New Bridges Over Lake Barkley and Kentucky Lake

US 68/Ky 80

MARCH 11, 2014
• Western KY & TN
• Tenn. River to Miss. River
• Ceded to US by Chickasaw Peoples
• Ceded in 1818
• Andrew Jackson & Isaac Shelby
• $300,000
KENTUCKY BEND

- 17.5 Sq. Miles
- Surrounded by Miss. River and Tenn.
- Only Access thru Tenn.
- A Church Divided
• 15,000 Acres
• Missouri v. Kentucky, 1870
• No Longer an Island
• Only Access thru Missouri
KENTUCKY LAKE

- Tennessee River
- Built by TVA, 1938-1944
- 184 Miles Long
- 2400 Miles of Shoreline
- 160,000+ Acres of Water
- 8,422 Ft Long, 206 Ft High
- 50 Million Tons/Yr of Cargo
- Largest Artificial Lake, E. US
Eggner’s Ferry Bridge

- Opened March 25, 1932
- Closed July 1943
- Raised 22’ – 25’
- Reopened Feb 1944
- 38 Approach Spans
- 5 Thru Truss Spans
- 3348’ Total Bridge Length
LAKE BARKLEY

- Cumberland River
- Built by USACOE 1959-65
- VP Alben W. Barkley
- 134 Miles Long
- 1000+ Miles of Shoreline
- 57,900 Acres of Water
- 10,180 Ft Long, 157 Ft High
- Eddyville & Kuttawa Reloc’d
- 1.75 Mile Barkley Canal
LAKE BARKLEY BRIDGE

Henry R. Lawrence Mem. Bridge

- Opened in 1932
- Closed in 1962
- Raised 10.5 Ft
- Reopened Dec. 1963

- 48 Approach Spans
- 2 Deck Truss Spans
- 2 Thru Truss Spans
- 3045’ Total Bridge Length
LAND BETWEEN THE LAKES

- Between Tennessee and Cumberland Rivers
- Lyon & Trigg Counties, KY
- Stewart County, TN
- 800 Families
- Settled in 1780’s
- Primary Access: Ferry
- National Recreation Area
- Kennedy Established in 1963
- 170,000 Acres in KY & TN
NEW MADRID FAULT

Project Site
New Madrid, MO

Mississippi River
Ohio River
Cumberland River
Tennessee River
Mississippi River

80 Miles

MISSOURI
KENTUCKY
TENNESSEE
New Madrid Earthquake

- Dec. 16, 1811, M 7.7
- Jan. 23, 1812, M 7.5
- Feb. 7, 1812, M 7.7
- 1800 Aftershocks through Mar. 1812
- Total of 10 of M 6 or Greater
- Largest East of Rocky Mountains
- 3 Meter Uplifts Reported
- 1.5 to 6 Meter Downdrops
- Formed Reelfoot Lake, TN
PROJECT ALIGNMENT

- Proposed Alignment
- Eggners Ferry Bridge
- Lawrence Memorial Bridge
- 502’ Minimum Horizontal Clearance

- 60’ Minimum Vertical Clearance
A SMALL CHANGE
OOOPS !!
17 WEEKS LATER
Public Involvement Process and KYTC Practical Solutions Initiative

- Consider Lower Cost Bridge Types
- Consider Reduced Bridge Width
- Bridge Type - Be Aesthetically Pleasing
- Stay on Schedule
BRIDGE CROSS SECTION

Kentucky Lake (Looking East)

Lake Barkley (Looking East)

EXISTING TYPICAL SECTION (Looking East)

23'-0"

2 LAKES @ 10'-0"

= 20'-0"

4'-0" SHLD

4'-0" SHLD

2 LAKES @ 11'-0" = 22'-0"

4'-0" SHLD

4'-0" SHLD

8'-0" SIDEWALK AND BIKE PATH

74'-6"

4'-0" SHLD

2 LAKES @ 11'-0" = 22'-0"

4'-0" SHLD

4'-0" SHLD

2 LAKES @ 10'-0" = 20'-0"
KY Lake

- 9080 Ft Total
- 1400 Ft West Causeway
- 1000 Ft East Causeway
- 580 Ft Lagoon Bridge
- 3611 Ft Lake Bridge
  - 1408.5 Ft West Approach
  - 550 Ft Arch
  - 1652.5 Ft East Approach
MAXIMIZE CAUSEWAYS

Lake Barkley

• 6050 Ft Total Project
• 650 Ft West Causeway

• 3805 Ft Lake Bridge
  • 1806 Ft West Approach
  • 550 Ft Arch
  • 1449 Ft East Approach
BASKET-HANDLE ARCH
Advance Construction

• Lagoon Bridge Construction
• Causeway Fill Material
• Pile Load Tests

Main Crossing Construction

• Basket-Handle Arch
• Approach Spans
• Final Paving & Multi-Use Paths
Construction Letting

- Letting - February 22, 2013
  - 2 Bids
  - Jim Smith Contracting Co. LLC
  - $24,212,491.14
  - 420 Calendar Days Total
  - Below Engineer’s Estimate
- Award Date - March 01, 2013
- Notice to Proceed - April 18, 2013
CAUSEWAY SECTION

TYPICAL SECTION

MAX FLOOD, EL. 375
EL. 363

Stone Rip Rap

Granular Embankment

3:1 Slopes

Existing Causeway

SUMMER POOL, EL. 359
WINTER POOL, EL. 354

US 68 / KY 80
NORMAL EAST CAUSEWAY
STA. 1025+00 TO 1034+50
CAUSEWAY MATERIAL

QUANTITIES

Granular Embankment 165,400 CY

Embankment in Place 172,500 CY
CAUSEWAY MATERIAL IN PLACE
LAGOON BRIDGE

Proposed Alignment

Lagoon

Kentucky Lake
LAGOON BRIDGE

180 Ft - 220 Ft - 180 Ft

580 Ft Total

Lagoon
LAGOON BRIDGE

TYPICAL SECTION
(Looking East)
THE LAGOON

Lagoon
Purpose

- Confirm Geot. Parameters
- Test Drivability
- Refine Ground Response
- Test Pile Capacity
Test Piles

- 48” Piles
- 72” Piles
- 1” Wall
- 1.5” Wall
- 2” Wall
- Near Causeway
- Deep Water
- Open End
- Constrictor Plate
Results

- Relatively Easy to Drive
- Constrictor Plate Functional
- Thinner Walls - No Significant Damage
Vierendeel Bracing

Network Cables

15° Incline
NETWORK STUDY RESULTS

- Minimal Affect on Dead Load Moments
• Major Reduction in Max. Live Load Moments
Criteria and Objectives

- AASHTO LRFD Seismic Design
- “Essential” Bridge Classification
- 1000 Year Return Period
- Elastic During Seismic Event
- Remain Open After Seismic Event
- Minor Repairs After Seismic Event
SEIZMIC SOLUTIONS

• Modular Exp. Joints

Joint Movements:
• 18” Longitudinal
• 6” Transverse

• Isolation Bearings

• Seizmic Dampers

![Seizmic Dampers Image]

![Isolation Bearings Diagram]

Middle Bearings (2)

Springs

FLUID VISCOS DAMPERS & LOCK-UP DEVICES
• KYTC prefers Bridge Structural Strand
• Good track record within KY
• Ribs designed for:
  – Sudden Loss
  – Replacement
• Box Versus H-Section
  – Fabrication, Maintenance, Inspection

• H-Section Challenges
  – In-Plane Moment, H-section Weak Axis
  – Hanger Loss
  – Torsion in End Panel

• H-Section Benefits
  – Economical
  – Inspectable
  – Hanger Connection
• Rib / Tie / End FB
• Critical for Geometric Control
• Most Complex Fabrication Item
• 3-D FEA
KY LAKE MULTI-USE PATH

Parking

Lagoon Bridge

Path Onto Bridge

US68/KY80

Path Along Water’s Edge

KY Lake

WEST APPROACH

Kenlake SRP
KY LAKE MULTI-USE PATH

KY Lake

Path Along Water’s Edge

Path Onto Bridge

US68/KY80

Land Between The Lakes

Path Into LBL

EAST APPROACH
• KYTC Committed to Contractor Info
  o 60% Plans, 90% Plans, Preliminary Special Note, etc.
  o Changes Tracked
  o Contractor Information Meeting
• Special Letting Date
• Marketing Info to Industry Groups
• Revisions to Reduce Constr. Costs
EFFECT OF MULTIPLE BIDDERS

Low Bid vs. No. of Bidders

Percent Low Bids was above or Below Engineer's Estimate

\[ y = -0.1914 \ln(x) + 0.2186 \]

December 20, 2013  Letting

Bid Appraisal

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<tr>
<th>BIDDER</th>
<th>BID</th>
<th>% Engineers Estimate</th>
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<tr>
<td>JOHNSON BROS CORP.</td>
<td>$131,501,214</td>
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<td>C J MAHAN CONST J/V PARSONS CONSTR GROUP</td>
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<td>AMERICAN BRIDGE CO J/V TRAYLOR BROS INC</td>
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<td>ALBERICI-KENNY JOINT VENTURE</td>
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<td>KAY &amp; KAY CONTRACTING LLC</td>
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<td><strong>AVERAGE</strong></td>
<td><strong>$142,849,353</strong></td>
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CONCLUSIONS

• First Network Arch in KY
• First Basket-Handle Arch in KY
• Designed for Fabrication, Construction, Maintenance, and Inspection
• Design Goal:
  – “Minimize Risk Not Minimize Material!”
• Maximize Competition
TS&L/Prel. Engineering Begun

- May - TS&L
- July - 60% Plans
- October - 90% and Final Plans
- Nov Advertisement

December 2014 Letting

Subsurface Exploration

- Main Span Piers Drilled
- Approach Span Piers - Spring 2014
KY Lake Similarities

- Basket-Handle Arch
- 550’ Span
- Typical Section
- Network Cables

KY Lake Differences

- FOUNDATIONS
  - Limestone, Karst Material
  - Drilled Shafts vs. Piles
- ACOE Requirements
LAKE BARKLEY MULTI-USE PATH

Land Between The Lakes

Parking

US68/KY80

Path Along Water’s Edge Under Bridge

Path Onto Bridge

West Approach

Path Into LBL

Lake Barkley
Canton Public Access

New Alignment

Existing causeway being converted to fishing access with a cul-de-sac
LAKE BARKLEY MULTI-USE PATH

EAST APPROACH

Lake Barkley

Path Under Bridge

Path To Water Access

Path Onto Bridge

Parking

US68/KY80 Proposed widening
Henry R. Lawrence Memorial Bridge

The Kentucky Department of Highways constructed the Henry R. Lawrence Memorial Bridge in 1934. Its name honors Henry R. Lawrence, then-editor of the Trigg County newspaper and long-time advocate of good roads for western Kentucky.

When built, the Lawrence Memorial Bridge spanned the Cumberland River. By the mid-1950s, plans were underway to dam the river and create Lake Barkley. In 1962, engineers raised the truss of the Lawrence Memorial Bridge ten and one-half feet to provide clearance for the new lake.

Paving the Way for Kentucky’s Modern Highways

The passage of the Murphy Toll Bridge Act of 1928 made construction of the Henry R. Lawrence Memorial Bridge possible. This act gave the state the power to acquire privately owned toll bridges and to issue bonds to construct new bridges. It also allowed the state to collect tolls on the bridges to pay for their construction and maintenance. The Murphy Toll Bridge Act paved the way for Kentucky’s modern road system.