Copper River Highway
Bridge 339, Cordova Alaska

AKSAS Project # 60555
July 17, 2012

Project Scope & Existing Conditions

1. **Project scope**

   Replace Bridge 339 located at milepost 36 on the Copper River Highway in Cordova Alaska. (see Figure 1)

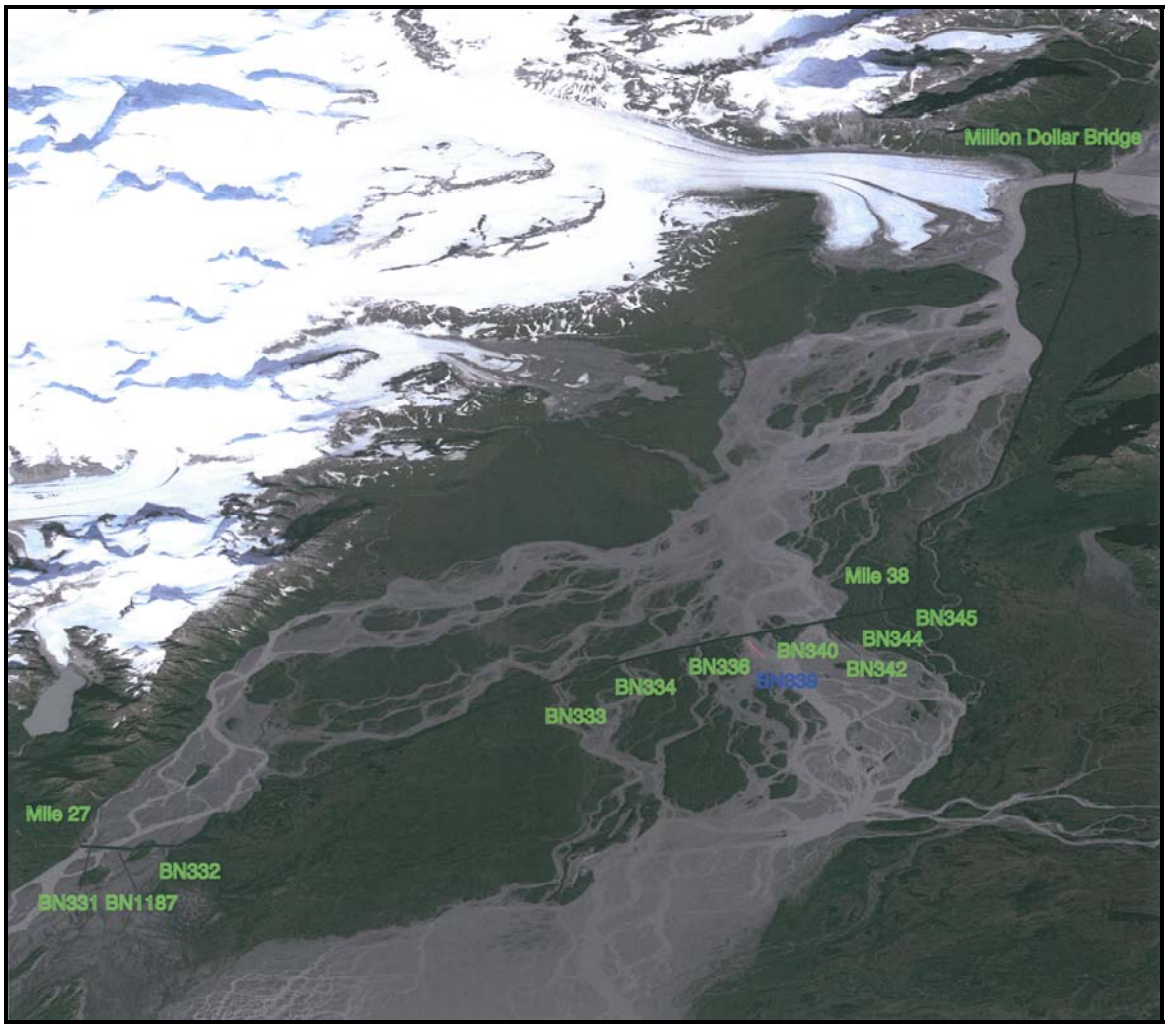


Figure 1 – Copper River Delta

2. Existing Conditions

Bridge 339 has structurally failed and has been indefinitely closed since August 2011. We (AK DOT&PF) believe bridge collapse is eminent.

Naturally occurring changes in flow between river channels across the braided Copper River delta have recently led to a dramatic increase in the amount of water flowing under bridge 339.

Because the bridge has a fixed opening (400' long) water velocities increase as water flows under the bridge. This velocity increase has scoured the streambed down 67 feet under the bridge and the river has breached the road creating a 100-foot gap on the east end. Bridge scour has removed and/or nearly removed all the soil around the pier and abutment piles. (see figures 2 and 3)

Figure 2 - Bridge 339 looking north October 6, 2011

Figure 3 – Bridge 339 looking south at the east abutment June 26, 2012

Background

1. Copper River

The Copper River drains an area of approximately 24,000 square miles north of the Million Dollar Bridge and is the sixth largest drainage basin in Alaska. Just downstream from the Million Dollar Bridge, the Copper River flows past the face of Childs Glacier before it enters a large, broad alluvial braided flood plain. (see figure 1)

This complex flood plain consists of highly erodible material the river is constantly migrating across. Multiple channels continually scour, fill and move from one location to another. (see page 9)

The river discharges through 11 bridges on the Copper River Highway:

- Prior to 1981 the flow distribution was relatively stable with a majority of the Copper River flow passing through three bridges at MP 27 (known as Flag Point).

- During the summer of 1981 a large flood caused a major channel shift (and flow) east towards Bridge 342 and decreased the flow going to Flag Point. This increase in flow caused embankment erosion and scour damage to bridge 342:
    - During 1987 thru 1988 major bridge repairs were constructed. Repairs consisted of installing deeper pier and abutment piles, lengthening the bridge and constructing upstream spur dikes.
    - During 1989 high water overtopped and destroyed the east spur dike.

    - During 1990 to 1991 the spur dikes were rebuilt and downstream spur dikes constructed.

- During the summer of 2006 a large flood initiated another major channel shift, directing flow away from Bridge 342 towards Bridge 339. The flood caused severe erosion to the west road embankment and bridge abutments prompting emergency repairs.

- During 2009 it was noticed things were changing again and more flow was being directed towards bride 339 and the west approach road. (See figure 4)

- In 2010 AK DOT&PF along with the U.S. Geological Survey began a comprehensive monitoring program at Bridge 339.

- By June of 2010 excessive flow at bridge 339 caused severe erosion to the road embankment on the west (Cordova) side of the bridge and both bridge abutments. Emergency placement of riprap on the embankment and abutments was required.

- During the summer of 2011 the river channel migrated east and began scouring the far east bridge piers and abutment.
    - By August 2011 the scour was so severe it was determined the bridge had lost its structural capacity and was closed for safety.

- Summer 2012 the river channel is still migrating east and the river has breached the road creating a 100-foot gap on the east end. (see figure 3)

Figure 4 – Bridge 339 looking north September 29, 2008

2. Copper River Highway

The 50 mile Copper River Highway (CRH) begins in Cordova and ends at the Million Dollar Bridge. The road is paved to milepost 13 and is closed during the winter beyond milepost 16.

The road provides summer/fall vehicle access to vast areas of the Copper River Valley. It's frequently used by hunters, recreationists, tourists and has the potential to support proposed resource development.

The highway traverses the Copper River Delta flood plain over 11 bridges between Mile 27 (also known as Flag Point) and Mile 38 (Bridge 345). The bridges were constructed in the 1970s and range in length from 240 feet to 1200 feet. (see figure 1)

3. The Copper River is Difficult to Predict

Migration of the Copper River through the delta has been observed for the past 70 years or more. The dynamic and complex alluvial plain of highly erodible material is constantly scouring, filling and migrating across its braided delta. Hydraulics and hydrology are not always dominant factors as geologic controls such as uplift or subsidence may also influence the alluvial system.

Maintaining existing roads/bridges or designing new bridge structures in alluvial flood plains is not a straightforward process. Over time the river will continue to migrate throughout the delta, changing flows under bridges for the foreseeable future.

Current Design

The design(s) described below address the current flow at Bridge 339. Replacement of Bridge No. 339 will not eliminate scour related risks at other bridges.

1. New Bridge

Replace the existing bridge following the same horizontal and vertical alignment. The most cost effective replacement structure appears to be a multiple span concrete girder bridge on single column supports:

- The current estimated bridge length is 840 feet long with six (140 foot) spans. Recent scour at the western abutment and increasing flow under the bridge suggest that an even longer bridge may be required – perhaps more than 1000 feet in length.
- The bridge will have six to eight foot diameter supporting columns bearing on larger diameter concrete shafts extending about 150 feet into the ground.
- Abutments will be designed as intermediate supports (piers) to allow for future lengthening of the bridge if needed.

This type of structure is common throughout Alaska and has proven to be durable, requiring little long-term maintenance.

2. River Training Devices. River training devices are intended to inhibit erosion and movement of stream channels and banks. At this time final training device options and designs have not been determined. Selecting optimum devices/designs is an iterative process of hydraulic modeling the Copper River with and without various training devices. The following are some river training devices that are being considered:

a. **Guide Banks (Spur Dikes).** Guide Banks align flow perpendicular to the bridge to minimize abutment sour by moving the scour-causing turbulence to the upstream end of the guide bank.

b. **Maintain a contraction scour hole at the new bridge.**
   i. Pros – Would encourage the preferred flow path to remain to this bridge, thus protecting nearby bridges
   ii. Cons - Road embankment adjacent to the bridge may need to be heavily armored with riprap

c. **Construct Dikes or Channels within the delta.**
   i. Pros
      - Could shift river flows to bridges with greater hydraulic capacity
      - Simple construction
      - May reduce road maintenance requirements beyond Bridge 342 and sediment-related impacts to Clear Creek
      - Channel locations could be strategically selected for favorable flow path development
   ii. Cons
      - River may react in unpredictable ways
      - May shift or create hydraulic and scour problems at other bridges
      - Large scale and volumes of material
      - There is a glacial flood outburst risk to work crews during construction
      - Difficult to get equipment out on delta and cross existing deep and swift river channels, i.e., may not be constructible
      - Don't know what the impacts will be to habitat and fisheries. Very large permit hurtles

Current Schedule & Estimate

1. **Schedule.**
   a. Summer/Fall 2012 - field surveys and data collection
   b. Fall/Winter 2012/2013 – hydraulic modeling, bridge and civil preliminary design
   c. Winter 2012/2013 – environmental document approval, permitting
   d. Summer 2013 – field foundation investigation
   e. Fall/Winter 2013/2014 – finalize design
   f. Summer 2015 - construction

2. **Estimate.** The proposed 840-ft long bridge is estimated to cost about $26M. This cost does not include the roadway work required at the ends of the bridge. The final length of the replacement structure has yet to be determined. Depending upon the hydraulic analysis, the required bridge length may be more than 1000 feet at a cost of about $31M.

Concerns for the road beyond bridge 339

The loss of highway access beyond Bridge 339 prevents M&O from providing maintenance beyond this point. Over time this lack of maintenance will be significant and costly as the road is expected to rapidly deteriorate.

High water events on the Copper River have historically damaged the road beyond Bridge 339, especially from milepost 40 to 44 where the river abuts the highway during high water events. In this area sections of highway have been breached by the river creating large washouts.

Cleaning culverts and maintaining the road embankment are critical maintenance activities. Without heavy equipment and access to a substantial material source, little can be done to protect the roadway.

The M&O Department is currently exploring options to provide limited maintenance beyond the bridge to protect highway assets. They will continue to open the CRH to mile 36 each spring and provide normal maintenance to this point.

Ideas considered & dismissed or not carried forward

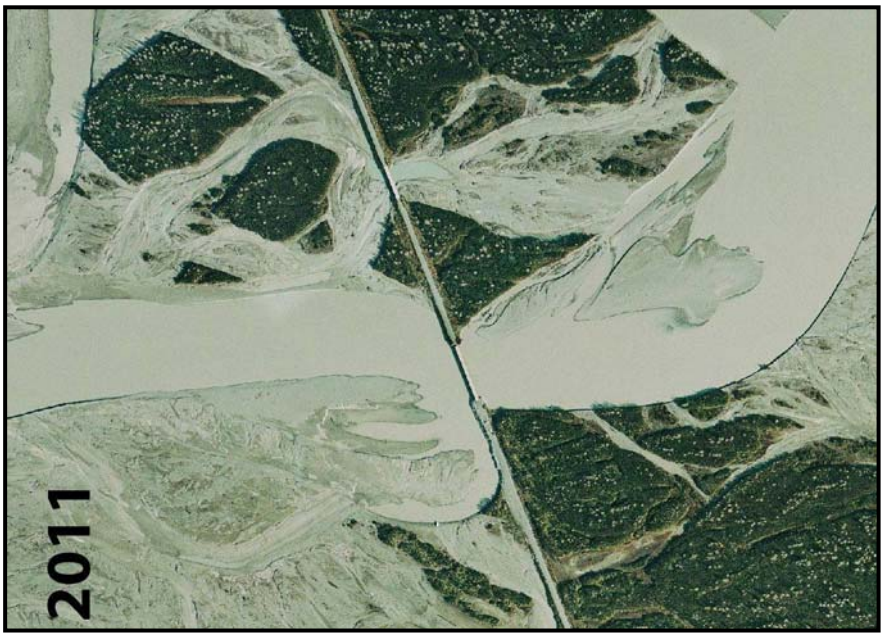
1. **Don't replace the bridge and close the road at MP36.**
    - **a.** Does not satisfy the scope of the project
    - **b.** The road beyond MP36 will soon deteriorate
    - **c.** Will have strong political, agency and public opposition
    - **d.** Hinders the possibility to connect a surface link with the contiguous highway system
2. **Close road at MP 36 and construct an airstrip at end of the road.**
    - **a.** Allows recreation and some light commercial activities
    - **b.** Requires heavy equipment to be transported across the river for construction activities
    - **c.** Would require allocation of equipment at airport for future maintenance
    - **d.** High construction cost
3. **Ferry service.** Shallow draft riverboat or hovercraft
    - **a.** High operating and maintenance costs
    - **b.** Need to develop launching and landing facilities
    - **c.** Unlikely to accommodate heavy industrial use such as that required for timber harvesting or mineral development
    - **d.** Safety concerns for successful operation of high-power, high-speed shallow draft boats on a fast current and channel changing river
4. **New bridge on new alignment.**
    - **a.** Often the existing bridge can be used to facilitate construction of a new bridge, but this is not the case for Bridge 339 since it has already structurally failed
    - **b.** No cost savings
5. **Construct a floating bridge.** Used on lakes or low flow small tidal waterways.
    - **a.** Not feasible due to fluctuations in water surface elevations combined with high water velocities
6. **Ice Road.**
    - **a.** Does not provide summer access
    - **b.** Mild winter temperatures in this coastal climate are not suitable for a reliable ice road

7. **Ice manipulation and/or Dams**
    - **a.** Simple construction (low cost) with readily available material (mostly water)
    - **b.** Could be implemented on a year-to-year basis, based upon need
    - **c.** Low environmental impacts
    - **d.** No known precedent. River may react in unpredictable ways
    - **e.** Anticipate large structure size to resist buoyancy forces. May require fiber-reinforcing to reduce cracking failure. May require sub-excavation
    - **f.** Challenging winter work conditions

Conclusion

The design team is proceeding in developing a bridge replacement design. M&O is investigating options to get crews, equipment and materials across the river past Bridge 339 to provide limited maintenance activities until the new bridge is opened.

The Copper River is difficult to predict and we do not believe this is a one-time fix. It's expected that over time the river will continue to migrate throughout the delta, changing the flow under bridges for the foreseeable future.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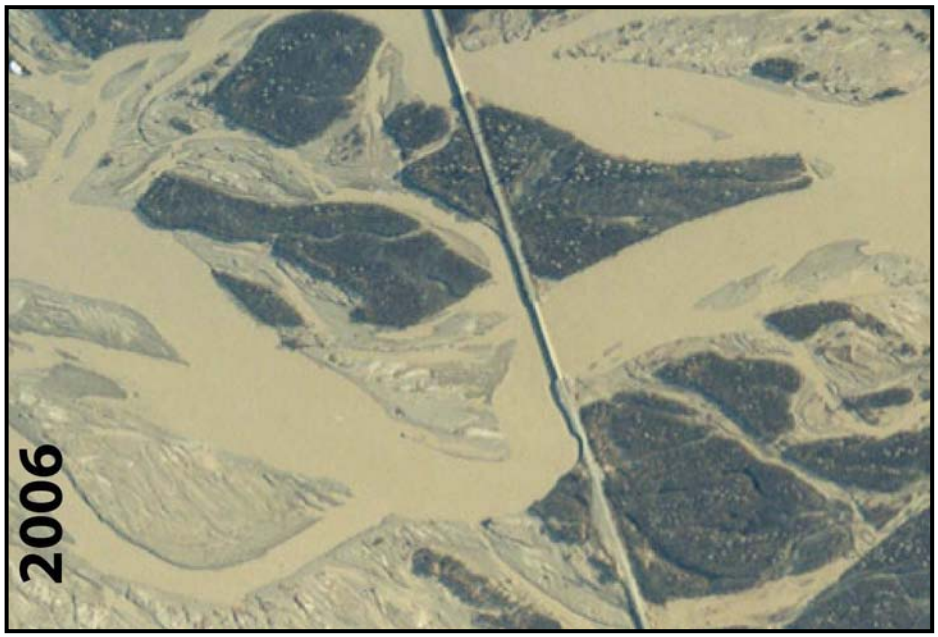
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