U.S. Department of Transportation
Federal Highway Administration

Brent Spence Bridge
Replacement/Rehabilitation Project

Bridge Type Selection Report
Executive Summary

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Executive Summary

A Bridge Type Selection Process (BTSP) was completed as part of the Brent Spence Bridge Replacement/ Rehabilitation Project to assist the Kentucky Transportation Cabinet (KYTC) and the Ohio Department of Transportation (ODOT) in selecting one bridge alternative to be constructed across the Ohio River. The recommended Final 3 Bridge Alternatives presented in this document are the result of the project's functional and budgetary requirements, as well as the public feedback received during the course of the BTSP.

The proposed bridge will span the Ohio River downstream (west) of the current Brent Spence Bridge which facilitates interstate and local travel by providing access to Covington, Kenton County, Kentucky and downtown Cincinnati, Hamilton County, Ohio. The Brent Spence Bridge, which opened to traffic in 1963, was designed to carry 80,000 vehicles per day. Currently, approximately 160,000 vehicles per day use the Brent Spence Bridge and traffic volumes are projected to increase to approximately 233,000 vehicles per day in 2035. Safety, congestion and geometric problems exist on the structure and its approaches.

Within this context, the new bridge must meet several requirements:

- Minimize its impact on local historic structures and local infrastructure;
- Work in conjunction with the existing Brent Spence Bridge;
- Fit into the construction schedule and budget of the larger project to increase capacity on I-75;
- Require minimal maintenance and maximum durability;
- Have no permanent effect on river navigation;
- Integrate itself in the landscape of the riverfront;
- Provide an improved crossing experience for drivers; and
- Conform to current design standards.

About The Project

The I-75 corridor within the Greater Cincinnati/Northern Kentucky region is experiencing problems which threaten the overall efficiency and flexibility of this vital trade corridor. Areas of concern include, but are not limited to, growing demand and congestion, land use pressures, environmental concerns, adequate safety margins and maintaining linkage in key mobility, trade, and national defense highways.

The Brent Spence Bridge Replacement/Rehabilitation Project is intended to improve the operational characteristics within the corridor for both local and through traffic. In the Greater Cincinnati/Northern Kentucky region, the interstate corridor suffers from congestion and safety–related issues as a result of inadequate capacity to accommodate current traffic demand. The objectives of this project are to:

- Improve traffic flow and level of service;
- Improve safety;
- Correct geometric deficiencies; and
- Maintain connections to key regional and national transportation corridors.

The Brent Spence Project/Bridge Design Team

The Brent Spence Replacement/Rehabilitation Project is directed by the KYTC and ODOT, along with the Federal Highway Administration (FHWA). Led by Parsons Brinckerhoff, the project design team includes a number of technical specialists required to provide all of the necessary professional services for the Brent Spence Replacement/Rehabilitation Project. Within the project design team, a bridge design team including KYTC, ODOT, and FHWA, was utilized for the BTSP.

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Advisory and Aesthetic Committees

At the outset of the project, KYTC and ODOT instituted two committees to provide input and guidance to the project design team. The Advisory Committee (AC) provides input from local community and political leaders on community issues and concerns. This provides an opportunity for important issues brought up to the AC to be communicated to the project design team, and how these issues were subsequently addressed reported back to the organizations represented by the members of the AC.

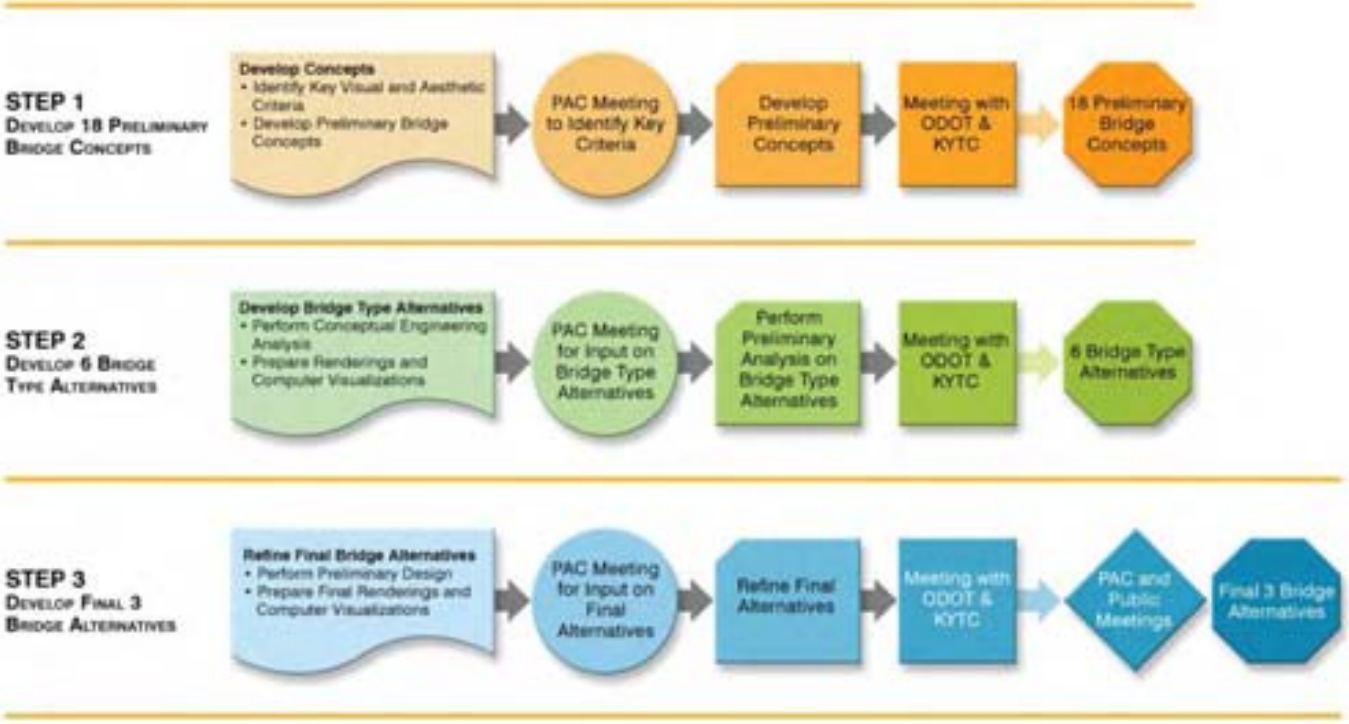
The Project Aesthetics Committee (PAC) is a sub-committee of the AC, and provides local input on the design and aesthetic appearance of the corridor, the main span of the new Ohio River Bridge, and the rehabilitated Brent Spence Bridge structure. The PAC is comprised of citizen and agency representatives from Kentucky and Ohio. This committee works with the project design team to develop context sensitive design solutions for the project.

Bridge Type Selection Process

As part of the Brent Spence Bridge Replacement/Rehabilitation Project, the BTSP was initiated in 2009. The BTSP is a three step process, which involves developing and analyzing numerous bridge concepts leading to a recommendation of the Final 3 Bridge Alternatives. This process will culminate in the selection of a new bridge that will be designed and built across the Ohio River just downstream (west) of the existing Brent Spence Bridge.

As described below, the BTSP is collaborative in nature and based on public input and engineering requirements. Public involvement was used throughout the three steps of the BTSP. The role of public involvement was to help create and provide avenues for local citizens, stakeholders, and officials to ask questions and offer their comments and suggestions. This feedback will ultimately be used in determining a final bridge type that would reflect, as much as possible, the needs and desires of the community.

The following BTSP flowchart presents the elements of the three steps:



STEP 1:

Develop 18 Preliminary Bridge Concepts

The Objective

The objective of Step 1 was to:

- Identify key visual and aesthetic criteria to be used as part of the BTSP;
- Obtain US Coast Guard design requirements for the new bridge; and
- Develop approximately 18 Preliminary Bridge Concepts.

The Process

Prior to meeting with the PAC, coordination with the US Coast Guard was conducted to determine their design requirements for the new bridge. Following verification by the US Coast Guard of the bridge clearance and pier locations, the bridge design team met with the PAC on September 25, 2009 to identify the key visual and aesthetic criteria. These visual and aesthetic criteria were then used to develop and refine the Preliminary Bridge Concepts, reflecting feasible bridge types and using engineering solutions that best reflected the characteristics identified by the PAC.

In coordination with the Federal Highway Administration (FHWA), KYTC, and ODOT, key design criteria and guidelines were developed as evaluation methodology to be used to evaluate the preliminary bridge concepts. The key design criteria developed to be used during each step were:

- Construction Cost;
- Constructability;
- Maintenance and Durability; and
- Major Rehabilitation Feasibility.

Evaluation guidelines were also developed as part of the overall project. Some of the guidelines reflected navigational, structural and highway limitations, and physical restrictions that exist at the bridge site. Other guidelines represented environmental commitments and financial constraints necessary to meet budgetary goals. The key design criteria, key visual and aesthetic criteria, and evaluation guidelines were used to select and to develop the Preliminary Bridge Concepts.

Public involvement in Step 1 included input provided at the PAC Meeting on September 25, 2009. The purpose of this meeting was to provide a project status report, present context of aesthetics in the project study area, and develop key visual and aesthetic criteria for the project. Prior to the BTSP, a Brent Spence Bridge Project Aesthetic Committee Charter was developed to define the role of the PAC. The general role of the PAC is to provide aesthetic guidelines and recommendations for the project corridor and to provide input on aesthetic treatments of bridge structure types.

During the PAC meeting, committee members provided their input on key visual and aesthetic criteria for the overall project and the new bridge. The key visual and aesthetic criteria identified by the PAC for assisting with selecting a bridge type included the following:

- The new bridge should be visually attractive;
- The new bridge should be visible looking "through" the existing bridge (from the east);
- As much as possible, crossing the new bridge should allow views of the surrounding context (unlike existing bridge);
- The new bridge should have distinctive characteristics that identify it as a local landmark; and
- The new bridge should have a visual relationship with the existing bridge.

Additional aesthetic criteria identified by the PAC were:

- The new bridge colors/textures/landscaping, etc. should be aesthetically pleasing; and
- The existing bridge should be maintained/repainted to blend in with the new bridge.

As a result of the September 25, 2009 PAC meeting, 24 preliminary bridge concepts were developed and evaluated during Step 1. During the evaluation process, 12 preliminary bridge concepts reflecting feasible bridge types and using engineering solutions that best reflected the characteristics identified by the PAC were reviewed and approved by FHWA, KYTC, and ODOT as best meeting the objectives of Step 1.

The Outcome

The results of Step 1 consisted of:

- Design Parameters (Mandatory Requirements);
- Design Guidelines (Desirable Objectives); and
- 12 Preliminary Bridge Concepts.

The bridge types that were recommended for further consideration in Step 2 included Through Truss, Through Arch, and Cable Stayed bridges. In all cases, the bridge concepts included a double-decked roadway with the top and bottom deck connected by trusses.

Existing Brent Spence Bridge

STEP 2:

Develop 6 Bridge Type Alternatives

The Objective

The objective of Step 2 was to:

- Present the preliminary bridge concepts approved during Step 1 to the PAC and public to gain feedback to help select the concepts to be recommended as the 6 Bridge Type Alternatives for further development in Step 2;
- Perform conceptual engineering analysis on the 6 Bridge Type Alternatives;
- Prepare renderings and computer visualizations of the 6 Bridge Type Alternatives; and
- Prepare cost estimates for the 6 Bridge Type Alternatives.

The Process

At the beginning of Step 2, the 12 preliminary bridge concepts were presented to a combined meeting of the AC and PAC on January 29, 2010. During this combined AC/PAC meeting, the bridge design team presented the 12 preliminary bridge concepts consisting of two truss bridge, three arch bridges and seven cable-stayed bridges. The bridge design team then solicited feedback from the two committees as to which concepts best met the five key visual and aesthetic criteria. During the meeting, the bridge design team presented various bridge components incorporated into the 12 preliminary bridge concepts and requested additional feedback on them to aid in the Step 2 bridge type selection process. The 12 preliminary bridge concepts were also posted on the project website to solicit public comment as well. Following the AC/PAC meeting, the public was provided a one-week comment period to submit feedback regarding the aesthetic elements of the new Ohio River Bridge. Comments were received through emails, the project website, faxes, and phone calls.

The 12 Preliminary Bridge Concepts presented were:

Truss Concepts

Concept	Elevation View	Section View	View from Upstream	Aerial Perspective
1				
2				

Concept	Construction Cost	Constructability	Maintenance and Durability	Major Rehabilitation Feasibility
1	Truss Support Type: Cantilever	Truss Support Type: Simply Supported	Truss Inclination: Inclined Trussess	Truss Inclination: Vertical Trussess
2	Truss Support Type: Cantilever	Truss Support Type: Simply Supported	Truss Inclination: Inclined Trussess	Truss Inclination: Vertical Trussess

Concept	Top Bracing			
1	Strut	K-Brace	Cross Braced	Lattice
2	Strut	K-Brace	Cross Braced	Lattice

Arch Concepts

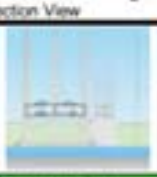
Concept	Elevation View	Section View	View from Upstream	Aerial Perspective
3				
4				
5				

Concept	Construction Cost	Constructability	Maintenance and Durability	Major Rehabilitation Feasibility
3	Leg Inclination: Vertical Leg	Top Bracing: Strut	Top Bracing: Lattice	Depth of Arch: Shallower
4	Leg Inclination: Inclined Leg	Top Bracing: Strut	Top Bracing: Lattice	Depth of Arch: Deeper
5	Leg Inclination: Inclined Leg	Top Bracing: K-Brace	Top Bracing: Lattice	Depth of Arch: Deeper

Concept	Hanger Arrangement	Deck Truss Type		
3	Vertical	Warren	Warren	Pratt
4	Vertical	Warren	Warren	Pratt
5	Inclined	Warren	Warren	Pratt

Legend		
Feasible	Feasible with Constraints	Not Feasible

Cable Stayed Concepts

Concept	Elevation View	Section View	View from Upstream	Aerial Perspective
6				
7				
8				
9				
10				

Construction Cost	Constructability	Maintenance and Durability	Major Rehabilitation Feasibility

Tower Shape & Number of Legs			Stay Cable Arrangement		
Inclined Leg/ Arch Tower	Vertical Leg 2 Leg Option	Vertical Leg 3 Leg Option	Harp	Fan	Semi Fan

Deck Truss Type			
Warren	Warren	Lattice	Pratt

Legend		
Feasible	Feasible with Constraints	Not Feasible

Cable Stayed Concepts, Continued

Concept	Elevation View	Section View	View from Upstream	Aerial Perspective
11				
12				

11	Construction Cost	Constructability	Maintenance and Durability	Major Rehabilitation Feasibility		
	Tower Shape & Number of Legs			Stay Cable Arrangement		
	Inclined Leg/ Arch Tower	Vertical Leg 2 Leg Option	Vertical Leg 3 Leg Option	Harp	Fan	Semi Fan
	Deck Truss Type					
	Warren	Warren	Lattice	Pratt		
12	Construction Cost	Constructability	Maintenance and Durability	Major Rehabilitation Feasibility		
	Tower Shape & Number of Legs			Stay Cable Arrangement		
	Inclined Leg/ Arch Tower	Vertical Leg 2 Leg Option	Vertical Leg 3 Leg Option	Harp	Fan	Semi Fan
	Deck Truss Type					
	Warren	Warren	Lattice	Pratt		

Legend		
Feasible	Feasible with Constraints	Not Feasible

Based on the results of the January 29th AC/PAC meeting and the public comments received, 6 preliminary bridge concepts were selected and approved by FHWA, KYTC, and ODOT to move forward during Step 2. The recommended 6 Bridge Type Alternatives for further development during Step 2 were:

1. **Arch Bridge**
   - Simply supported arch
   - Inclined arch ribs (Concept 4)

2. **Arch Bridge** (New Concept)
   - Continuous arch
   - Vertical arch ribs

3. **Cable Stayed Bridge** two towers, three vertical legs/tower
   - Various stay cable arrangements (developed from Concepts 6 and 7)

4. **Cable Stayed Bridge** two towers, three inclined legs/tower
   - Harp stay cable arrangement (Concept 10)

5. **Cable Stayed Bridge** two towers, two inclined legs/tower
   - Various stay cable arrangements (developed from Concept 9)

6. **Cable Stayed Bridge** one tower, two vertical legs/tower
   - Harp stay cable arrangement (Concept 12)

The truss bridges were consistently unpopular and were eliminated from further consideration.

Through a series of design meetings with the FHWA, KYTC, and ODOT during Step 2, the 6 Bridge Type Alternatives were further refined for conformance to the design parameters and best meeting the design guidelines of the project. As a result of the conceptual engineering analysis, each of the 6 Bridge Type Alternatives were evaluated based on construction cost, constructability/construction time, maintenance and durability, major rehabilitation feasibility, and maintenance of traffic. Renderings and computer visualizations showing different views and details were developed for each of the 6 Bridge Type Alternatives. At the end of Step 2, the 6 Bridge Type Alternatives were reviewed and approved by FHWA, KYTC, and ODOT as best meeting the objectives of Step 2.

The Outcome

The primary results from Step 2 included the analysis of the 6 Bridge Type Alternatives and an updated evaluation matrix.

STEP 3:

Develop Final 3 Bridge Alternatives

The Objective

The objective of Step 3 was to:

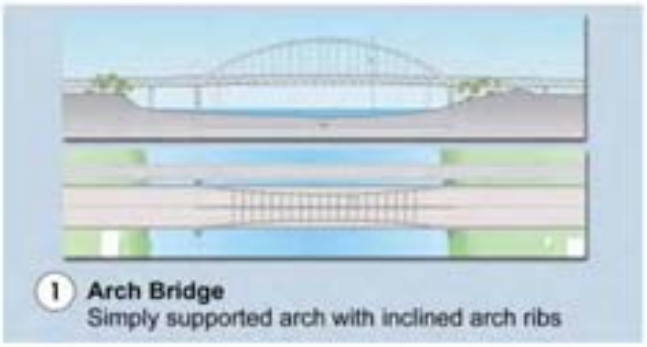
- Present the 6 Bridge Type Alternatives approved during Step 2 to the PAC and public to gain feedback to support selection of the bridge type alternatives recommended as the Final 3 Bridge Alternatives for preliminary design in Step 3;
- Perform significant preliminary design on the Final 3 Bridge Alternatives;
- Revise and develop additional renderings and computer visualizations of the Final 3 Bridge Alternatives, including animations;
- Prepare cost estimates for the Final 3 Bridge Alternatives;
- Present the Final 3 Bridge Alternatives at two public meetings; and
- Complete the Bridge Type Selection Report.

The Process

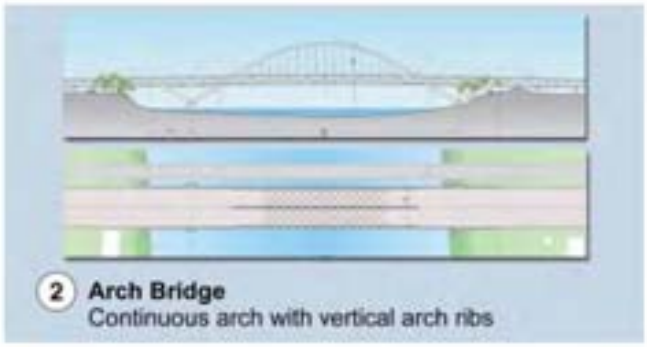
Step 3 involved one combined meeting of the AC and PAC on April 15, 2010 and an AC meeting on December 17, 2010. The 6 Bridge Type Alternatives were presented to a combined meeting of the AC and PAC on April 15, 2010. The purpose of the meeting was to receive feedback on the 6 Bridge Type Alternatives to aid the project design team in selecting the Final 3 Bridge Alternatives. Key visual and aesthetic criteria previously established were used by the AC and PAC to evaluate the 6 Bridge Type Alternatives.

The 6 Bridge Type Alternatives were also posted on the project website to solicit public comment. Following the AC/PAC meeting, the public was provided a one-week comment period to submit feedback. Comments received indicated that the public is in favor of both the arch type bridges as well as the cable stayed bridge types, with no clear preference for either.

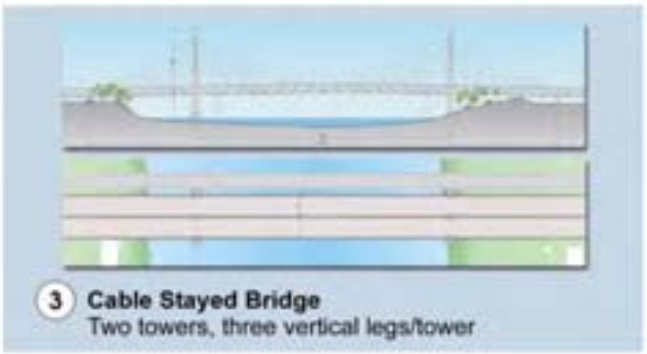
The 6 Bridge Type Alternatives presented were:



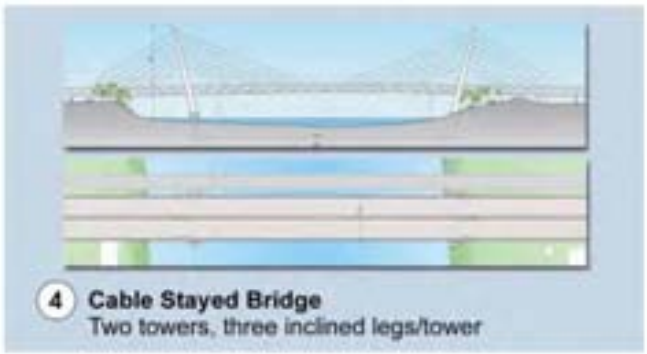
1 **Arch Bridge**
Simply supported arch with inclined arch ribs



2 **Arch Bridge**
Continuous arch with vertical arch ribs

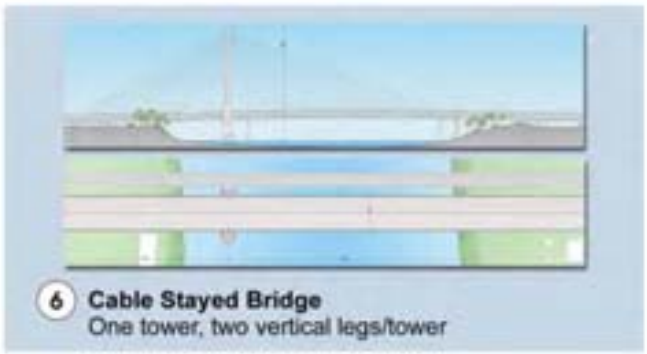


3 **Cable Stayed Bridge**
Two towers, three vertical legs/tower



4 **Cable Stayed Bridge**
Two towers, three inclined legs/tower

5 **Cable Stayed Bridge**
Two towers, two inclined legs/tower



6 **Cable Stayed Bridge**
One tower, two vertical legs/tower

Based upon the results of the AC/PAC meeting and public outreach efforts, the following Final 3 Bridge Alternatives were selected and approved by FHWA, KYTC and ODOT for further study. Additional technical analysis for the Final 3 Bridge Alternatives was also presented to the AC on December 17, 2010. To date, the bridge design team has not received additional comments from the AC.

During this step, the project bridge design team assessed the suitability of the Final 3 Bridge Alternatives based on more detailed examination of the structural requirements, cost, constructability, environmental impacts, aesthetics, and other key criteria. This task included performing significant preliminary design and preparing additional renderings for the Final 3 Bridge Alternatives.

While each of the Final 3 Bridge Alternatives has distinct characteristics, there are some elements common to all. The following is a list of these common elements:

- A bridge alignment adjacent to and downstream (west) of the existing Brent Spence Bridge;
- A double-decked truss superstructure carrying two roadways on each deck, with each roadway composed of two or three 12-foot-wide lanes and two 14 foot-wide shoulders;
- An approximately 1,000-foot main span with piers outside of the main span piers of the existing Brent Spence Bridge;
- A river to superstructure clearance no lower than that of the existing Brent Spence Bridge, and
- A bridge to work in conjunction with the existing Brent Spence Bridge, to carry the Design Year 2035 traffic projection of approximately 233,000 vehicles per day.

Alternative 1: Tied Arch Bridge

Alternative 3: Two Tower Cable Stayed Bridge

Alternative 6: One Tower Cable Stayed Bridge

The estimated construction cost for the Final 3 Alternatives are:

Alternative	Main Bridge ($M)	Approaches ($M)	Total ($M)
Alternative 1 Tied Arch 	$358.3	$212.4	$570.7
Alternative 3 Two Tower Cable Stayed 	$632.3	$36.3	$668.6
Alternative 6 Single Tower Cable Stayed 	$561.0	$85.3	$646.3

The Outcome

The technical analyses for the Final 3 Bridge Alternatives were presented to the AC on December 17, 2010. To date, the bridge design team has not received additional comments from the AC.

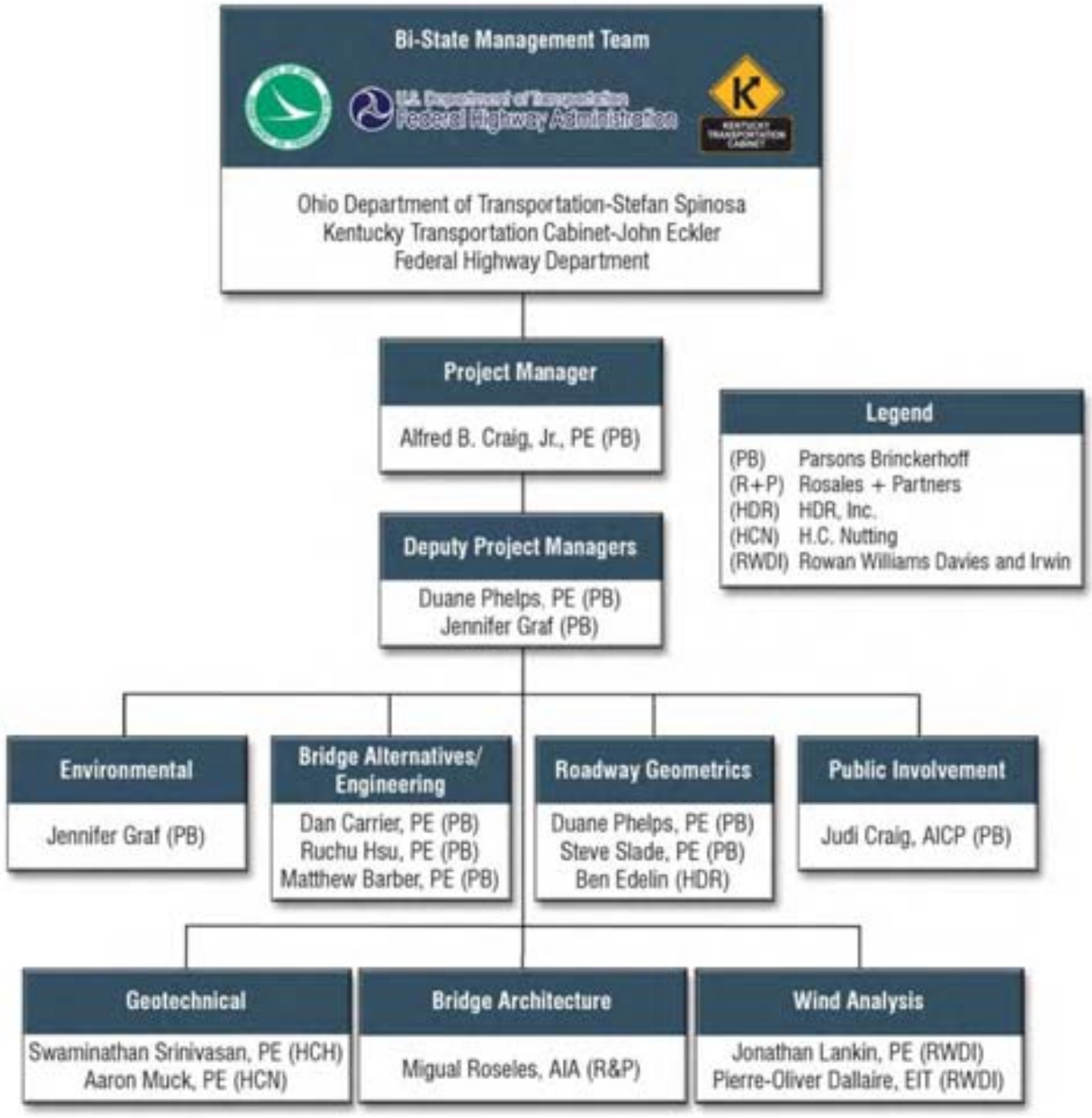
Bridge Type Study – Next Steps

As part of the National Environmental Policy Act (NEPA), public hearings for the Brent Spence Bridge Replacement/Rehabilitation Project will be held in 2011. The focus of the hearings will be the selection of the recommended Preferred Alternative for the highway and the new bridge type crossing the Ohio River. The purpose of the hearings is to provide the public the opportunity to comment on the project, its impacts, and proposed mitigation strategies.

During public hearings, the public will have the opportunity to vote on components of the three bridge alternatives using a hand-held audience response polling system.

In addition, a comment period of at least 14 days will follow the public hearings. Following the public comment period, the selection of a new Ohio River Bridge type will be determined by KYTC and ODOT in consultation with FHWA. The selection of the preferred bridge type will be based upon consideration of several factors including the technical analyses completed for the project and public input.

The Brent Spence Bridge Replacement/Rehabilitation Project Bridge Design Team



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