Sue Shannon

From: Schock, Larry [lschock@mt.gov]
Sent: Friday, June 19, 2009 1:48 PM
To: Tiffany Lyden; Sue Shannon
Cc: Sears, Traci; Story, Steve; Siroky, Laurence
Subject: Johnson Creek Floodplain Delineation Review

The DNRC has the following comments and questions after reviewing the Billmayer & Hafferman, Inc. (BHI) Floodplain Delineation Report for Johnson Creek at the Historic Kootenai Lodge dated April 6, 2009, and associated HEC-RAS model:

Since this application will be submitted to FEMA for a LOMR on Johnson Creek, the DNRC reviewed the report and model using similar guidelines that FEMA will use. The DNRC's review will hopefully help to streamline the LOMR process, however it is the applicant's responsibility to prepare the LOMR in accordance with FEMA Guidelines and Specifications. Also, since a detailed floodplain analysis for the entire length of Johnson Creek is proposed during the FEMA map modernization process, this should allow the Kootenai Lodges study to be incorporated into the process.

LOMR

A LOMR should be submitted for the project and BHI has included a draft of the LOMR in the report. However, the LOMR submittal should also include a Riverine Structures Form (MT2, Form 3) for the new culvert. Lake County should coordinate with BHI to discuss completion of this form with the LOMR submittal.

For the LOMR submittal, profiles for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods should be added to the HEC-RAS model.

Hydrology

Although a 280 cfs flow was used in the design of the culvert, and was presumed reasonable at the time by DNRC, further review of the flow selection raises concerns as it is not a conservative estimate based on the Johnson Creek watershed information presented by BHI. Under the FEMA Map Modernization program, DNRC will be completing a detailed floodplain study of Johnson Creek between the Swan River confluence and the Forest Service boundary. A hydrologic analysis will be completed as part of the study, and DNRC does not currently support the non-conservative flow magnitude selected by BHI for the detailed study without definitive evidence of the geologic characteristics and influences to peak flow discharges. .

In order to discount the application of basin characteristics USGS regression equations completely and use the channel-width equations explicitly to estimate peak flows, conclusive evidence must be presented based on vetted scientific data and analysis, and field investigation specific to the Johnson Creek watershed. Limiting the peak flow estimate to the channel-width equations may be appropriate when it can be conclusively demonstrated that unique geohydrologic or climatic features exist (Parrett & Johnson, WRIR 03-4308) and that they have a direct effect to the 100-year recurrence interval flood discharge. However, at this time, the BHI information that has been presented to date is insufficient to extrapolate such a conclusion.

In regard to USGS Water Supply Paper 2260, the statements related to Johnson Creek having lower mean annual runoff values and that the stream may traverse permeable or fractured bedrock, are in DNRC's opinion inconclusive and insufficient evidence to eliminate application of the basin characteristics regression equations altogether. In fact, results from a recent USGS study in South Dakota (SIR 2008-5104) determined that peak flow magnitudes, for streams in loss-zone settings, were only suppressed for smaller 2-to 5-year recurrence intervals. This may or may not be the case for Johnson Creek, and more data is needed to substantiate the hydrogeologic conditions and effects of the Johnson Creek watershed.

For the USGS West Region, the regression equations using a weighted estimate (WRIR 03-4308) including basin characteristics, channel bankfull width, and active-channel width results in the methodology with the best statistical reliability (the average SEP – standard error of prediction). It is unclear whether or not BHI evaluated or considered this option as it is not discussed in their report. Reliability increases as the SEP (%) decreases. A comparison of the regression methods and SEP results using the variables determined by BHI is presented below:

USGS Method (WRIR 03-4308)	**Q100 (cfs)**	**SEP (%)**	
Basin Characteristics (BC)	353	57.6	
Active Channel Width (ACW)	281	69.4	
Bank Full Channel (BFC)	276	72.2	
Weighted, BC + ACW + BFW	329	53.8	**Recommended Method**
Weighted, BC + ACW	329	54.6	
Weighted, BC + BFC	330	54.9	
Weighted, ACW + BFC	280	69.3	**Selected by BHI**

The BHI selected Q100 flow represents the low end of the data set and is the <u>least conservative choice of the weighted methods</u> The DNRC's recommended selection is the weighted method which incorporates both basin and channel characteristics and has the lowest SEP. In addition, non-conservative peak flow estimates often do not consider or take into account future changes which could affect the discharge such as development and forest fires. For instance, a 10% reduction in forest cover for the basin would result in a Q100 increase of 18 cfs for the recommended method.

For a litmus test, the DNRC looked at a gaged basin at the south end of Swan Lake. It's gage ID 104, # 12369650 North Fork Lost Creek near Swan Lake, basin size of 13 sm, 10 years of record, discontinued gage. It has a Q100 of 448 cfs, and using that data, we can estimate the Q100 at a point with 9.26 sm (same as Johnson Ck) resulting in a Q100 = 348 cfs. It may have variable basin characteristics that differ from Johnson Creek, however it does provide a valuable comparison.

After considering the information provided to date, the DNRC recommends using the Weighted BC+ACW+BFW peak flow of 329 cfs which has the best reliability and incorporates basin characteristics. Using the higher 329 cfs Q100, it appears that the new culvert across Sunburst Drive does not overtop and can convey the flow. The consequence of using a Q100 flow that is 49 cfs higher than BHI's Q100 in the current HEC-RAS model may be bank overtopping at some cross sections, higher BFEs, and potentially more expansive floodplain boundaries (at any potential bank overtopping locations). The possible effects on the BHI HEC-RAS model are only conjecture until all of the identified issues are resolved.

Boundary Conditions

The FIS for Lake County and Incorporated Areas reports the BFE for cross section X to be at 3071.8 (Table 3, Lower Swan River). The FIS profile for this reach of the Lower Swan River (02P) also indicates that the Johnson Creek confluence is approximately 50' upstream of cross section X. The BHI report (Sect. 3.3.4, pg. 13) lists a BFE of 3071.19, and the hydraulic model uses a downstream boundary condition (known water surface elev.) of 3071.2. BHI should address this issue and make the appropriate revision. From the FIS data reviewed, it appears the appropriate starting water surface elevation (WSEL) should be 3071.8' + 0.11' (upstream adjustment) = 3071.91'.

Since the current HEC-RAS model was ran in a "Subcritical" mode, the "Critical Depth" upstream boundary condition does not make a difference. However, if the model is to be ran in a "Mixed Flow" regime, the upstream boundary condition should be changed to "Normal Depth".

Cross Sections

Per the Check-RAS output, the end points of sections 11 and 33 were extended vertically in order to fully contain the Q100. At a minimum, all cross sections should extend beyond the 1-percent-annual-chance floodplain boundaries on either side of the stream, and are recommended to extend beyond the 0.2-percent-annual-chance floodplain boundaries.

BHI should also address the appropriate starting location for the downstream boundary condition and the influence of the Swan River BFE. While the BHI model starts at the confluence of Johnson Creek and Swan Lake using the last know water surface associated with the last BFE of the Swan River detailed study, it may not be appropriate to start out the downstream end of a HEC-RAS model with two consecutive cross sections (XS) that are incomplete and had to have the end points vertically extended. Based upon the output and the water surface elevations, it may be advisable to investigate the impacts on the HEC-RAS model to start out with the same Known WS at XS #3. The backwater may extend upstream to the rock bridge.

The sources of cross section data and methods of measurement and hydraulic modeling should be fully documented. This new BHI HEC-RAS model contains 25 cross sections. Based upon a review of the original BHI HEC-RAS model "Johnson Creek BE 4 final.prj", the new model appears to contain 9 interpolated cross sections. They are cross section #'s 2, 4, 12.33, 12.66, 16.6, 19, 21, 24.33, and 32.5. Any interpolated cross sections should be identified, explained, and justified.

The new BHI HEC-RAS model appears to be missing some of the actual surveyed cross sections. Based upon a review of the original BH model cross sections 2, 4, 6, 8, 9, 14, 16, 18, 20, 22, 23, 24, 26, 29, and 30. BHI should explain why some cross sections (of the 33 surveyed in 2007) were not utilized in the model, and if survey data was filtered, details of those changes should be provided.

Also, the lack of actual cross sections in stretches of a model that is only filled with cross sections interpolated from cross sections (that are no longer in the model), leaves large gaps in data that reflects actual on the ground cross sections and elevations. The length of the gaps these interpolated cross sections create is 555.48 ft. between XS #19 - #25 and 203.5 ft. between XS #15- #17.

The exclusion of some of the actual surveyed cross sections and the use of interpolated cross sections creates reaches in the HEC-RAS model that are not based upon actual survey data. This could potentially create an accuracy issue with the model. Since there was actual survey data available for this area and the survey data was used in the original HEC-RAS model to generate the interpolated cross section that are in the current HEC-RAS model, the DNRC needs to understand why these gaps exist.

Report section 3.3.1.2 Levees, pg. 11 – BHI states that "Levees used in the HEC-RAS model at cross sections represent corrections made to prevent divided flow and loss of conveyance that could not possibly occur on site." The DNRC recommends BHI further explain this statement as to how and why divided flow would not occur. In addition, we would request further explanation regarding BHI's statement that "cross section data entered into the HEC-RAS model are <u>reflective</u> of actual ground conditions".

<u>Model Output</u>

The model has produced some sort of critical depth warning for 13 of the 25 cross sections. While this is something that may be expected with divided flows and/or structures, this is an inordinately large number of cross sections to have critical depth warnings on, even for a streambed slope over 1% slope. The modeler should address this issue by justifying the remarks or taking steps to reduce them. Often times on stream channels with steeper slopes, the HEC-RAS model is sensitive to changes in the Manning's roughness coefficient and a slight increase in the coefficient may help alleviate the warning messages. Usually, with a steeper slope it is justifiable to used a larger Manning's coefficient.

<u>Structures</u>

The DNRC recommends that Lake Co. request confirmation that the new Sunburst Drive culvert data is based upon as-built survey? BHI states that additional cross sections were surveyed upstream and downstream and we would assume that was done post construction? Also, the as built specifications will be required for the Riverine Structures Form (MT2, Form 3) for the new culvert during the LOMR process.

Please contact me if you have any questions.

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