OHIO RIVER BRIDGES
SECTION 5 - EAST END BRIDGE
VALUE ENGINEERING STUDY REPORT

Item Number 5-118.00

Study Date: February 18 - 22, 2008
Report Date: March 7, 2008

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VALUE ENGINEERING STUDY
for
Kentucky Transportation Cabinet

Study Date: February 18 - 22, 2008

Final Report

March 7, 2008

URS Corporation

EXECUTIVE SUMMARY

General

URS conducted a Value Engineering Study of the Louisville-Southern Indiana Ohio River Bridges, Section 5 – East End Bridge project. The topic was the 20% Design Development Submission prepared for the Kentucky Transportation Cabinet (KYTC) by P.B. America, Inc.

The VE Team undertook the task assignment using the value engineering work plan and approach. The ideas generated from this process and chosen for full development as VE Team Recommendations are presented in Section 3 of this report. These recommendations are presented to all project stakeholders for judgment as to whether they should be implemented.

Estimate of Construction Costs and Budget

The construction cost estimate provided to the VE Team with the project documents indicates a total construction cost of $257,777,092. This project is scheduled to be let as a design/bid/build project, thus the cost of construction will be determined on a contractor bid.

As a result of this value engineering study, should all of the VE Team's selected combination of recommendations be accepted for implementation, the total potential savings available to KYTC for this project is $95,044,000. These potentials are based upon the VE Team's cost estimates of the individual recommendations selected by the VE Team as noted on the Summary of Recommendations table below. Total cost savings realized by KYTC will be based upon the final implementation status of these VE recommendations.

Summary of VE Study Results

During the speculation phase of this VE study, 26 creative ideas were identified. 20 of these ideas were developed into VE recommendations and design comments with cost implications where applicable. Many of the ideas represent changes in design approach, reconsideration of criteria, and in some cases, modification of the project scope. In general, the idea evaluation took into account the economic impact, other benefits obtained, and the effect on the overall project objectives.

The following table presents a summary of the ideas developed into recommendations and design comments with cost implications where applicable. Since cost is an important issue for comparison of VE proposals, the costs presented in this report are based upon original design quantities with unit rates obtained from the estimate as prepared by the design team and included in their submission to KYTC, published cost databases, and VE Team member experience.

The table also identifies the recommendations and alternatives that, in the opinion of the VE Team, are the best combination of all the VE recommendations. This selection takes into account not only that the recommendations (and likewise their cost savings) are summarily additive, but also whether the cost savings or project improvement potential of the recommendations are worth the change to the project design.

SUMMARY OF RECOMMENDATIONS AND DESIGN COMMENTS			
Rec #	Title / Description	1st cost savings (or cost)	VE Selected Combo
1	Reconfigure cable stay bridge to a 3 span system in lieu of a 5 span system; shorten main span and increase side spans to balance system (550-1100-550 in lieu of 412-1235-412)	$27,097,000	
2	Decrease transverse width of the tower to narrow the bridge	$5,020,000	
3	Consider open framing for the superstructure in lieu of smooth bottom soffit of the steel and concrete box girder	$95,044,000	X
4	Towers below deck should utilize bladed columns with a architectural fascia for aesthetics in lieu of elliptical shape	Comment	
5	Column walls below high water need to be able to resist barge impact forces. Use solid sections in lieu of thin walled columns	Comment	X
6	Cantilevered sidewalk needs to be designed for an under-bridge inspection vehicle	Comment	
7	Cantilevering of asymmetric cross-section creates large torsions and twists has experienced on Ringling Causeway in Florida	Comment	
8	Columns for Pier 1 and anchor piers need to be able to resist barge impact forces between struts	Comment	
9	Tower elliptical shapes should have a variable width flat section along sides so forms can be simplified; flat section varies from 0 feet to 4 feet maximum	Comment	
10	Consider using a wearing surface on sidewalk	Comment	
11	Coordinate Section 2 and 5 to design appropriate concrete barriers	Comment	
12	Eliminate closed drainage system from East End Bridge	Comment	X
13	Utilize storm water capturing on roadway only and allow sidewalk to drain into river	Comment	X
14	Outlet storm water captured on bridge to river outside wellhead protection area	Comment	X
15	Reduce shoulder widths to 4 feet in lieu of 12 feet	$25,442,000	
16	Eliminate skew on north abutment	Comment	X
17	Tower foundations need to be submerged to 15 feet below normal pool to eliminate navigation obstacle under high water conditions	Comment	X
18	Utilize northbound lane slope toward median in lieu of away from median	Comment	
19	Eliminate the curve off the north end of the bridge	Comment	

SUMMARY OF RECOMMENDATIONS AND DESIGN COMMENTS			
Rec #	Title / Description	1st cost savings (or cost)	VE Selected Combo
20	Eliminate sump by revising freeway profile	Comment	

Summary of VE Team Selected Combination $95,044,000

Acknowledgments
A thank you is given to the staff members from the Kentucky Transportation Cabinet and the design team members from P.B. America, Inc. Special thanks are also extended to Mr. Robert Semones for his assistance with the setting up of this study.

Value Engineering Study - Core Team

Name	Discipline / Role	Organization	Telephone
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David Jeakle, PE	Bridge Expert	URS	813-636-2467
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Norman Roush, PE, PS	Geometrics Expert	URS	304-757-6642
Kyle Schafersman, EIT, CVS	VE Team Leader	URS	913-344-1019

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

Kyle Schafersman, EIT, CVS
Value Engineering Program Manager

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Appendices

SECTION 1 - INTRODUCTION

This report documents the results of a value engineering study on the Ohio River Bridge, Section 5 – East End Bridge. The study workshop was held at the URS offices in Louisville, KY on February 18 - 22, 2008. The study team was from URS. Kyle Schafersman, a Certified Value Specialist (CVS) team leader from URS, facilitated the study. The names and telephone numbers of all participants in the study are listed in Appendix A.

The Job Plan
This study followed the value engineering methodology as endorsed by SAVE International, the professional organization of value engineering. This report does not include any detailed explanations of the value engineering / value analysis processes used during the workshop in development of the results presented herein. This would greatly expand the size of the report. The sole purpose of this report is to document the results of the study. Additional information regarding the processes used during the study can be obtained by contacting the Certified Value Specialist team leader that facilitated the study.

Ideas and Recommendations
Part of the value engineering methodology is to generate as many ideas as is practical, evaluate each idea, and then select as candidates for further development only those ideas that offer added value to the project. If an idea thus selected, turns out to work in the manner expected, that idea is put forth as a formal value engineering recommendation. Recommendations represent only those ideas that are proven to the VE Team's satisfaction.

Design Comments
Some ideas that did not make the selection for development as recommendations, were, nevertheless judged worthy of further consideration. These ideas have been written up as Design Comments and are included in Section 3 after the recommendations.

Level of Development
Value Engineering studies are working sessions for the purpose of developing and recommending alternative approaches to a given project. As such, the results and recommendations presented are of a conceptual nature, and are not intended as a final design. Detailed feasibility assessment and final design development of any of the recommendations presented herein, should they be accepted, remain the responsibility of the designer.

Organization of the Report
The report is organized in the following outline.

1. Introductory Information
    a. Section 1- Introduction
    b. Section 2- Project Description
2. Primary body of results……….Section 3- Recommendations and Design Comments
4. Supporting documentation……Appendices

SECTION 2 – PROJECT DESCRIPTION

The Ohio River Bridges Project (Project) is comprised of six primary sections including: 1) reconstruction/relocation of the Interstates and ramp systems to the south of the existing Kennedy Interchange ("Spaghetti Junction"); 2) a new Downtown Bridge just east of the existing Kennedy Bridge; 3) a new Indiana approach to the (new) bridge and ramps systems in Jeffersonville; 4) a new connection linking the new East End Bridge to the existing Gene Snyder Freeway (KY 841); 5) an East End Bridge approximately eight miles from downtown Louisville; and 6) a new Indiana connection linking the Lee Hamilton Highway (I-265) to the new East End Bridge.

The Final Environmental Impact Statement for this project was signed March 26, 2003 and the project is authorized by the Federal Highway Administration's Record of Decision signed September 6, 2003. This project will improve cross-river mobility between Jefferson County, Kentucky and Clark County, Indiana.

The Ohio River and its shorelines are the most predominant natural and historic features of the East End Bridge (Section 5) site. The location is rural in character with mature native trees framing the shorelines on both sides of the river. A limestone bluff rises steeply from the alluvial plain on the Indiana shore, and a series of historic residential country estates and large historic houses characterize the Kentucky approach.

The East End Bridge is made up of the following characteristics:

- Median Tower Cable Stayed with Variable Depth Deck (Median Cables)
- 2510' Long x 154.5' Wide
- Span Arrangement = 225'-6" - 412' - 1235' - 412' – 225'-6"
- Sta. 187+40 to Sta. 212+50
- 915' Single Steel Box Girder – 12' Depth (main span)
- 640' Double Concrete Box Girder – 12'-24' Depth (cantilever from towers)
- 955' Single Concrete Box Girder – 12' Depth (anchor and end spans)
- 120' x 80' Elliptical Shaped Tower Pier Caps
- Elliptical / Circular Shaped Tapered Tower Piers
- Two 3-Column Anchor Piers with Struts to Resist Barge Collision
- One 3-Column Land Pier with Struts to Resist Barge Collision (KY side)
- One Abutment (Indiana)
- No need for additional elevated approach structure in Section 6.

The current method of construction requires the use of two crane-mounted barges for lifting each element into position, plus additional material supply barges to carry the elements to the crane-barge site. Crews are required to support the element erection and also support the batching and placing of the superstructure concrete. This requires a fleet of about six barges and several dedicated tug or push boats. It is possible that the tower construction would be accomplished by use of two tower cranes. This requires construction of the tower bases and the table sections of cast-inplace box girder to establish a base for erection. This would result in a minor reduction in duration of the barge cranes.

The 20% design cost estimate for this bridge, dated January 31, 2008 and based on July 2006 dollars, indicates a total construction cost of $257,777,092. This project is scheduled to be let as a design/bid/build project, thus the cost of construction will be determined on a contractor bid.

The LSIORB Project's Initial Financial Plan (IFP) dated September 2007 provides a breakdown of all of the costs for Section 5. The IFP shows a year-of-expenditure estimate of $328,200,000 for construction of the East End Bridge. This includes a contingency value of 15%. The annual inflation rate for 2008 is assumed in the IFP to be 8% and then reduced to a 4% annual rate in 2009.

It is assumed at this time that construction of the bridge would begin in January 2010 and would take 36 months to complete. Therefore, mid-point of construction would be June 2011. From January 2008 to June 2011 this would result in a 19.2% escalation. Therefore, the current $257,800,000 20% Design estimate in January 2008 dollars would be equal to $307,200,000 in June 2011 dollars. This is $21,000,000 less than the IFP's estimate.

SECTION 3 - VE RECOMMENDATIONS & DESIGN COMMENTS

Organization of Recommendations
This section contains the complete documentation of all recommendations to result from this study. Each recommendation has been marked by a unique identification number.

The parent idea, or ideas from which the recommendation began, can be determined from the Creative Idea List located in Appendix D of this report.

Each recommendation is documented by a separate write-up that includes a description of both the original design and recommended change, a list of advantages and disadvantages, sketches where appropriate, calculations, cost estimate, and the economic impact of the recommendation on the first cost, and where applicable, the life cycle cost. The economic impact is shown in terms of savings or added cost.

Acceptance of VE Recommendations
The Summary of Recommendations table presented in the Executive Summary of this report identifies the recommendations that, in the opinion of the VE Team, are the best combination of all the VE recommendations. This selection takes into account not only that the recommendations (and likewise their cost savings) are summarily additive, but also the likelihood and ease of implementing the recommendations.

However, this report also includes other recommendations that could enhance the value of this project. These recommendations are either mutually exclusive of the recommendations selected by the VE Team (i.e. implementing one immediately precludes the implementation of another) or they require additional design and/or evaluation prior to implementation. These recommendations should be evaluated individually to determine whether they are worthy of implementation or not. Consideration should be given to the areas within a recommendation that are acceptable and implement those parts only. Any recommendation can be accepted in whole or in part as the owner and design team see fit.

Design Comments
Design Comments are ideas that in the opinion of the team were good ideas, but for any number of reasons were not selected for development as VE recommendations. Design Comments can be notes to the owner or designer, a documentation of various thoughts that come up during the course of the study, a reference to possible problems, suggested items that might need further study, or questions that the owner and designer might want to explore. Some comments might relate to things of which the owner or designer is already aware. Because the study is done on a design in progress and as an independent team, the VE Team may not be aware of everything intended by the owner and designer. The following comments are presented with the intent that they may aid the design team in some way.

VALUE ENGINEERING RECOMMENDATION # 1

PROJECT: OHIO RIVER BRIDGES, SECTION 5 - EAST END BRIDGE
LOCATION: LOUISVILLE, KENTUCKY
STUDY DATE: FEBRUARY 18 - 22, 2008

DESCRIPTIVE TITLE OF RECOMMENDATION:
Reconfigure cable stayed bridge to a 3-span system in lieu of a 5-span system; shorten main span and increase side spans to balance system (550’-1100’-550’ in lieu of 225.5’-412’-1235’-412’-225.5’).

ORIGINAL DESIGN:
The Preliminary Design Plans shows a 5-span continuous unit with span lengths of 225.5’-412’-1235’-412’-225.5’ with Spans 2, 3 and 4 being cable supported. The approach span (225’-6”), side span (412’-0”) and 160’ of the main span is a concrete box girder system; while the central 915’ of the main span is a composite steel box girder system. The superstructure is supported by a single plane of cables and towers located along the centerline of the roadway. The superstructure is integral with all of the substructure units with the exception of the north abutment.

RECOMMENDED CHANGE:
Decrease the main span length to 1100’ by placing the towers up tight to the navigation channel. Tower foundations should be submerged to 15’ below normal pool as discussed in Design Comment 20 which also allows main span length to be reduced. Increase the side span lengths from 412’ to 550’ in order to properly balance the 1100’ main span without resorting to a steel box girder mains span section.

Replace the 915’ long composite steel box girder system with the concrete box girder system utilized in the side spans. Since the main span and side span lengths are now balanced, the use of a light weight and more expensive steel box girder system is unnecessary.

Approach span on Kentucky and Indiana bank will be reduced from 225’-6” to 155’-0” due to increase in total length of cable stayed bridge. The Kentucky approach span should be consistent and continuous with the structural system utilized in the Section 4 Kentucky approach bridge, probably steel plate girders. Also use steel plate girders for the Indiana approach span.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$236,897,000		$236,897,000
RECOMMENDED DESIGN	$209,800,000		$209,800,000
ESTIMATED SAVINGS OR (COST)	$27,097,000	$0	$27,097,000

VALUE ENGINEERING RECOMMENDATION # 1

ADVANTAGES:

- Reducing the main span from 1235’ to 1100’ will have a significant impact on the quantity of materials utilized and cost of the structure. It also allows for a more balanced system that eliminates the need for the single steel box girder in the main span.
- The use of a concrete box girder in lieu of the steel box girder section for the main span eliminates the need for the complex fabrication, delivery and installation of the extremely large steel field sections (30’-0” long by 137’-6” wide).
- Replacing the steel box girder section in the main span with a concrete box girder will reduce the cost of the bridge and the long-term maintenance requirements.
- Approach spans on both ends of this section can be simplified and reduced in cost by replacing the multi-cell concrete box girder system cast on falsework with a more traditional bridge system utilizing steel plate girders.
- If the tower heights remain the same, then the shorter tower heights will allow the stay cables to be at a more appropriate and efficient angle. Currently, the angle of the main span forestay is too steep due to the tower height limitation.
- These recommendations can be incorporated without altering the architectural or aesthetic nature of the bridge.

DISADVANTAGES:

- Length of the cable supported bridge is increased from 2059’ to 2200’.
- Concrete box girder main span will introduce more flexural demand on the tower legs below deck and the foundations from the integral connection between the superstructure and tower due to creep and shrinkage of the concrete superstructure relative to a steel superstructure.
- Replacing the steel box girder main span with a heavier concrete box girder section will increase the axial demand on the tower foundations.

JUSTIFICATION:
Reducing the main span length from 1235’ to 1100’ meets the functional requirements of horizontally clearing the defined navigation channel. Decreasing the main span length to the minimum necessary to clear the navigation channel will be the most cost effective and prudent solution. However, for long-span bridges the shortest main span length possible should always be chosen unless there are other significant factors that dictate a longer span is necessary; however, for this project we are unaware of any other factors that would require an increase in span length beyond the minimum necessary to clear the channel.

VALUE ENGINEERING RECOMMENDATION # 1

JUSTIFICATION (CONTINUED):
With an 1100’ main span length is becomes possible to increase the side span lengths to 550’ each which allows for a balanced three span cable stayed bridge. The cable stayed bridge depicted in the Preliminary Plans has short side spans of 412’ using a concrete box girder and because the side spans are so short the main span must utilize a relatively light weight steel box girder system with a concrete deck. However, with a more balanced cable stayed system as is being recommended (550’-1100’-550’) the use of the steel box girder system for the main span is no longer necessary and a concrete box girder can be used for both the side span and main span sections.

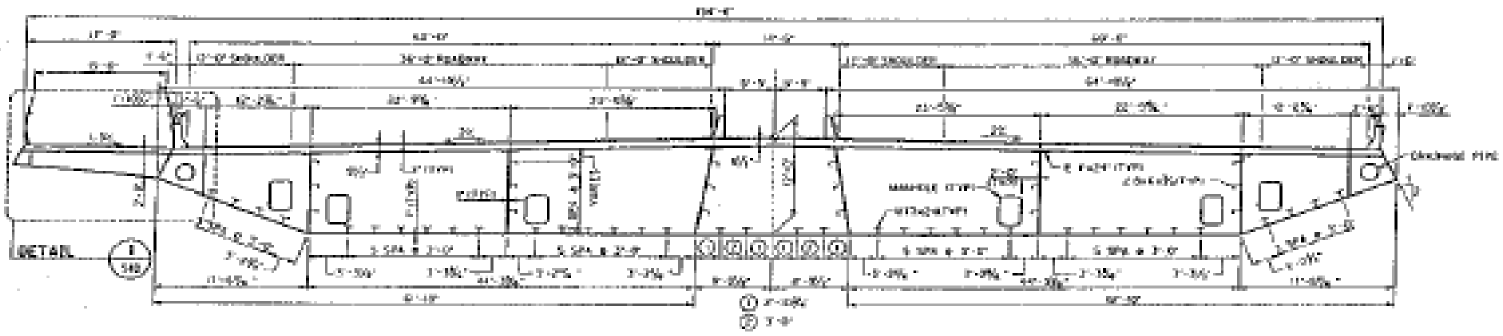
The single steel box girder main span superstructure proposed in the Preliminary Plans should be replaced with a concrete box girder system for several reasons. First, the steel box girder will be a very expensive system compared to a concrete system. Second, the extremely large steel field sections (30’ long by 137’-6” wide by 12’ deep at 300 tons) will need to be fabricated somewhere along the river bank so they can be directly loaded on barges for delivery without transportation on trucks, or each field sections must be broken into numerous small pieces to accommodate trucking and then bolted back together on site for installation thus greatly increasing field labor. If the steel fabrication must occur along the river due to size of the field sections then the number of fabrication shops that can produce this project is extremely small and prices may increase dramatically. Third, the use of steel box girders for the main span will increase the long-term maintenance requirements relative to the concrete box system.

For the superstructure system proposed in the Preliminary Plans the concrete box girder system will require the contractor to purchase two very expensive form traveler systems; however, the traveler used for the main span side will only be used to cast 160’ of bridge then dismantled. This is will be a very expensive traveler system for casting only 160’ of bridge. If the steel box girder is replaced with a concrete box system for the main span, at least the money paid for the second traveler system will be utilized for 550’ instead of only 160’.

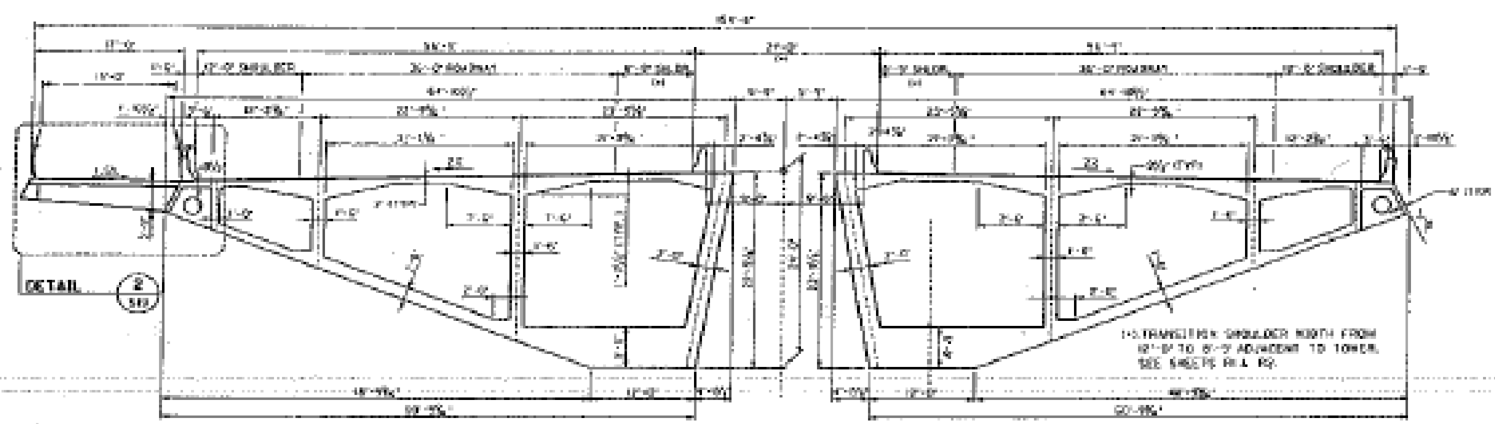
The approach span on the Kentucky bank should be part of the Section 4 contract and de-coupled from the cable-stayed bridge system. The Advanced Situation Folder lists the Section 4 structures as steel plate girder and this structure should be continued directly to the cable stayed anchor pier. With respect to transitioning between steel plate girders and the cable stayed concrete box girder, this shouldn’t matter if it is at the anchor pier or the next pier back. Consideration should also be given to providing a simple span steel plate girder bridge span from the Indiana anchor pier and the abutment. Currently, the Preliminary Plans indicate that the approach spans on both ends of the cable stayed bridge are cast-in-place on falsework. For these two short spans the contractor will need to invest in all of the falsework and formwork systems plus introduce a third method of construction for these small spans. By replacing these spans with more conventional steel plate girder spans, the major investment in formwork and falsework can be eliminated.

VALUE ENGINEERING RECOMMENDATION # 1

SKETCH OF ORIGINAL DESIGN



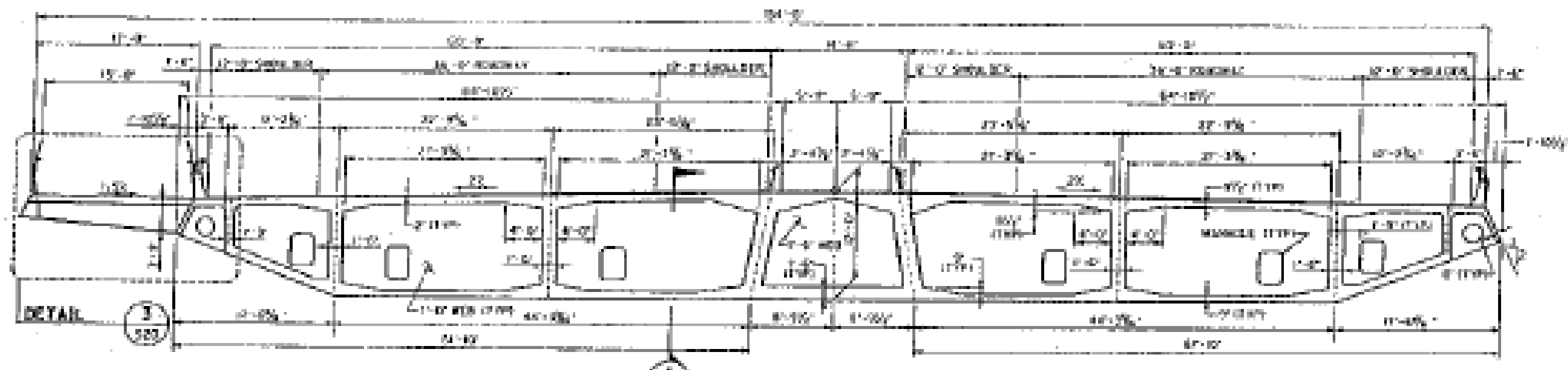
TYPICAL SECTION – A
GRAPHIC SCALE (A)



TYPICAL SECTION – B
GRAPHIC SCALE (A)

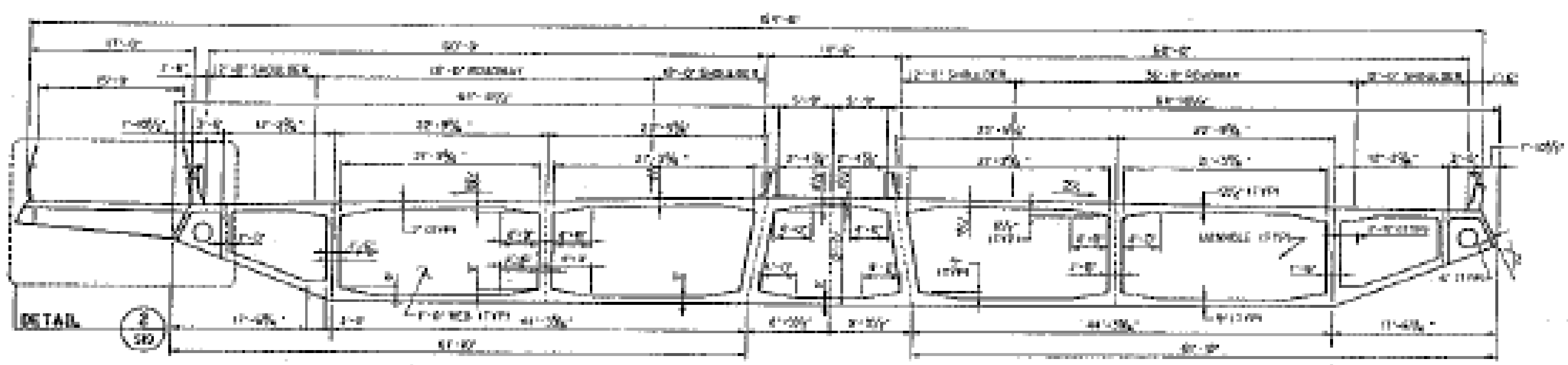
VALUE ENGINEERING RECOMMENDATION # 1

SKETCH OF ORIGINAL DESIGN



TYPICAL SECTION – C

GRAPHIC SCALE

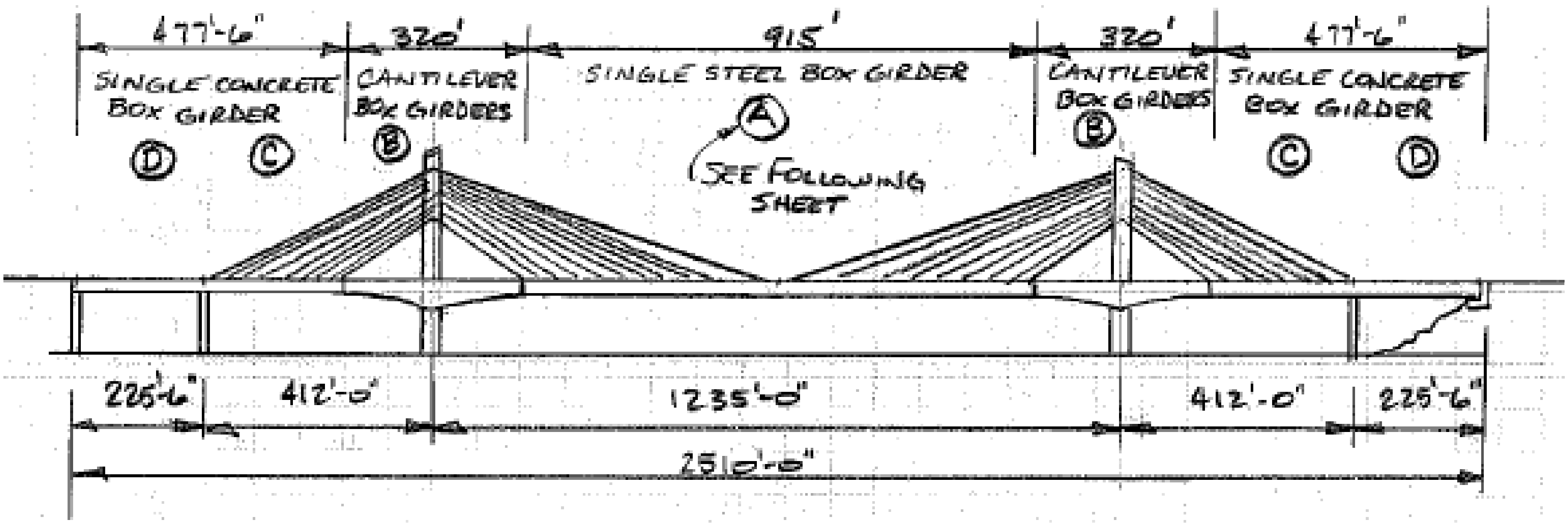


TYPICAL SECTION – D

GRAPHIC SCALE

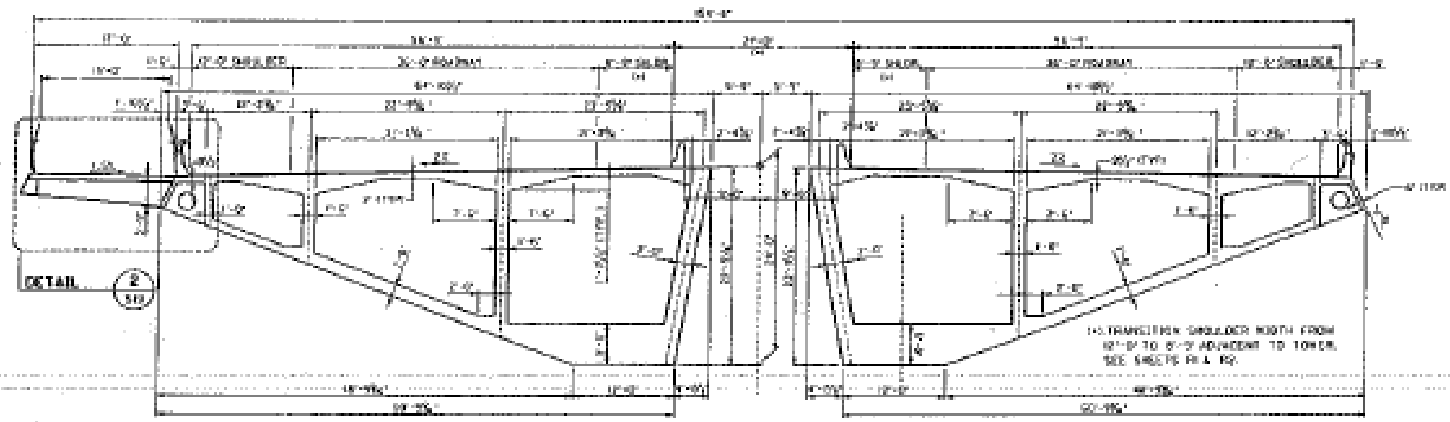
VALUE ENGINEERING RECOMMENDATION # 1

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 1

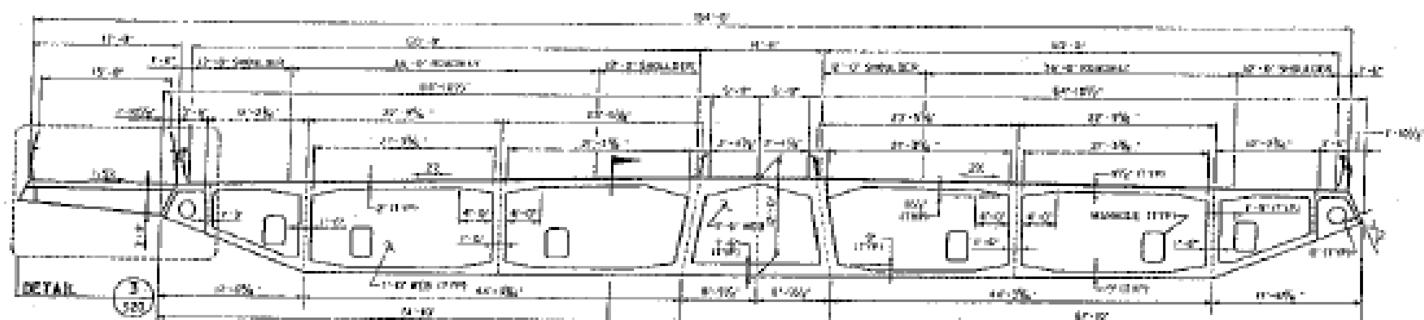
SKETCH OF RECOMMENDED DESIGN



TYPICAL SECTION – B

TOWER LOCATIONS SHOWN, OTHER LOCATIONS SIMILAR

GRAPHIC SCALE (A)

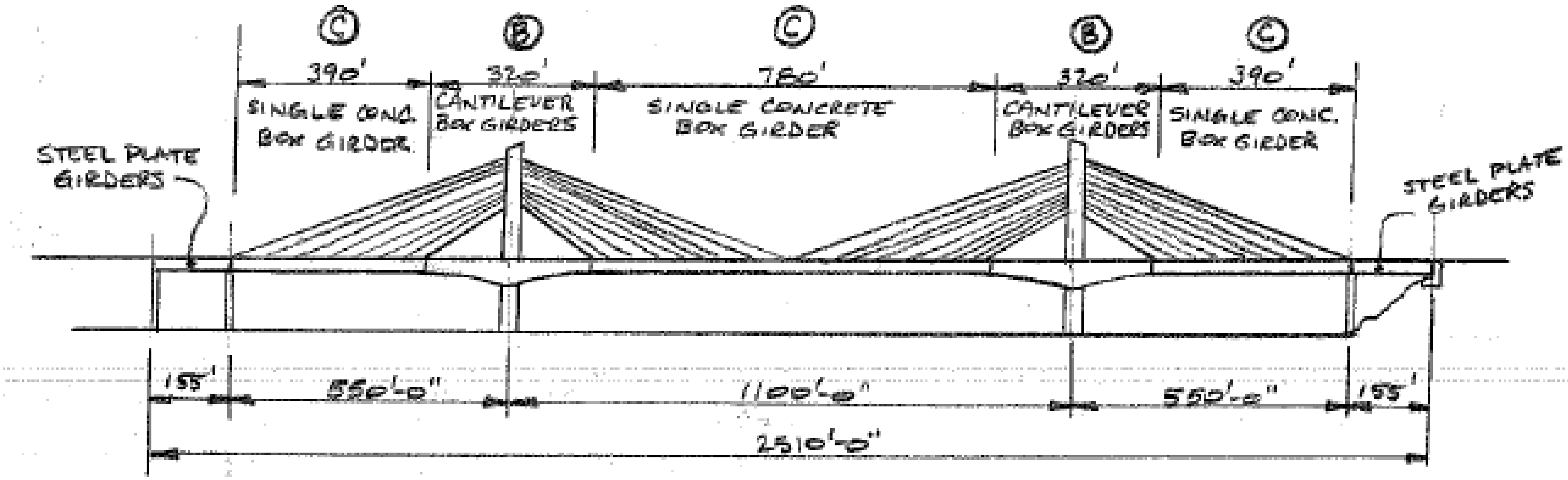


TYPICAL SECTION – C

GRAPHIC SCALE (A)

VALUE ENGINEERING RECOMMENDATION # 1

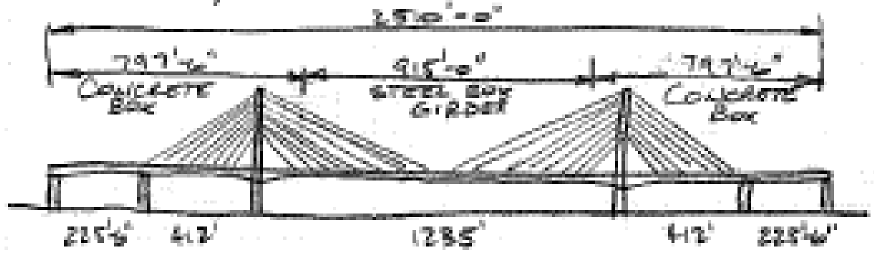
SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 1

CALCULATIONS

~ Preliminary Plans:



ℓ = 2510'
width = 154'-6"
sidewalk = 17'
box = 137'-6"

~ Recommendation Configuration:

~ Determine cost for steel box girder section. Use cost estimate provided by PB. Exclude sidewalk.

Steel floorbeam = $8,835,201
Steel Box Girder = $21,557,571
Support Deck Steel Erection = $28,274,912
Concrete Deck (Steel Box) = $1,316,921
Concrete Deck Reinf. = $1,885,190

$61,869,786 ⇒ $492/sf

VALUE ENGINEERING RECOMMENDATION # 1

CALCULATIONS

~ Stay cables

Increase the quantity of stay cables to support the heavier mainspan system.

* Concrete box girder:

$$wt = \frac{\overset{concrete}{8600cy}(27^{cf}/_{cy})(0.15kcf) + \overset{Reinf}{989^k} + \overset{PT}{545^k}}{504'} = 72^k/_{ft}$$

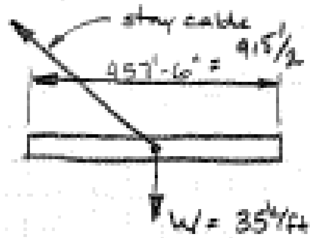
* Steel box girder w/ concrete deck:

$$wt = \frac{\overset{steel}{5580^k} + \overset{steel}{12{,}484^k} + \overset{conc.}{3700cy}(27)(0.15) + \overset{RF}{1120^k}}{915'} = 37^k/_{ft}$$

* Increase in weight going to concrete mainspan:

$$\Delta w = 72^k/_{ft} - 37^k/_{ft} = 35^k/_{ft}$$

* Determine additional stay cable quantity



$W = 35^k/_{ft}(457.5') = 16{,}013^k$

Number of additional strands required $= \frac{40{,}159^k}{0.217in^2(270ksi)(0.45)} = 1523$ strands

Average length = 420'

Additional Strand Weight:
$\Delta W = 1523str.(420')(0.74^{lbs}/_{ft})(2 sides) = 946{,}700^{lbs}$

VALUE ENGINEERING RECOMMENDATION # 1

CALCULATIONS

* Also, adjust stay cable quantity for longer total cable stayed bridge length.

$l_{original} = 412' + 1235' + 412' = 2059'$

$l_{proposed} = 2200'$

$Ratio = \frac{2200'}{2059'} = 1.068$ Increase total stay cable quantity by this ratio.

VALUE ENGINEERING RECOMMENDATION # 1

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Steel Floorbeam	LBS	1.58	1	5,580,000	$8,816,400		
Steel Box Girder	LBS	1.73	1	12,433,642	$21,510,201		
Concrete Deck (Steel Box Unit)	CY	355.92	1	3,700	$1,316,904		
Concrete Deck Reinforcing	LBS	1.68	1	1,120,000	$1,881,600		
Stay Cable Strand	LBS	10.00	7	2,919,000	$29,190,000	4,128,568	$41,285,676
Concrete Box Girder (cable)	CY	590.48	1	8,600	$5,078,128	15,613	$9,219,220
Concrete Box Girder (approach)	CY	1,143.88	1	7,200	$8,235,936	15,613	$17,859,507
Concrete Box Girder (cantilever)	CY	541.10	1	15,080	$8,159,788	15,613	$8,448,246
Box Girder Reinforcing (cable)	LBS	1.58	1	989,000	$1,562,620	1,795,506	$2,836,899
Box Girder Reinforcing (approach)	LBS	1.58	1	850,000	$1,343,000	1,795,506	$2,836,899
Box Girder Reinforcing (cantilever)	LBS	1.58	1	3,672,000	$5,801,760	1,795,506	$2,836,899
P/T Strand (cable)	LBS	6.37	1	545,000	$3,471,650	989,435	$6,302,698
P/T Strand (approach)	LBS	6.37	1	970,000	$6,178,900	989,435	$6,302,698
P/T Strand (cantilever)	LBS	6.37	1	1,132,200	$7,212,114	989,435	$6,302,698
Marine Support Superst. Concrete	LS	16,290,498	1	1	$16,290,498	1.5	$24,435,747
Marine Support Steel Erection	LS	28,274,912	1	1	$28,274,912		
Steel Plate Girders (approach)	LBS	1.75	7			1,484,745	$2,598,304
Concrete Deck (approach)	CY	355.92	1			1,242	$441,976
Concrete Deck Reinforcing (approach)	LBS	1.68	1			279,401	$469,394

VALUE ENGINEERING RECOMMENDATION # 1

COST ESTIMATE - FIRST COST (CONTINUED)

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Steel Edge Beam (Walkway)	LBS	2.17	1	439,000	$952,630	469,063	$1,017,866
Steel Floorbeam (Walkway)	LBS	2.17	1	339,000	$735,630	362,215	$786,006
Concrete Deck (Walkway)	CY	582.34	1	1,160	$675,514	1,239	$721,774
Concrete Deck Reinforcing (Walkway)	LBS	1.65	1	354,000	$584,100	378,242	$624,099
Cable to Girder Connection	LBS	9.64	1	1,680,000	$16,195,200	1,680,000	$16,195,200
Cable to Tower Connection	LBS	9.64	1	1,200,000	$11,568,000	1,200,000	$11,568,000
LMC Overlay	SY	18.30	1	35,140	$643,062	37,546	$687,099
Barriers	LF	182.95	1	10,040	$1,836,818	10,728	$1,962,603
Pedestrian Railing	LF	182.95	1	5,020	$918,409	5,364	$981,302
Miscellaneous Items	LS	1,387,912	1	1	$1,387,912	1	$1,387,912
Subtotal					$189,821,686		$168,108,722
Contingency	@	20%			$37,964,337		$33,621,744
Mobilization	@	4%			$9,111,441		$8,069,219
Total					$236,897,464		$209,799,686

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

VALUE ENGINEERING RECOMMENDATION # 2

PROJECT: OHIO RIVER BRIDGES, SECTION 5 - EAST END BRIDGE
LOCATION: LOUISVILLE, KENTUCKY
STUDY DATE: FEBRUARY 18 - 22, 2008

DESCRIPTIVE TITLE OF RECOMMENDATION:
Decrease transverse width of the tower to narrow the bridge.

ORIGINAL DESIGN:
The Preliminary Design Plans shows a 5-span continuous unit with span lengths of 225.5'-412'-1235'-412'-225.5' with Spans 2, 3 and 4 being cable supported. The superstructure is supported by a single plane of cables and towers located along the centerline of the roadway. The tower above deck is an elliptical shape 18'-0" wide and longitudinal length varying from 21'-0" at the top to 25'-0" at deck level.

RECOMMENDED CHANGE:
Reduce the tower width from 18'-0" to 13'-0" by placing the two stay cable steel anchorage boxes side by side. In the Preliminary Plans the stay cable anchorage boxes are separated by 3'-6" to provide for inspection access within this gap. This gap can be eliminated and the two anchor boxes set side-by-side and inspection access provided within one of the anchorage boxes. The entire bridge deck width can be reduced by 5'-0" due to a narrower tower.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$5,020,000		$5,020,000
RECOMMENDED DESIGN	$0		$0
ESTIMATED SAVINGS OR (COST)	$5,020,000	$0	$5,020,000

VALUE ENGINEERING RECOMMENDATION # 2

ADVANTAGES:

- Narrower bridge deck reduces superstructure quantities, stay cable quantities and substructure quantities.
- Cable anchorage system at deck level also becomes simpler and lighter.

DISADVANTAGES:

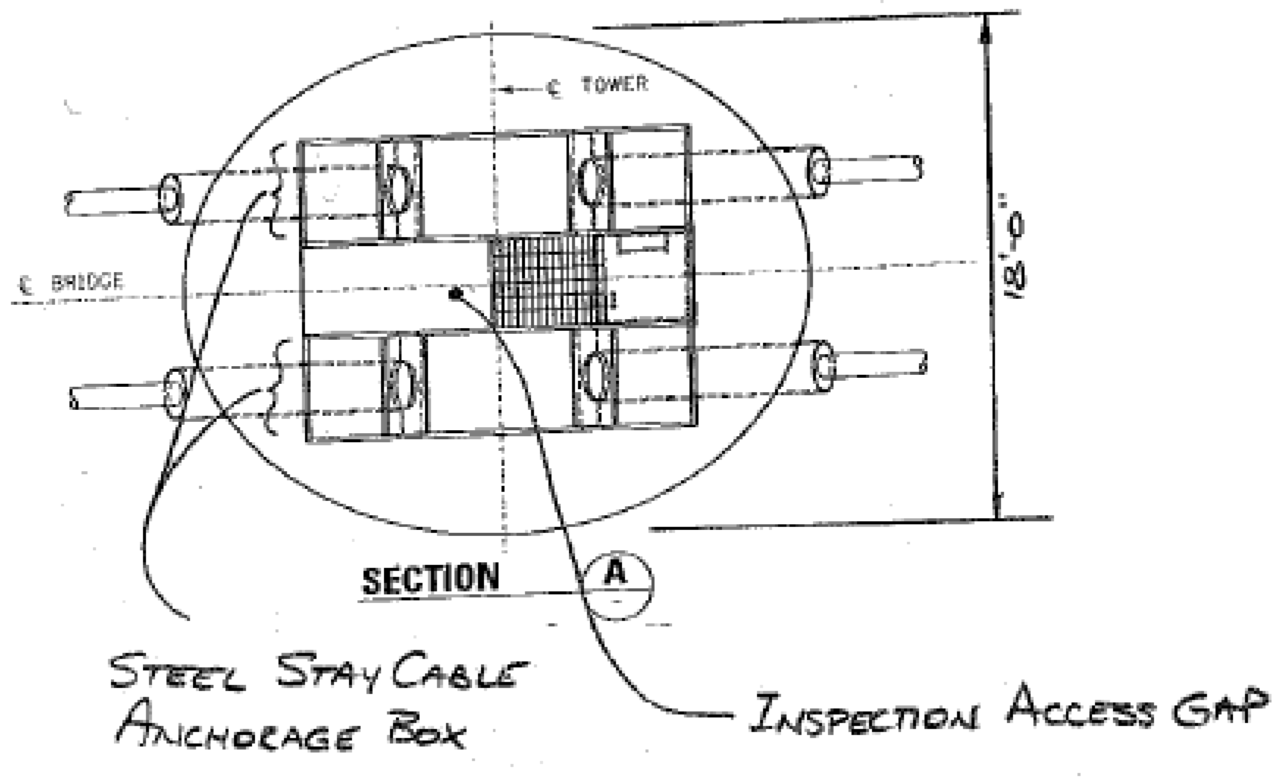
- Longitudinal length of the tower leg may need to be increased from the minimum dimension of 21'-0" to ensure proper space between the stay cable anchors within the anchorage box for inspection access.

JUSTIFICATION:
Since the unit price of the original bridge system depicted in the Preliminary Plans is so high, and the width of the bridge deck is a function of the tower width, it is recommended that the width of the tower legs be minimized. The original concept uses the space between the two independent steel anchor boxes in the tower head region to provide maintenance and inspection access. It is recommended to eliminate this space between the two independent anchor boxes and instead utilize the space within one of the anchor boxes to provide maintenance and inspection access. Eliminating this space and reconfiguring the elliptical shape of the tower allows for a 5'-0" total reduction in tower width. Since the superstructure width is influenced by the tower width, a 5'-0" reduction in tower width can be accommodated by a 5'-0" width reduction in the superstructure.

The longitudinal length of the anchorage boxes must be selected to ensure that there is adequate clearance between opposing stay cable anchors to allow for maintenance and inspection activities to be properly performed.

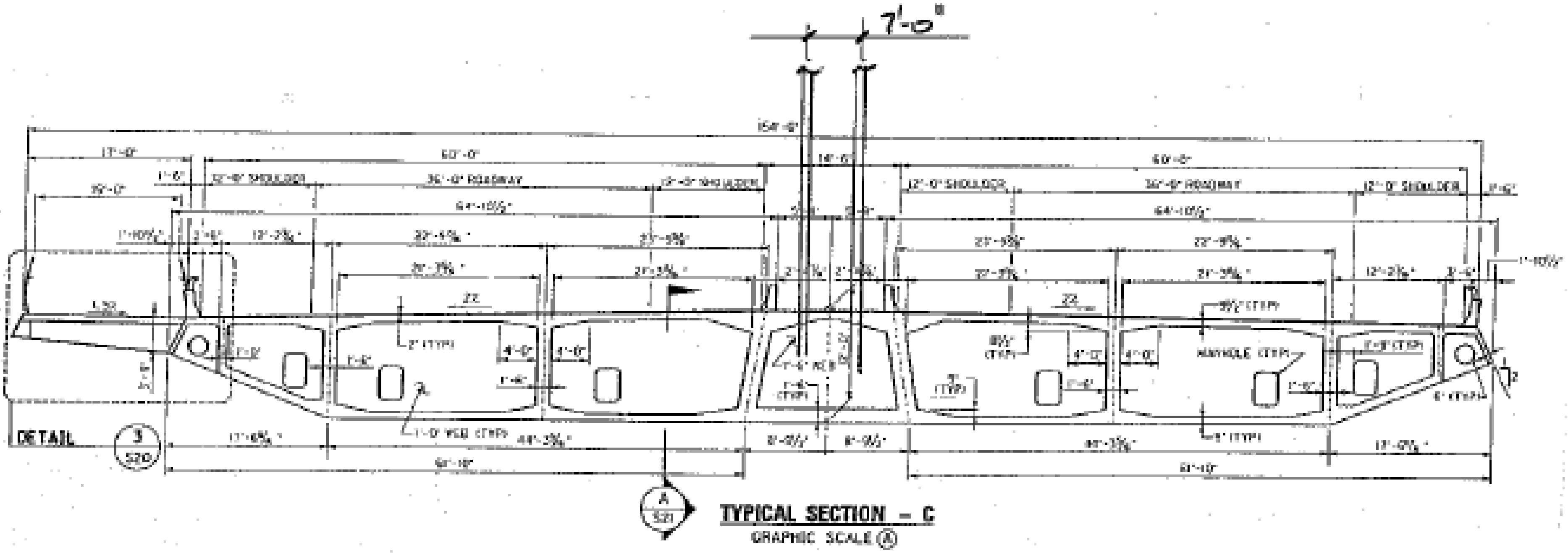
VALUE ENGINEERING RECOMMENDATION # 2

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 2

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 2

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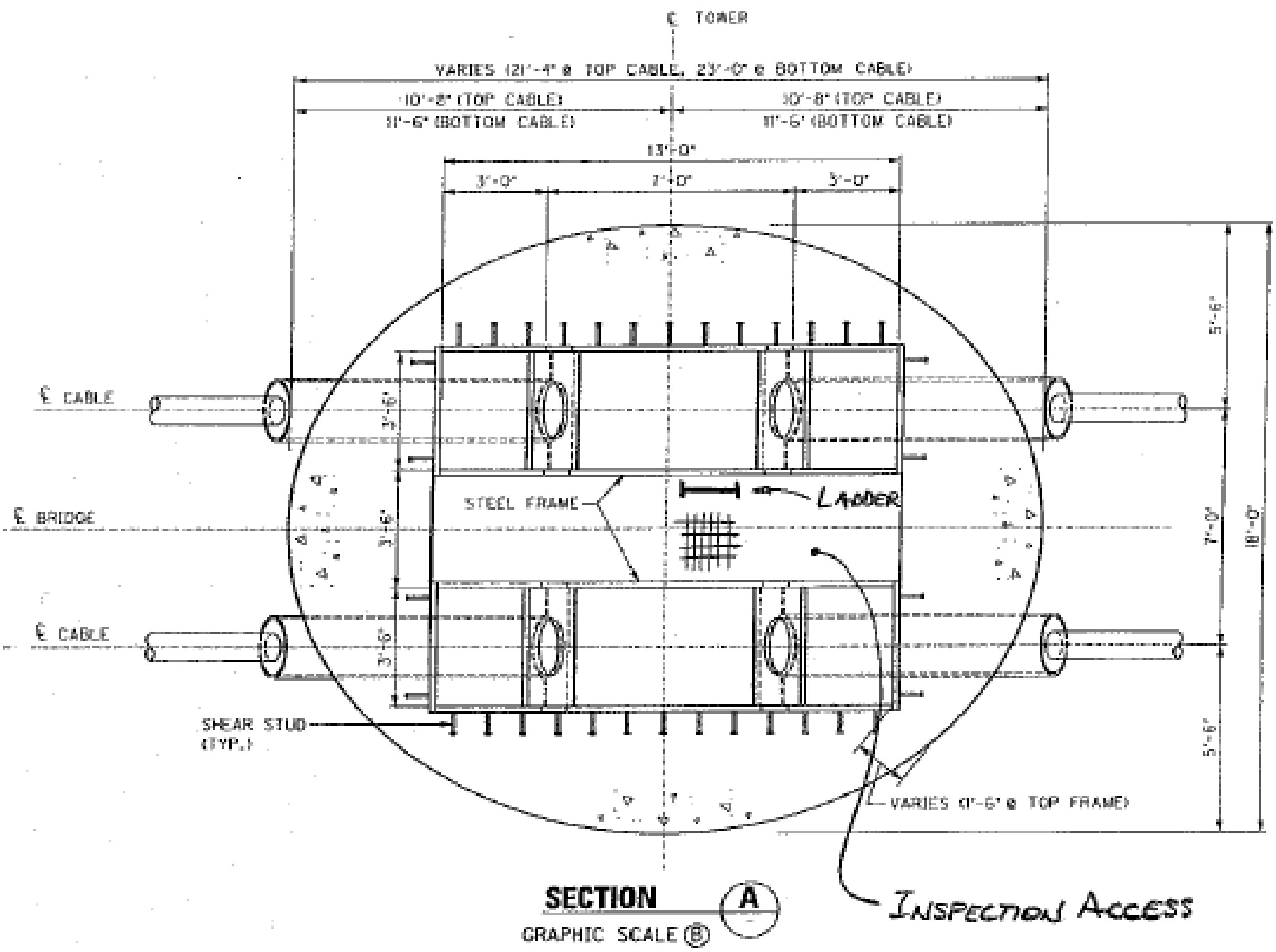
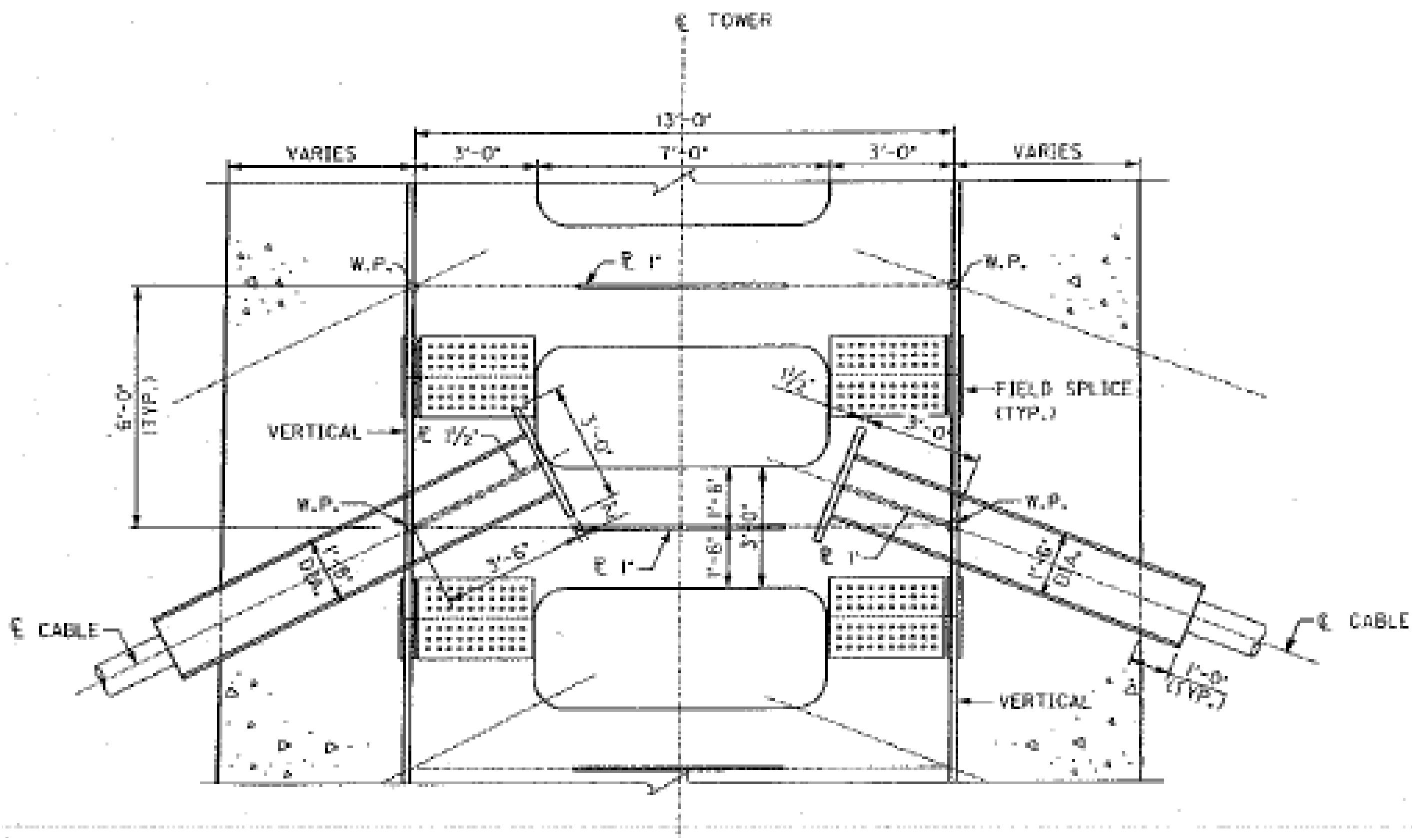


VALUE ENGINEERING RECOMMENDATION # 2

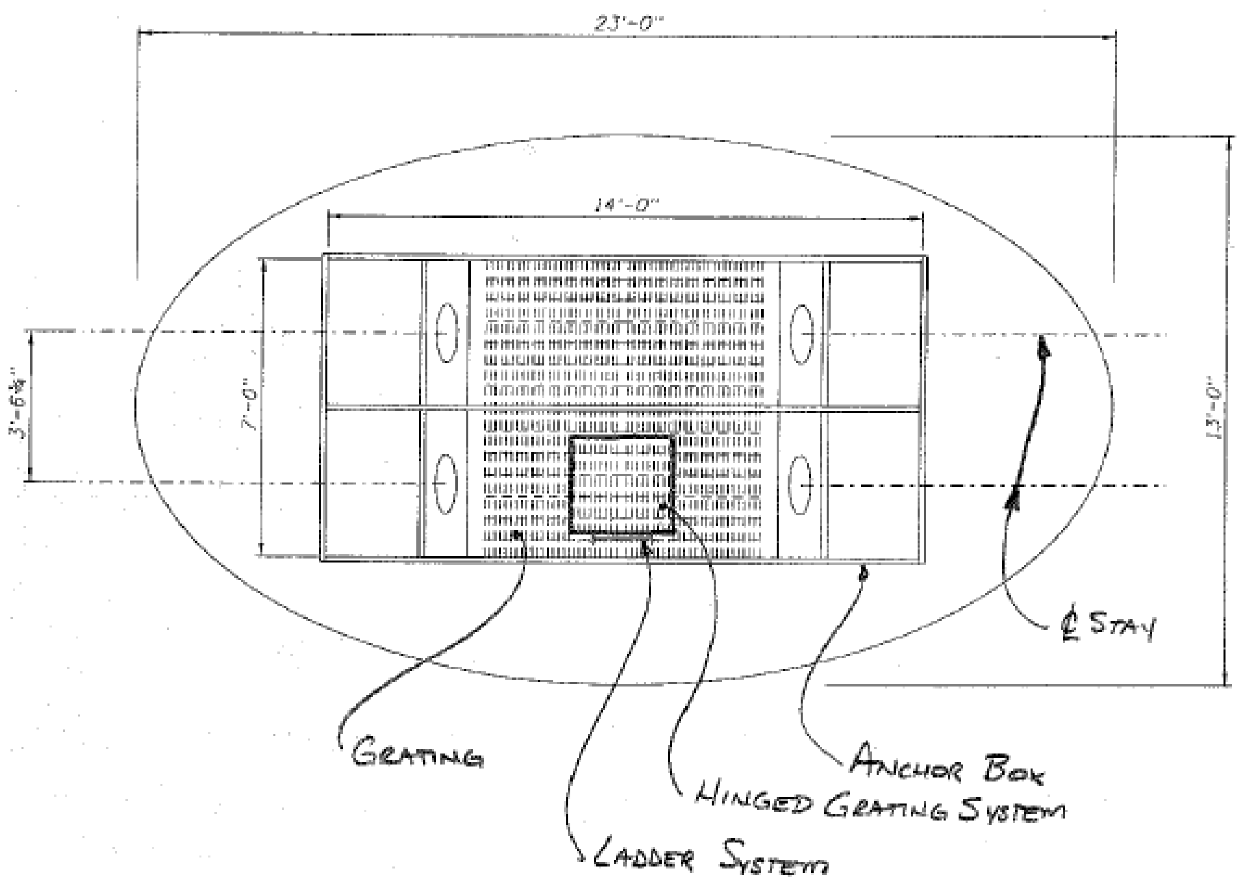
SKETCH OF ORIGINAL DESIGN



SECTION B
TYPICAL FRAMES

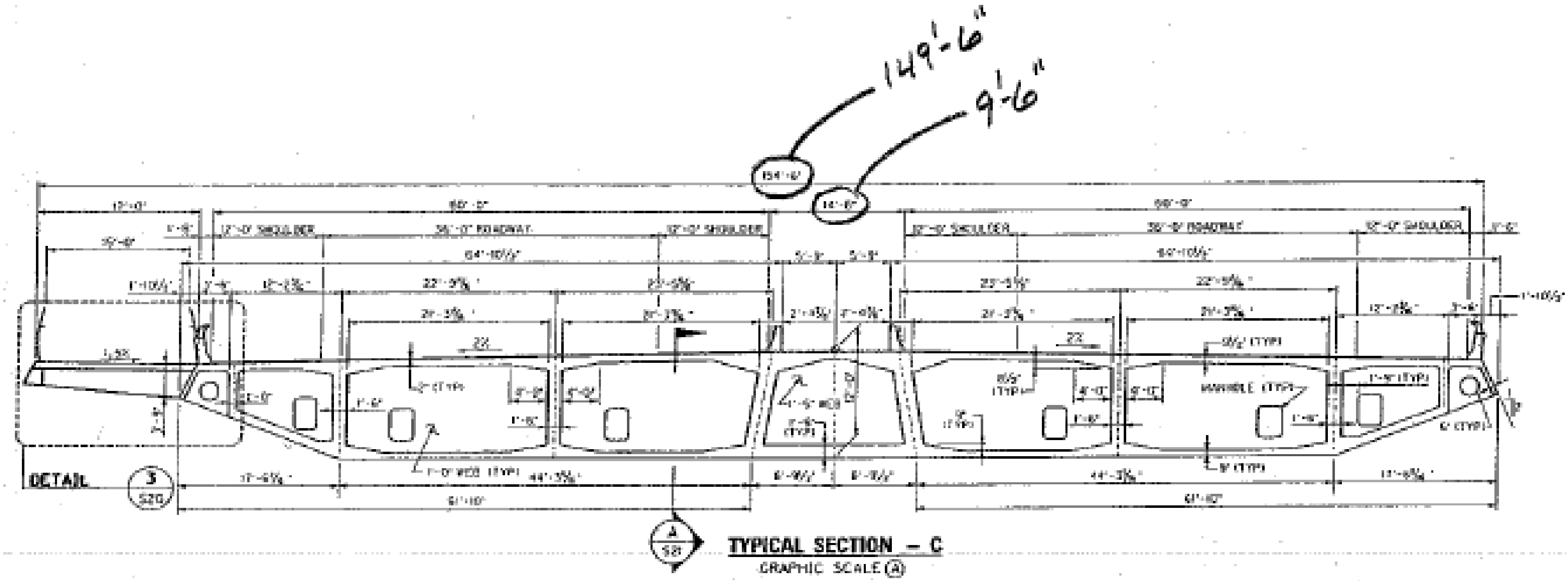
VALUE ENGINEERING RECOMMENDATION # 2

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 2

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 2

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Reduce Bridge Deck Width by 5'-0"	SF	400.00	7	12,550	$5,020,000		
Subtotal					$5,020,000		$0
Contingency	@	0%			$0		$0
Mobilization	@	0%			$0		$0
Total					$5,020,000		$0

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

VALUE ENGINEERING RECOMMENDATION # 3

PROJECT: OHIO RIVER BRIDGES, SECTION 5 - EAST END BRIDGE
LOCATION: LOUISVILLE, KENTUCKY
STUDY DATE: FEBRUARY 18 - 22, 2008

DESCRIPTIVE TITLE OF RECOMMENDATION:
Consider open framing for the superstructure in lieu of smooth bottom soffit of the steel and concrete box girder.

ORIGINAL DESIGN:
The Preliminary Design Plans shows a 5-span continuous unit with span lengths of 225.5'-412'-1235'-412'-225.5' with Spans 2, 3 and 4 being cable supported. The approach span (225'-6"), side span (412'-0") and 160' of the main span is a concrete box girder system; while the central 915' of the main span is a composite steel box girder system. The superstructure is supported by a single plane of cables and towers located along the centerline of the roadway.

RECOMMENDED CHANGE:
Replace the large concrete and steel box girders that utilize a smooth bottom soffit with a superstructure system utilizing an open grid system of longitudinal edge girders and transverse floorbeams. To facilitate the open grid system with longitudinal edge girders, a plane of stay cables will be required along both edges of the superstructure. Furthermore, towers will be required along each edge of the superstructure to support the two planes of stay cables. The open grid superstructure system is the most economical cable stayed bridge system and can be utilized as a baseline to evaluate the cost premium associated with the original design.

The longitudinal layout of the bridge should be consistent with the layout proposed in VE Recommendation 1.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$267,178,000		$267,178,000
RECOMMENDED DESIGN	$172,134,000		$172,134,000
ESTIMATED SAVINGS OR (COST)	$95,044,000	$0	$95,044,000

ADVANTAGES:

- Reduction in superstructure quantities and cost.
- A more traditional cable stayed system with less risk of cost over runs.
- Constructability is significantly better than the system shown in the Preliminary Plans.

VALUE ENGINEERING RECOMMENDATION # 3

ADVANTAGES (CONTINUED):

- Narrower bridge since centrally located tower and associated median can be removed.
- Can be constructed with either a full cast-in-place concrete superstructure or with a composite steel grid system as shown in the sketches.
- Structural steel elements are small common elements that can be handled by numerous fabricators, thus increasing bidding competition.

DISADVANTAGES:

- Changes the architectural look and aesthetics of the bridge.
- Increase in number of tower legs due to the number of cable planes.

JUSTIFICATION:
The open grid superstructure system for cable stayed bridges is a very common approach and is generally the most cost effective system. The open grid system utilizes longitudinal edge girders along each side of the bridge that are supported directly by planes of cables. Transverse floorbeams span between the edge girders and are utilized to support the roadway concrete deck. The edge girders and transverse floorbeams can be either concrete or steel, as both can be used economically and choice becomes an owner’s preference. The structural system developed for this Recommendation assumes the use of steel edge girders and floorbeams made composite with a concrete deck. The concrete deck may consist of precast, prestressed deck panels connected to the steel grid system with cast-in-place closure pours.

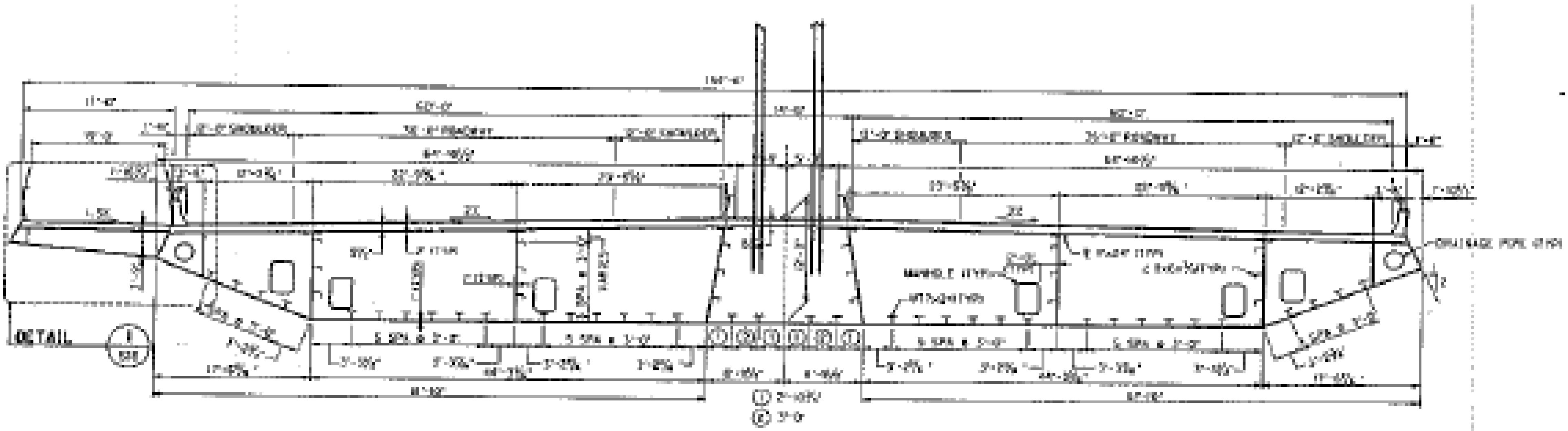
This structural system differs drastically from the architectural and aesthetic character of the system shown in the Preliminary Plans. However, this system will be the most cost effective solution for this site and should as a minimum be developed in sufficient detail in order to establish a base line price for the East End Bridge. The cost estimate for this open grid system can be utilized to help KYTC understand the cost premium that will be associated with the system that is in the Preliminary Plans.

The open steel grid superstructure is a tried-and-true cable stayed system with a well established construction methodology compared to the system presented in the Preliminary Plans which requires four distinct methods of superstructure erection. The constructability of the open grid system carries substantially less risk which will translate to cost savings and accelerated construction schedules.

If the smooth bottom soffit is a must have for aesthetic reasons, it is possible to use fiberglass panels between the transverse floorbeams to close off the bottom of superstructure to produce the smooth bottom soffit. Additionally, the steel plate girder longitudinal edge girder can be replaced with relatively narrow steel box girders that will provide a cleaner appearance. Both of these modifications will increase cost and may affect inspection access.

VALUE ENGINEERING RECOMMENDATION # 3

SKETCH OF ORIGINAL DESIGN

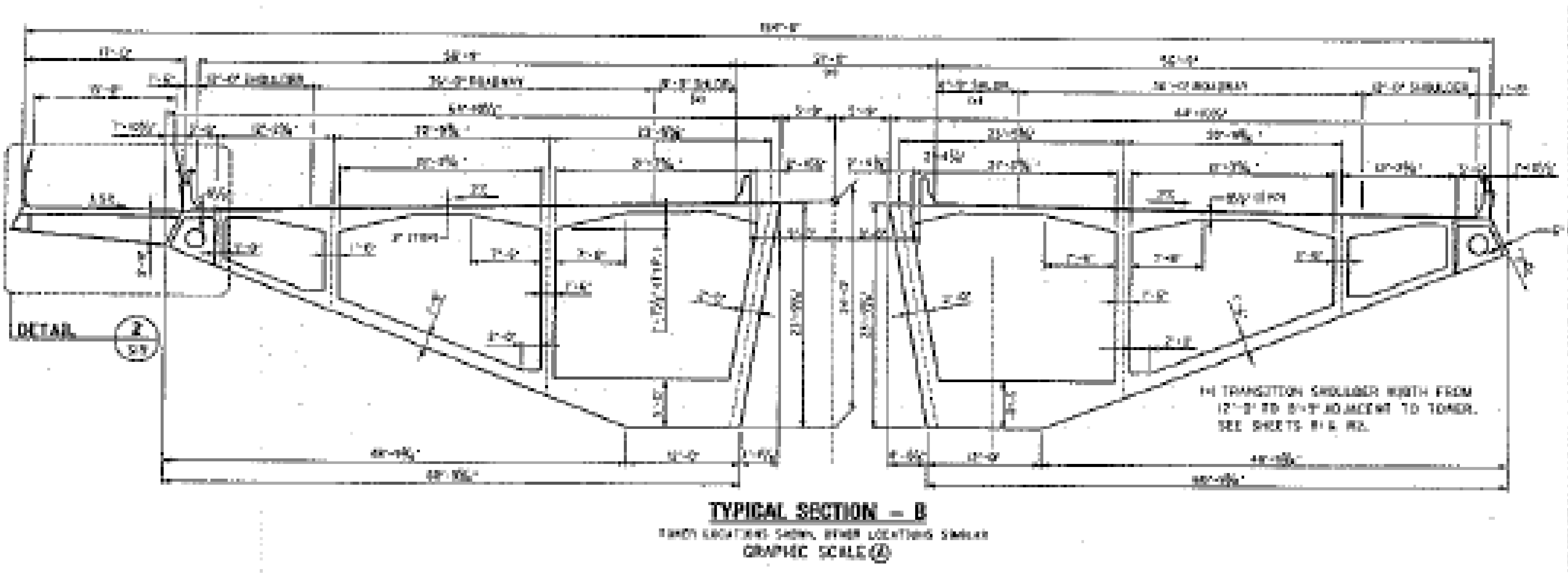


TYPICAL SECTION – A

GRAPHIC SCALE (A)

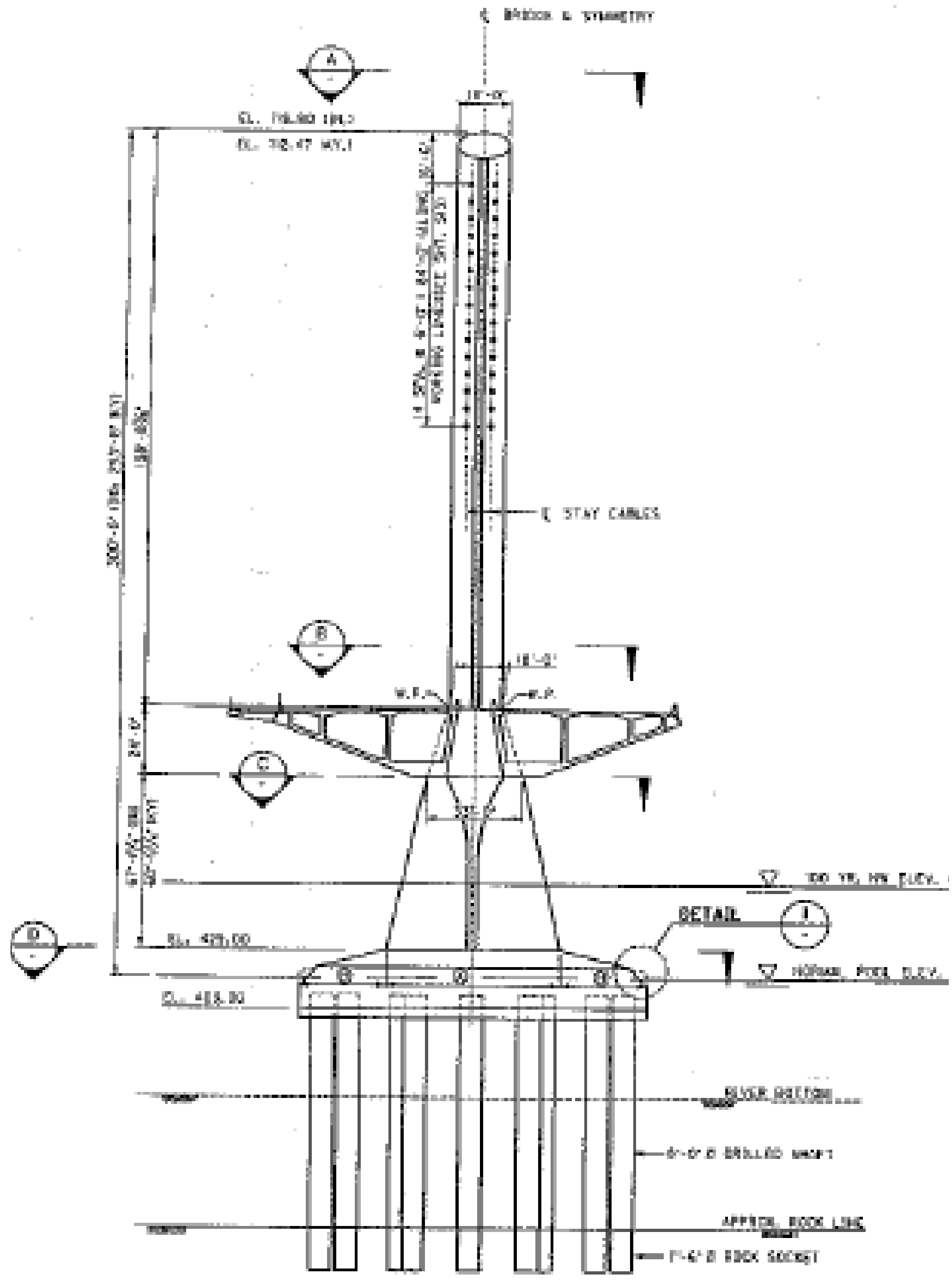
VALUE ENGINEERING RECOMMENDATION # 3

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 3

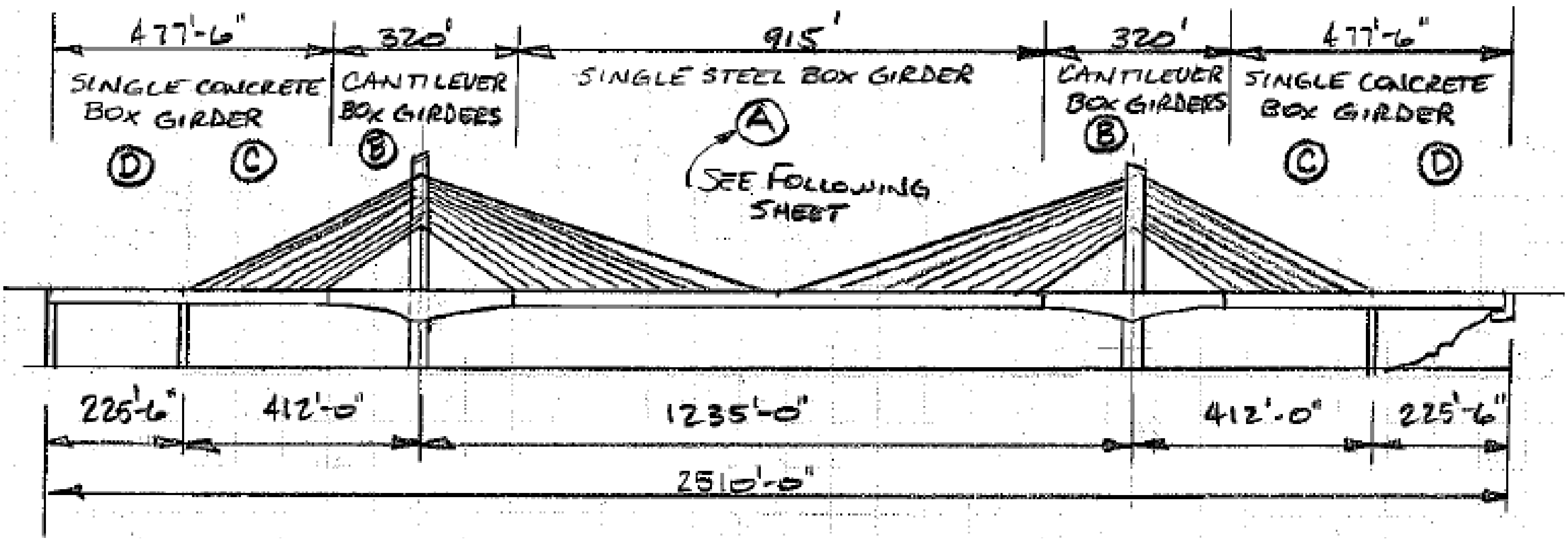
SKETCH OF ORIGINAL DESIGN



TRANSVERSE ELEVATION

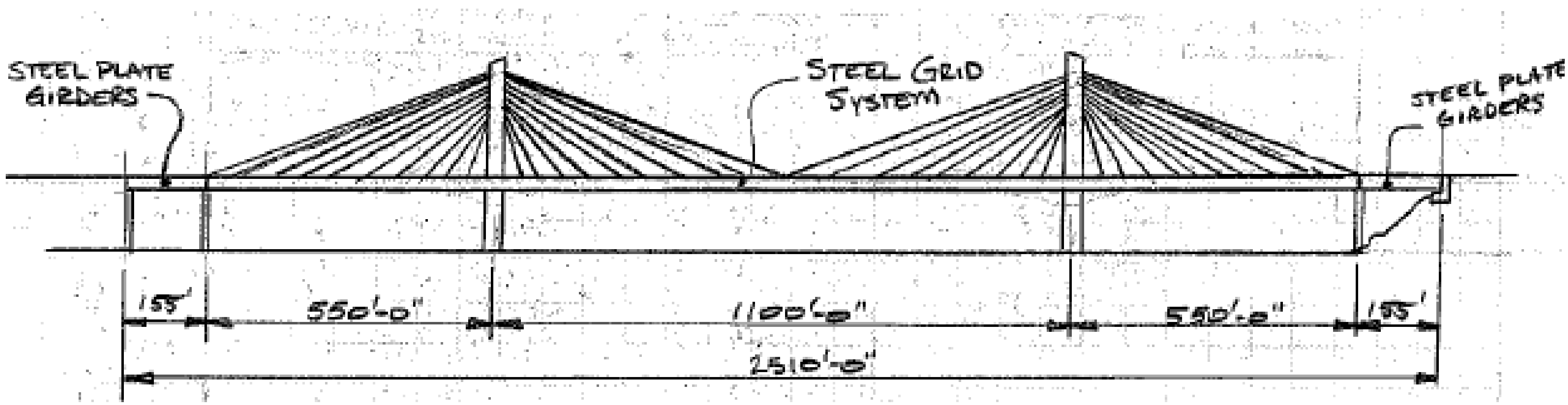
VALUE ENGINEERING RECOMMENDATION # 3

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 3

SKETCH OF RECOMMENDED DESIGN



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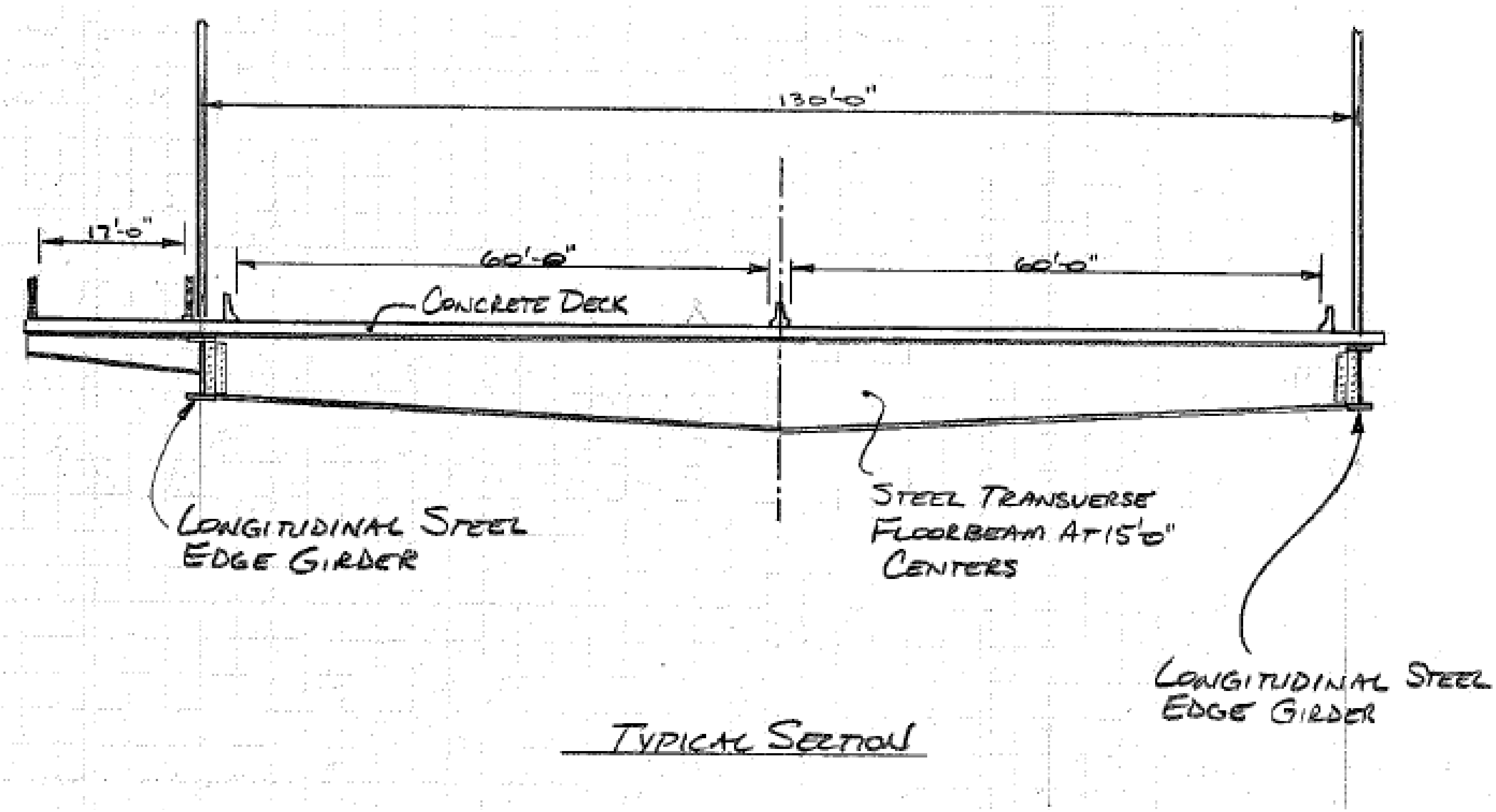
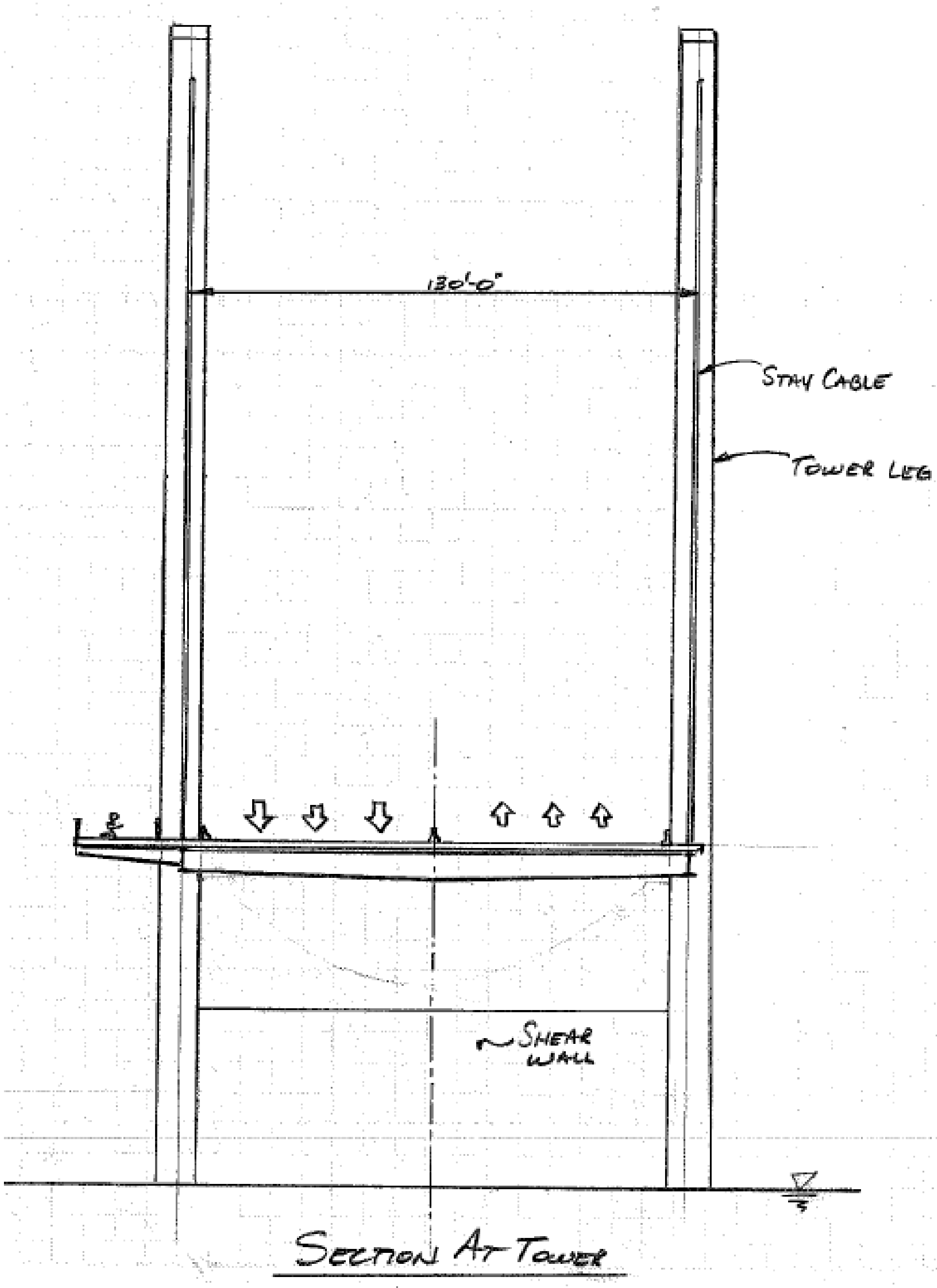


VALUE ENGINEERING RECOMMENDATION #3

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 3

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Steel Floorbeam	LBS	1.58	1	5,580,000	$8,816,400		
Steel Box Girder	LBS	1.73	1	12,433,642	$21,510,201		
Steel Edge Girders and Floorbeams	LBS	2.25	7			13,200,000	$29,700,000
Concrete Deck (Steel Box Unit)	CY	355.92	1	3,700	$1,316,904	10,185	$3,624,966
Concrete Deck Reinforcing	LBS	1.68	1	1,120,000	$1,881,600	3,055,433	$5,133,128
Stay Cable Strand	LBS	10.00	7	2,919,000	$29,190,000	1,857,855	$18,578,554
Concrete Box Girder (cable)	CY	590.48	1	8,600	$5,078,128		
Concrete Box Girder (approach)	CY	1,143.88	1	7,200	$8,235,936		
Concrete Box Girder (cantilever)	CY	541.10	1	15,080	$8,159,788		
Box Girder Reinforcing (cable)	LBS	1.58	1	989,000	$1,562,620		
Box Girder Reinforcing (approach)	LBS	1.58	1	850,000	$1,343,000		
Box Girder Reinforcing (cantilever)	LBS	1.58	1	3,672,000	$5,801,760		
P/T Strand (cable)	LBS	6.37	1	545,000	$3,471,650		
P/T Strand (approach)	LBS	6.37	1	970,000	$6,178,900		
P/T Strand (cantilever)	LBS	6.37	1	1,132,200	$7,212,114		

VALUE ENGINEERING RECOMMENDATION # 3

COST ESTIMATE - FIRST COST (CONTINUED)

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Marine Support Superst. Concrete	LS	16,290,498	1	1	$16,290,498		
Marine Support Steel Erection	LS	28,274,912	1	1	$28,274,912	1	$28,274,912
Steel Plate Girders (approach)	LBS	1.75	7			1,484,745	$2,598,304
Concrete Deck (approach)	CY	355.92	1			1,242	$441,976
Concrete Deck Reinforcing (approach)	LBS	1.68	1			279,401	$469,394
Steel Edge Beam (Walkway)	LBS	2.17	1	439,000	$952,630		
Steel Floorbeam (Walkway)	LBS	2.17	1	339,000	$735,630		
Concrete Deck (Walkway)	CY	582.34	1	1,160	$675,514		
Concrete Deck Reinforcing (Walkway)	LBS	1.65	1	354,000	$584,100		
Cable to Girder Connection	LBS	9.64	1	1,680,000	$16,195,200		
Cable to Tower Connection	LBS	9.64	1	1,200,000	$11,568,000	1,200,000	$11,568,000
LMC Overlay	SY	18.30	1	35,140	$643,062	37,546	$687,099
Barriers	LF	182.95	1	10,040	$1,836,818	10,728	$1,962,603
Pedestrian Railing	LF	182.95	1	5,020	$918,409	5,364	$981,302
Tower Tremie Seal	CY	119.19	1	1,960	$233,612	2,940	$350,419
Tower Drilled Shaft (8' diam)	VF	1,542.09	1	2,935	$4,526,034	4,403	$6,789,051

VALUE ENGINEERING RECOMMENDATION # 3

COST ESTIMATE - FIRST COST (CONTINUED)

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Tower Rock Socket (7.5' diam)	VF	905.64	1	540	$489,046	810	$733,568
Tower Footing Concrete	CY	254.34	1	8,780	$2,233,105	13,170	$3,349,658
Tower Footing Reinforcement	LBS	1.66	1	1,492,600	$2,477,716	2,238,900	$3,716,574
Concrete Tower	CY	612.23	1	5,137	$3,145,026	7,706	$4,717,538
Concrete Tower Reinforcing	LBS	1.77	1	1,926,375	$3,409,684	2,889,563	$5,114,526
Marine Support Tower Drilled Shaft	LS	5,946,951	1	1	$5,946,951	1	$5,946,951
Marine Support Tower Footing	LS	1,801,700	1	1	$1,801,700	1	$1,801,700
Miscellaneous Items	LS	1,387,912	1	1	$1,387,912	1	$1,387,912
Subtotal					$214,084,560		$137,928,135
Contingency	@	20%			$42,816,912		$27,585,627
Mobilization	@	4%			$10,276,059		$6,620,550
Total					$267,177,530		$172,134,312

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

VALUE ENGINEERING DESIGN COMMENT # 4

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Towers below deck should utilize bladed columns with an architectural fascia for aesthetics in lieu of elliptical shape

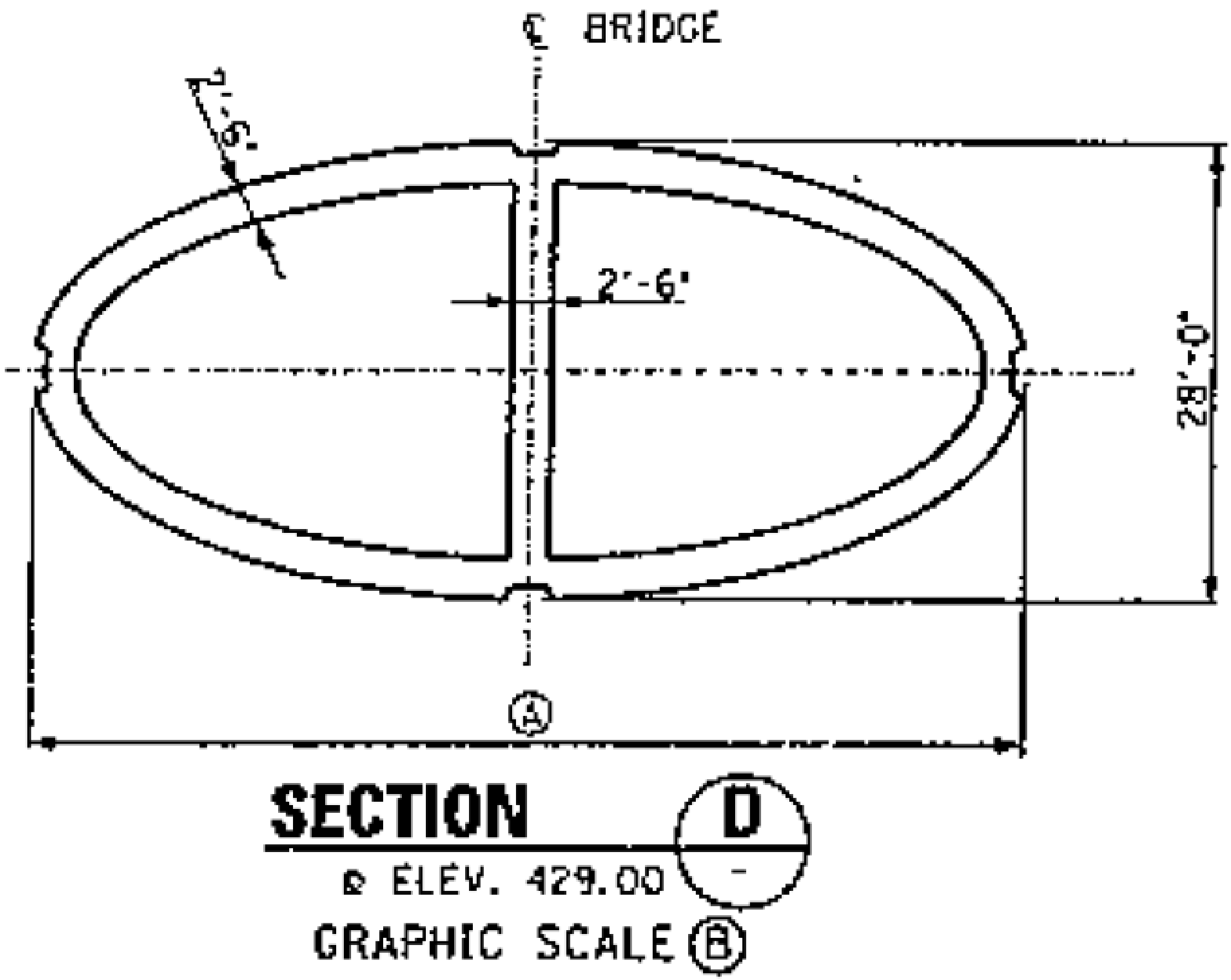
COMMENTARY:
The Preliminary Plans show that the tower legs below deck are thin walled elliptical shapes that measure 28'-0" longitudinally and vary in width from 33'-0" to 60'-0". Additionally, the superstructure is cast integral with the towers at both tower locations.

Since the superstructure is integral with the tower at both locations the foundations will experience large forces from temperature variations because the elliptical tower legs below deck are very stiff flexural elements (28' in depth and only 60' tall). To alleviate the large forces in the foundations from temperature movements it is recommended to replace the closed elliptical shape below deck with twin wall bladed columns. The twin wall bladed columns will allow the superstructure to move longitudinally due to temperature variations with very little demand on the foundations, while still providing excellent restraint of the superstructure rotationally.

If the elliptical shape is desired from an aesthetics standpoint then a non-structural fascia can be added to encompass the twin wall bladed columns.

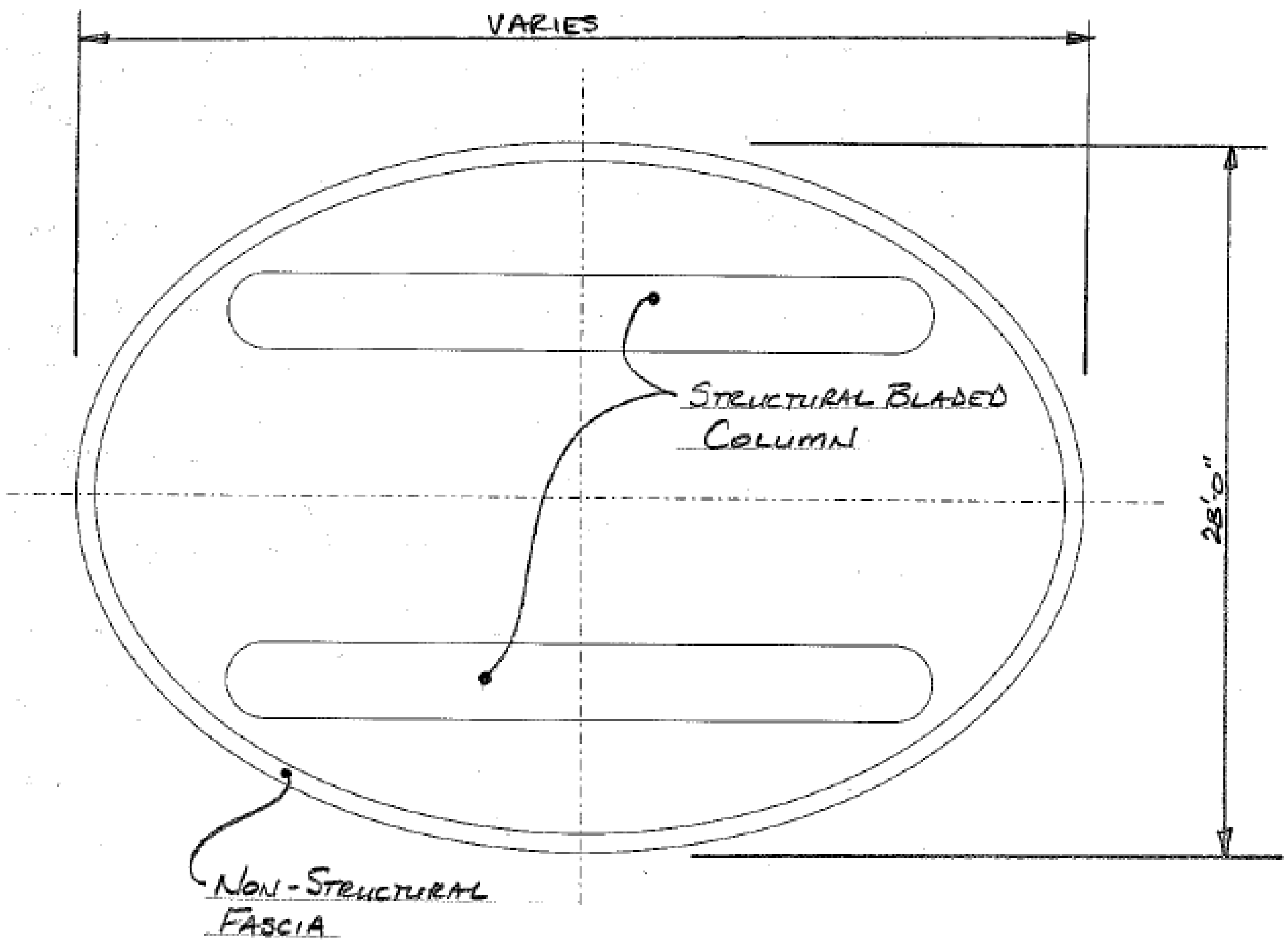
VALUE ENGINEERING DESIGN COMMENT # 4

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING DESIGN COMMENT # 4

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 4

PHOTOGRAPH OF RECOMMENDATION

VALUE ENGINEERING DESIGN COMMENT # 5

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Column walls below high water need to be able to resist barge impact forces. Use solid sections in lieu of thin walled columns.

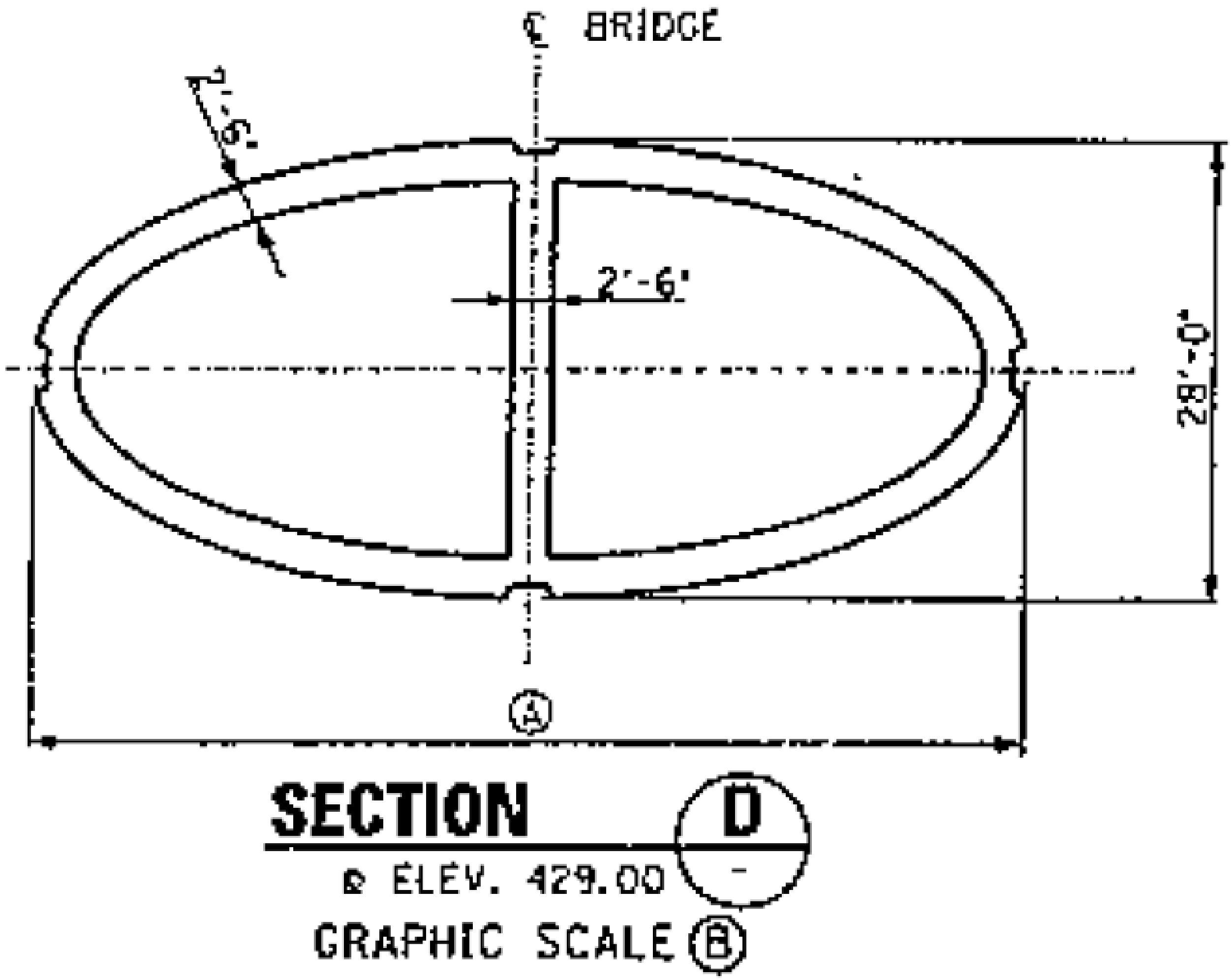
COMMENTARY:
The Preliminary Plans show that the tower legs below deck are thin walled elliptical shapes that measure 28'-0" longitudinally and vary in width from 33'-0" to 60'-0". The top of footing is 10' above normal pool level. The columns within the barge impact zone need to be designed to resist the localized barge impact forces. The thin walled column shape shown in the Preliminary Plans may not be able to resist these large impact forces (6,023 kips) and consideration should be given to providing solid sections within this zone.

According to the Barge Impact Analysis Report (dated November 2007), the fully loaded barge impact force is applied at elevation 421.8, which is 3' above the normal pool elevation. The unloaded barge impact force should be applied at elevation 454.7, which is 3' above the 100 year high water elevation. The recommended impact elevation for the fully loaded barge at the normal pool elevation plus 3' should be re-evaluated in accordance with the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges. Generally, fully loaded barges will utilize the river at all water elevation until the locks are closed; therefore, the impact force application elevation should take this into account. On recent cable stayed projects over the Ohio River (Pomeroy-Mason, U.S. Grant and Ironton-Russell) the fully loaded barge impact forces are applied 2' above the mean high water level (often taken as the 2% flow line). This will be substantially higher than the normal pool level recommended in the Barge Impact Analysis Report.

If the recommendations of Design Comment 4 are incorporated and bladed columns with an elliptical fascia are utilized for the tower legs below deck, then the space between the elliptical fascia and the structural blades can be filled with low grade concrete to provide barge collision resistance as long as an adequate gap is provided completely around the blades to allow the blades to flex independent of the elliptical fascia and fill concrete.

VALUE ENGINEERING RECOMMENDATION # 5

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING DESIGN COMMENT # 6

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Cantilevered sidewalk needs to be designed for an under-bridge inspection vehicle.

COMMENTARY:
The sidewalk deck slab and steel girder framing system needs to be designed to accommodate the loading associated with an under-bridge inspection vehicle in its fully extended position with outriggers deployed. Even though the vehicle is light enough to be considered a legal load for traversing over bridges, with the boom fully extended a majority of the load will be placed on one set of outriggers and this needs to be accounted for in the sidewalk design.

VALUE ENGINEERING DESIGN COMMENT # 7

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Cantilevering of asymmetric cross-section creates large torsions and twists that needs to be addressed

COMMENTARY:
The Preliminary Plans indicate that the first 160’ in each direction from the towers will be constructed using cast-in-place balanced cantilever methodology. The bridge cross section is comprised of two independent three cell box girders that are very asymmetric. It is noted that the large asymmetry associated with the proposed box shape will introduce large torsions and twists into the section due to self-weight and the weight of the form traveler. The Ringling Causeway Bridge in Sarasota, Florida utilized an asymmetric box girder shape for the balanced cantilever construction. During cantilevering operations the large torsions created by the asymmetric shape of the box caused significant cracking in the box girder webs which lead to long time delays and extensive retrofit costs. Before committing to the asymmetric shape for the balanced cantilever portion of this bridge, the designers should be aware of the issues that occurred on the Ringling Causeway.

VALUE ENGINEERING DESIGN COMMENT # 8

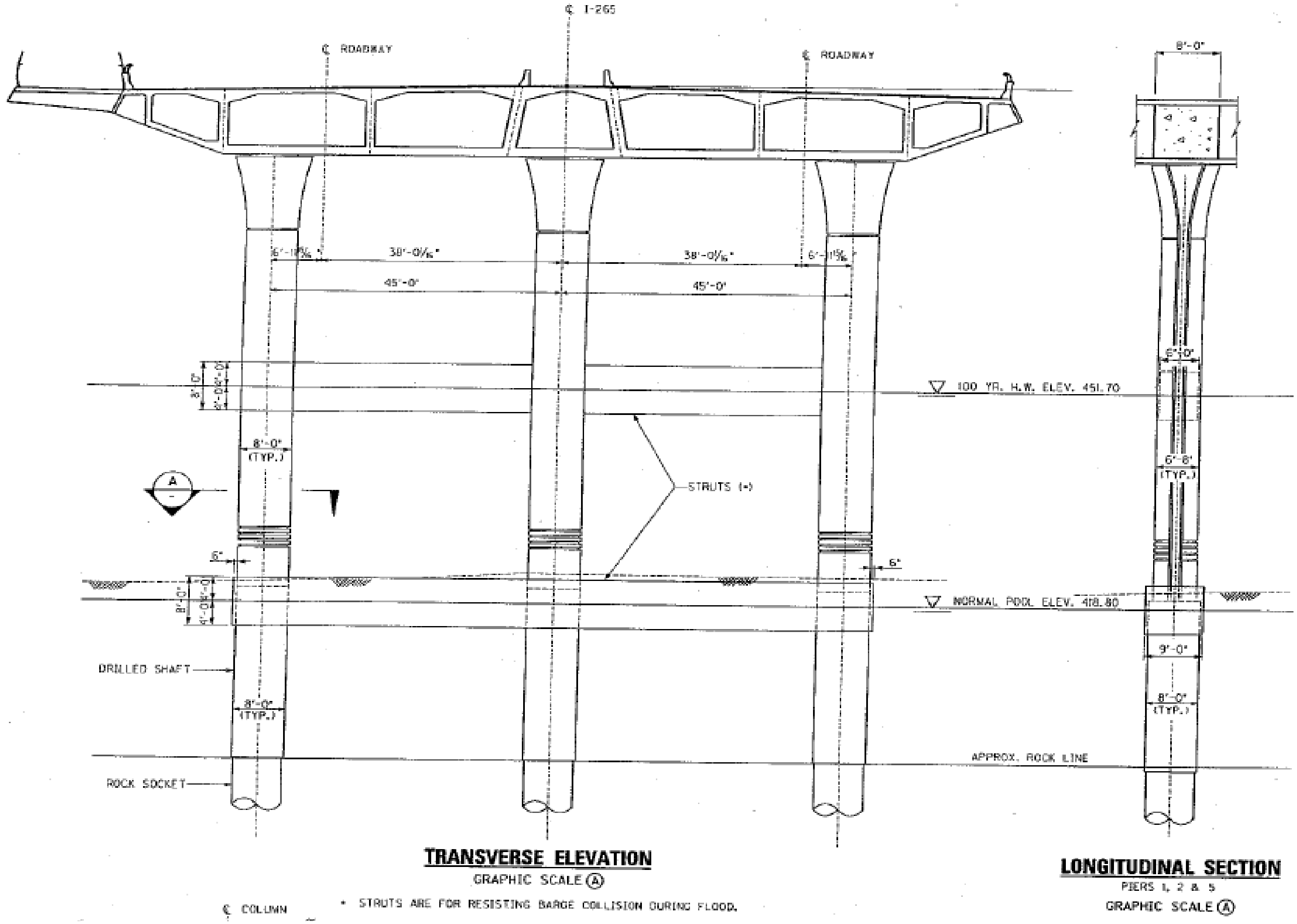
DESCRIPTIVE TITLE OF DESIGN COMMENT:
Columns for Pier 1 and anchor piers need to be able to resist barge impact forces between struts.

COMMENTARY:
The Preliminary Plans show two horizontal struts between the three columns for Piers 1, 2 and 3. One strut is provided at normal pool level and the other strut is provided at the 100 year high water level. As noted on the drawing, these struts are provided to resist the barge collision forces.

As the piers are currently detailed, the individual columns need to be designed to resist the appropriate barge impact forces when the water level is in between the normal pool and the 100 year high water level. According to the Barge Impact Analysis Report (dated November 2007), the fully loaded barge impact force is applied at elevation 421.8, which is 3' above the normal pool elevation. The unloaded barge impact force should be applied at elevation 454.7, which is 3' above the 100 year high water elevation. The recommended impact elevation for the fully loaded barge at the normal pool elevation plus 3' should be re-evaluated in accordance with the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges. Generally, fully loaded barges will utilize the river at all water elevation until the locks are closed; therefore, the impact force application elevation should take this into account. On recent cable stayed projects over the Ohio River (Pomeroy-Mason, U.S. Grant and Ironton-Russell) the fully loaded barge impact forces are applied 2' above the mean high water level (often taken as the 2% flow line). This will be substantially higher than the normal pool level recommended in the Barge Impact Analysis Report.

VALUE ENGINEERING DESIGN COMMENT # 8

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING DESIGN COMMENT # 9

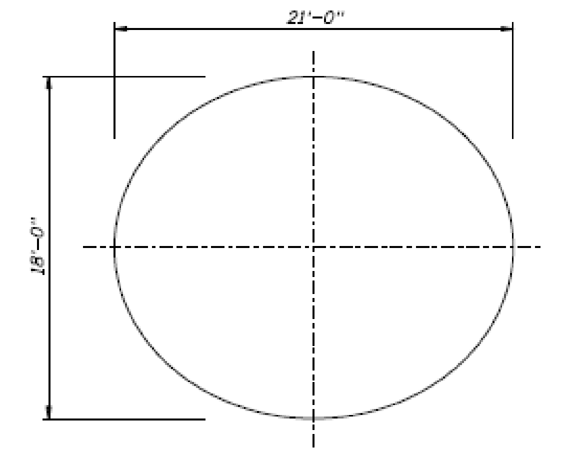
DESCRIPTIVE TITLE OF DESIGN COMMENT:
Tower elliptical shapes should have a variable width flat section along sides so forms can be simplified; flat section varies from 0-feet to 4-feet maximum.

COMMENTARY:
The Preliminary Plans show elliptical tower shapes that are a constant 18'-0" wide, but vary in length from 21'-0" at the top to 25'-0" at deck level. This variable length ellipse means the section must warp as it goes upwards and that each section of form work needs to be customized.

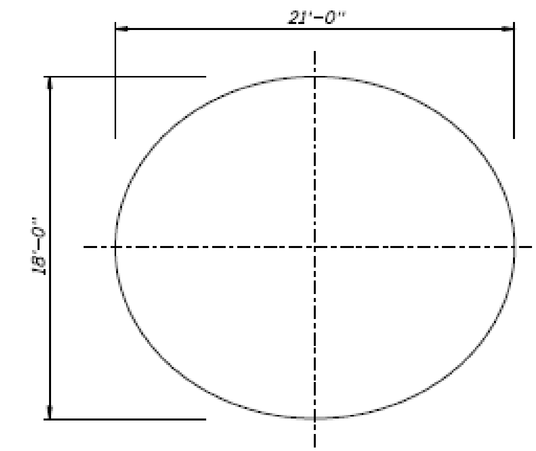
It is recommended to place a short variable width tangent section in the side walls to simplify the form system while having almost no visual change from the original proposal. The variable width tangent section allows the end forms and reinforcement details to remain constant for the full height of the tower which will speed construction and reduce costs.

VALUE ENGINEERING DESIGN COMMENT # 9

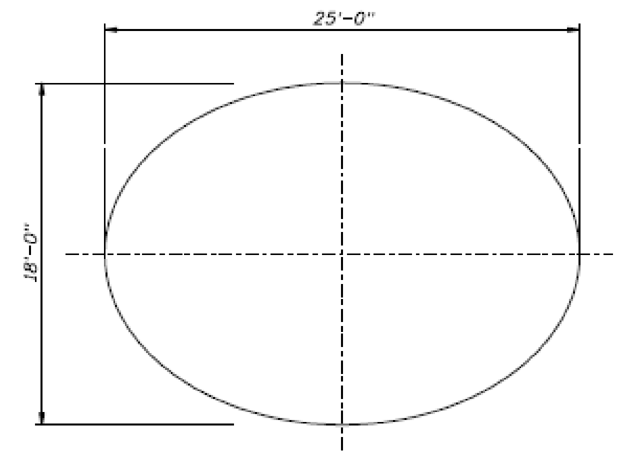
SKETCH OF ORIGINAL AND RECOMMENDED DESIGN



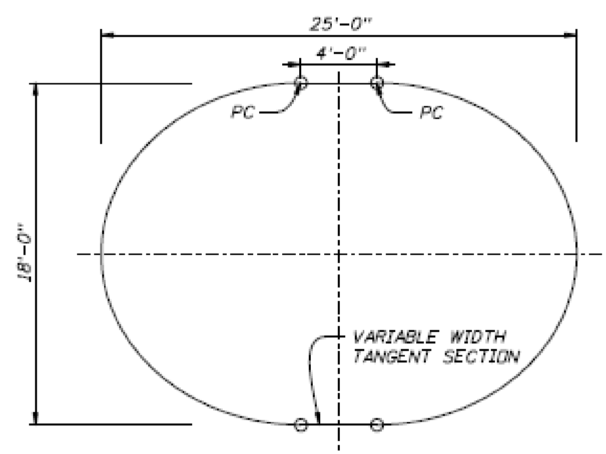
SECTION AT TOP OF TOWER - ORIGINAL



SECTION AT TOP OF TOWER - PROPOSED



SECTION AT DECK LEVEL - ORIGINAL



SECTION AT DECK LEVEL - PROPOSED

VALUE ENGINEERING DESIGN COMMENT # 10

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Consider using a wearing surface on sidewalk.

COMMENTARY:
The Preliminary Plans show that the sidewalk cantilever utilizes precast concrete deck panels with a cast-in-place closure pour to the main box girder deck panel just behind the roadway barrier. It is also noted that the sidewalk has a 1.5% cross-slope towards the roadway barrier. It is recommended to provide a wearing surface on the sidewalk in order to seal the construction joints at the low point of the sidewalk. There will be a tendency for salt laden water to pool over the cast-in-place closure joints.

VALUE ENGINEERING DESIGN COMMENT # 11

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Coordinate between Section 2 and 5 to design appropriate concrete barriers.

COMMENTARY:
During the Design Team's inbriefing on this project, there was discussion about the concrete barriers being TL-5 crash compliant. In reviewing the new I-65 NB bridge plans it was not evident if that project was utilizing similar design criteria for the concrete barriers. The VE Team feels it is prudent to use the same design criteria for the concrete barriers on both bridges since they are included under one project. This would help limit liability from a future incident and will provide design consistency between the bridge projects, as well as a safer facility for the traveling public.

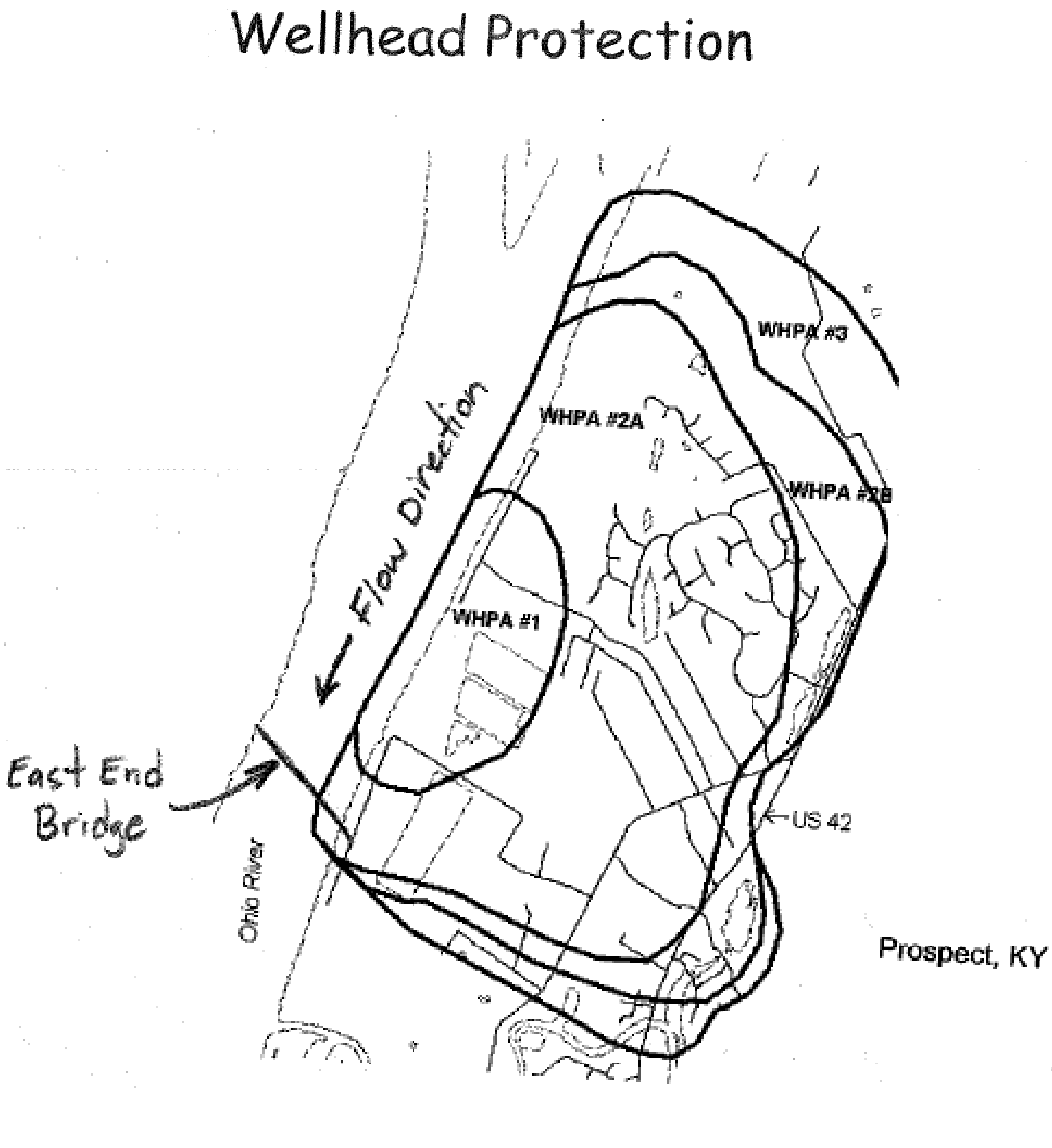
VALUE ENGINEERING DESIGN COMMENT # 12

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Eliminate the closed drainage system from the East End Bridge.

COMMENTARY:
The drainage deck analysis performed by the Design team indicated that the FEIS required the bridge deck runoff be captured in a closed drainage system and piped to a treatment facility located in Section 4. The intent of the treatment is to protect the Wellhead Protection Area (WPA) owed by the Louisville Water Company. This commitment in the FEIS for the Section 5 bridge project seems extreme and would require treatment of large volumes of deck runoff when the Louisville Water Company is only concerned with a toxic spill, such as a gasoline tanker leak. The VE team thinks it would be prudent to investigate eliminating this closed system from the bridge project and drain the deck directly into the Ohio River as is standard practice. This would reduce long term maintenance on the bridge, long term treatment costs, and reduce the size of the treatment chambers. Justification should be centered around the fact that the new bridge is on the downstream fringe of the WPA (see drawing) and with the flow of the river it is reasonable to assume that a spill will not likely infiltrate the WPA. Additionally, collection of the more routine pollutes from the deck such as oil, gas or salt would be much more concentrated and drained directly back into the WPA which is the area you are trying to protect. This change could result in a substantial cost savings due to reducing the need to treat large volumes of water.

VALUE ENGINEERING RECOMMENDATION # 12

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING DESIGN COMMENT # 13

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Utilize storm water capturing on roadway only and allow sidewalk to drain into the Ohio River.

COMMENTARY:
The VE team recommends draining the runoff from the sidewalk directly into the Ohio River. This will reduce the pipe sizes in the closed drainage system. This would not violate the FEIS since the roadway runoff will still be captured to address a potential toxic spill situation and the runoff from the sidewalk and roadway is separated by a barrier wall. The VE team did not have the available information to estimate the cost reduction, but reducing the flow into the storage chamber in Section 4 will result in a smaller chamber and less volume of water to be treated, which will certainly reduce costs.

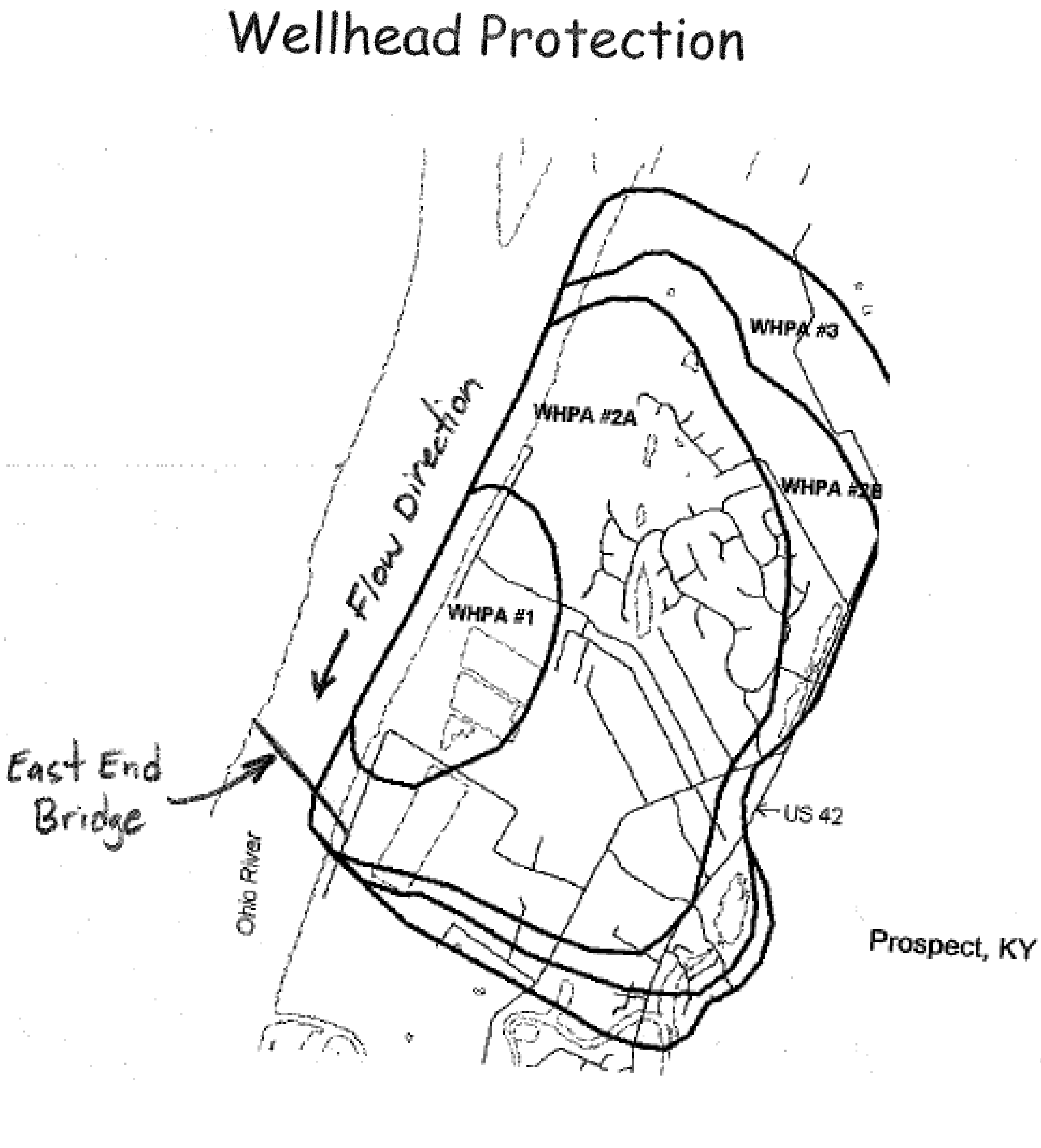
VALUE ENGINEERING DESIGN COMMENT # 14

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Outlet storm water captured on the bridge to the Ohio River outside of the Wellhead Protection Area (WPA).

COMMENTARY:
As illustrated on the attached drawing, the new East End Bridge is on the downstream fringe of the WPA. The VE team suggests that in lieu of capturing all the bridge deck runoff and piping it to the Section 4 project, it would be prudent to only capture the runoff that is directly inside the WPA to reduce the amount of runoff that will need to be treated and reduce the long term maintenance of the bridge drainage system. Given the location of the proposed bridge and the direction of flow, it seems unlikely that a spill outside the WPA will reach the sensitive area. Additionally, collection of the more routine pollutes from the deck such as oil, gas or salt would be much more concentrated and drained directly back into the WPA which is the area you are trying to protect. This change could result in a substantial cost savings due to reducing the need to treat large volumes of water.

VALUE ENGINEERING DESIGN COMMENT # 14

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 15

PROJECT: OHIO RIVER BRIDGES, SECTION 5 - EAST END BRIDGE
LOCATION: LOUISVILLE, KENTUCKY
STUDY DATE: FEBRUARY 18 - 22, 2008

DESCRIPTIVE TITLE OF RECOMMENDATION:
Reduce shoulder width from 12 feet to 4 feet.

ORIGINAL DESIGN:
Construct bridge with 12 foot wide shoulders on both left and right side of roadway. At the towers the shoulder is reduced from 12 foot to 8 foot 9 inches for 360 feet. The hole in the median is 11 foot 6 inches within a 21 foot median.

RECOMMENDED CHANGE:
Reduce shoulder to 4 foot in width on both the left and right of the traveled way. Widen the narrow median section from 14’6” to 21’0” to match median at the towers and to maintain the 4’ shoulder constant through the entire bridge.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$25,442,000		$25,442,000
RECOMMENDED DESIGN	$0		$0
ESTIMATED SAVINGS OR (COST)	$25,442,000	$0	$25,442,000

VALUE ENGINEERING RECOMMENDATION # 15

ADVANTAGES:

- Reduce total width of the superstructure on the bridge
- Reduces weight of superstructure
- Meets AASHTO criteria for long bridges
- Discourages use of shoulder as an unauthorized travel lane
- Reduces the deck drainage runoff
- Reduces the maintenance needs given less deck surface
- Reduces construction time since there is less deck to construct
- Reduces the materials needed to construct the bridge

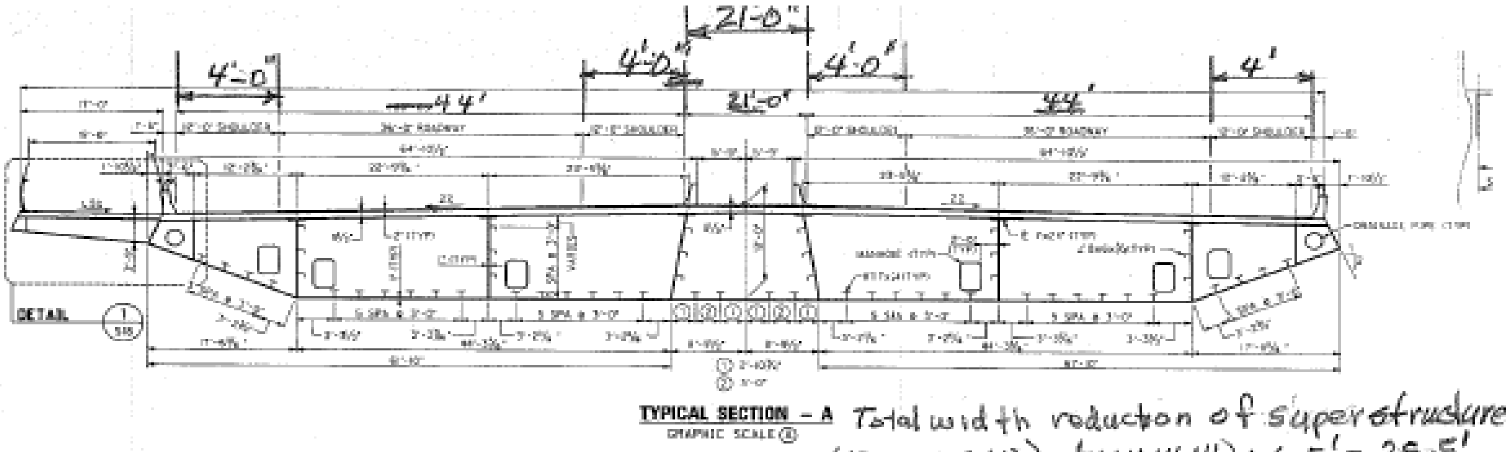
DISADVANTAGES:

- Does not provide room for a disabled vehicle to be completely removed from the traveled way
- Reduced capacity due to proximity of edge of traveled way to the roadside barrier
- Less area which can be used for storage of snow allowing the traveled way to be clear
- Increases drainage inlets and bridge drainage due to reduced spread area

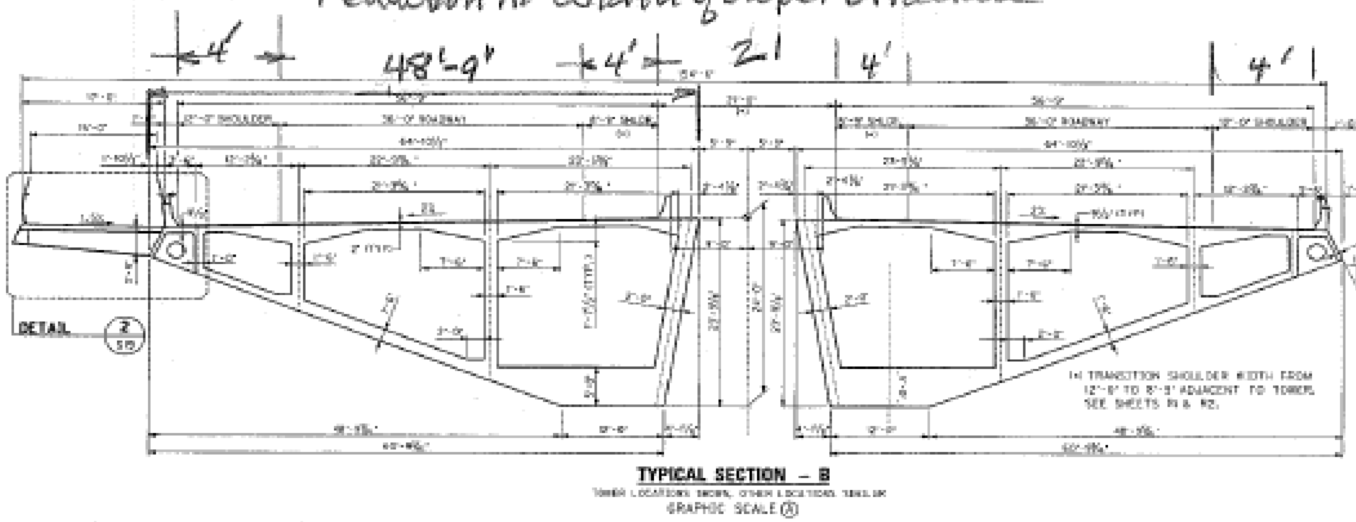
JUSTIFICATION:
The reduced shoulder width reduces the cost of the bridge, allowing limited funds to be used on other facets of the project. In turn, this will allow earlier use of the highway by the public.

VALUE ENGINEERING RECOMMENDATION # 15

RECOMMENDED SKETCH



(12-4) + (8.75 - 4) = 12.75' x 2 = 25.5'
reduction in width of superstructure



VALUE ENGINEERING RECOMMENDATION # 15

CALCULATIONS

Bridge Length = 1720’

Bridge Width Reduction = 25.5’

Area Reduction = 1720’ X 25.5’ = 63, 604 SF

Based on cost estimate performed for VE Recommendation 1, the original superstructure plus stay cable costs are:

Cost= $236,897,464

Unit Cost= $236,897,464/(2510’ X 154.5’) = $611/SF
For East End Superstructure plus stay cable cost

~For any Design Comments or Recommendations that reduce the width of the superstructure assume the following savings:

ΔCost = $400/SF

Total Reduction = $400/SF X 63,605 SF = $25,442,000

VALUE ENGINEERING RECOMMENDATION # 15

COST ESTIMATE - FIRST COST

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Reduce Shoulder Bridge Deck	SF	400.00	7	63,605	$25,442,000		
Subtotal					$25,442,000		$0
Contingency	@	0%			$0		$0
Mobilization	@	0%			$0		$0
Total					$25,442,000		$0

SOURCE CODE:
1 Project Cost Estimate
2 CES Data Base
3 CACES Data Base
4 Means Estimating Manual
5 National Construction Estimator
6 Vendor Lit or Quote (list name / details)
7 Professional Experience (List job if applicable)
8 Other Sources (specify)

VALUE ENGINEERING DESIGN COMMENT # 16

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Eliminate skew on north abutment.

COMMENTARY:
In the original design, the abutment on the north end of the bridge is on a 20^{o} right forward skew. The VE team recommends designing and constructing the abutment on the north end (Indiana) of the bridge perpendicular to the centerline. The bridge will have the same length in both the northbound and the southbound lanes. Elimination of the skewed abutment by replacement with a perpendicular abutment simplifies design and construction. The finger joint will be less likely to malfunction.

ADVANTAGES:

- Eliminates special forming and details on the concrete box superstructure
- Simplifies abutment, bearing detailing, and construction
- Finger expansion joint will be at right angle to centerline rather than skewed thus fabrication will be simplified and construction will be less demanding
- Simplifies approach slab construction
- Reduces length of abutment
- Provides a square end to the superstructure
- Appearance will better fit the existing contours

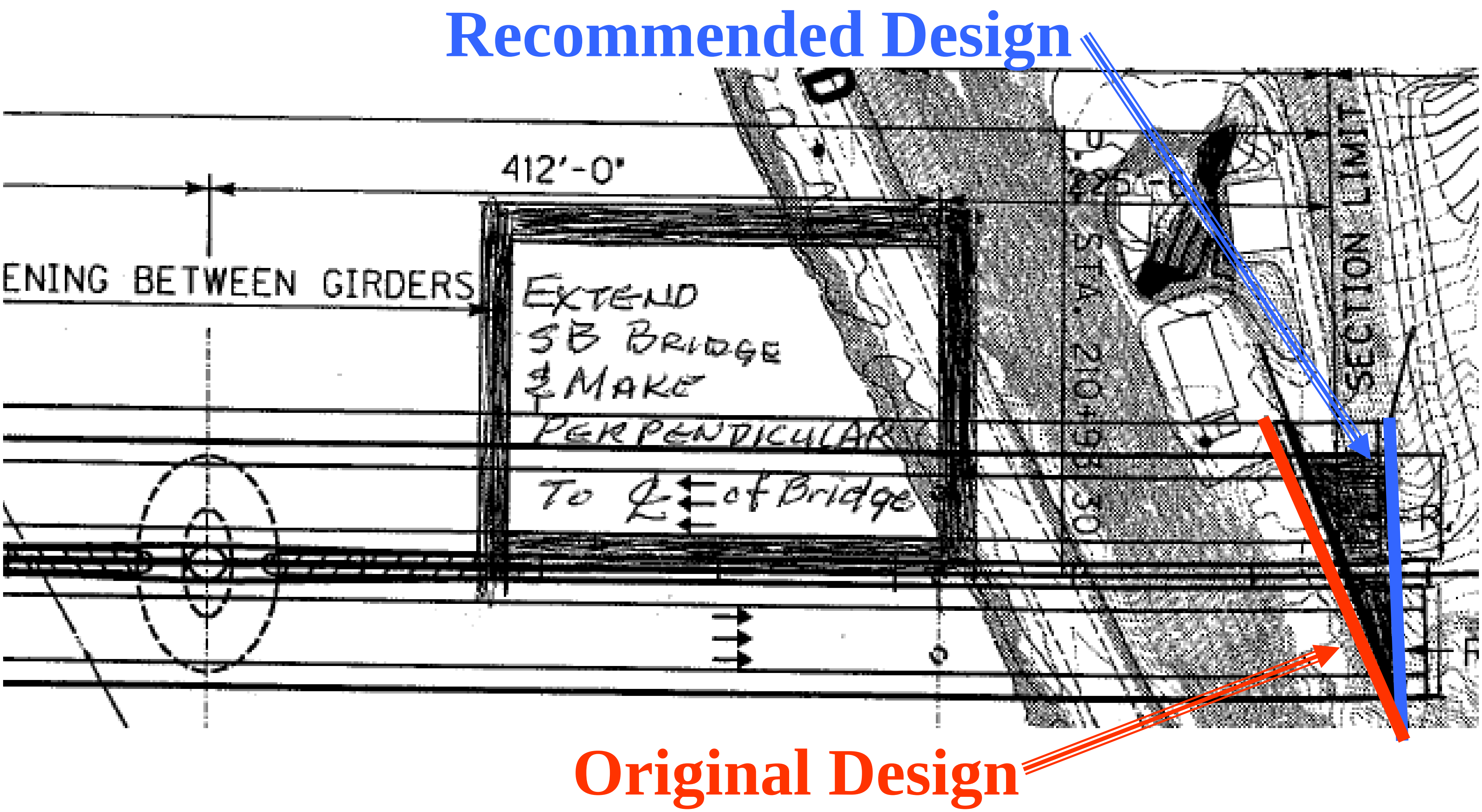
DISADVANTAGES:

- Total bridge surface area will be increased
- Earthwork volume may be reduced

With the information available and with the type of modifications proposed, it would be necessary to do a time and materials evaluation in order to determine any cost increase or decrease. There will be more concrete required, but the complexity of forming the superstructure concrete, the bridge seats, and the finger expansion joint will provide for a reduced cost. The shorter, less complicated finger joint and shorter abutment wall may reduce cost. The earthwork may change but in a minor manner. This recommendation may be dollar neutral.

VALUE ENGINEERING DESIGN COMMENT # 16

SKETCH OF ORIGINAL AND RECOMMENDED DESIGN



VALUE ENGINEERING DESIGN COMMENT # 17

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Tower foundations need to be submerged to 15 feet below normal pool to eliminate navigation obstacle under high water conditions.

COMMENTARY:
The bridge foundation is developed at normal pool on top of drilled shafts. The top of the foundation is 9 feet above normal pool and 22 feet below the 100 year high water elevation. It is recommended that the top of the foundation be lowered to 15 feet below the normal pool.

ADVANTAGES:

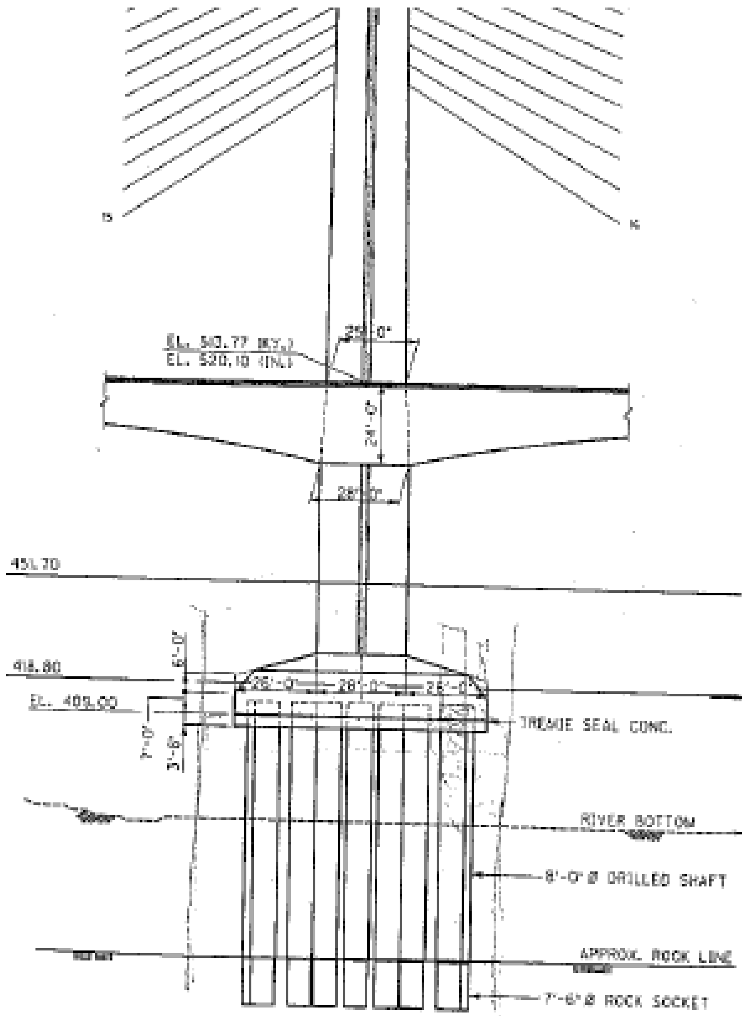
- Lowers the top of the foundation deep enough below the water surface to preclude collision of watercraft when the top of the foundation is submerged in flood
- The special slopes and rounding on top of the foundation will not be necessary, making the foundation easier to construct
- With the top of the nest of drilled shafts located lower in the River, the collection of debris will be less likely than at the current design

DISADVANTAGES:

- The construction of the top of the foundation below the normal pool elevation will require additional care on the development of cofferdams due to the additional water pressure at the greater depth

VALUE ENGINEERING DESIGN COMMENT # 17

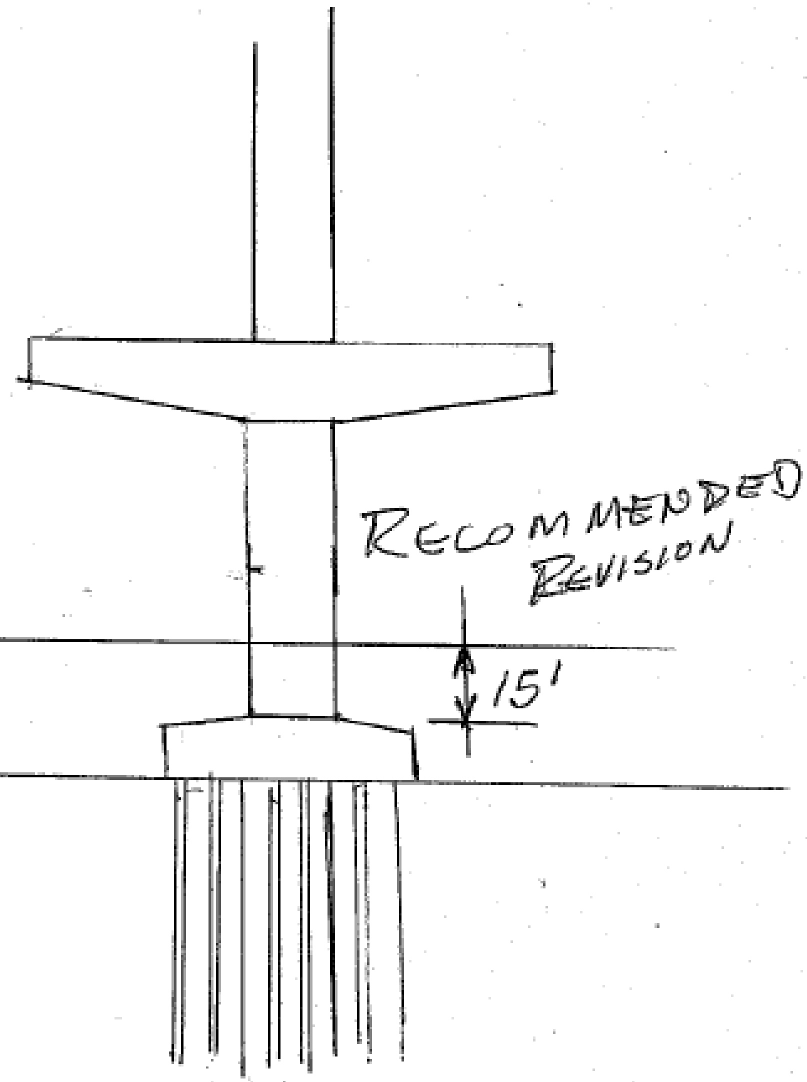
SKETCH OF ORIGINAL AND RECOMMENDED DESIGN



LONGITUDINAL ELEVATION

LOOKING WEST AT KY. TOWER - LOOKING EAST AT IN. TOWER

GRAPHIC SCALE (A)



VALUE ENGINEERING DESIGN COMMENT # 18

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Utilize northbound lane slope toward median in lieu of away from median.

COMMENTARY:
The bridge as currently designed has a curve for 157 feet on the north end of the bridge. The curve not only affects the superstructure alignment but requires a transition from normal roadway cross slope to the needed superelevation.

As designed the transition starts at Station 207+93 and develops into a full superelevation at Station 211+24. The PC of the curve is located at station 210+93. This places 90 percent of the transition on the tangent and 10 percent on the curve.

As detailed, the slope at station 210+37 is 0.02%, which is the same as the cross slope on the tangent on the southbound lanes and is the reverse of the cross slope on the northbound lanes. Full superelevation is attained at Station 211+24. The end of the bridge is at station 212+50.

It is proposed that the cross slope in the northbound lanes be sloped toward the median for the entire length of the bridge. This will eliminate the portion of the transition from station 207+93 to 210+93.

Since this transition from tangent to curve is being accomplished without the use of spirals it is necessary for either the tangent or the curve to be sloped at a greater than desirable rate or the curve to be sloped at a lesser than desirable rate. Common practice for the superelevation transitions is for 1/2 to be developed on the tangent and 1/2 on the curve or 2/3 on the tangent and 1/3 on the curve. When this is done, a portion of the curve has less superelevation than full design superelevation.

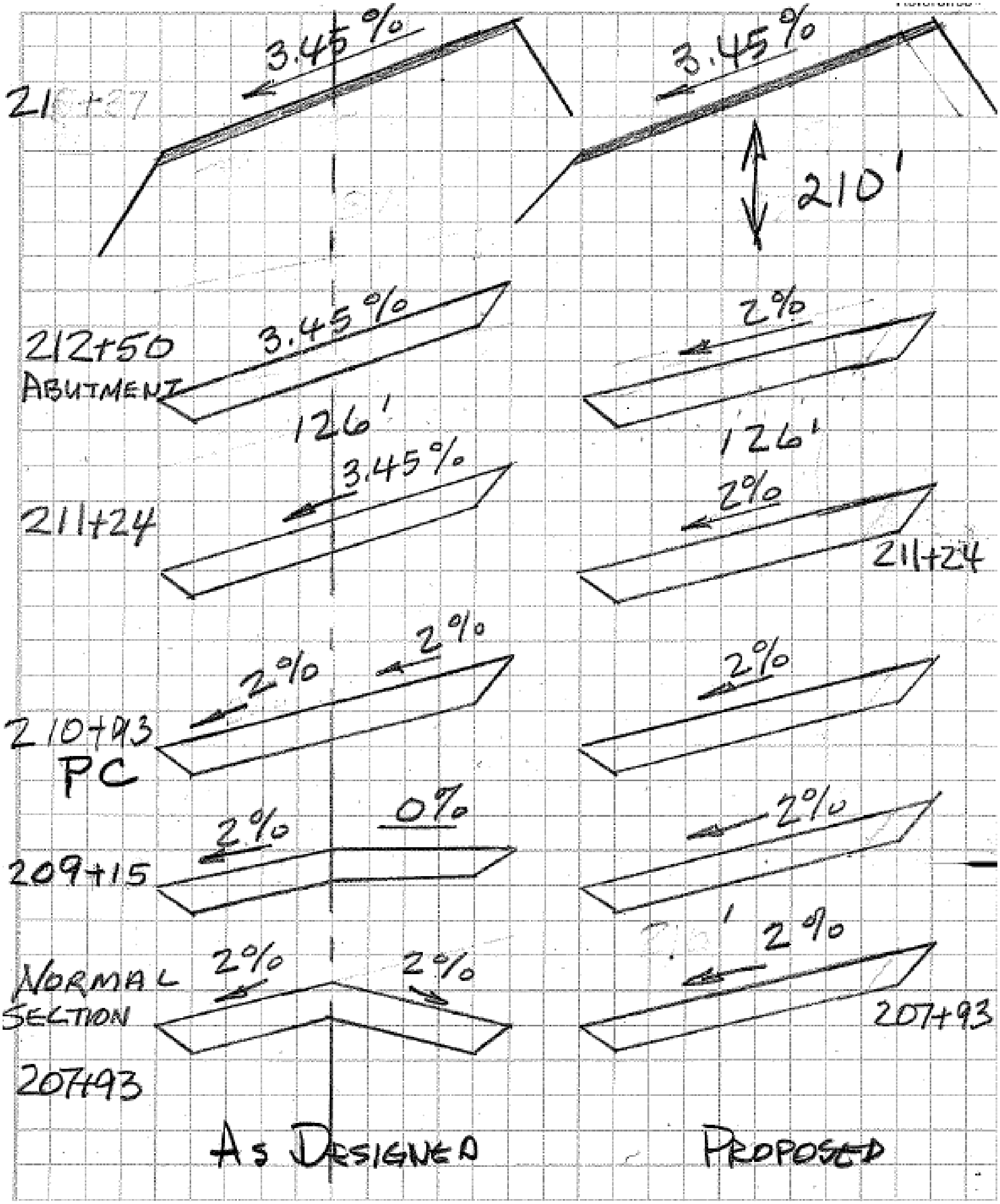
This proposal is to revise the transition of the normal cross slope to the superelevation completely beyond the bridge. By sloping the northbound lanes toward the median, the only transition required would be that needed to transition from 0.02% to 0.0345%, which in the current design is accomplished in 210 feet.

If the 0.02% normal cross slope were to be continued to the end of the bridge at station 212+50, and then transitioned from 0.02% to 0.0345% the transition would end at (212+50)+(210’) = 214+60.

This proposal would allow less than full superelevation for a section of the horizontal curve. If this is done, it would just extend the less than full superelevation on the curve for a longer distance.

VALUE ENGINEERING DESIGN COMMENT # 18

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING DESIGN COMMENT # 19

DESCRIPTIVE TITLE OF DESIGN COMMENT:
Eliminate the curve off the north end of the bridge.

COMMENTARY:
The plans, as currently designed, propose a horizontal curve with a radius of 5932.65 feet to the left.

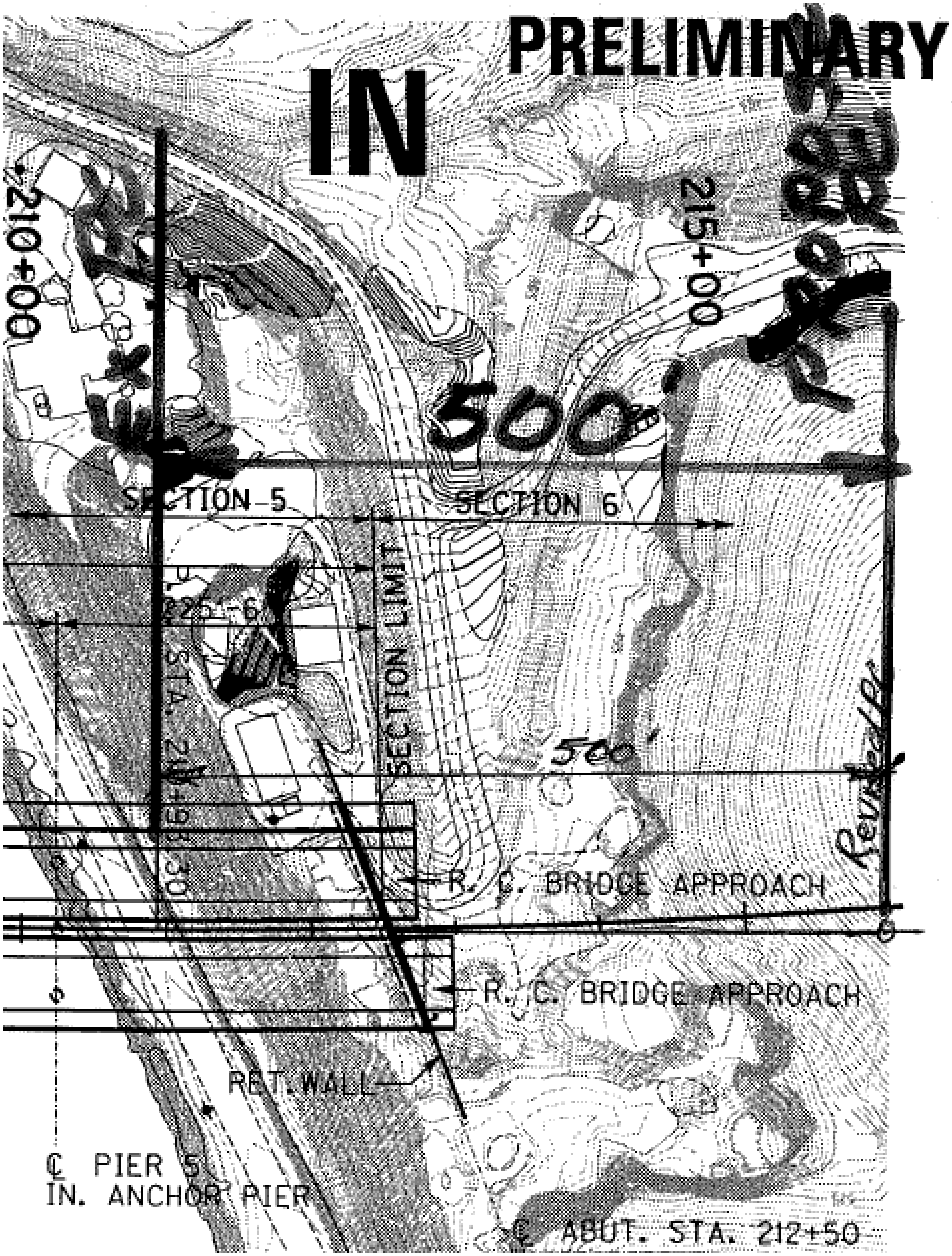
It is proposed that the radius of the curve be decreased by a sufficient length to remove the curve from the bridge. If the PC of the curve, station 210+93.30 were to be moved 500 feet to the north, the transition from the tangent cross slope to the curve superelevation could be completely removed from the structure. The deflection angle for this curve is 69.69^{o}, the tangent is 4130.51, and the radius is 5932.6 feet.

To move the PC 500 feet to the north would require the radius to be shortened to 5215 feet. With this curve, the external dimension of the curve would be reduced from 1296 feet to 1139 feet; therefore the midpoint of the curve would be shifted 157 feet to the northeast.

The moving of this curve 157 feet to the northeast would move the right of way an equivalent amount. It is understood that this may be a problem due to advanced acquisition activities based on the designed centerline. If the right of way acquisition problem or physical controls can be overcome it is suggested that the PC at 210+93.30 be moved 300 feet to the north. This change would simplify the construction of the northern end of the bridge and would eliminate superelevation on the bridge. This would allow the typical section on the bridge to be consistent for the entire length of the bridge.

VALUE ENGINEERING DESIGN COMMENT # 19

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 19

CALCULATIONS

T = 4130.51'

R = 5932.65

Δ = 69.693861°

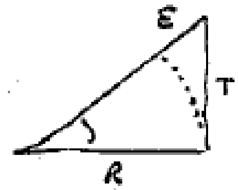
69° 41' 38"

E = 1296.28'

3630.51'

5214.50'

1139.36'



Diff = 156.92'

VALUE ENGINEERING RECOMMENDATION # 20

PROJECT: OHIO RIVER BRIDGES, SECTION 5 - EAST END BRIDGE
LOCATION: LOUISVILLE, KENTUCKY
STUDY DATE: FEBRUARY 18 - 22, 2008

DESCRIPTIVE TITLE OF RECOMMENDATION:
Eliminate sump by revising freeway profile.

ORIGINAL DESIGN:
Construct 3 lanes in each direction with a gradient of +0.5125%. Near the north end of the Section 5, construct a horizontal curve to the left having a maximum superelevation of 0.0345. The median edge of pavement (EOP) is offset 19.25' from the centerline, the outside EOP is offset 55.25', and the gutter line is offset 67.25'. The superelevation runoff is 209', resulting in relative gradients of 0.32% at median EOP, 0.91% at outside EOP, and 1.11% at gutter. The gutter has an adverse slope of 0.60%

RECOMMENDED CHANGE:
Construct 3 lanes in each direction with a gradient of +0.5% as previously done, except within the remove crown area of the superelevation transition, construct a sag vertical curve in the profile grade to increase the grade to +1.0%. Construct the superelevation runoff to be 345', resulting in relative gradients of 0.19% at median EOP, 0.55% at outside EOP, and 0.67% at gutter. With this change, the sump would not exist because the left gutter in the superelevation transition area would have a slope no less than 0.3% in the same direction as the profile grade.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN			
RECOMMENDED DESIGN			
ESTIMATED SAVINGS OR (COST)			Negligible

VALUE ENGINEERING RECOMMENDATION # 20

ADVANTAGES:

- Eliminates sump from bridge
- Provides less abrupt superelevation relative gradient
- Smoother appearance

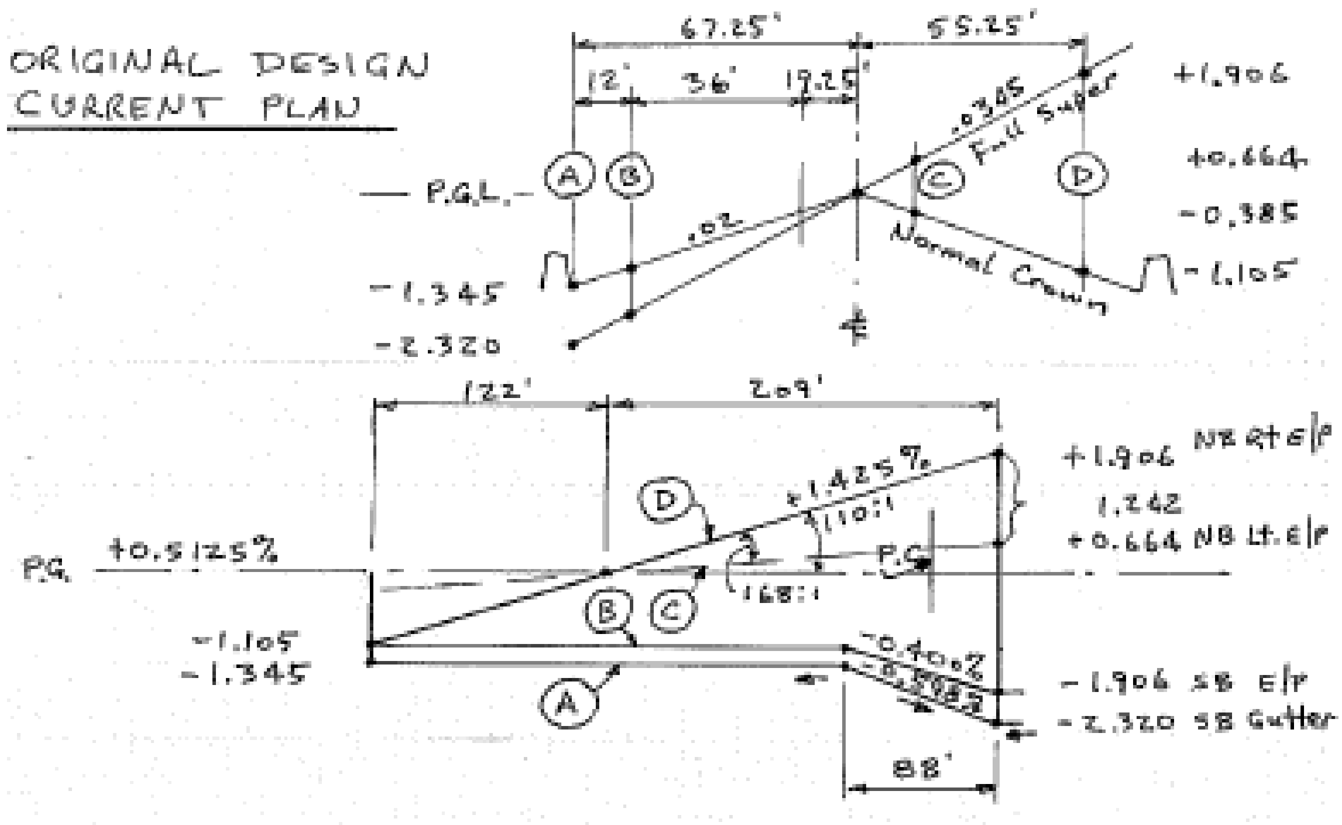
DISADVANTAGES:

- Increased length of transition on structure

JUSTIFICATION:
Although drains still will be required on the structure, eliminating a sump will reduce the risk of water ponding if a drain becomes clogged or blocked. Also, lengthening the superelevation runoff will significantly smooth the transition to better meet AASHTO requirements for superelevation relative gradient. The impacts to construction and cost are negligible.

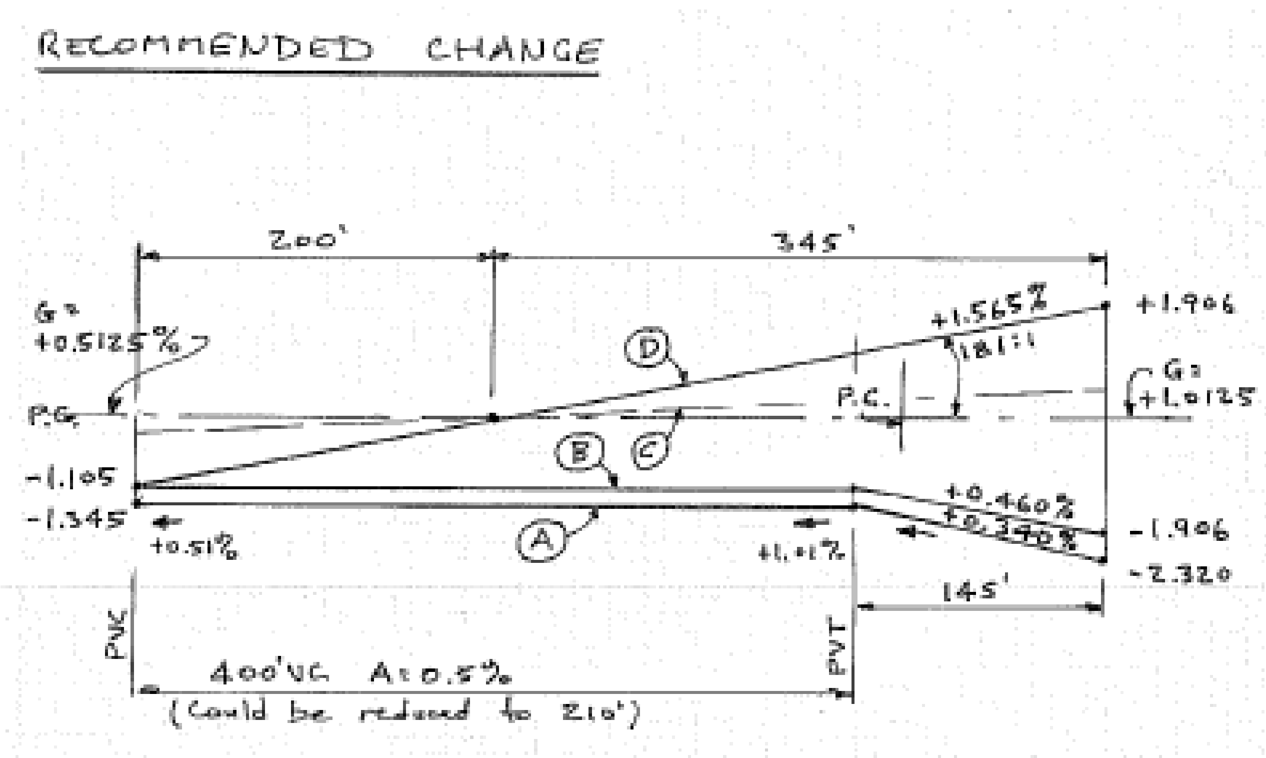
VALUE ENGINEERING RECOMMENDATION # 20

SKETCH OF ORIGINAL DESIGN



VALUE ENGINEERING RECOMMENDATION # 20

SKETCH OF RECOMMENDED DESIGN



VALUE ENGINEERING RECOMMENDATION # 20

CALCULATIONS

AASHTO 2004 70 MPH Three Lanes Rotated

PP 177 - 178

Max Relative Gradient = 0.40% (1:250)

Adjustment Factor b_w = 0.67

Min L_r = (12 x 3)(3.45)(0.67)/0.4 = 208'

Min L_r = (55.25)(3.45)(0.67)/0.4 = 320'

70 mph → 103 fps SB E/P 0.8' Vertically in:

Current Plan: 88 ÷ 103 = 0.86 Sec

Recommended: 145 ÷ 103 = 1.41 Sec

APPENDICES

The appendices in this report contain backup information supporting the body of the report, and the mechanics of the workshop. The following appendices are included.

CONTENTS

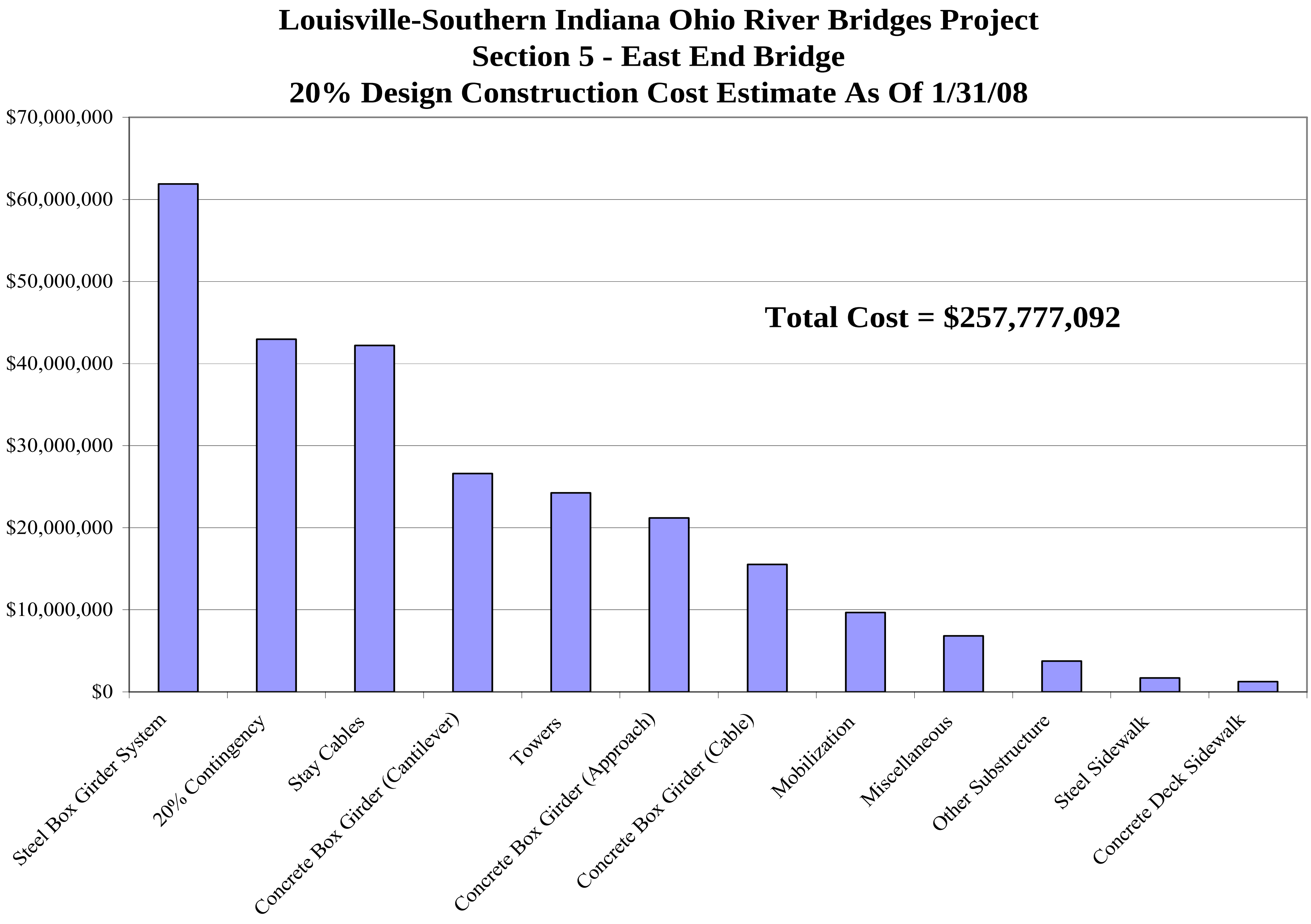
APPENDIX A
Participants

APPENDIX A - Participants

Workshop Attendance										
Attendees				Participation						
				Meetings		Study Sessions				
Name	Organization and Address	Tel # and Email	Role in wk shop	Intro	Out Brief	Day 1	Day 2	Day 3	Day 4	Day 5
Paul Boone	INDOT	812-282-7493 pboone@indot.in.gov	INDOT Owner		X					
John Bryson	PB 2333 Alumni Park Plaza Ste. 330 Lexington, KY 40517		SDC-5 Design Team		By Phone					
Matt Bullock	KYTC District 5, 8310 Westport Rd. Louisville, KY 40242	502-367-6411 Matt.Bullock@ky.gov	KYTC Owner	X						
Stephen Curless	URS 36 East Seventh St. Ste. 2300 Cincinnati, OH 45202	513-419-3504 Steve_curless@urscorp.com	VE Roadway/MOT	X	X	X	X	X	X	X
Greg Groves	URS 325 W Main St. Ste. 1200 Louisville, KY 40202	502-217-1509 Greg_Groves@urscorp.com	VE Design Expert	X	X	X	X	X	X	X
Rob Harris	CTS 305 N Hurstbourne Parkway Ste 100 Louisville, KY 40222	502-394-3841 rharris@CTSGEC.com	KYTC Deputy Project Manager	X	X					
Ruchu Hsu	PB One Penn Plaza New York, NY 10119	212-465-5146 hsu@pbworld.com	Design Project Engineer	X	X					
David Jeakle	URS 7650 West Courtney Campbell Causeway, Tampa, FL 33607	813-636-2467 David_jeakle@urscorp.com	VE Bridge Expert	X	X	X	X	X	X	X
Craig Klusman	URS 325 W Main St. Ste. 1200 Louisville, KY 40202	502-217-1502 Craig_klusman@urscorp.com	Observer		X					
Lauren Mudd	URS 325 W Main St. Ste. 1200 Louisville, KY 40202	502-569-2301 Lauren_Mudd@urscorp.com	VE Technical Recorder		X	X	X	X	X	X
Kim Mulder	KYTC 200 Metro St. Frankfort, KY 40622	502-564-0319 Kimberley.Mulder@ky.gov	KYTC Owner		X					
Sam Raies	CTS 305 N Hurstbourne Parkway Ste 100 Louisville, KY 40222	502-394-3844 Wisam.Raies@Parsons.com	SDC-2 &5 Project Manager	X	X					
Miguel Rosales	R & P		SDC-5 Bridge Architect		By Phone					
Norman Roush	URS # 4 Mission Way Ste. 201 Scott Depot, WV 25560	304-757-6642 Norman_Roush@urscorp.com	VE Geometrics & Roadway Design	X	X	X	X	X	X	X
John Sacksteder	CTS 305 N Hurstbourne Parkway Ste 100 Louisville, KY 40222	502-394-3847 jsacksteder@CTSGEC.com	CTS Project Manager	X	X					
Kyle Schafersman	URS 8300 College Blvd. Ste. 200 Overland Park, Kansas 66210	913-344-1019 Kyle_Schafersman@urscorp.com	VE Team Leader	X	X	X	X	X	X	X
Steve Slade	PB 2333 Alumni Park Plaza Ste. 330 Lexington, KY 40517	859-245-3862 slade@pbworld.com	Project Manager	X	X					
Jadie Tomlinson	KYTC 200 Metro St. Frankfort, KY 40622	502-564-0319 Jadie.Tomlinson@ky.gov	KYTC Owner	X	X					

APPENDIX B
Cost Information

APPENDIX B - Cost Information


Louisville-Southern Indiana Ohio River Bridges Project
Section 5 - East End Bridge
20% Design Construction Cost Estimate As Of 1/31/08
Total Cost = $257,777,092
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Steel Box Girder System
20% Contingency
Stay Cables
Concrete Box Girder (Cantilever)
Towers
Concrete Box Girder (Approach)
Concrete Box Girder (Cable)
Mobilization
Miscellaneous
Other Substructure
Steel Sidewalk
Concrete Deck Sidewalk

APPENDIX C
Function Analysis

APPENDIX C - Function Analysis

Function Model

Item	Function
East End Bridge	
-5 total spans (3 span cable stay)	Providing 900' navigation channel
-single composite steel box girder main span (915')	Lightweight superstructure
-single concrete box girder side spans	Weight balances main span
-single tower; single plane of cables	Accommodate aesthetics
-limited height tower	Accommodate historic preservation plan
-unsupported superstructure near towers	Accommodate aesthetics (light and airy)
-water line footings for towers	Eliminate deep cofferdams
-opening between girders near towers	Accommodate aesthetics
-steel cantilevered sidewalk	Accommodate pedestrian path
-variable median shoulder	Reduce cross-section width
-30 degree skew to Ohio River	Avoid historical and environmental impacts
-horizontal curve on Indiana approach (1 degree curve)	Accommodate desirable criteria
-sump in the gutter	Cross slope transition
-skewed north abutment	Align with natural terrain
-considering rip rap for anchor pier barge protection	Protect from barge impact
-17' pedestrian path	Accommodate local interest groups
-12' shoulders, narrowed at towers	Accommodate AASHTO desirable
Drainage	
-deck runoff (12" pipe to 36" pipe)	Protect Kentucky wellhead
-captured and conveyed off the structure	To protect Kentucky wellhead
-external to box girder	Eliminate long term problems
-median drains directly to river	Eliminates capturing water
Constructability	
-difficult to barge in or construct in place steel sections	Complicate construction
-limited or no ROW for staging area	Requires contractor to supply ROW

APPENDIX D
Creative Idea List and Evaluation

APPENDIX D - Creative Idea List and Evaluation

List of CREATIVE IDEAS			
ID #	Name of Idea / Description	Develop Status	TM Resp.
1	Reconfigure cable stay bridge to a 3 span system in lieu of a 5 span system; shorten main span and increase side spans to balance system (550-1100-550 in lieu of 412-1235-412)	Develop	D. Jeakle
2	Replace steel box girder main span with a concrete box girder main span	Develop	D. Jeakle
3	Approach span 1 in Kentucky should utilize same structure type as proposed for Section 4 (steel plate girders)	Develop	D. Jeakle
4	Tower foundations need to be submerged to 15 feet below normal pool to eliminate navigation obstacle under high water conditions	DC	N. Roush
5	Towers below deck should utilize bladed columns with a architectural fascia for aesthetics in lieu of elliptical shape	DC	D. Jeakle
6	Column walls below high water need to be able to resist barge impact forces; use solid sections in lieu of thin walled columns	DC	D. Jeakle
7	Cantilevered sidewalk needs to be designed for an under-bridge inspection vehicle	DC	D. Jeakle
8	Cantilevering of asymmetric cross-section creates large torsions and twists has experienced on Ringling Causeway in Florida	DC	D. Jeakle
9	Columns for pier 1 and anchor piers need to be able to resist barge impact forces between struts	DC	D. Jeakle
10	Tower elliptical shapes should have a variable width flat section along sides so forms can be simplified; flat section varies from 0 feet to 4 feet maximum	DC	D. Jeakle
11	Consider using a wearing surface on sidewalk	DC	D. Jeakle
12	Place barrier wall upstream of the foundations of Piers 3 & 4	DC	N. Roush
13	Remove superelevation transition from northbound bridge	Eliminate	
14	Utilize northbound lane slope toward median in lieu of away from median	DC	N. Roush
15	Keep shoulders and medians the same widths throughout in lieu of variable widths	Eliminate	
16	Reduce shoulder widths to 4 feet in lieu of 12 feet	Develop	N. Roush
17	Eliminate skew on north abutment	Develop	N. Roush
18	Eliminate sump by revising freeway profile	DC	S. Curless
19	Eliminate closed drainage system from East End Bridge	Develop	G. Groves
20	Eliminate the curve off the north end of the bridge	DC	N. Roush
21	Coordinate between Section 2 and 5 to design appropriate concrete barriers considering recommendations of FHWA	DC	G. Groves
22	Decrease transverse width of the tower to narrow the bridge	Develop	D. Jeakle
23	Support bridge along the edges with two towers and two planes of cables in lieu of 1 tower and 1 central plane of cables	DC	D. Jeakle

List of CREATIVE IDEAS			
ID #	**Name of Idea / Description**	**Develop Status**	**TM Resp.**
24	Consider open framing for the superstructure in lieu of smooth bottom soffit of the steel and concrete box girder	Develop	D. Jeakle
25	Utilize storm water capturing on roadway only and allow sidewalk to drain into river	DC	G. Groves
26	Outlet storm water captured on bridge to river outside wellhead protection area	DC	G. Groves

Development Status Legend:

Develop: Idea is considered by the VE team to be a viable value enhancement possibility and is currently being developed as a VE recommendation

Eliminate: Idea was not considered to enhance the value of the project and has been eliminated from further consideration by the VE team

DC: Idea is being developed as a Value Engineering Comment to the designers with no easily quantifiable cost associated

END OF REPORT

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