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Chal A. Martin, P.E.
Director/County Engineer
Skagit County Public Works Department
1800 Continental Place,
Mount Vernon, WA 98273-5625

Dear Mr. Martin:

Prior to Dr.Jarrett's review of the draft report, "Evaluation of Flood Peaks Estimated by USGS," I drafted a response to the numbered topics in a letter to Cindi Barton from yourself, dated December 13, 2004. I felt that since I was more familiar with issues brought up in your letter than Dr. Jarrett and since I had easy access to much of the original notes by Stewart and others concerning flooding on the Skagit, I should respond to the numbered topics so that Dr. Jarrett could focus on his review of the draft report. The following are my responses (I have repeated the text of numbered topics for clarity):

1. Availability of the HWM's survey data that USGS acquired for the October 2003 flood event

2. Availability of the cross section data that USGS acquired for the October 2003 flood event.

The HWM and cross-section survey data will be available once the USGS Open-File report on the 1921 peak discharge verification study has received Director's Approval. We have written the first draft of the report, received three colleague reviews, and have responded to those reviews. We expect to have Director's Approval before the end of the February of this year.

3. The significance of knowing the location of the Concrete hotel referenced by Stewart and the location of the HWM's for the floods on 1897, 1909 and 1917.

The USGS Water-Supply Paper (WSP) 1527 (p. 29) refers to the 1909 flood evidence on the "footing of a hotel near the cement plant was just reached by the water." At the time of Mr. Stewart's survey (1918), there were two cement plants in Concrete, the Superior plant at the west end of Concrete that is well removed from either the Baker or the Skagit Rivers and the Washington plant near the confluence of the Baker and Skagit Rivers. The next sentence in the WSP refers to oil marks from the 1909 flood outside a Washington Cement Plant shop. In the WSP and in Stewart's 1922 survey notes (we can't find his 1918 survey notes) there are only references to the Washington Cement Plant and never the Superior Cement Plant. This fact that only the Washington Cement Plant is ever referenced plus the fact that the Superior Cement Plant is so distant from the river would lead one to think that the hotel mentioned in reference to HWMs is near the Washington Cement Plant.

With all that being said and after reviewing Stewart's 1922 survey notes, we feel that the importance of the HWMs at the hotel in defining the water-surface elevation of the four historic floods is less than the importance of HWMs found in other locations. See comments to item number 4 for more details.

4. Method used by Stewart to transfer the HWM's for the 1897,1909 and 1917 floods from the hotel to the staff gage.

Rather than simply talk about the HWMs at the hotel, we would like to outline our findings of HWMs in Stewart's survey field book recorded in 1922. We feel these are more supportive of the final gage heights used for the historic floods as published in the WSP.

For reference, the gage heights at current gage datum and discharges of the four historic floods as published in the WSP are listed here as follows:

Year	Gage Height, feet	Discharge, ft^3/s
1897	51.1	275,000
1909	49.1	260,000
1917	45.7	220,000
1921	47.6	240,000

There is substantial evidence from the HWMs that the relative magnitude of the four historic floods were correctly stated in the WSP. Downstream of the gage where there is no question of whether the marks are more representative of flooding on the Baker River or flooding of the Skagit River, Stewart found several sets of HWMs that could only represent the water surface of the Skagit River. However, the river was probably not confined within the main stream banks and the relative HWM difference would not necessarily be the same at the difference in stages at the gage. In the town of Hamilton at River Mile (RM) 40 (gage is at RM 54.15), Stewart found a 1917 HWM 0.55 feet below a 1909 HWM and 0.84 feet below a 1921 HWM (pi4, field book). At Kemerick Ranch (about RM 45), Stewart found HWMs that showed the 1897 peak was about the same as the 1909 peak and 0.8 feet above the 1921 peak (p. 27, field book). At Savage Ranch across from Old Birdsviews School (about RM 46), the notes show the 1909 flood to be 0.67 and 0.51 feet higher than the 1921 flood and the 1917 flood to be 0.68 feet below the 1921 flood (p.27, field book). At Pressentin Ferry (assumed to be at the mouth of Pressentin Creek and existing boat ramp, RM 47), the notes show a 1897 HWM 2.8 feet above an "approx." 1921 HWM (p.25, field book).

At the streamgage, Skagit River near Concrete, Stewart originally ran levels to a 1921 HWM in a maple tree at an elevation of 47.0 feet (corrected to current gage datum) (p. 59, field book) and later found a nearby mark 0.6 ft higher (p. 75, field book) to give the published gage height of 47.6 feet. Near this same location at the Dalles Cabin, Stewart found several sand bars and ran levels to them. He notes that, "These shots on sandbar show 1909 at least 1.3 [feet] above 1921 while levels bottom of page 18 show 1909 1.3 [feet] above 1921 at Concrete." (p. 58, field book). On page 18, Stewart has levels at McDaniel's residence, noted to be east of Washington Cement Plant and above the Baker River, showing a 1909 HWM 1.27 feet above a 1921 HWM. The elevation difference of the sandbars near the gage, provides evidence that the elevation differences between HWMs found near the confluence of the Baker River and the Skagit are similar to the differences at the gage. Also near the confluence, Stewart notes (p. 22, field book) that a 1897 HWM on a stump noted by Magnus Miller near the Old Baker Highway Bridge was 3.6 feet higher than a 1921 HWM. (NOTE: The WSP has an error on p. 28, bottom of fifth paragraph where it states that the "flood of 1897 was found to be 3.6 feet higher than the flood of 1909 at Concrete." It should read, "...3.6 feet higher than the flood of 1921...') At the Washington Cement Plant's machine shop, Stewart found a 1909 mark 2.0 feet higher than a 1921 mark (p. 23, field book).

Stewart ran levels from *a 1921* HWM at Wolfs residence to the gage and calculated a gage height of 46.7 (current gage datum) (p. 30,33, field book) and found a 1917 HWM that was 1.52 feet below the 1921 HWM (p. 19, field book). The elevation difference between the 1921 and 1917 HWM do not quite agree with the WSP; therefore, one might suspect that Stewart may have found better HWMs for the 1917 peak during his 1918 survey. It is unknown where Wolfs residence is in relation to the gage other than the clue that the 1921 HWM closely agree with 1921 HWMs at the gage and the fact that the survey notes show that it took only 12 turning points to get from the Wolf HWMs to the gage.

At Robertson's Ranch (RM 58.5) about 2 miles above the confluence of the Skagit and Baker Rivers, L. Robertson marked the 1909, 1917, and 1921 floods with knife cuts on siding board on his barn (p. 2, field book). The 1909 peak was 1.83 feet above the 1917 peak water surface and 0.29 feet above the 1921 peak.

5. The elevation difference for same flows between the current USGS gage and the staff gage used by Stewart.

The old gage is said to be 200 feet above the current gage that was established in 1937. The gorge is a natural constriction that causes a fairly flat surface-water profile in the approach section due to backwater upstream of the constriction and a relatively steep profile as water drops down through the gorge. Our field survey on 8/4/04 showed a slight rising profile (0.03 ft, unadjusted for rising stage which probably accounts for the rise) from the old gage site to the current gage site at a gage height of 16.9 feet. As flows increase, the draw down through the gorge seems to begin further upstream somewhere upstream of the current gage location. The HWMs from the October 2004 peak flow, gage height of 42.14, showed a drop of 0.5 to 1.5 feet from the old gage site to the current gage site depending on which HWMs are chosen to represent the slope.

No corrections have been made to the historic peak discharges to account for the fall in slope on the right bank. This is probably because there is little information to determine an appropriate stage-related correction that would be needed to be applied. The discharge for the 1921 flood was determined independent of the stage-discharge rating by indirect methods; therefore, it is not affected by adjusting the gage height. The discharge estimates for the other three historic floods were based on rating extension through the 1921 peak discharge. The rating was based on gage heights collected at the old gage site, so the fall does not affect the computation of the discharges.

6. The flow at which the Skagit will have right-bank overflow just above the Dalles.

Refering to survey notes made 9/5/23 by the Skagit County Engineer, R.E.L.Knapp, the low spot in the right-bank overflow channel is at an elevation of 51.5 feet (current gage datum) and is 1,145 feet upstream from the old gage site. A rough estimate of the water-surface slope in the reach above the gage can be estimated from a HWM for the 2003 flood reported by the U.S. Army Corps of Engineers in their draft flood-reduction report at RM 59.65 at an elevation of 195.48 feet and the HWM at the gage (RM 54.15) at an elevation of 172.14 (NGVD '29) resulting in a slope of 0.0008. At this slope, the elevation at the low spot of 51.5 (current gage datum) would translate to a gage height of 50.58 feet at the point when overflow would occur in the overflow channel. The 1897 peak stage is estimated to be 51.1 feet, and therefore, would probably have flowed through the overflow channel, but at depths less than one foot. The next highest peak, the 1909 flood, had a peak stage estimated at 49.1 feet, and therefore, would probably not have flowed through the overflow channel. Stewart reported that the 1921 flood was completely contained within the gorge. At a peak stage of 47.6 feet, the elevation of the overflow channel appears to be well above the elevation of the peak water surface of the 1921 flood, and there is no reason to dispute Stewart's statement.

7. Methods of extending the rating curves presented in the draft report.

The method used to extend the rating curve in the draft report was to calibrate a HEC-RAS model to HWMs from the October 2003 flood and then run various higher discharges through the model and note the water-surface elevation at the gage. In order for the simulated water-surface to match the HWMs through the gorge, some very high contraction and expansion coefficients, much higher than are normally used, were needed. The approach to the Dalles Gorge consists of two 90 degree bends in the flow path that generates a reverse flow and pile-up along the left bank (HWMs from the 2003 flood slope upward in a downstream direction). The one-dimensional HEC-RAS model that was constructed for the Gorge is probably compensating for energy losses due to complicated two-dimensional flow patterns with it unusually high contraction and expansion coefficients. Since the model is being used outside it basic assumption of one-dimensional flow, one has to be cautious applying the model much beyond the range it was calibrated. The simulated stage-discharge relation however matches very closely to the current stage-discharge rating with a straight-line extension on logarithmic graph paper.

The current rating in use today at the gage is for current channel conditions. Historical photographs of the channel show that in 1937 (oldest photograph) the island downstream of the gage was totally bare of vegetation. Sequential photographs of the island show a gradual increase in vegetation until today an impenetrable forest exists on the downstream half of the island that becomes submerged at high flows (about 5-10 feet during the October 2003 flood). HEC-RAS model runs show that lowering the roughness coefficient (n value)for cross sections on the island to represent historical, less resistant flow conditions results in lower water-surface elevations at the gage. Assuming the island was bare during the historical floods, we would expect that the measurements would plot to the right of the current rating.

In general, rather than extend a rating to estimate the value of a peak discharge, it is most desirable to have a direct measurement of the highest flows in order to define a rating. This is rarely possible, because it is difficult to be at the site during the peak stage ready to measure, and conditions are often too extreme to make a current-meter measurement. When no current-meter measurement is available to define the high portion of a rating, the next best option is to make an indirect measurement of the peak flow. While the accuracy of an indirect measurement is generally less than a current-meter measurement, it is consider better than an excessive extension of an existing rating.

8. Request to substitute the Slope Area calculation Stewart used to predict flood flows associated with unrecorded historic HWMs with more current methodology.

The current methodology that we use today to define the upper end of ratings when no current-meter measurements are available to define the upper portion of the rating is to make an indirect measurement, usually a slope-area measurement. We have gone beyond the usual requirements in the case of the slope area for the 1921 flood calculated by Stewart by performing an n verification of the study reach using the October 2003 flood and a current-meter measurement. The recalculation of the 1921 peak-flow discharge using current slope-area procedures and verified roughness coefficients produced an estimate almost the same as Stewart's estimate. All the evidence points to the fact that Stewart's estimate of the 1921 peak discharge was a good estimate and the use of a slope area indirect with a verified n value is the better methodology to estimate the peak discharge rather than rating extension.

Sincerely yours,

Mark Mastin
Surface-Water Specialist