjusting for the increased skew the resulting span length could be as much as 188'. It's likely that an economical steel bridge would be a 4 span bridge with a maximum span close to 200'.

Recommended Change

Adjust the span lengths so that 150' pre-stressed concrete girders can be used.

Advantages	Disadvantages
▪ Allows a more economical superstructure ▪ Improved long-term maintenance ▪ More common construction	▪ Longer (but fewer) pieces to ship ▪ Heavier pieces to erect – larger cranes, crane pads, etc. ▪ Will require up to 2 additional piers.

Summary of Cost Analysis

	Original Design	Recommendation	Estimated Savings
First Costs	$12.18 M	$8.70 M	$3.48 M x 56% markup = $5.43 M
Life Cycle Costs	$0.60 M	$0	$0.60 M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
				✓

Recommendation VE-1 River Bridge	IDEA NO. 3

Justification

Having not gone through the structure selection process, the current design conservatively assumed utilizing 8' deep steel girders in the superstructure. The existing structure has a center span length over the river of 178'. By holding this span length and adjusting for the increased skew the resulting span length could be as much as 188'. It's likely that an economical steel bridge would be a 4 span bridge with a maximum span close to 200'.

This recommendation, or similar, would likely have been looked at by the project team as the project advanced. Prestressed beams are typically the preferred beam type for most structures in Kentucky. Prestressed Services has fabricated and shipped hybrid girders up to approximately 170' long.

The VE Team recommends that the span lengths are limited such that pre-stressed girders (simple for dead load and continuous for live load) may be used in the new structure. It looks like a 150' span would allow piers to be placed at each edge of the river. The approximate spans lengths for this proposal are already shown in the baseline drawings, which is for a six span bridge. The required short end spans are not very efficient for the deeper pre-stressed beams required in the interior spans. See additional recommendation for using MSE walls at end bents and eliminating end spans.

Recommendation VE-1 River Bridge	IDEA NO. 3

Sketches/Photos

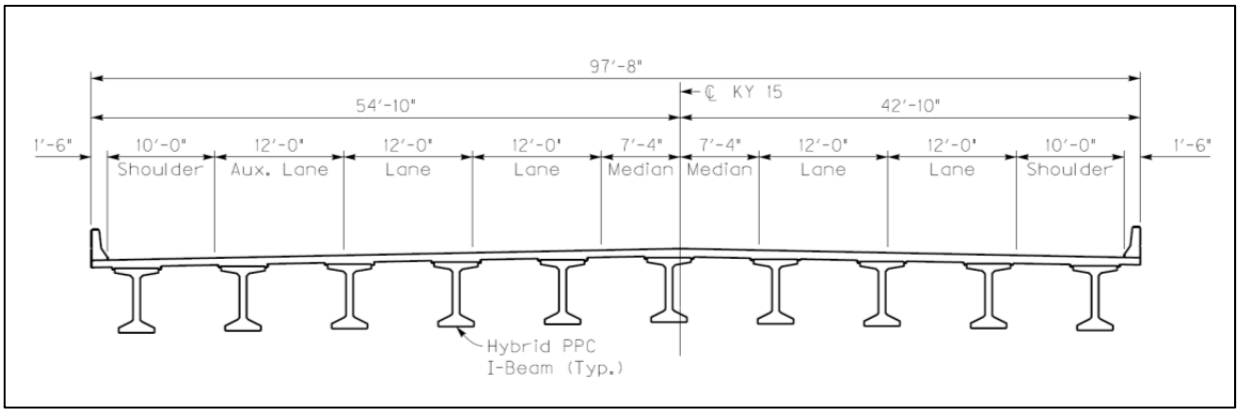

Figure 8 - VE Team recommended girder layout

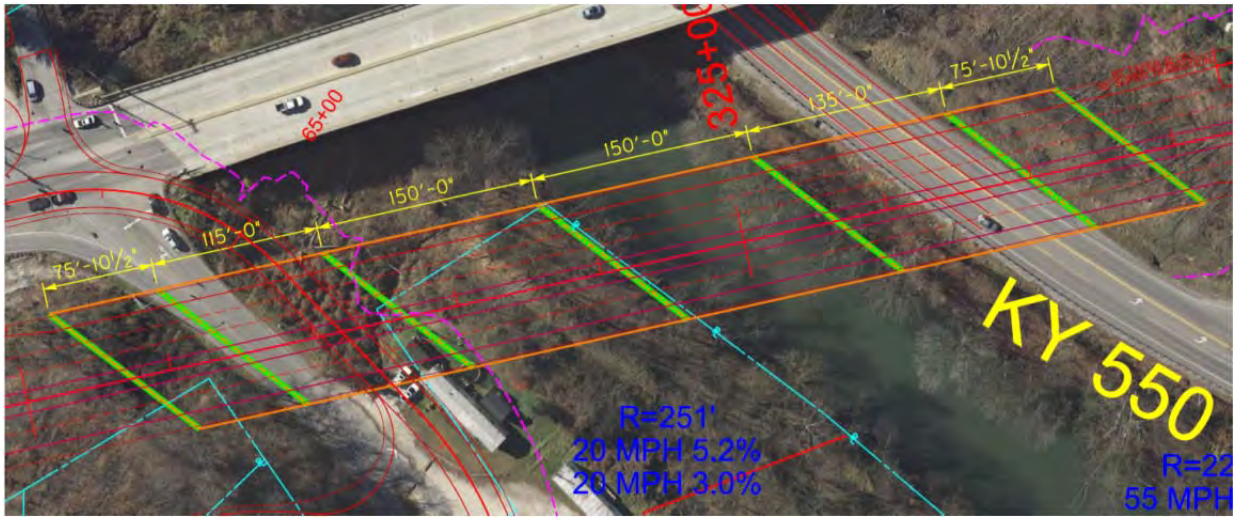

Figure 9 - VE Team recommended span lengths

Recommendation VE-1 River Bridge	IDEA NO. 3

Assumptions/Calculations

Assumes that 150'+ girders can be transported to the project site.

Assumes the additional pier(s) does not adversely affect the hydraulics.

Assumes that the steel bridge utilized painted steel girders. The use of weathering steel would reduce long term maintenance costs.

69,602 SF x 35 lbs/SF = 2,436,070 lbs of Structural Steel = 1,218 Tons

Repaint Cost = 1,218 Tons x $250/Ton = $300,000 to Repaint Bridge. Assume 2 repaint cycles over 75 year life of bridge.

Cost Estimate Worksheet

Item Description	Unit	Original Design			Recommended Design		
		Qty	Unit Cost	Total	Qty	Unit Cost	Total
KY 15 Bridge over N.F. Kentucky River	SF	69,602	$175	$12,180,350	69,602	$125	$8,700,250
Totals		**Original Design**		**$12,180,350**	**Recommendation**		**$8,700,250**
						Cost Savings	**$3,480,100**

Recommendation VE-1 River Bridge		IDEA NO. 3	
Performance Measures			
Attributes and Rating Rationale for Recommendation	**Performance**	**Original Design**	**Recommended Design**
Mainline Operations ▪ No change to baseline	Rating	5	5
	Weight	26.2	
	Contribution	131	131
Local Operations ▪ No change to baseline	Rating	5	5
	Weight	26.2	
	Contribution	131	131
Maintainability ▪ Assumes the baseline utilized painted steel girders that need to be repainted in the future. Corroded elements may need to be replaced.	Rating	5	7
	Weight	16.7	
	Contribution	83	117
Construction Impacts ▪ Adding two additional piers ▪ May require larger cranes ▪ Simpler construction with smaller pieces	Rating	5	5
	Weight	11.9	
	Contribution	60	60
Environmental Impacts ▪ Piers closer to river.	Rating	5	4
	Weight	14.3	
	Contribution	71	57
Project Schedule ▪ Reduced material procurement and fabrication time.	Rating	5	6
	Weight	4.8	
	Contribution	24	29
Total Performance:		**500**	**524**
Net Change in Performance:			**+5%**

Recommendation VE-2 Median Width	IDEA NO. 12

Original Design

Alternative 6 - Median with 6’ inside shoulders and concrete barrier wall.

Recommended Change

Reduce the median width to 4’ inside shoulders with a concrete barrier wall.

Advantages	Disadvantages
▪ Less right of way to purchase ▪ Less earthwork costs ▪ Less asphalt pavement costs ▪ Less crushed stone base costs ▪ Less impervious pavement	▪ Reduces shy distance to barrier ▪ May reduce operations of mainline ▪ May impair sight distance for south bound KY 15 (south of Morton Blvd.) ▪ May increase number of drainage inlets in median.

Summary of Cost Analysis

	Original Design	Recommendation	Estimated Savings
First Cost	$10.72M	$10.33M	$0.39M x 56% markup = $0.61M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
			✓	

Recommendation VE-2 Median Width	IDEA NO. 12

Justification

Design Memorandum 01-14 DRAFT addresses reducing the inside shoulders of divided highways from 6’ wide to 4’ wide

- Reduces foot print of typical section by 4’
- Reduces pavement costs for entire alignment
- Reduces earthwork costs for entire alignment

Double face guardrail was analyzed, but determined to be more expensive than concrete barrier wall based on recent bid documentation.

Double faced Guardrail recent bids was $20/LF

Concrete Barrier recent bids was $13/LF

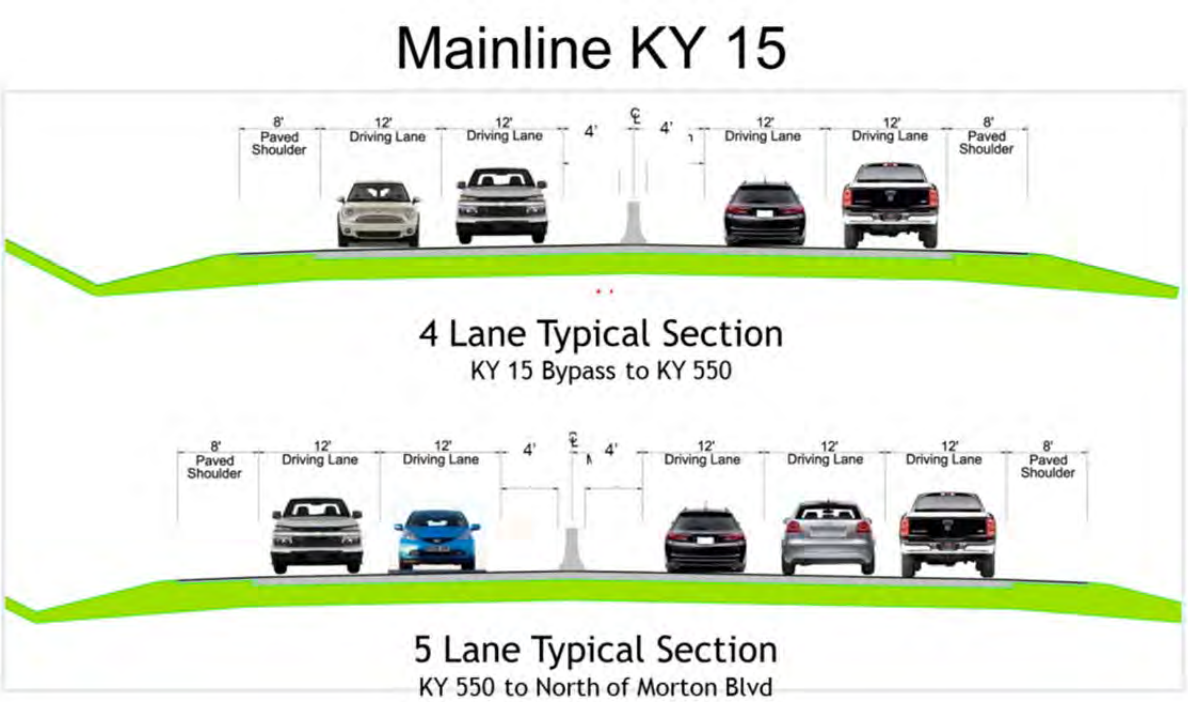

Figure 10 – VE Team recommended KY 15 Typical Sections

Recommendation VE-2 Median Width	IDEA NO. 12

Assumptions/Calculations

Pavement Reduction

Reduce inside shoulder to four feet reducing overall footprint of Alternate 6 design for KY 15

(5 lanes) x (12' wide) = 60'
(2 shoulders) x (10' wide) = 20'
(1 median) x (~15' wide) = 15'
Total footprint width = 95'

4' reduction => 4'/ 95' = 4.21%

Original mainline design cost from POB to POE = $3,439,489
Recommended Pavement savings = $3,439,489.00 x 4.21% = $144,821

Earthwork Reduction

Alternate 6 original cost $7,277,260 (from POB to POE)
Reduce footprint by 4' => 4'/95' = 4.21%

Earthwork cross sections for this revised section are not available. Since this is mostly a cut job narrowing the cross section will catch the slopes sooner. To be conservative and for calculations we assumed we can realize approximately 80% of the reduced earthwork.

Recommended Earthwork Savings $7,277,260 (4.21%) = $306,373 (80%) = $245,098

Total savings $245,098 + $144,821 = $389,919

Recommendation VE-2 Median Width			IDEA NO. 12
Performance Measures			
Attributes and Rating Rationale for Recommendation	**Performance**	**Original Design**	**Recommended Design**
Mainline Operations ▪ Reduces shy distance from barrier and may increase impacts with barrier wall ▪ May impair sight distance on horizontal curve	Rating	5	4
	Weight	26.2	
	Contribution	131	105
Local Operations ▪ No change to Original Design	Rating	5	5
	Weight	26.2	
	Contribution	131	131
Maintainability ▪ No change to Original Design	Rating	5	5
	Weight	16.7	
	Contribution	83	83
Construction Impacts ▪ Less Pavement construction ▪ Less Earthwork	Rating	5	6
	Weight	11.9	
	Contribution	60	71
Environmental Impacts ▪ Less Earthwork	Rating	5	6
	Weight	14.3	
	Contribution	71	86
Project Schedule ▪ No change to Original Design	Rating	5	5
	Weight	4.8	
	Contribution	24	24
Total Performance:		**500**	**500**
Net Change in Performance:			**0%**

Recommendation VE-3 Roadway Section	IDEA NO. 15

Original Design

The current design of KY 15 is three lanes northbound and two lanes southbound from KY 550 to Sta. 383+00 north of Morton Boulevard. The on-ramp from KY 550 creates the third northbound lane.

Recommended Change

The VE Team recommends ending the acceleration ramp from KY 550 northbound at the proposed right-in/right-out Willies Way southern intersection.

KY 15 from the Willies Way southern intersection (Sta. 360+50) to north of Morton Boulevard (Sta. 383+00) will be two lanes northbound and southbound.

Advantages	Disadvantages
▪ Less cost ▪ Less impacts to ROW and environmental ▪ Less earthwork ▪ Less maintenance of asphalt pavement ▪ Less impervious pavement	▪ LOS will be degraded (but still acceptable)

Summary of Cost Analysis

	Original Design	Recommendation	Estimated Savings
First Costs	See calculation assumptions	See calculation assumptions	$1.56M x 56% markup = $2.43M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		✓	✓	✓

Recommendation VE-3 Roadway Section	IDEA NO. 15

Justification

The original design of KY 15 has three northbound lanes running from the on-ramp at KY 550 (orange arrow on figure below) uphill and ending north of Morton Boulevard at approximate Sta. 383+00 (green arrow).

The VE Team recommends ending the northbound on-ramp from KY 550 at the proposed right-in/right-out Willies Way southern intersection (yellow arrow). Northbound KY 15 from the Willies Way southern intersection (Sta. 360+50) to north of Morton Boulevard (Sta. 383+00) will be two lanes.

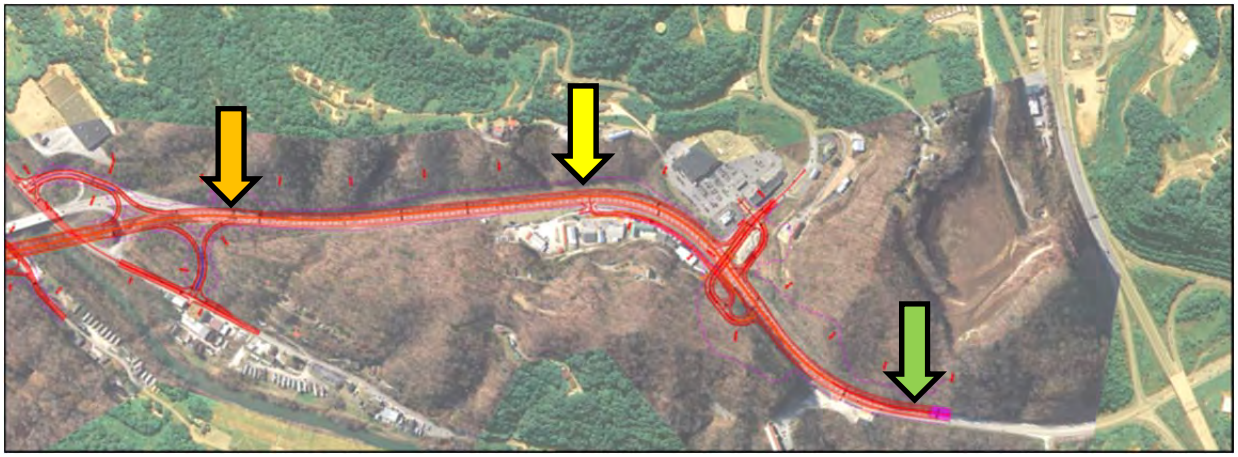

Figure 11 - Location of 3rd Northbound Lane

Alternative 4, developed by the Project Team, is similar to this recommendation. The difference is that this recommendation increases the length of the acceleration lane by approximately 1,100 feet, dropping it north of southern Willies Way intersection to accommodate acceleration from Willies Way.

This recommendation will reduce construction costs (less pavement and excavation), reduces environmental impacts, reduces long term maintenance and reduces the amount of impervious surface.

Recommendation VE-3 Roadway Section	IDEA NO. 15

Assumptions/Calculations

Assumes that the proposed roadway will continue to follow the existing north side edge of pavement. The proposed roadway would be reduced by one 12' lane width from Sta. 360+50 to Sta. 383+00.

Used $60/SY for pavement and $10/CY for excavation from the project teams estimate

Construction Cost Savings:

Reduction of full depth pavement:

Sta. 383+00-360+50 = 2,250 LF

2,250 x 12' wide = 27,000 SF

27,000 SF/9 = 3000 SY

3,000 SY x $60/SY = $180,000

Reduction of excavation:

Station	Roadway Width	Height of Cut	Cut Slope Left	Rdwy Ex CY
373+00	12	14	1	
				3845
374+00	12	29	1	
				6357
375+00	12	35	1	
				8932
376+00	12	47	1	
				13228
377+00	12	62	1	
				18793
378+00	12	77	1	
				23845
379+00	12	86	1	
				25571
380+00	12	85	1	
				19733
381+00	12	59	1	
				18158
383+00	12	24	1	
			Total	138462 CY

Sta. 383+00 to Sta. 373+00 = 138,462 CY X $10/CY = $1,384,620

Total cost reduction =$1,384,620 + $180,000= $1,564,620

Right of Way Savings:

Project team spreadsheet shows $25,000 per acre for this estimate the VE Team assumed $5,000 per acre.

Reduction of required right of way:

Sta. 383+00-373+00 =1,000 LF

1,000 x 12' wide = 12,000 SF

12,000 SF/43,560 SF/AC = 0.275 AC

0.275 AC x $5,000/AC = $1,377

Recommendation VE-3 Roadway Section		IDEA NO. 15	
Performance Measures			
Attributes and Rating Rationale for Recommendation	**Performance**	**Original Design**	**Recommended Design**
Mainline Operations ▪ Will reduce lane capacity on uphill and force a merge with slower moving vehicles	Rating	5	3.5
	Weight	26.2	
	Contribution	131	92
Local Operations ▪ No change to original design	Rating	5	5
	Weight	26.2	
	Contribution	131	131
Maintainability ▪ less asphalt pavement to maintain	Rating	5	5.5
	Weight	16.7	
	Contribution	83	92
Construction Impacts ▪ Reduced earthwork and less pavement	Rating	5	6
	Weight	11.9	
	Contribution	60	71
Environmental Impacts ▪ Reduce earthwork impacts	Rating	5	5.5
	Weight	14.3	
	Contribution	71	79
Project Schedule ▪ Reduced earthwork and less pavement	Rating	5	6
	Weight	4.8	
	Contribution	24	29
Total Performance:		**500**	**493**
Net Change in Performance:			**-1%**

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

Original Design

Alternative 6 – The intersection of KY 15 with Perry Park Rd., Cherokee Hills Rd., and the entrance to the Asphalt Plant is relocated to the south and east. New frontage roads are provided on both sides of the new KY 15 alignment to provide right-in/right-out access for Cherokee Hills Road, Asphalt Plant, Shell station, Pawn Shop, and Perry Park Rd. from both directions. A portion of the existing Perry Park Road is shifted to the north to pass under the proposed bridge.

Recommended Change

Maintain existing KY 15 alignment with widening to the east. Keep the existing signalized intersection for Perry Park Road, Cherokee Hills Road and the Asphalt Plant north entrance. Realign the intersection's eastbound approach to provide direct access to the Asphalt Plant and modify Cherokee Hills Road so that it "Tees" into the new Asphalt Plant access. Widen and rehabilitate the existing bridge to provide a southbound auxiliary lane, 2 southbound through lanes, and a left turn lane from KY 15 onto Perry Park Road. The speed limit along KY 15 from the river bridge to KY 15 bypass may need to be reduced to 45 MPH.

Advantages	Disadvantages
▪ Reduces excavation & significantly reduces the amount of excavation that has to be hauled across the river ▪ Reduces the amount of new structure for the river bridge ▪ Less right-of-way needed ▪ Likely won't need to purchase the Exxon Station ▪ Likely won't need to relocate any residents on Fugate Mountain. ▪ Reduces initial cost of project	▪ Adds another signal on KY 15 ▪ River bridge would need to be widened ▪ Utilizing existing bridge would require more life cycle cost versus a totally new bridge ▪ More complex maintenance of traffic during construction ▪ The Shell Station and Pawn Shop would only have right-in/right-out access ▪ Enforcement may be needed if speed limit is reduced

Summary of Cost Analysis

	Original Design	Recommendation	Estimated Savings
First Costs - Construction	$19.49M	$8.23M	$11.26M x 56% markup = $17.57 M
First Costs – Right-of-Way	$1.57M	$0.79M	$0.78M
O&M Costs	$48,240 (Repave Frontage Roads at Year 15)	$4,800 (O&M of Signal - $20/mo. For 20 yrs.)	$43,440

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		✓	✓	

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

Justification

The VE Recommendation is to maintain the existing KY 15 alignment with widening to the east and keeping the existing signalized intersection for Perry Park Road, Cherokee Hills Road and the Asphalt Plant north entrance.

The recommendation would realign the intersection's eastbound approach to provide direct access to the Asphalt Plant and modify Cherokee Hills Road so that it "Tees" into the new Asphalt Plant access.

The existing river bridge would be widened (27' 8") to accommodate the additional lanes and rehabilitated to provide additional capacity. The speed limit along KY 15 from the river bridge to KY 15 bypass may need to be reduced to 45 MPH.

- This recommendation does add another signal on KY 15, which will reduce the performance along the mainline when compared to the original design of Alternative 6.
- This recommendation causes the Shell Station and Pawn Shop to have right-in/right-out access, whereas they were accessing KY 15 via a frontage road in Alternative 6
- Because this recommendation follows the existing alignment, maintenance of traffic (MOT) will be more complex during construction
- Enforcement may be needed if it is decided to reduce the speed limit along KY 15 through this section.
- Maintaining an alignment that more closely follows the existing KY 15 alignment reduces the amount of excavation on the right side of Section 1 (POB to the River bridge). This will significantly reduce the amount of excavation that has to be hauled across the river to a waste site.
- Maintaining the existing alignment allows for the existing bridge to be re-used for the SB lanes. This reduces the amount of new structure to build since you would basically be widening the existing bridge to accommodate northbound traffic. The existing bridge would need to be rehabilitated and widened, which would require more life cycle (maintenance) cost versus a totally new bridge, but the cost of widening and rehabilitating a 400' bridge versus building a completely new 700' bridge is significantly less.
- This recommendation requires less right-of-way. This means that the Exxon Station and the residents on Fugate Mountain will likely not have to be purchased and/or relocated. (Note: If these parcels are not purchased, then they would have right-in/right-out access to KY 15.)
- All of these advantages significantly reduces the initial project costs
- Despite the reduction in performance along the mainline, the significant savings in cost create a positive added value for the project.

<u>Notes & Discussion about re-use of existing bridge:</u>

Overall, the existing bridge, built in 1965, is in great condition. It has a sufficiency rating of 92.6, which is better than most bridges in the State, including much newer bridges.

Only 3 girder lines would need to be added to the existing cross section. The current inventory rating is 42.4 tons, which is more than sufficient. However, additional capacity can be achieved by installing shear studs on the existing girders during deck replacement. In order to not have to remove cross frames, accommodating the new bridge cross slope would require a larger than normal haunch between the top of some girders and the bottom of the proposed deck. This haunch area could be reinforced to provide proper composite action.

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

The rehabilitated and widened structure would have a reduced service life over a complete replacement. However, the cost savings with this option could pay for a new bridge to be built at a later date. This is due to the fact that the rehabilitated and widened bridge and its future replacement would both be 240' shorter than the bridge currently being proposed.

In theory, the existing steel girders could have a finite fatigue life. The longitudinal web stiffeners appear to be located on the compression side of the web. Near the field splices there could be a stress reversal causing tension, but the stresses would be relatively low. In addition, the lateral bracing in the exterior bays are attached to the bottom flange by gusset plates that are fillet welded. A remaining fatigue life analysis could be performed and dye penetrate testing of areas of concern, if any. It is likely the lateral bracing could be removed and the flanges ground smooth if there is any concern.

Sketches/Photos

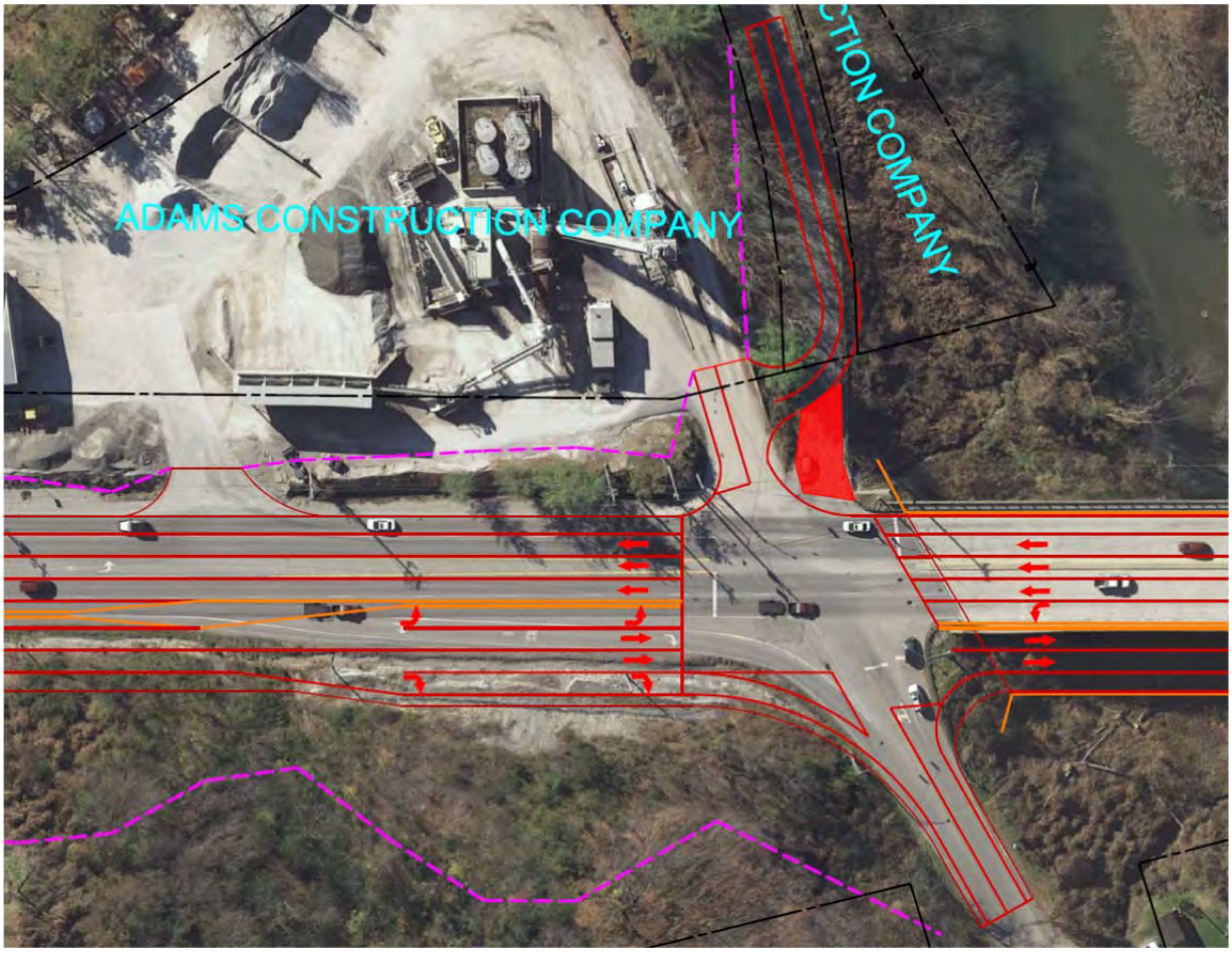

Figure 12 - VE Recommended intersection at Cherokee Hills Road

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

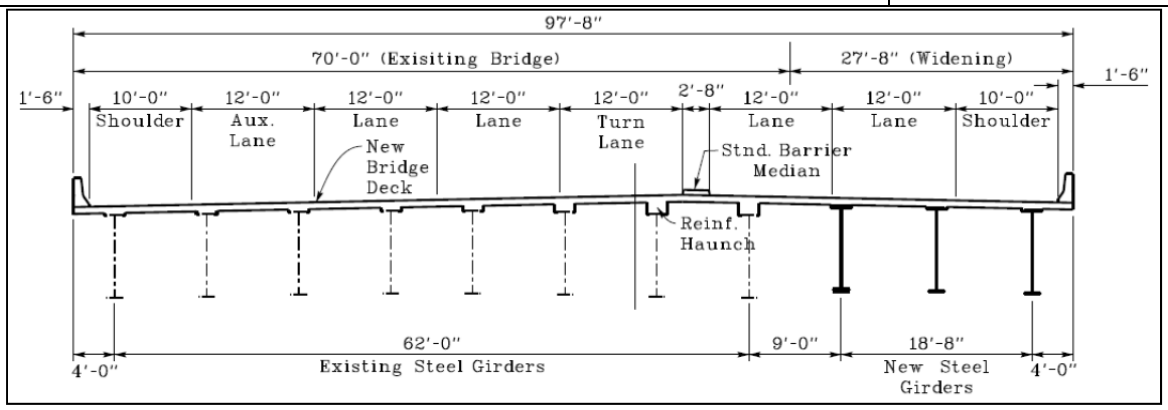

Figure 13 - VE Recommended Bridge Widening Detail

Assumptions/Calculations

Assumptions:

- There will be no changes in the design from just north of the KY 550 ramps to the POE, so Stream Impact costs and the cost of the retaining wall will not change.
- Utility impact costs are assumed to be the same for this recommendation and the Alt. 6 design.
- This recommendation is similar to Alt 1A from POB to the KY 550 ramps, so the earthwork calculations from the Alt 1A spreadsheet were utilized to estimate the earthwork for this recommendation. Also, since this project has excess excavation, only the Cut volumes have been estimated.
- Assumes the current inspection report adequately reflects the condition of the existing bridge.

Construction Calculations:

EARTHWORK:

Original Design (from POB to KY 550 Ramps):

- Section 1 (POB to Bridge):

  Estimated Cut = 378,684 CY x $10/CY = $3,786,840
- KY 550 Ramps:

  Estimate Cut = 85,829 CY x $10/CY = $858,290

  $3,786,840 + $858,290 = $4,654,130 Earthwork Cost of Sec. 1 & Ramps of Original Design

Recommendation (from POB to KY 550 Ramps):

- Section 1 (POB to Bridge):

  Estimated Cut = 50,000 CY x $10/CY = $500,000
- KY 550 Ramps:

  Estimate Cut = 79,500 CY x $10/CY = $795,000

  $500,000 + $795,000 = $1,295,000 Earthwork Cost of Sec. 1 & Ramps of Recommendation

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

PAVEMENT:

Original Design (Section 1 & 2):

- Section 1 (POB to Bridge): $1,024,962
- Section 2 (Bridge to Willies Way Entrance): $1,725,850

$1,024,962 + $1,725,850 = $2,750,812 Pavement Costs of Sec. 1 & 2 of Original Design

Recommendation (Section 1 & 2):

- Section 1 (POB to Bridge): By not building the frontage roads associated with Perry Park Rd., approximately 1,900 LF of 32' wide frontage road pavement (2-12' lanes & 2-4' shoulders) could be eliminated.

  1,900 LF x 24' = 45,600 SF ÷ 9 = 5,067 SY x $40/SY = $202,667

  1,900 LF x 8' = 15,200 SF ÷ 9 = 1,689 SY x $25/SY = $42,222

- Section 2 (Bridge to Willies Way South Entrance): Because this recommendation's alignment will more closely follow the existing alignment, the ramps at the KY 550 interchange will be slightly shorter, primarily Ramps C & D. It is estimated that 700 LF of 21' wide ramp pavement (15' lane, 6' shoulder) could be eliminated.

  700' x 15' = 10,500 SF ÷ 9 = 1,167 SY x $40/SY = $46,667

  700' x 6' = 4,200 SF ÷ 9 = 467 SY x $25/SY = $11,667

  $202,667 + $42,222 + $46,667 + $11,667 = $303,223 of Pavement Cost can be eliminated.

  So, $2,750,812 - $303,223 = $2,447,589 Pavement Costs of Sec. 1 & 2 of Recommendation

STRUCTURES:

Original Design (New River Bridge – 700' Long):

- $12,085,850 Structure Costs of River Bridge of Original Design

Recommendation (Rehabilitate and Widen Existing River Bridge – 460' Long):

New Construction Portion: 27' – 8" of width

- 27.67' x 460 LF = 12,768 SF x $175/SF = $2,227,400

New Deck & Repair Existing Portion: 70' of width

- 70' x 460 LF = 32,200 SF x $50/SF = $1,610,000

$2,227,400 + $1,610,000 = $3,837,400 Structure Costs of River Bridge of Recommendation

Right-of-Way Calculations:

Original Design (Section 1 & 2):

- Section 1 (POB to Bridge): $1,427,750
- Section 2 (Bridge to Willies Way South Entrance): $142,750

$1,427,750 + $142,750 = $1,570,500 ROW Costs of Sec. 1 & 2 of Original Design

Recommendation (Section 1 & 2):

- Section 1 (POB to Bridge): ROW impacts should be substantially less. This recommendation should allow the Exxon station to remain. We have assumed ROW costs of Section 1 for this recommendation to be 50% of Alt 6.

Recommendation VE-4 Perry Park Road	IDEA NO. 5, 6, 16, 19, 22

- Section 2 (Bridge to Willie's Way South Entrance): This recommendation's alignment more closely follows the existing, so Ramps A & B would not have to shift to the east as far as in Alt 6, reducing the needed ROW. We have assumed ROW costs of Section 2 for this recommendation to be 50% of Alt 6.

  $1,570,500 x 0.5 = $785,250 ROW Costs of Sec. 1 & 2 of Recommendation

Operations and Maintenance Calculations:

8,390 SY of additional pavement to resurface along the Frontage Roads:

8,390 SY x 1.25" x 115 lb/SY ÷ 2,000 lb/Ton = 603 Tons x $80/Ton = $48,240

Operating the signal: assumption that electrical costs would be $20/mo.

$20/mo. X 12 mo./yr. x 20 yrs. = $4,800

Widening and rehabilitating the existing structure will require additional future maintenance costs to the existing girders and piers. However, the structure in this recommendation is 240' shorter than the proposed Alt 6 bridge, so this recommendation will realize savings due to lesser overlay costs. The additional costs to the girders and piers will be offset by the lesser overlay costs, so we have assumed that maintenance costs of the river bridge will be similar.

Cost Estimate Worksheet

Item Description	Unit	Original Design			Recommended Design		
		Qty	Unit Cost	Total	Qty	Unit Cost	Total
Earthwork				$4,654,130			$1,295,000
Pavement				$2,750,812			$2,447,589
Structures				$12,085,850			$3,837,400
Additional Cost for Phased Construction of Bridge							$400,000
Signal at Perry Park							$100,000
Additional MOT Cost							$150,000
Totals		**Original Design**		**$19,490,792**	**Recommendation**		**$8,229,989**
						Construction Cost Savings	**$11,260,803**
Right-of-Way				$1,570,500			$785,250
						Right-of-Way Cost Savings	**$785,250**
						Total Cost Savings	**$11,992,053**

Recommendation VE-4 Perry Park Road			IDEA NO. 5, 6, 16, 19, 22
Performance Measures			
Attributes and Rating Rationale for Recommendation	**Performance**	**Original Design**	**Recommended Design**
Mainline Operations ▪ Added a signal to mainline that is closer to the bridge.	Rating	5	3
	Weight	26.2	
	Contribution	131	79
Local Operations ▪ Revising access to the Asphalt Plant and the right-in, right-out at Shell, Pawn Shop. Right in Right out for Exxon and Fugate Mtn. Rd.	Rating	5	4
	Weight	26.2	
	Contribution	131	105
Maintainability ▪ Additional signal to maintain ▪ Less pavement to maintain and overlay ▪ Re-use of existing bridge may require more routine maintenance ▪ Shorter bridge to maintain and overlay	Rating	5	5.5
	Weight	16.7	
	Contribution	83	92
Construction Impacts ▪ Considerably less earthwork/ less blasting ▪ Less bridge to build ▪ MOT will be more complicated	Rating	5	5
	Weight	11.9	
	Contribution	60	60
Environmental Impacts ▪ Less excavation to waste ▪ Not cutting as much of the hill ▪ Reduced risk of contaminated soils ▪ May avoid property impacts on Fugate Mtn.	Rating	5	6.5
	Weight	14.3	
	Contribution	71	93
Project Schedule ▪ Less overall construction work but productivity will likely be lower due to MOT, so may not see much change in construction time.	Rating	5	5
	Weight	4.8	
	Contribution	24	24
Total Performance:		**500**	**451**
Net Change in Performance:			**-10 %**

Recommendation VE-5 Morton Blvd.	IDEA NO. 9

Original Design

Alternative 6 – Full interchange on KY 15 with Morton Blvd. and the north end of Willies Way. Willies Way will also be improved and a right-in/right-out entrance provided at the south end of Willies Way.

The alignment of Morton Blvd. is shifted slightly to the north to minimize right-of-way taking on the east side of KY 15 and to provide a slip ramp for eastbound right turns from Morton Blvd. to southbound KY 15.

Recommended Change

Provide signalized intersection at Morton Blvd. (similar to proposed design shown in Alternate 4) with:

- Dual northbound left turn lanes from KY 15 to Morton Blvd.
- Single eastbound left turn lane from Morton Blvd. to KY 15, utilizing "green" or "inside" left turn lane
- Right-in/right-out movement for westbound Willies Way approach (north end).

Provide unsignalized intersection at Willies Way (south end), also utilizing "green" or "inside" left turn lane for turning movements onto KY 15.

Advantages	Disadvantages
▪ Significantly less cost ▪ Northbound mainline does not stop at intersection ▪ Less confusion for traveling public ▪ Less right-of-way is required ▪ Reduces earthwork ▪ Reduces maintenance without bridge	▪ Left hand merge onto mainline ▪ Added signal to southbound mainline ▪ Additional maintenance of traffic (MOT) will be required ▪ Snow and ice removal may be more difficult

Summary of Cost Analysis

	Original Design	Recommendation	Estimated Savings
First Costs - Construction	$5.35M	$3.50M	$1.85M x 56% markup = $2.89M
First Costs – Right-of-Way	$1.00M	$0.50M	$0.50M
O&M Costs		$20/month for 20 years	

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
			✓	

Recommendation VE-5 Morton Blvd.	IDEA NO. 9

Justification

The existing intersection currently operates under a signalized condition. Although some relatively long queues develop during peak hours, it is assumed the current LOS (D or better) is within acceptable limits.

Due to issues with some trucks overturning as they attempt to turn left from the eastbound approach onto northbound KY 15 (as a result of the 7% upgrade and full superelevation), this movement is prohibited. Access to the north end of Willies Way is provided by a full intersection located just north of the existing Morton Blvd. intersection.

Alternative 4 was initially developed to improve operations at the Morton Blvd. intersection. According to the information provided, the LOS for this alternative is C/D (AM/PM) based on the design year traffic. The design of Alternative 4 provides:

- Dual northbound left turn lanes from KY 15 to Morton Blvd.
- Single eastbound left turn lane from Morton Blvd. to KY 15, utilizing "green" or "inside" left turn lane. This design technique allows northbound traffic to continue through the intersection without stopping at the signal. This is significantly important due to the number of large vehicles on the 7% upgrade through the intersection.
- The Morton Blvd. approach is shifted to the north slightly to move the intersection out of the curve – either eliminating or reducing the superelevation through the intersection. This will allow the left turn movement to be reintroduced into the intersection.
- Right-in/right-out movement for westbound Willies Way approach (north end). The RI/RO movement is required in order to allow the northbound traffic to move through the intersection without stopping at the signal.

To allow vehicles attempting to turn left (to the south) from Willies Way (since this movement is not allowed at Morton Blvd.), an un-signalized intersection is proposed in Alternative 4 at the south end of Willies Way. The VE Team recommendation slightly modifies this to also provide a "green" or "inside" left turn lane for the turn onto KY 15. This would allow the left turning vehicles to turn across only the northbound lanes to a protected lane in which they could then merge onto the southbound lanes. This recommendation would have improved operations if only two northbound lanes are provided on KY 15 (see Recommendation VE-3).

If the Project Team determines that the left turn from Willies Way (to the south) is not desirable, an option would be to design the intersection to function as right-in/right-out and provide a U-turn movement at the Morton Blvd. intersection. This option may be more desirable if three northbound lanes are provided on KY 15.

Recommendation VE-5 Morton Blvd.	IDEA NO. 9

Sketches/Photos

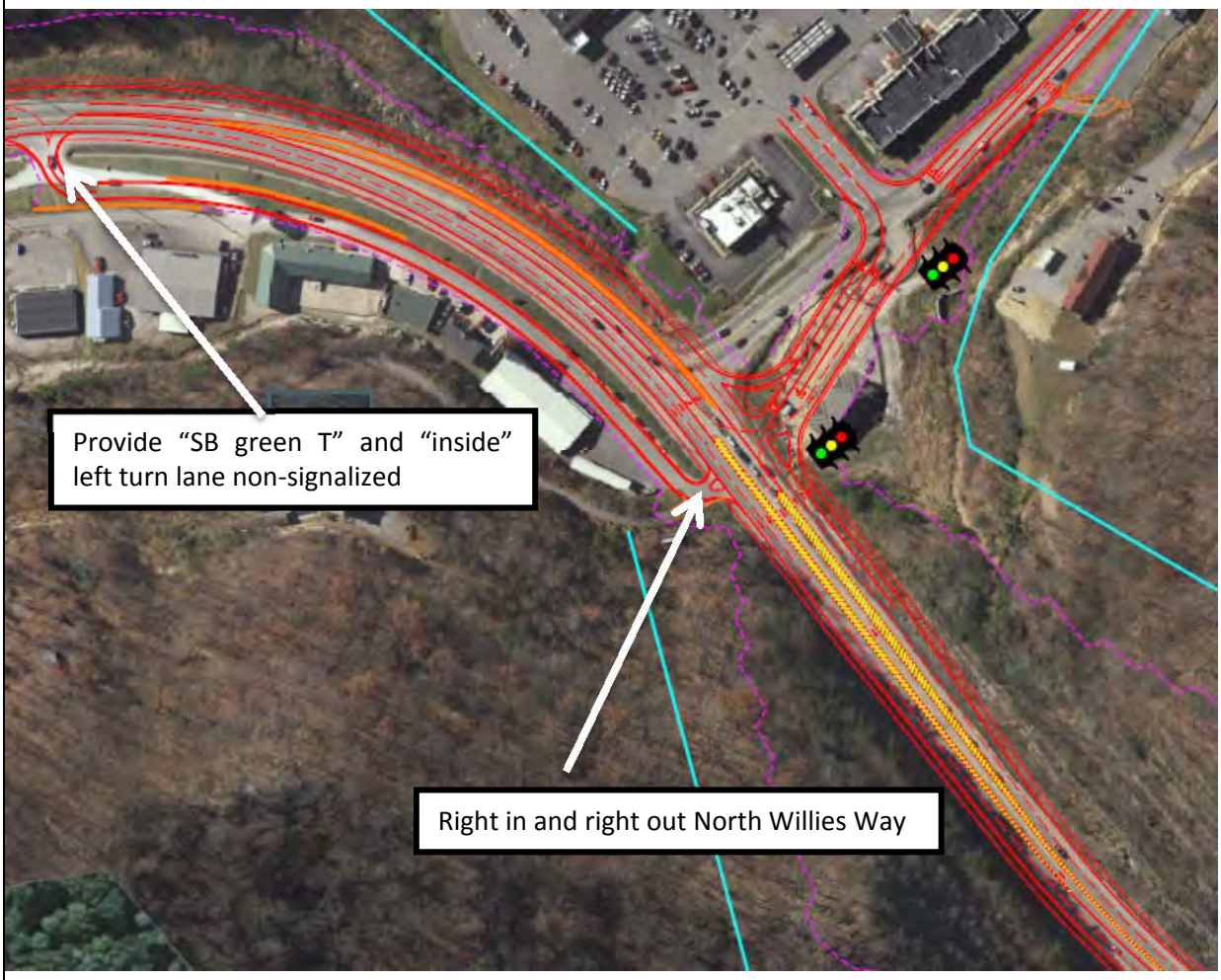

Figure 14 – VE Recommendation for Morton Blvd

Recommendation VE-5 Morton Blvd.	IDEA NO. 9

Assumptions/Calculations

1. Quantities and unit prices are developed from a comparison between Alt. 4 and Alt. 6 estimates provided by consultant.
2. Right-of-Way - Still need to acquire the Dentist office but the red roof building will not be needed.

Cost Estimate Worksheet

Item Description	Unit	Original Design			Recommended Design		
		Qty	Unit Cost	Total	Qty	Unit Cost	Total
Morton Blvd. Structure	LS	1	$1.5 M	$1,500,000			
Excavation	CY	500,000	$5.00	$2,500,000	450,000	$5.00	$2,250,000
Pavement	SY	30,000	$45.00	$1,350,000	25,000	$45.00	$1,125,000
Signalization	LS				1	$125 K	$125,000
Totals		**Original Design**		**$5,350,000**	**Recommendation**		**$3,500,000**
						Construction Cost Savings	**$1,850,000**
R/W – Business Relocation	EA	2	$500,000	$1,000,000	1	500 K	$500,000
						Right-of-Way Cost Savings	**$ 500,000**

Recommendation VE-5 Morton Blvd.			IDEA NO. 9
Performance Measures			
Attributes and Rating Rationale for Recommendation	**Performance**	**Original Design**	**Recommended Design**
Mainline Operations ▪ A signal will impact LOS as compared to an interchange. Since an "Inside" left is proposed, the northbound movement will not be effected.	Rating	5	4
	Weight	26.2	
	Contribution	131	105
Local Operations ▪ A signal will impact the LOS of the side streets as compared to an interchange but the overall operation will be slightly improved due to the traveled route is more direct, less confusion to drivers and low speeds on interchange ramps.	Rating	5	5.5
	Weight	26.2	
	Contribution	131	144
Maintainability ▪ A signal will increase maintenance, but the reduction of the bridge and reduced overall pavement should offset this increase.	Rating	5	5.5
	Weight	16.7	
	Contribution	83	92
Construction Impacts ▪ Increased MOT during construction	Rating	5	5.5
	Weight	11.9	
	Contribution	60	66
Environmental Impacts ▪ No change to Original Design	Rating	5	5
	Weight	14.3	
	Contribution	71	71
Project Schedule ▪ Reduces construction duration	Rating	5	6
	Weight	4.8	
	Contribution	24	29
Total Performance:		**500**	**506**
Net Change in Performance:			**1%**

Design Comments

In addition to the recommendations above, the VE Team generated a number of ideas that they felt were important enough to be documented and should be further considered by the project team.

DC-1 - Spliced prestressed girder for spans greater than 150' on the river bridge - If the spans need to exceed 150' for the river bridge then consider spliced pre-stressed girders as an alternative to the baseline assumed steel girders. This can reduce cost and potentially structure depth.

DC-2 - Only beef up two lanes on new bridge for hauling off road earth movers - The VE Study Team's Analysis concluded that legal load trucks would most likely be used due to the current projected waste site's locations relative to the excess material. The material is coming from the south side of the river and the east side of KY 15. Even with an over designed bridge, haul trucks would still have to cross KY 15 to get to the proposed waste site on the western side. This may require additional repairs to the crossing sites and significant MOT.

However, if an over designed bridge is desired, the VE Study Team's recommendation is to only over design 24' width of the proposed bridge. This width would be sufficient enough for haul trucks to cross the river.

DC-3 - Consider a con-span or wagon box over Perry Park Rd and shorten the main river bridge - Using a wagon box or con-span structure over Perry Park would allow a shortened proposed bridge structure. The shortened bridge will reduce initial structure costs and long term maintenance costs associated with the bridge. This suggestion may reduce impacts to the existing Perry Park Road alignment. Drawbacks to this design consideration includes: creating a tunnel effect on Perry Park Road and a reduction of access during construction to the river bridge from the south.

DC-4 - Eliminate end spans on River Bridge and use MSE walls - By eliminating the end spans of the bridge and incorporating MSE walls the costs of constructing the bridge could be lowered. There will be less bridge to maintain however this could have more settlement at the bridge ends due to increased fill heights.

DC-5 - Use short soil nail walls and rock bolting to reduce excavation - Based on the bedrock type of the region, it is likely the roadway cut will consist of sandstone, shale, limestone and coal varying in thicknesses. The shale bedrock may consist of durable and nondurable shales as classified by the KYTC Geotechnical Manual.

The typical KYTC roadway cut benching configuration (as shown by the Designer) is one method for taller cut slopes and may result in nondurable bedrock beneath durable bedrock. As the nondurable bedrock weathers overtime, the durable bedrock may be undercut and fall onto the intermediate bench below or the roadway ditch at the base of the cut. This method requires long-term maintenance to keep the benches clear of talus and rock fall. It may be necessary to perform a rock fall catchment design with localized rock bolting and a drape system to prevent the loose bedrock from encountering the driving lanes of the roadway.

If the preliminary geotechnical subsurface investigation reveals thick (30+ feet) nondurable shales, a rock bolting solution may reduce the excavation yardage and stabilize the nondurable shale bedrock. The rock bolting option is preferred within homogeneous bedrock conditions. However, the height of the rock bolting solution will be a determining feasibility factor. Typical heights are 50 feet or less. If the height exceeds 50 feet, benching may be required.

A localized rock bolting solution is a typical solution for a bedrock slide failure within the existing roadway cut. As portions of the existing roadway cut break away and fall onto the intermediate bench, the lifts may become unstable. If maintenance is not performed and the benches become filled, they may serve as a launching feature for future rock fall. The remaining loose bedrock would be chipped away and localized rock bolts would be installed with a drape system to stabilize the bedrock. A catchment ditch with a fence may be required at the roadside ditch. This method would extend the life of the existing cut to the design life of the rock nails and fence material.

DC-6 - Eliminate median barrier and use narrower median with mountable median curbing - Possibility of eliminating placing barrier wall throughout project and replace with mountable median. This could lessen earthwork and required right of way due to being able to use narrower shoulders. It would also allow better access for Emergency vehicles that could cross it for accidents in the area.

DC-7 - Re-evaluate ESALS to define the appropriate pavement section - The ESAL forecasts provided for the project should be reviewed and verified. By re-evaluating the traffic forecasts you could find that reduction in ESALS would result in a reduction in the final pavement section over the entire project.

Performance Assessment

As the VE Team developed recommendations; the performance of each is rated against the baseline concept. Changes in performance are always based upon 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 recommendations can be compared to the original design concept. For details on performance attributes please see Appendix page 52.

In order to compare and contrast the potential for value improvement, individual recommendations are compared to the baseline project for all attributes. For this exercise the Original Design or Baseline was given a score of 5. The resulting value improvement scores allow a way for KYTC to assess the potential impact of the VE recommendations on total project value.

Table 4 – Performance Attribute Scores

KY-15 Improvements, Item #10-158.00

Attribute	Attribute Weight	Concept	Performance Rating										Total Performance
			1	2	3	4	5	6	7	8	9	10	
Mainline Operations	26.19	Baseline					5						131
		VE-1					5						131
		VE-2				4							105
		VE-3				3.5							92
		VE-4			3								79
		VE-5				4							105
Local Operations	26.19	Baseline					5						131
		VE-1					5						131
		VE-2					5						131
		VE-3					5						131
		VE-4				4							105
		VE-5					5.5						144
Maintainability	16.67	Baseline					5						83
		VE-1							7				117
		VE-2					5						83
		VE-3					5.5						92
		VE-4					5.5						92
		VE-5					5.5						92

Table 4 – Performance Attribute Scores													
KY-15 Improvements, Item #10-158.00													
Attribute	**Attribute Weight**	**Concept**	**Performance Rating**										**Total Performance**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Construction Impacts	11.90	Baseline					5						60
		VE-1					5						60
		VE-2						6					71
		VE-3						6					71
		VE-4					5						60
		VE-5					5.5						65
Environmental Impacts	14.29	Baseline					5						71
		VE-1				4							57
		VE-2						6					86
		VE-3					5.5						79
		VE-4						6.5					93
		VE-5					5						71
Project Schedule	4.76	Baseline					5						24
		VE-1						6					29
		VE-2					5						24
		VE-3						6					29
		VE-4					5						24
		VE-5						6					29

Understanding the relationship of cost, performance, and value of the Original Design and VE recommendations 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 5 – Value Matrix Totals							
OVERALL PERFORMANCE		**Performance (P)**	**% Change Performance**	**Cost (C)**	**% Change Cost**	**Value Index (P/C)**	**% Value Improvement**
	Baseline	500		$57.7		8.67	
VE-1	River Bridge	524	+5%	$52.3	-9%	10.02	+16%
VE-2	Median Width	500	0%	$57.1	-1%	8.76	+1%
VE-3	Roadway Section	493	-1%	$55.3	-4%	8.92	+3%
VE-4	Perry Park Road	451	-10%	$38.6	-33%	11.70	+35%
VE-5	Morton Blvd.	506	+1%	$54.3	-6%	9.32	+8%

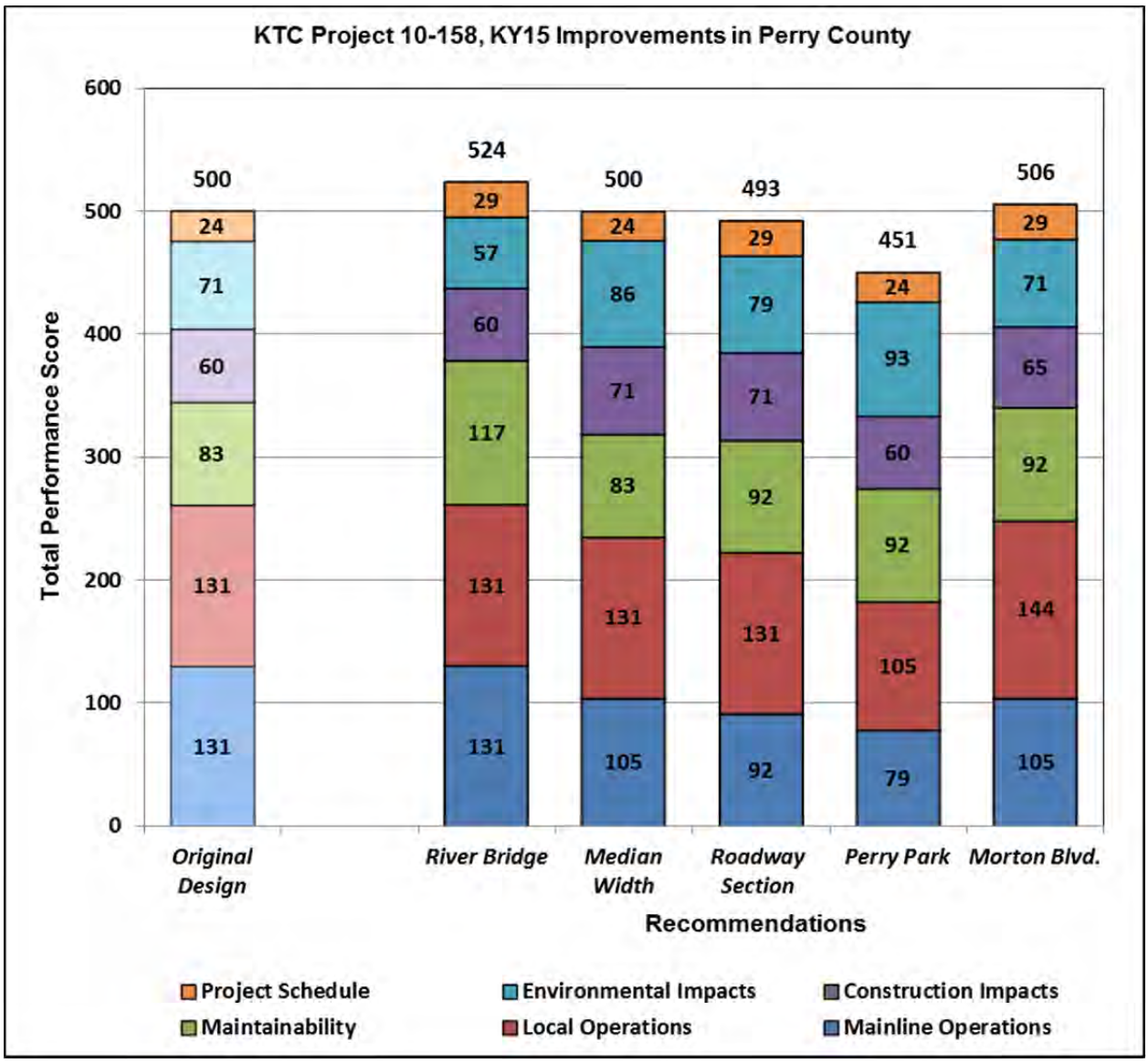

Figure 15 – Overall Performance Comparison

Scenarios

Since Recommendations VE-1 and VE-4 are mutually exclusive and cannot be both implemented the VE Team created two scenarios. Scenario 1 includes VE-1, VE-2, VE-3 and VE-5 while Scenario 2 includes VE-2 through VE-5.

Table 6 – Scenario Value Matrix Totals

OVERALL PERFORMANCE		Performance (P)	% Change Performance	Cost (C)	% Change Cost	Value Index (P/C)	% Value Improvement
	Baseline	500		$57.7		8.67	
	Scenario #1	506	+1%	$45.9	-21%	11.03	+27%
	Scenario #2	488	-2%	$32.9	-43%	14.80	+71%

Appendix A: Study Participants

KENTUCKY TRANSPORTATION CABINET					**VE Study Attendees** ***KY-15 Improvements*** ***Item No. 10-158.00***			HDR	
April 2014					**NAME**	**ORGANIZATION**	**POSITION/DISCIPLINE**	**TELEPHONE**	
								Office	**Cell**
21	**22**	**23**	**24**	**25**				**EMAIL**	
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✓	✓	✓			John Broadus	HDR	Structures	(502) 909 - 3254	(303) 887 - 5681
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✓	✓	✓	✓	✓	Ken Smith	HDR	VE Team leader	360-570-4415	360-451-2527
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✓	✓	✓	✓	✓	Mike Vaughn	KYTC	VE Coordinator	(502) 782 - 4923	(859) 582 - 6858
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VE Study Attendees

KY-15 Improvements

Item No. 10-158.00

April 2014					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
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✓		✓	✓		Darren Back	KYTC – District 10	Project Manager	(606) 666 - 8841	(606) 207- 5562
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VE Study Attendees

KY-15 Improvements

Item No. 10-158.00

April 2014					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
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				✓	Eileen Vaughan	KYTC – Co Planning	Strategic Corridor	(502) 782 – 4916	
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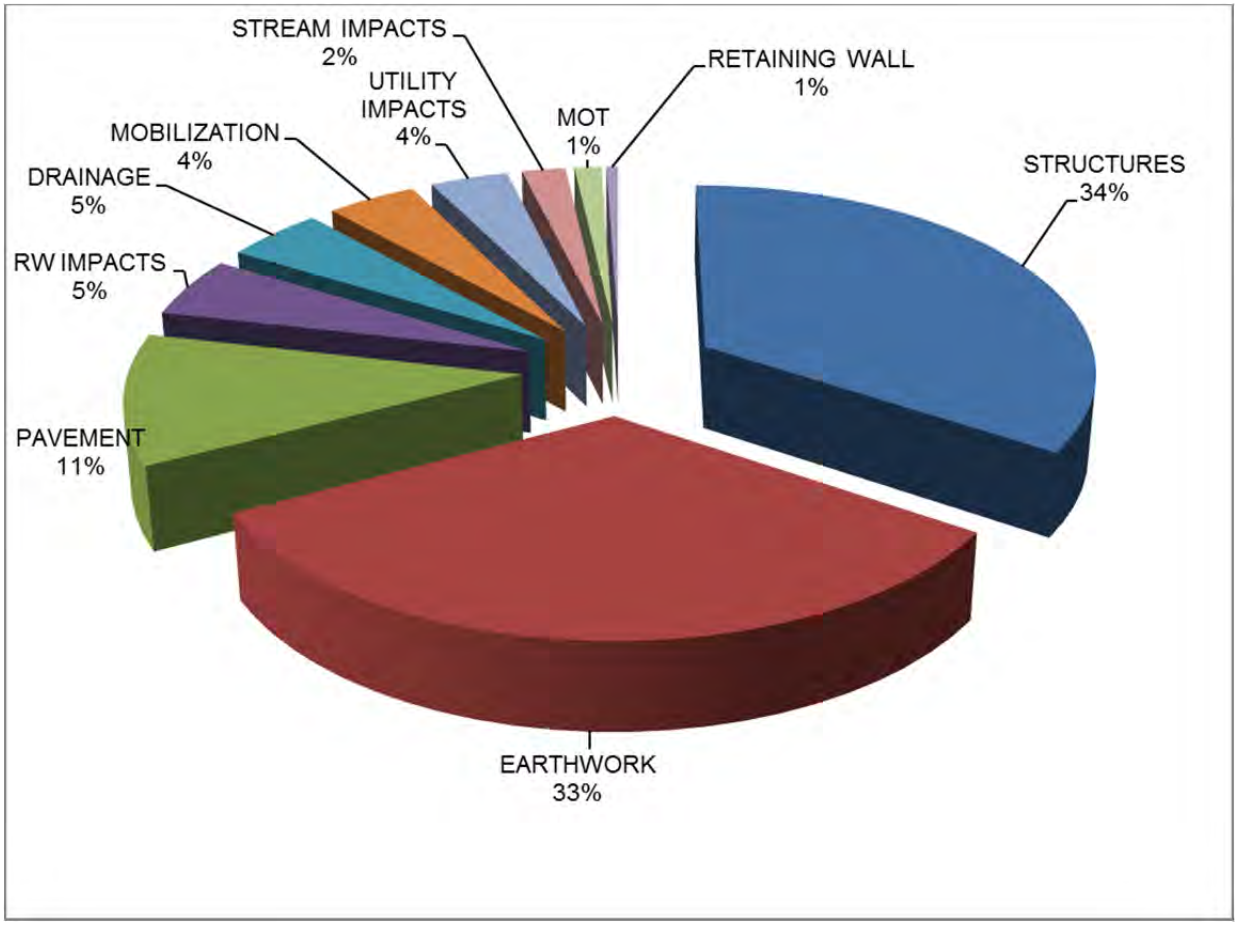
				✓	Gary Valentine	KYTC	Executive Director Project Development	(302) 782 – 4569	
								Gary.valentine@ky.gov	

Appendix B: Pareto Cost Models

The VE Team Leader prepared a cost model from the cost estimate provided to the team.

The cost model is organized to identify major construction elements or trade categories, and the percent of total project cost for the significant cost items.



Alternative 6 Cost Model

The figure above clearly demonstrates that combined cost of the structures and the earthwork is two thirds of the overall project cost. The pavement provides another 11% of the project costs.

This cost model provided the basis for determining the functional analysis and assisted the VE Team in focusing on the high cost areas of the project.

Appendix C: Functional Analysis

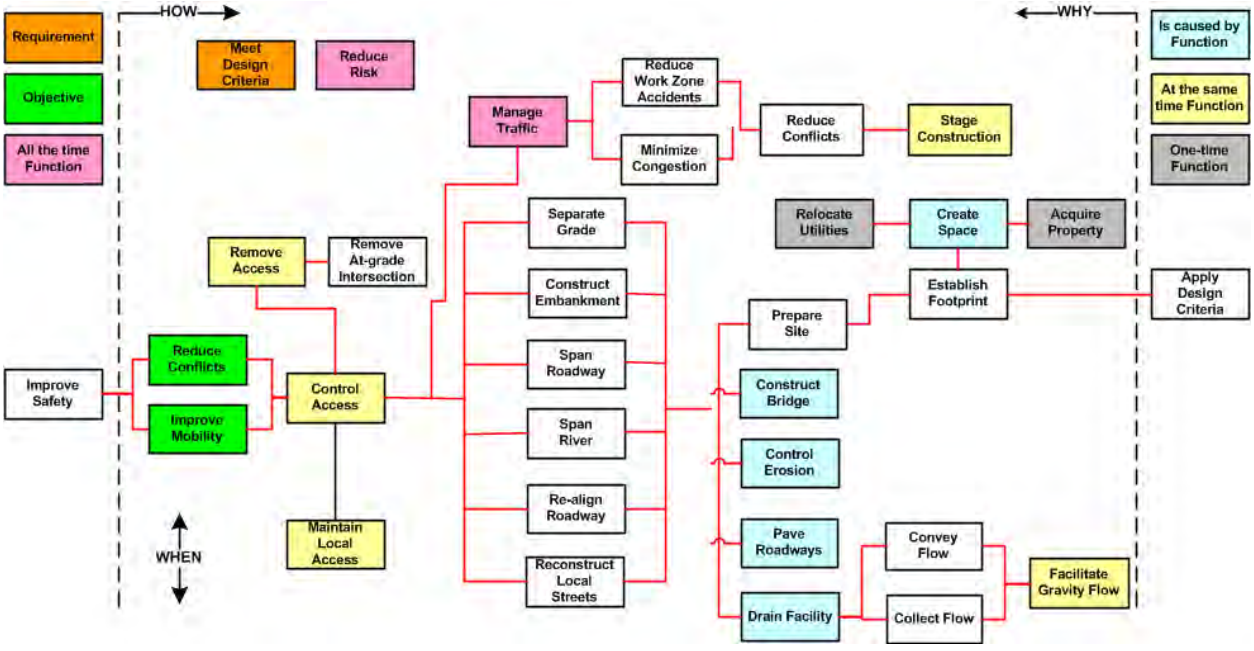
Functional analysis results in a unique view of the project. It transforms project elements into functions, which moves the VE Team mentally away from the original design and takes it toward a functional concept of the project.

Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level. Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions. The major functions identified by the team were:

- Reduce Conflicts
- Improve Mobility
- Improve Safety
- Control Access

The Functional 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 for this project shows Reduce Conflicts and Improve Mobility as the basic functions of this project. Key secondary functions included Improve Safety and Control Access. This provided the VE Team with an understanding of the project design rationale and which functions offer the best opportunity for cost or performance improvement.



Appendix D: Creative List & Evaluation

Creative List

During the creative phase of the VE Job Plan the VE Team, brainstormed ideas on how to perform the various functions. These ideas were based on the available information given to them at the time of the study, taking into consideration the constraints and controlling decisions that were also given to them.

The ideas listed below coincide with each function being considered:

Function: Span River - (baseline 8' steel girder on new alignment)

- Spliced Concrete girder
- Only beef up two lanes for hauling off road earth movers
- Keep spans < 150' and use prestressed beams
- Use con-span or wagon box over Perry Park Rd and shorten the main river bridge
- Widen existing and rehabilitate river bridge
- Move river bridge closer to the existing structure
- Re-use existing river bridge for local traffic
- Eliminate end spans and use MSE walls

Function: Separate Grade - Morton Blvd.

- Green "T" signalized intersection at Morton and Willies Way (Similar to Alt 4)
- Urban I/C at Morton and close north entrance to Willies Way
- At grade signal and do not take dentist office

Function: Realign Roadway

- Reduce inside shoulder to 4'
- Realign access to Exxon to across from KY 15 bypass (includes access to Fugate Mtn. Rd.)
- Transfer the risk of waste of excess material to the contractor
- Reducing from five lane section to four lane section (between Morton Blvd and KY 550)
- Do not buy out Exxon; shift KY 15 alignment to the west
- Use soil nail walls to reduce excavation
- Raise the profile in the vicinity of Station 378+00

Function: Reduce Conflicts – Perry Park Road

- Keep a signalized intersection at Perry Park and re-align with entrance of Asphalt plant and do not build the Perry Park east connector
- Leave Perry Park Rd as is with no left turns from KY-15 to Perry Park Rd.
- Right in and Right out at Perry Park/ Right in and Right out for Cherokee Hill Rd.
- Reduce speed on KY 15 and use fully signalized intersection at Perry Park and Cherokee Hills Rd.
- Bring Cherokee Hills Rd. along the ROW in front of Asphalt plant with right in right out at Perry Park Rd.
- Round about at Perry Park, KY-15, Asphalt plant and Cherokee Hills Rd.
- Eliminate median barrier and use narrower median with mountable median curbing
- Use double faced guardrail

Performance Based Results

Using performance attributes process is an integral part of the value engineering process. This process provides the cornerstone of the VE process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the value study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

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

The VE Team Leader will lead the team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops forms the basis for the VE Team 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 value engineering 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 recommendation'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 value engineering 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 upon 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 project value. 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 "the 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 value study. In the event that project functions have been substantially modified, the methodology must begin a new from the beginning (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. All performance requirements MUST be met by any idea 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 Leader will initially request that representatives from the 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 the attribute be discretely defined, and they must be quantifiable in some form. By quantifiable, it is meant that a useable scale must be delineated with values given on a scale of 0 to 10. A "0" indicates unacceptable performance, while a "10" indicates optimal or ideal performance. The vast majority of performance attributes that typically appear in transportation value studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Step 2 – Determine the Relative Importance of the Attributes

Once the group has agreed upon the project's performance attributes, the next step is to determine their relative importance in relation to each other. This is accomplished through the use of an evaluative tool termed in this report as the "Performance Attribute Matrix."

This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?" A letter code (e.g., "a") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of essentially equal importance, both letters (e.g., "a/b") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed.

When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote", as it made the list in the first place and should be given some degree of importance.

Step 3 – Establish the Performance "Baseline" for the Original Design
The next step is to define the baseline as it pertains to each performance attribute. The baseline is then given a score of 5 on a scale of 0 to 10 for each attribute.

Step 4 – Evaluate the Performance of the VE Recommendations
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 recommendations as they are developed during the course of the value study. The Performance Measures form at the back of each recommendation is used to capture this information.

It is important to consider the recommendation's impact on the entire project, rather than on discrete components.

Step 5 – Compare the Performance Ratings of Recommendations to the "Baseline" Project
The last step in the process is to develop the performance ratings for the original design concept. The VE Team groups the recommendation into a scenario (or scenarios) to provide the decision makers a clear picture of how the recommendations fit together into possible solutions. At least one scenario is developed to present the VE Team's consensus of what should be implemented. Additional scenarios are developed as necessary to present other combinations to the decision makers that should be considered. The scenario(s) of VE recommendations are rated and compared against the original concept. The performance ratings developed for the VE Scenarios are entered into the matrix, and the summary portion is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations.

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

Performance Attributes

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

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 following performance attributes were used throughout the study to identify, evaluate, and document ideas and recommendations.

Table 3 - Performance Attributes		
Performance Attribute	**Definition**	**Baseline**
Mainline Operations	An assessment of traffic operations and safety on the KY-15 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.	2 lanes NB and 3 lanes SB from the beginning of the project (POB) at KY 15 bypass to the KY 550 interchange, AND 3 lanes NB and 2 lanes SB from the KY 550 interchange to the end of the project (POE), grade separations at Perry Park Rd and KY 550 and Morton Blvd. 12' lanes, 10' outside & 6' inside shoulders. Design speed of 55 mph. WB 62 at I/C and WB 40 at Morton Blvd. Willies Way to SB KY-15 Asphalt pavement.
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure (cross streets). 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.	Improvements to Morton Blvd, Willies Way, KY 550 I/C and Perry Park Rd
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.	Assume steel girders for river structure and concrete over Morton Blvd. All pavements will be asphalt. Signals at KY 550 and KY 15 bypass. Concrete barrier divider. W-beam guardrail where required. Open channel drainage.
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.	Minimal impacts to businesses, traffic holding during blasting.
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.	Hazardous materials at Exxon service station and possible impacts to cluster homes Fugate Mountain.
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.	Currently around 30% design ROW and utilities in 2015 Construction in 2016-2018 Assume 24- 36 months for construction.

Performance Attribute Matrix

A matrix was used to determine the relative importance of the individual performance attributes for the project. The Project and VE Teams 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 - Performance Attribute Matrix

Which attribute is more important to the outcome of the project?							TOTAL	%
Mainline Operations	**A**	A/B	A	A	A	A	5.5	26.19%
Local Operations		**B**	B	B	B	B	5.5	26.19%
Maintainability			**C**	C	C/E	C	3.5	16.67%
Construction Impacts				**D**	D/E	D	2.5	11.90%
Environmental Impacts					**E**	E	3.0	14.29%
Project Schedule						**F**	1.0	4.76%
							21	100%

Evaluation

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

Taking into consideration the constraints and controlling decisions, the team discussed each idea and documented the advantages and disadvantages. The team then determined if the idea was an improvement in performance for each of the attributes.

Each idea was then carefully evaluated with the VE Team reaching consensus on the overall rating of the idea (zero through five). High-rated ideas (four or higher) were developed further; those that were considered to be equivalent to the baseline (rated three) were documented as design comments; and low-rated ones (two or lower) were dropped from further consideration; however, the team provided a short description and justification to support the low rating. The rating values are shown below:

5 = Great Opportunity
4 = Good Opportunity
3 = Design Comment (comparable to project team's approach)
2 = Minor Value Degradation
1 = Major Value Degradation
0 = Fatal Flaw (unacceptable impact or doesn't meet the project purpose and need)

= Advanced as recommendation

= Forwarded as design consideration

= Dropped from future consideration

Function: Span River - (baseline 8' steel girder on new alignment)

#	Description	Advantages	Disadvantages
1	Spliced prestressed girder	▪ Less cost ▪ Lower Maintenance ▪ Shorter pieces for hauling ▪ Can reduce procurement time to get the girders	▪ Bad track record in state ▪ Less industry experience in this type of girder ▪ May require temporary false work for splicing

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍	👎		

Rating:	Justification/Comments/Disposition:
3	*Should only be considered if the 150' spans cannot work.*

#	Description	Advantages	Disadvantages
2	Only beef up two lanes for hauling off road earth movers	▪ Reduced cost over beefing up the whole structure ▪ Constructability	▪ Non uniform stiffness ▪ Could require one way off-road haulers across the bridge

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👍		👍

Rating:	Justification/Comments/Disposition:
3	*Only to considered if allowing off road hauling equipment on bridge*

#	Description	Advantages	Disadvantages
3	Keep spans < 150’ and use prestressed beams	▪ Less cost ▪ Easier to construct ▪ Reduced lifecycle and maintenance cost	▪ Requires piers to be closer to the river ▪ Bigger cranes needed for heavier pieces

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍			

Rating:	Justification/Comments/Disposition:
5	*Moved to further development - Recommendation VE-1*

#	Description	Advantages	Disadvantages
4	Use con-span or wagon box over Perry Park Rd and shorten the main river bridge	▪ Shorten river bridge ▪ Reduce bridge to maintain ▪ Could reduce the amount of reconstruction/ realignment of Perry Park Rd	▪ Tunnel effect ▪ It would limit access during construction to the river bridge from the south

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍	👎		

Rating:	Justification/Comments/Disposition:
3	*Cost may be nearly the same.*

#	Description	Advantages	Disadvantages
5	Widen and rehabilitate the existing river bridge	▪ Significantly less cost ▪ Fewer stream impacts ▪ Less ROW impacts ▪ Considerably less earthwork	▪ Will require phase construction ▪ Will require revisions to the alignment and intersection designs ▪ Maintenance of the older structure ▪ Limits the ability of grade separation with Perry Park

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👎	👍	

Rating: 3.5	Justification/Comments/Disposition:
	Moved to further development but will require other alignment ideas for this to work. Included as part of Recommendation VE-4

#	Description	Advantages	Disadvantages
6	Move river bridge closer to the existing structure	▪ Shorten new structure ▪ Reduces skew of new structure ▪ Reduces earthwork ▪ Reduce cost	▪ Complex geometry for proposed intersections ▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎		👍		

Rating: 4	Justification/Comments/Disposition:
	Moved to further development but would require shifting alignment to the west of KY 15. Included in Recommendation VE-4

#	Description	Advantages	Disadvantages
7	Re-use existing river bridge for local traffic	▪ Could eliminate an intersection on KY 15	▪ Another bridge to maintain ▪ Complicated traffic flow ▪ Could have adverse impacts on businesses due to circuitous route ▪ Geometry of Perry Park Rd. ▪ High cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👎			

Rating: 1	Justification/Comments/Disposition:
	Dropped from further consideration

#	Description	Advantages	Disadvantages
8	Eliminate end spans and use MSE walls	▪ Less cost ▪ Less bridge to maintain	▪ Risk of settlement

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍			

Rating:	Justification/Comments/Disposition:
3	*Design Comment*

Function: Separate Grade - Morton Blvd.

#	Description	Advantages	Disadvantages
9	Green "T" signalized intersection at Morton and Willies Way (Similar to Alt 4)	▪ NB mainline does not stop at intersection ▪ Significantly less cost ▪ Less confusion for traveling public ▪ Less ROW required ▪ Reduces earthwork ▪ Less maintenance for bridge	▪ Left hand merge ▪ May require a U-turn movement at Morton Blvd (to accommodate right in right out at Willie's Way SE) ▪ Added signal to SB mainline

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎	👍	👍	👍		👍

Rating:	Justification/Comments/Disposition:
4.5	*Moved to further development but would require a similar intersection for Willie's Way on south end. Recommendation VE-5*

#	Description	Advantages	Disadvantages
10	Urban I/C at Morton and close north entrance to Willies Way	▪ Driving expectancy over Alt C ▪ Less earthwork ▪ Could save dentist office	▪ NB ramp grades my exceed standards ▪ Cutting off Willie's Way ▪ Space between Willie's Way and NB KY 15 ▪ Would require walls or additional take from Applebee's ▪ Higher bridge cost ▪ More walls

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👎			

Rating:	Justification/Comments/Disposition:
2	*Dropped from further consideration*

#	Description	Advantages	Disadvantages
11	At grade signal and do not take dentist office	▪ Reduce cost ▪ Lower maintenance (no bridge) ▪ Diver expectancy for local traffic ▪ Better exposure for businesses ▪ Reduces earthwork ▪ Reduce ROW impacts	▪ Could disrupt businesses on the east side ▪ Introducing a signal on KY 15 ▪ May take the Carpet store ▪ NB traffic would have stop at 7% grade ▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎	👎	👍	👍		

Rating:	Justification/Comments/Disposition:
0	*Upon further review a fatal flaw was discovered that the adverse super on KY 15 may cause vehicle rollovers turning on NB KY-15 from Morton Blvd.*

Function: Realign Roadway

#	Description	Advantages	Disadvantages
12	Reduce inside shoulder to 4’	▪ Less ROW ▪ Less earthwork ▪ Reduced cost ▪ Less impervious pavement	▪ Reduces shy distance to barrier ▪ Could reduce operations of mainline ▪ Could impair sight distance SB KY 15 (south of Morton Blvd) ▪ May increase number of drainage inlets in median

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎			👍	👍	

Rating:	Justification/Comments/Disposition:
4	*Moved to further development. Recommendation VE-2*

#	Description	Advantages	Disadvantages
13	Realign access to Exxon to across from KY 15 bypass (includes access to Fugate Mtn. Rd.)	▪ Potentially saves Exxon ▪ Provides full access to Fugate Mtn. Rd. ▪ ▪	▪ KY 15 widening may still have adverse impacts on Exxon ▪ Could have adverse impact on KY 15 and KY 15B ▪ Large cut required for access point ▪ May increase cost ▪ Added maintenance cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎		👎	👎	👎	

Rating:	Justification/Comments/Disposition:
1	*Dropped from further consideration*

#	Description	Advantages	Disadvantages
14	Transfer the risk of waste of excess material to the contractor	▪ Contractor may have more flexibility than KYTC ▪ Transfer risk to the contractor ▪ Less ROW required ▪ Could reduce environmental impacts	▪ Contractor will price the risk

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
				👍	

Rating:	Justification/Comments/Disposition:
2	*Dropped from further consideration*

#	Description	Advantages	Disadvantages
15	Reducing from five lane section to four lane section (between Morton Blvd and KY 550)	▪ Less cost ▪ Less impacts to ROW and environment ▪ Less earthwork	▪ LOS will be degraded

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎		👍	👍	👍	👍

Rating:	Justification/Comments/Disposition:
4	*Moved to further development. Recommendation VE-3*

#	Description	Advantages	Disadvantages
16	Do not buy out Exxon; shift KY 15 alignment to the west	▪ Wouldn't require ROW from Exxon (reduces risk of ROW cost) ▪ Reduces risk of encountering contaminated soils ▪ Reduced cost ▪	▪ Will have railroad impact ▪ Doesn't resolve the access issue to Fugate Mtn. Rd. ▪ May require an added lane on KY 15 bypass bridge ▪ May tighten radius onto KY 15 bypass

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎				👍	

Rating:	Justification/Comments/Disposition:
3.5	*Moved to further development. Recommendation VE-4*

#	Description	Advantages	Disadvantages
17	Use soil nail walls to reduce excavation	▪ Reduce earthwork ▪ Reduce ROW	▪ Stability of the upper slope ▪ May require shotcrete above wall ▪ May increase maintenance cost ▪ May increase construction risks

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎			

Rating:	Justification/Comments/Disposition:
3	*Design Comment*

#	Description	Advantages	Disadvantages
18	Raise the profile in the vicinity of Station 378+00	▪ Reduced excavation ▪ Help the profile of the ramps	▪ May still have to stabilize slopes ▪ May compromise sight distance on KY 15 ▪ May incorporate a sag VC on KY 15 ▪ Maintenance of traffic ▪ Would require full depth pavement through the raised profile area

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎			👎	👍	

Rating:	Justification/Comments/Disposition:
2	*Dropped from further consideration*

Function: Reduce Conflicts – Perry Park

#	Description	Advantages	Disadvantages
19	Keep a signalized intersection at Perry Park and re-align with entrance of Asphalt plant and do not build the Perry Park east connector	▪ Reduces earthwork ▪ Less confusing ▪ Less roadway to maintain ▪ Reduces cost ▪ Less ROW ▪ Full access for local roads	▪ Added signal on mainline ▪ Close spacing on signals on KY 15

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎	👍	👍	👍	👍	

Rating:	Justification/Comments/Disposition:
4	*Similar to Alternative 4. Moved to further development. Recommendation VE-4*

#	Description	Advantages	Disadvantages
20	Leave Perry Park Rd as is with no left turns from KY-15 to Perry Park Rd.	▪ Shortens river bridge ▪ Reduced cost ▪ Reduce earthwork	▪ The profile of Perry Park Rd. may not work ▪ Does not serve all directions

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎	👎	👍	👍	👍	

Rating:	Justification/Comments/Disposition:
3	*May require lower KY 15 profile or raising Perry Park Rd. profile. Could be designed to keep left turns in. See Recommendation VE-4*

#	Description	Advantages	Disadvantages
21	Right in and Right out at Perry Park/ Right in and Right out for Cherokee Hill Rd.	▪	▪

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Rating:	Justification/Comments/Disposition:
0	*Fatally flawed; not providing business access to KY 15 due to not having underpass circulation.*

#	Description	Advantages	Disadvantages
22	Reduce speed on KY 15 and use fully signalized intersection at Perry Park and Cherokee Hills Rd.	▪ Different standards for median type ▪ Reduce cost ▪ Reduce earthwork	▪ Enforcement ▪ Adds another signal on KY 15 ▪ Intersection leg at Cherokee Hills and Asphalt plant may not meet design standards ▪ River bridge would need to be wider ▪ More complex maintenance of traffic during construction

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎	👍	👎	👎		

Rating:	Justification/Comments/Disposition:
4	*Moved to further development. Works best with alternatives that are on the existing alignment. Recommendation VE-4*

#	Description	Advantages	Disadvantages
23	Bring Cherokee Hills Rd. along the ROW in front of Asphalt plant with right in right out at Perry Park Rd.	▪ Less earthwork ▪ Reduce cost	▪ May adversely impact the asphalt plant ▪ Could have impacts to other businesses on the east side of KY 15 ▪ Profile grade of Cherokee Hills Rd. may be challenging

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎				

Rating:	Justification/Comments/Disposition:
2.5	*Work best with widen bridge options.*

#	Description	Advantages	Disadvantages
24	Round about at Perry Park, KY-15, Asphalt plant and Cherokee Hills Rd.	▪	▪ Would require reducing the speed ▪ Would require large footprint

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Rating:	Justification/Comments/Disposition:
0	*Fatal flaw due to required size and location.*

#	Description	Advantages	Disadvantages
25	Eliminate median barrier and use narrower median with mountable median curbing	▪ Less earthwork ▪ Less ROW ▪ Reduced cost ▪ Emergency vehicles have easier access to incidents	▪ May require a lower design speed ▪ Would not be positive separation ▪ Increased maintenance if it's grass

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎		👍👎		👍	

Rating:	Justification/Comments/Disposition:
3	*Evaluated with recommendation #2*

#	Description	Advantages	Disadvantages
26	Use double face guardrail	▪ Reduce capital cost ▪ Eliminate some drainage issues ▪ Could help with the sight distance	▪ Higher maintenance cost

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍		

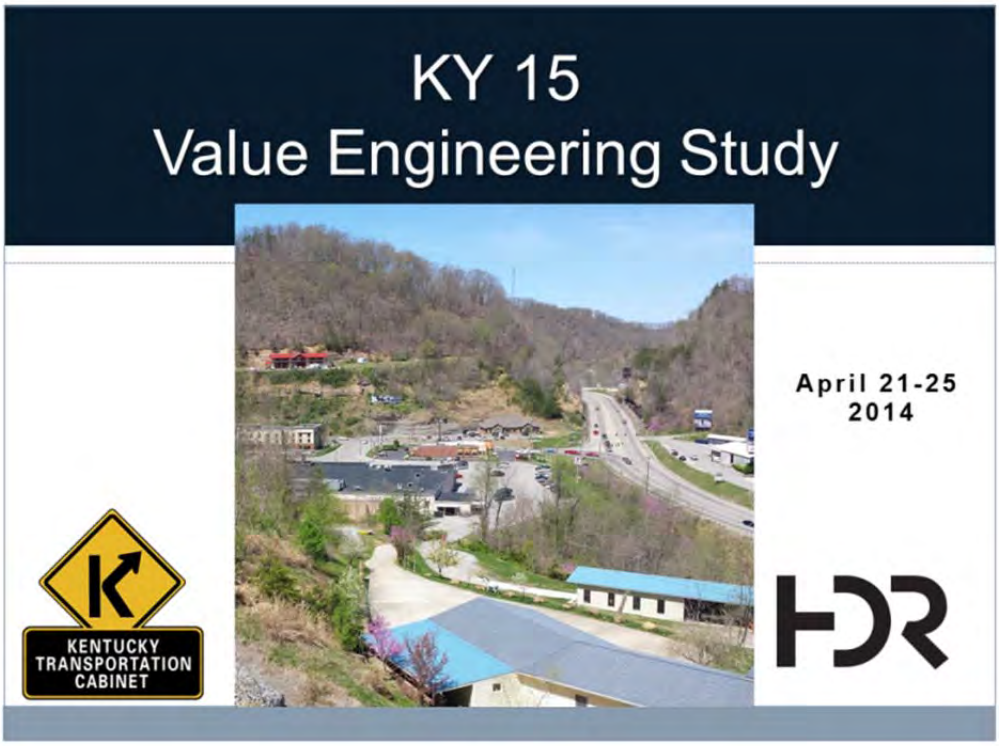
Rating:	Justification/Comments/Disposition:
2	*Recent bids show double face GR at $20 lf and barrier was $13 LF*

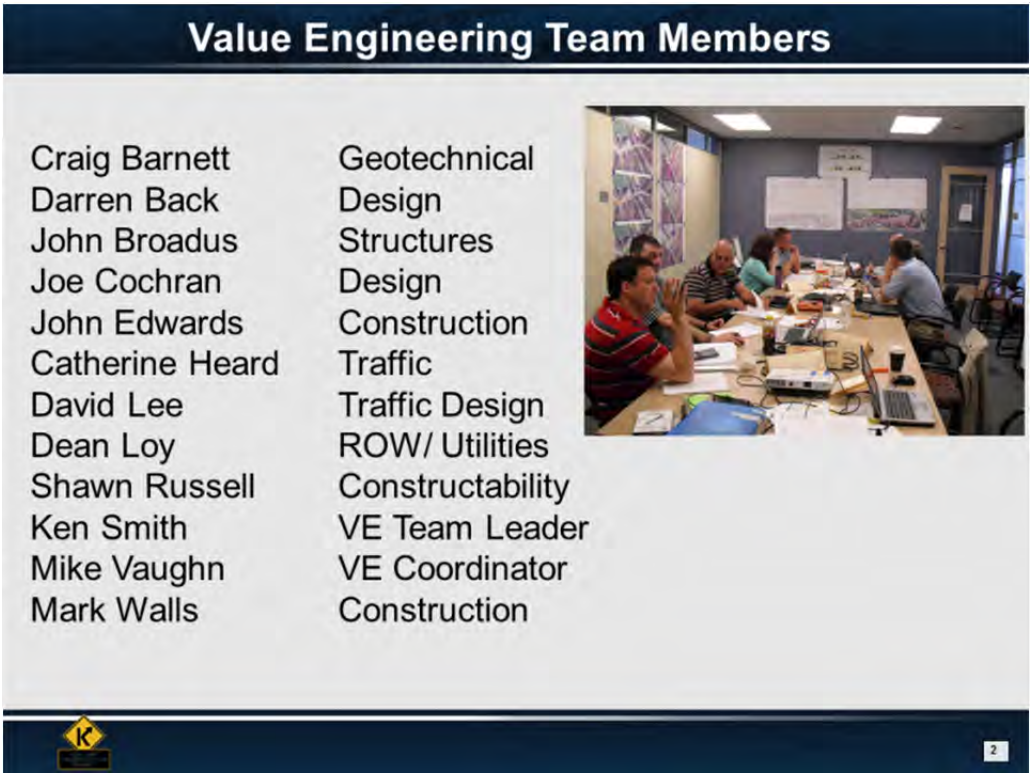
#	Description	Advantages	Disadvantages
27	Pavement section to re-evaluate ESALS to define pavement section	▪ Could reduce pavement section over the entire project.	▪ None noted

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Rating:	Justification/Comments/Disposition:
3	*Design Comment*

Appendix E: VE Report Out Presentation



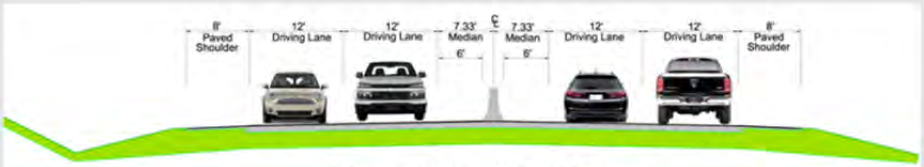


Project Corridor

Preferred Alternative 6

Typical Section Options

Mainline KY 15



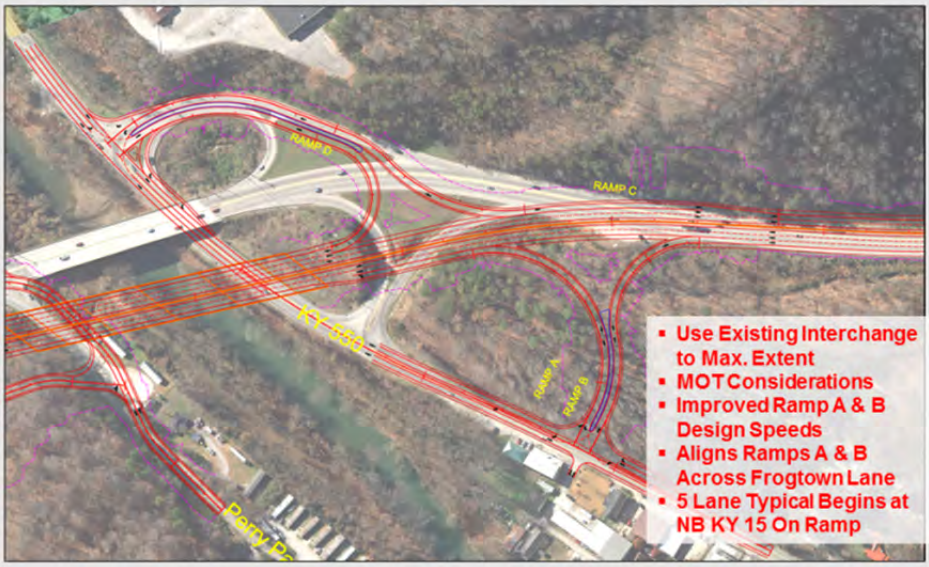
4 Lane Typical Section
KY 15 Bypass to KY 550

5 Lane Typical Section
KY 550 to North of Morton Blvd

Preferred Alternative 6 @ KY 15 Bypass

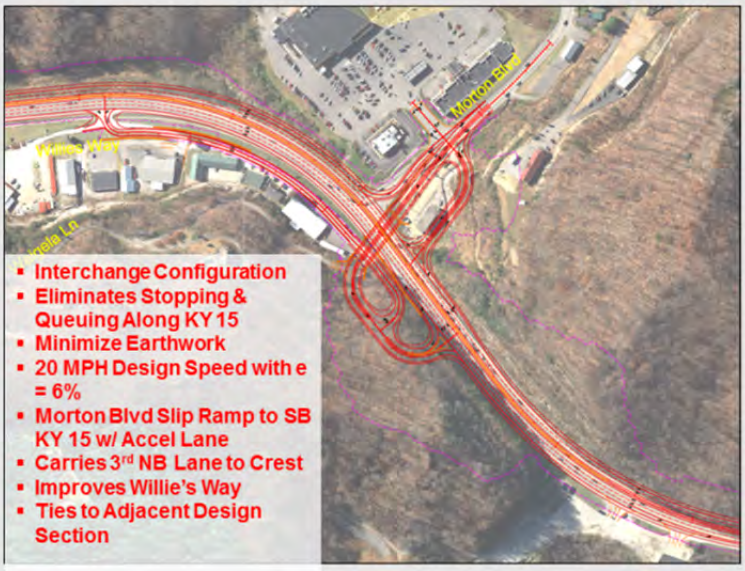
Preferred Alternative 6 @ Perry Park Road

Preferred Alternative 6 @ KY 550



Preferred Alternative 6 along KY 15

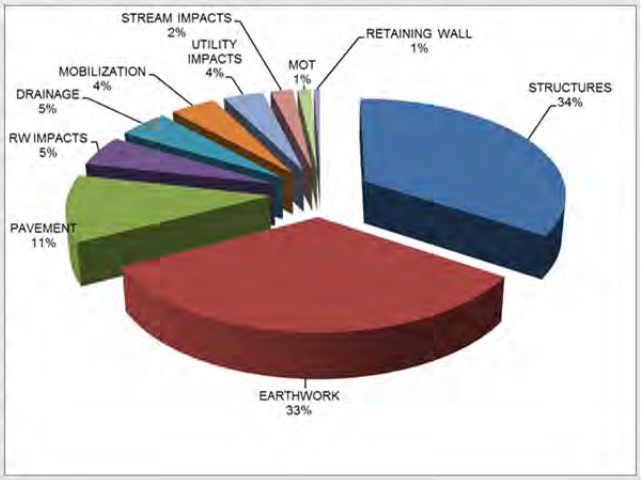
Preferred Alternative 6 @ Morton Blvd



Preliminary Estimate of Construction Costs

ALTERNATE 6 COST SUMMARY

EARTHWORK	$13,034,600
PAVEMENT	$4,400,037
STRUCTURES	$13,510,850
RETAINING WALL	$214,500
DRAINAGE (5%)	$1,557,999
MOT	$500,000
MISCELLANOUS (25%)	$8,304,497
4% MOBILIZATION	$1,660,899
20% CONTINGENCY	$8,304,497
TOTAL Construction	$51,487,878
RW IMPACTS	$2,931,500
UTILITY IMPACTS	$2,096,200
STREAM IMPACTS	$1,171,200
Total	$57,686,778



11

Potential project risks

- Exxon Station ROW estimated at $500,000 may be under estimated.
- The ROW costs for section one may grow for residential costs due to impacts to residents on Fugate Mountain. There are 3 residents in estimate but could impact all 9 homes.
- May have claim of damages due to access to Shell station.
- Contaminated soils in the vicinity of Exxon Station ROW.
- Filling in the stream for the waste site.
- ROW needed for waste site is not included in current estimate.
- Due to minimal geotechnical information the conditions may require flatter slopes than assumed in the base which would increase earthwork and ROW requirements.
- ROW for commercial property in the vicinity of Morton Blvd could exceed the $1,000,000 in the section 3 estimate.

12

WHAT IS VALUE?

Value Engineering has traditionally been perceived as an effective means for reducing project costs.

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

This paradigm only addresses one part of the value equation, often times at the expense of overlooking the role that VE can play with regard to improving project performance.

PERFORMANCE ATTRIBUTES

Establishing the Goals and Objectives of VE Study is critical to its outcome.

Defining "Performance Attributes" will give the VE Team a better understanding of the project's purpose and need.

Typical Highway Performance Attributes

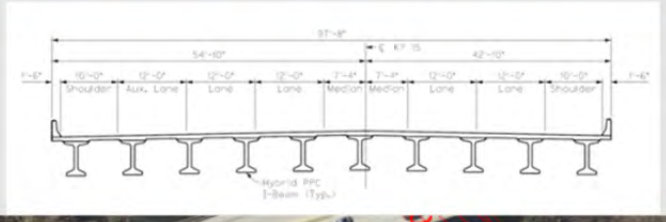
- **Mainline Operations**
- **Local Operations**
- **Maintainability**
- **Construction Impacts**
- **Environmental Impacts**
- **Project Schedule**

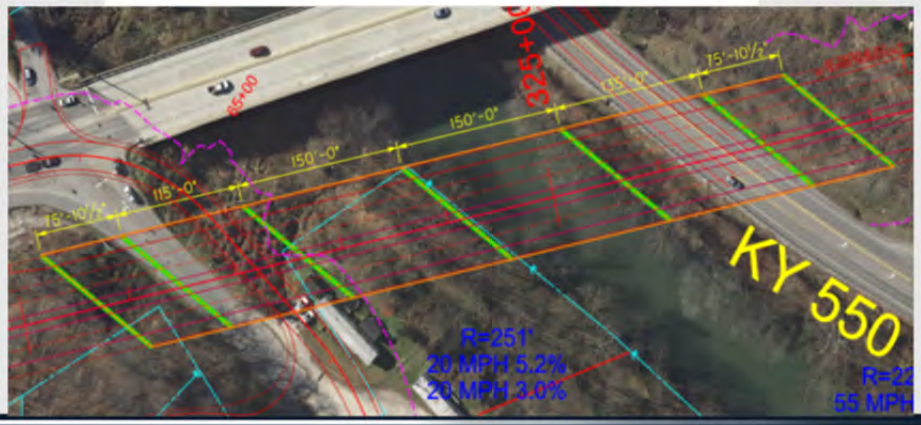
PERFORMANCE ATTRIBUTES

KTC Project 10-158 KY 15 in Perry County

Which attribute is more important to the outcome of the project?							TOTAL	%
Mainline Operations	A	A/B	A	A	A	A	5.5	26.2%
Local Operations	B		B	B	B	B	5.5	26.2%
Maintainability	C			C	C/E	C	3.5	16.7%
Construction Impacts	D				D/E	D	2.5	11.9%
Environmental Impacts	E					E	3.0	14.3%
Project Schedule	F						1.0	4.8%

Recommendation # 1 River Bridge

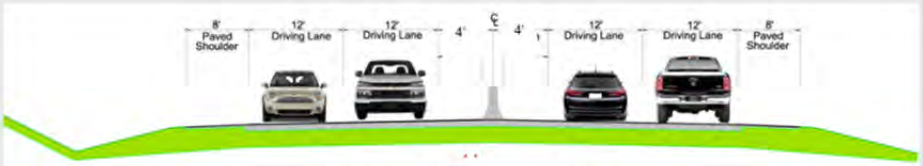




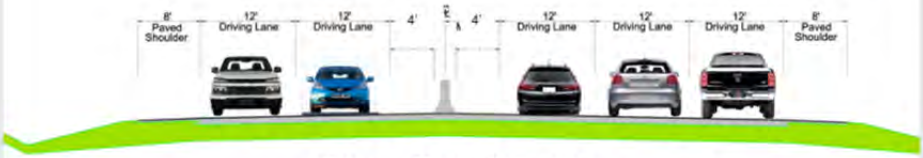
16

Recommendation # 2 Median Width

Mainline KY 15

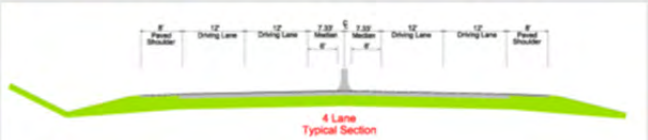


4 Lane Typical Section
KY 15 Bypass to KY 550



5 Lane Typical Section
KY 550 to North of Morton Blvd

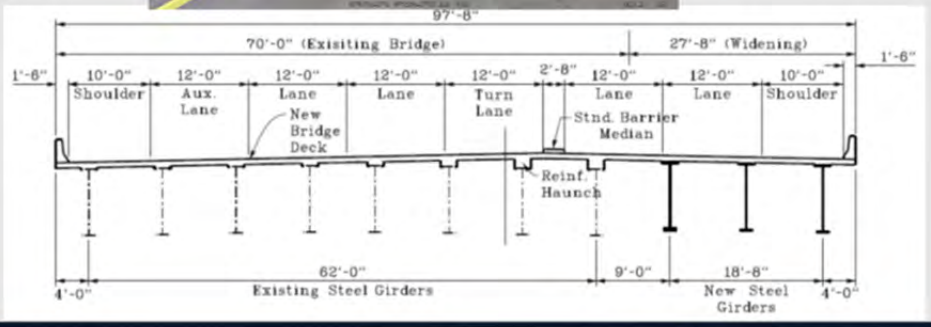
Recommendation # 3 Roadway Section



Design Comments for Alternative 6

- Spliced prestressed girder for spans greater than 150’
- Only beef up two lanes on new bridge for hauling off road earth movers
- Consider a con-span or wagon box over Perry Park Rd and shorten the main river bridge
- Eliminate end spans on river bridge and use MSE walls
- Use short soil nail walls and rock bolting to reduce excavation
- Eliminate median barrier and use narrower median with mountable median curbing
- Re-evaluate ESALS to define the appropriate pavement section

Existing River Bridge



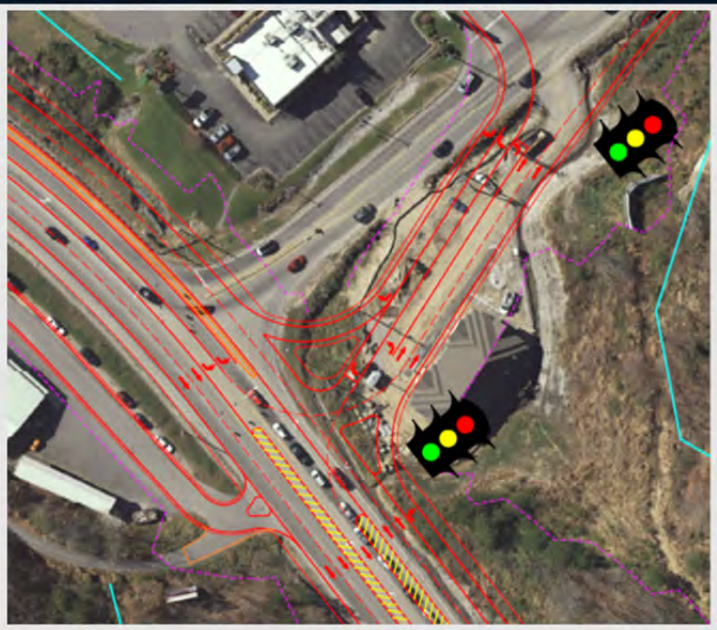
KY 15 Signals

21

Recommendation # 4 Perry Park Rd.

22

Recommendation # 5 Morton Blvd.



23

Recommendation # 5 Morton Blvd.

24

Summary of Recommendations

Table 6 - Summary of Recommendations

#	Description	Cost Savings	Performance
1	River Bridge	$5.43M	+5%
2	Median Width	$0.61M	0%
3	Roadway Section	$2.43M	-1%
4	Perry Park	$19.14M	-10%
5	Morton Blvd.	$3.39M	+1%
	Total 1,2,3,5	**$11.86M**	
	Total 2,3,4,5	**$25.57M**	

Results

OVERALL PERFORMANCE		% Change Performance	% Change Cost	% Value Improvement
	Baseline			
1	River Bridge	5%	-9%	16%
2	Median Width	0%	-1%	1%
3	Roadway Section	-1%	-4%	3%
4	Perry Park	-10%	-33%	35%
5	Morton Blvd.	1%	-6%	8%

26