Crossing the Keweenaw Waterway in an Emergency with a U.S Army Floating Bridge

Photo: John Kiefer

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Contributions by Brent Cousino,
BSENVE, MSCE, are acknowledged
Presentation Objectives

• Context – The Keweenaw Peninsula
• Explain the importance an emergency IRB** crossing
• How the preferred crossing location was selected
• Details of the proposed crossing infrastructure
• Traffic flow analysis
• Identify next steps leading to implementation

** Improved Ribbon Bridge
March 3, 1865
Rivers and Harbors Act
Portage Lake Lift Bridge

- Opened in 1959
- Only roadway link between “Copper Island” and the mainland
  - 21,000 people live north of the bridge
- 27,000 daily crossings; 2.5 times the traffic on the Mackinac Bridge
- Vital for emergency services, economy, institutions, and society
Why an Emergency Crossing is Vital

- Only vehicular link between Copper Island and the mainland

- Separation of key components of community
  - Both hospitals and only airport located north of the bridge
  - Food, fuel, medicine, and other essentials must flow north
  - Mix of employers and employees on both sides
  - Commerce and businesses on both sides
  - Michigan Tech on south side, Finlandia on north side
Vulnerabilities

What could happen?

- Electro-mechanical failure
  - Failure in August 2010 put bridge out of operation for 3 hours
- Struck by a vessel
- Major roadway transportation accident and ensuing fire
Assessing the Risk

Risk = Probability × Consequences

The *probability* of occurrence is low
But the *consequences* are very high

Therefore, the *risk* must be addressed
Bridge Collision – Ems River, Germany

December 2015

Photo: Jan-Timo Häckel
Oakland Maze Bridge Fire – California

April 2007

Photo: Contra Costa Times
Gasoline Tank Truck Accident - Chassell
February 2018

4,500 gallon fuel spill
Improved Ribbon Bridge (IRB)

- U.S. Army modular floating bridge deployed by the Michigan National Guard
  - Ramp bays – 2 lanes by 22 feet long
  - Interior bays – 2 lanes by 22 feet long
  - 704 foot maximum length

Launch

Rafting

Full Enclosure

Photo: Primeportal.net

Photo: asc.army.mil
Objectives of Keweenaw Waterway Emergency Deployment

• Robust rafting between Houghton and Hancock
  • Operating like a ferry for vital movements (emergency vehicles, food, fuel, buses, and other high priority vehicles)

• Full enclosure at the preferred crossing location
  • Used for public conveyances
  • Two lane bridge for all types of highway vehicles
Lake Superior Water Levels

• 100 years of water level data
  • Low water = 599.48 feet (April 1926)
  • High water = 603.38 feet (October 1985)
  • Range = 3.90 feet

• The full enclosure length exceeds the shore-to-shore distance
  • Water will rise some distance up the on-shore access ramp
Lake Superior Water Levels
Cross Sections at Lily Pond

Low Water Level

- Waterway Cross Section: 400 feet
- IRB Floating on Water

High Water Level

- Waterway Cross Section: 400 feet
- 8% slope
Lake Superior Water Levels
Houghton County Marina
Three Potential Crossing Locations
South Entry

- Narrowest shore-shore span = 530 ft.
  - Few IRB bays for rafting
- 82 mile round trip
  - Energy use and emissions
- Existing roads not highly developed
- No publicly owned land on either side

Photo: USACE

Ruled Out
Downtown Houghton and Hancock

- Narrowest shore-shore span = 540 ft.
  - Few IRB bays for rafting
- Crossing would run through historic Quincy Smelting Works
- Full enclosure could impede rafting
- Problematic road geometry
- Potential traffic impacts in downtown areas

**Ruled Out**
North Entry

- Shortest shore-shore span of 400 feet
- Almost all of land is publicly owned
- Two potential crossing sites

Photo: USACE
North Entry – Alternative 1

- 40 mile round trip
- Private property on west side
- Unacceptable access road grades on west side
- Concern about high waves
- Deep cuts for access roads
  - Makes snow removal challenging
  - High erosion potential
- No wetlands, but significant environmental impacts due to excavation

Ruled Out
Alternative 1 Hill
Alternative 1 Details

- **Option A**: 200' access road at 11% grade
- **Option B**: 400' access road at 7.5% grade

- **Hill**: Elev. = 635
- **From Houghton**: Elev. = 633
- **N**
- **Scale (feet)**

Cross Section A-A' and B-B'
North Entry – Alternative 2

- 36 mile round trip
- Takes advantage of existing roads
  - West – Stanton Twp. Boat Launch
  - East – two track off of M-203
- Acceptable road profiles
- Reduced waves
- Minimal total wetland impacts

Preferred Site
Preferred Alternative – West Side

- Uses existing Stanton Twp. Boat Launch Access Road
  - Land is owned by Stanton Twp. or U.S.A.
- 90 foot long by 50 foot wide concrete ramp at 8%
  - Modifications to steel sheet pile revetment required
- New 85 foot long access road
- Total wetland impact = 7,050 ft$^2$ (0.16 acres)
Preferred Alternative – West Side

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Preferred Alternative – West Side
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From Canal Rd. (S553)

Existing Stanton Twp., Boat Launch Access Rd.

Access Road

6 ft. Shoulder

24 ft.

6 ft. Shoulder

34 ft.

85 ft.

90 ft.

Existing Field Stone 80# to 320# 2 ft. Deep

Edge of High Water (603.4) 86 ft. from SSP

Keweenaw Waterway

Modified PZ-32 SSP (7.6 ft. cut off)

60 ft. Off-Shore Ramp

Required SSP Wall (Top at 604.1)

Required Silt Fence (Both Sides)

Scale (Feet)

0 10 20

Top of 8.0% Grade Concrete Ramp

Existing PZ-32 SSP

592.1

579.1 (Approx.)

603.4 HW

599.5 LW

596.5 Top of SSP

Section A - A'
Ramp Construction

Water inflated rubber membrane cofferdam

Photos: Aqua Dam, Inc.
Preferred Alternative – East Side

- Uses existing two track off of M-203
  - Widen to accommodate two lanes
- Crosses small slice of private property
- Crosses small wetland areas
  - Two track is not considered wetland
  - Culvert connects the two fragments
  - Wetland impacts = 1,990 ft² (0.05 acres)
- Cleared grassy area that can be used for staging
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- Staging Area (Grass)

- 8% slope ramp

- 25 ft. Field Stones
  80# - 320# 2' deep

- 66 ft. ROW

- CL Aggregate Surface Access Road

- Wetlands along approx. 130 ft. of proposed road

- Wetlands (continue south)

- Wetlands (continue north)

- Section 28 USA

- Section 27 Ralph Coon Trust Fund

- Property Line

- M-203

- 66 ft. ROW

- 24" Culvert

- 50 ft. ROW

- Scale (feet):

  0  50  100

- Keweenaw Waterway

- 90’x50’ On-Shore Ramp
  See Drawing 2 for Details

- From Hancock
Timber Transition
Timber Transition

- Must design for all angles of approach and departure
  - Angle of 5.8° will accommodate all vehicles
- Timber transition design spans full width of lanes
- Can be tested at Lily Pond Boat Launch
  - Both have 8% grades

Source: www.commons.Wikipedia.org
## Theoretical IRB Traffic Flow

<table>
<thead>
<tr>
<th>Condition</th>
<th>Vehicle Spacing (feet)</th>
<th>Max Speed (MPH)</th>
<th>Capacity/Direction ** (autos per hour)</th>
<th>Lift Bridge Volume (northbound autos)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal – 25 mph</td>
<td>100</td>
<td>25</td>
<td>1,318 (106%)</td>
<td>1,238</td>
</tr>
<tr>
<td>Normal – 15 mph</td>
<td>100</td>
<td>15</td>
<td>791 (64%)</td>
<td>1,238</td>
</tr>
<tr>
<td>Caution – 5 mph</td>
<td>170</td>
<td>5</td>
<td>153 (12%)</td>
<td>1,238</td>
</tr>
<tr>
<td>Risk</td>
<td>580</td>
<td>3</td>
<td>31 (3%)</td>
<td>1,238</td>
</tr>
</tbody>
</table>

* Condition a function of wave height and weather as determined by 1437th field commander.
** Based on theoretical calculations. Actual rates will be less.

### Measured Lift Bridge Traffic Volumes, 10/01/13, 4 to 5 pm

<table>
<thead>
<tr>
<th>All vehicle types</th>
<th>Northbound</th>
<th>Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vehicle types</td>
<td>1,305</td>
<td>1,111</td>
</tr>
<tr>
<td>Autos only</td>
<td>1,238</td>
<td>1,054</td>
</tr>
</tbody>
</table>

Traffic volumes will be less during a lift bridge outage. How much?
First Step – Permit

Joint USACE/MDEQ Permit Application

All required information is in the report
Next Steps

- Joint USACE/MDEQ Application
- 1437th MNG exercise at Lily Pond
  - Same 8% slope
- Develop operational plans
- Civil Engineering Design
- USACE Section 408 Design Review
- Secure grant funding
- MOUs and property acquisition
- U.S. Coast Guard Bridge Permit Application
Thank You!

plan the work...work the plan

Photo: John Kiefer
Acknowledgements

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