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Memorandum

To: The Maclay Bridge Alliance

From: Traci Sylte, P.E., fluvial geomorphology/hydrology, Watermark Consulting, LLC

Date: September 8, 2012

Re: – Maclay Bridge - Review Comments on Mr. Michael Burnside's letter to the Missoula County Commissioners

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The following comments summarize my review of Mr. Michael Burnside's letter to the Missoula County Commissioners about the Maclay Bridge and bridge site. I commend both The Maclay Bridge Alliance (MBA) and Mr. Burnside for their interest, professionalism, and attention towards this matter, and appreciate the opportunity to provide additional comment and rationale. Below, you will find the following sections: comment summary, specific comments, and pertinent references.

COMMENT SUMMARY

1. Mr. Burnside raises valid concerns about the environmental, geological and engineering implications of the Maclay Bridge, and these concerns will apply to any alternative that will be considered. It is necessary to consider the Maclay Bridge in the larger context of adjacent river segments. It is very probable that the existing long-term location will be shown to be the lowest impact location for a crossing in this area of the Bitterroot River. More assessment of this type is necessary.

2. Mr. Burnside is addressing a very important topic at road-stream crossings – stream structure and function (i.e. fluvial geomorphology). Understanding, and properly accommodating, fluvial geomorphology and environmental river mechanics is absolutely critical to fulfilling typical bridge design objectives and making informed decisions.

   [Additional background/discussion: Typical fundamental engineering objectives in bridge and culvert design are: 1) maximize structure life, 2) minimize maintenance, 3) optimize safety. In order to fulfill these objectives, a fourth objective is critical: 4) understand and provide for proper stream structure and function. If objective 4) is not met, all other objectives are at best compromised; at worst, they often fail.

3. Mr. Burnside's letter focuses on stream trends at the immediate Maclay Bridge site. This is a very necessary and well-founded effort. A fluvial assessment over much longer river lengths would provide higher certainty to some of Mr. Burnside's observations, as the context of the adjacent river segments and processes is very important.

[Additional background/discussion: As a very general rule in fluvial assessments, a subject river section, or "reach", includes a segment having similar features for at least the length of 20 "bankfull" widths (defining bankfull here as the active channel width representing a stable, relatively natural or minimally altered condition). Often, both large and small scale features and processes are important to fully understand and describe processes occurring at a particular site.]

4. A thorough fluvial geomorphic assessment (historic and predictive) would be prudent for all routes and crossing locations that are currently under consideration.

[To maximize structure life, minimize maintenance, minimize adjacent bank erosion and land loss, and optimize safety, here are some basic, but important fluvial considerations in road-stream crossing designs:

- *Floodplain capacity and function: Minimize road and crossing footprint within the floodplain and channel migration zone*
- *Planform (i.e. planform or "plan view" means to look down on a subject, as opposed to a cross-section or profile view; in fluvial geomorphology it is the meander of the river, how it moves from side to side and upstream to downstream{laterally and longitudinally}, and from an aerial view):*
  - *cross on the most stable and straight river segments that are "sediment transport dominated" rather than "sediment transport limited (depositional)"*
  - *cross where "belt width" (i.e. amplitude of stream meander) is narrowest to minimize negative road-stream interactions with the channel migration zone (e.g. on meandering systems this is best achieved by crossing floodplains where they are the most narrow, between terraces; or in other words, where the stream is most "entrenched" or confined. Also, it is important to assess human-made entrenchment, like the levees at the existing bridge site in this context, unless they are to be removed and the natural beltwidth or channel migration zone reestablished).*
- *Dimension: At least span (i.e. cross without impeding) the bank full or unaltered active channel width*
- *Discharge, sediment, and wood transport: accommodate the design discharge and associated bedload and debris without backwater effects. In other words, large floods should pass through the bridge and road approaches without retarding or ponding flow, sediment, and debris. This is largely achieved by at least spanning the active channel width with additional floodway or side-channel and road-approach accommodations.*
- *Gradient: facilitate the natural stable stream gradient through the crossing site*
- *Stability: understand, predict trend, and accommodate river instability*
- *Substrate and bedforms (i.e. river gravels and bed shape and composition): provide for the distributions and forms of the adjacent river sections*

5. In full context, Mr. Burnside's concerns could be resolved by eliminating and removing Maclay Bridge, not building another crossing, removing the levees, and sending all traffic to cross at either Kona Ranch or Buckhouse Bridges.

SPECIFIC COMMENTS

Following are my comments to several observations that Mr. Burnside stated in his letter.

1. Photos reveal that since the 1930s, there has been loss of river bank land on the west side of the river immediately downstream of the bridge

   [I agree with the observation; however, it is important to place this in context with entire stream reach and system to better understand potential bridge effects. The levees also are responsible for constriction (Mr. Burnside notes this too)].

2. The water should be shallower and banks should grow on the inside of a river bend downstream of the bridge

   [I agree. Mr. Burnside is describing typical point bar formation. The point bar is not present on the inside bend at the bridge site, but the processes described are present not far down stream. It would be good to understand the reach significance of this].

3. Comparison of the 1935 and 2011 photos reveal both bed and bank erosion downstream of the west bridge abutment.

   [I agree; however significance is not known without a larger context. It does appear that the bridge and levees are creating conditions of higher stress on both bed (deep scour hole) and banks. Also keep in mind - bank erosion is a relation between stress and bank integrity. Shallow rooted grass species typically have much lower ability to resist erosive stresses than the more native, dense, and deep-rooted riparian species (i.e. riparian species and land management is prudent to consider in context because there is a high probability that many river banks in this system exist with similar high bank stresses without high erosion rates....
   As far as the scour hole is concerned, it may be helpful to ask, why do we not like the scour? Historic large wood jams probably created such scour in this system, but wood and large debris jams are largely not present any longer... scour is a natural, and can be, a good river function.... do we not care for the pier/abutment risk; recreational risk; fish catch/predation risk? Other? Is the scour acceptable? What values are at risk, or not?]

4. Bridge and levees are causing unusual changes in the river channel

   [This most likely is an accurate statement; however, a comprehensive fluvial assessment of the river system in this area would help understand how "unusual" the changes are – stream systems are highly variable.]

5. River has slowed the water flow upstream of the bridge and may be causing river to drop sediment and adding to the sand bar growth on the island's north end

   [Undersized bridges cause backwater conditions, which decrease the shear stress necessary to transport sediment, commonly causing bar formation/deposition/aggradation upstream. What is interesting at this site is the location of the bridge relative to the island – because, deposition on both the upstream and downstream ends of islands in rivers occurs as a natural result of flow separation around the island, which causes slower velocities at the separation point, and subsequent sediment deposition. So, there seems to be an interesting complexity of natural deposition (typical island extension) and human caused deposition (potential undersized bridge backwater), all in the same local reach where energies are also increased because of the levees and flow constriction. In other words, there appears to be a mix of river processes and cause-effects, bearing more need of assessment, day-lighting of significance and answering questions of impact, risk, and values (i.e. why do we care about x and y? what features/entities are affected and why? towards what probable trend? and how can design and mitigations accommodate multiple-values best?).]

6. The center pier is not center line for the channel any longer

   [This is very common, especially for older crossings. Bridges are a hard point in a moving system (i.e. akin to holding the middle section of a wiggling snake). Bridge-stream alignment issues present one of many conundrums for roads spanning these types of rivers, making it prudent to minimize crossings, keep spans as large as possible/feasible, limit road/infrastructure presence in floodplains, and to cross on the most stable, transport dominated, and confined river sections.]

7. Bridge was clearly not designed for the present site

   [I can't comment on this; I don't know. What I can comment on is that this bridge has lasted a long time, more than 75 years; it has issues common to a lot of undersized bridges on meandering streams; it also has not washed out like so many other bridges of its era have...making one wonder that the site and bridge have functioned together much better than many bridge crossings. It is prudent to ferret out all pros and cons.]

8. Bridge causing loss of private property and expanding beaches
   [See comment 3 and 5. The bridge is causing an eddy, which is likely increasing shear stress on the river bank. River eddies and associated bank stress is natural, but typically it would not occur on the inside of a meander, as Mr. Burnside highlights. Also, bank integrity, past/present land management and presence/absence of deep-rooted riparian species are important to address as well. Longitudinal extension of islands is natural, as is point bar development on the inside of bends, but the bridge is no doubt influencing these processes in some manner.]

9. Deep scour hole and sand bars invite bridge jumping, swimming, and recreation use along with health, safety, and other problems

   [I agree. The scour hole is likely caused from bridge constriction with consequent recreational issues. The sand bars (or at least deposition of gravel/cobble size material {as substrate size relates to the river-energy environment}) have a high probability of being present anyway because of the natural processes associated with island extension and processes associated with the inside of river bends, lateral migration, and point bar development. In addition, bridges are public access points, and unless Montana's access laws change, they probably always will be points of public use with various positive and negative impacts – leaving design, mitigation, and enforcement as key issues at road-stream crossings, especially in municipal/residential settings.]

10. Scouring action could also be undercutting and destabilizing the pier and abutment

    [Local scour at bridges is a large issue with mandated inspection requirements to identify presence, degree of impact, and associated risk. I assume that our public officials are prudently addressing this with sound environmental engineering approaches – if not, the public and structure are at an unacceptable risk]

11. Environmental and engineering concerns are significant, warranting further study
    [I agree, and would suggest that a comprehensive study include a complete investigation of the fluvial geomorphology of this section of river and any other alternative bridge locations. There will be environmental impacts associated with any alternative, even removing the existing bridge and levee.]

(Please note: The potential for personal bias is of issue in any technical documentation or opinion, making it prudent for the audience to understand the author's relationship with the subject. In this regard, please understand that I live in lower O'Brien Creek and use the Maclay Bridge as my primary access route into Missoula. I also have close family on South Avenue West, and colleagues/friends that would be affected by either route. Consequently, I have mixed feelings on both routes, and any taint of personal bias is unintentional.

My personal goal in this effort is to assist in developing comprehensive, sound, and unbiased information for which informed opinions and decisions can be based. I believe that despite the challenges of multiple objectives, and agendas, win-win scenarios can be achieved through well-informed, innovative, and collaborative approaches. I've kept comments brief and focused with the understanding that often brevity is perhaps the best approach in communications – more detail can be provided if necessary. I've attached a bio-sketch of my professional background and experience.)

SOME FUNDAMENTAL REFERENCES

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