

LJK Comments on the applicability of 17B on Stewart Flood Flows



**Guidelines  
For  
Determining**

**Flood  
Flow  
Frequency**

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of the  
Hydrology Subcommittee

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INTERAGENCY ADVISORY COMMITTEE  
ON WATER DATA



U.S. Department of the Interior  
Geological Survey  
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## Executive Summary

The publication by the Interagency Advisory Committee commonly referred to as 17B, is not a regulation. In its own words it is a “guideline” that federal agencies are “requested” to use and state and local governments are “encouraged” to use. There is nothing that is “mandatory” about this publication.

As justified herein, use of the “Stewart Data” in lieu of the historic record, violates the spirit and intent of 17B.

Also, as justified herein, use of flow data on the Willamette River in Oregon and the Elwha River in a rain forest instead of using data from rivers in a “similar region” (i.e. the Nooksack and Snohomish) violates the spirit and intent of 17B.

With respect to watershed changes, using Mr. Stewart’s “estimates” unless all of the subsequent flows are “unregulated” violates the spirit and intent of 17B with respect to computing an accurate flood flow frequency analysis as they skew the final determination.

By not separating out the different populations of flood events on the Skagit River, the computation of the flood frequency analysis is skewed and would appear to violate the spirit and intent of 17B.

The use of the 4 historic flood events, all estimates, all qualifying as maximum flows, violates the spirit and intent of 17B due to the lack of reliability of said flows.

The use of the historic data due to the reliability of the data, the peak discharge magnitude, changes in watershed conditions over the extended period of time, and the effects of these on the computed frequency curve all without any kind of an “adjustment” in accordance with Appendix 6, combine to violate the spirit and intent of 17B.

In 2005, Robert Jarrett, Ph.D., with the USGS National Research Program wrote the following:

*Stewart's study of historical floods in the Skagit River basin had, by today's standards short-comings, simplifications, incomplete documentation, no known photographic documentation, and took decades to review and complete the evaluation of flood hydrology for the Skagit River near Concrete. . . . I believe much of the uncertainty in the historical flood estimates that can be evaluated now resides in factors that likely may remain unknown (unless someone can find newspaper records, diaries, or other historical documents) and need to be evaluated. (Source: [Review & Comments](#) of "Draft Evaluation of Flood Peaks Estimated by USGS" by Robert D. Jarrett, Ph.D., USGS, National Research Program 2/14/2005)*

This analysis of 17B on the usage of the Stewart study of historical floods contains the newspaper records, diaries and other historical documents mentioned by Dr. Jarrett and they need to be evaluated.



## **COMMENTS ON THE APPLICABILITY OF 17B ON STEWART FLOOD ESTIMATES**

Before I begin I want to state that any reviewer of this document must first realize that I am not a hydraulic engineer or for that matter an engineer of any kind. I openly admit that much of what is contained in 17B is far beyond my personal comprehension as a layperson. This is especially true of the highly complicated mathematical logarithm formulas. Instead my interest is to see how 17B treats historical floods.

The impetus for this review was due to the fact that for several years the U.S. Army Corps of Engineers had stated through a former Colonel of the Seattle District that the Corps of Engineers was “mandated by law to use the figures provided to it by USGS”. When the Colonel was asked to produce said regulation she ultimately could not as no regulation or law exist. Instead, her staff referred to the “accepted guidelines of hydraulic principals” which are allegedly contained in 17B. A document that apparently does not contain any weight in law, instead appearing to be a suggestion of request and encouragement according to the below text contained in the Forward section:

Federal agencies are requested to use these guidelines in all planning activities involving water and related land resources. State, local and private organizations are encouraged to use these guidelines also to assure more uniformity, compatibility, and comparability in the frequency values that all concerned agencies and citizens must use for many vital decisions.

*(Source: Page ii, 17B)*

In Skagit County the main point of contention with respect to size and frequency analysis of flood flows are the 4 historic floods of 1897, 1909, 1917 and 1921 which have the impact of “skewing” the analysis. All determined by one man who saw none of the flood events in question, who wrote two very conflicting reports (1918 and 1923) just 5 years apart, never justifies the extreme differences between the two reports, never completes his research for the second report, and his findings are not supported by local history (i.e. the accounts of the actual flood events by people who were on the ground observing the floods). In the opening paragraph of 17B it states the following:



## FOREWORD

An accurate estimate of the flood damage potential is a key element to an effective, nationwide flood damage abatement program. Further, there is an acute need for a consistent approach to such estimates because management of the nation's water and related land resources is shared among various levels of government and private enterprise. To obtain both a consistent and accurate estimate of flood losses requires development, acceptance, and widespread application of a uniform, consistent and accurate technique for determining flood-flow frequencies.

*(Source: Page i, 17B)*

It is ironic that the document begins with its purpose to ensure accuracy for that is the very issue in the instant case at hand, the accuracy and/or the reliability of using one mans work product that is not supported by historic documentation. However, 17B itself seems to put in a qualifier with respect to the accuracy requirement when it states the following:

Major problems are encountered when developing guides for flood flow frequency determinations. There is no procedure or set of procedures that can be adopted which, when rigidly applied to the available data, will accurately define the flood potential of any given watershed. Statistical analysis alone will not resolve all flood frequency problems. As discussed in subsequent sections of this guide, elements of risk and uncertainty are inherent in any flood frequency analysis. User decisions must be based on properly applied procedures and proper interpretation of results considering risk and uncertainty. Therefore, the judgment of a professional experienced in hydrologic analysis will enhance the usefulness of a flood frequency analysis and promote appropriate application.

*(Source: Page , 17B)*

## HISTORIC DATA

When it comes to using historic data 17B suggest, recommends and encourages the following:



## B. Historic Data

At many locations, particularly where man has occupied the flood plain for an extended period, there is information about major floods which occurred either before or after the period of systematic data collection. This information can often be used to make estimates of peak discharge. It also often defines an extended period during which the largest floods, either recorded or historic, are known. The USGS includes some historic flood information in its published reports and computer files. Additional information can sometimes be obtained from the files of other agencies or extracted from newspaper files or by intensive inquiry and investigation near the site for which the flood frequency information is needed.

Historic flood information should be obtained and documented whenever possible, particularly where the systematic record is relatively short. Use of historic data assures that estimates fit community experience and improves the frequency determinations.

*(Source: Page 5, 17B)*

.. The USGS includes some historic flood information in its published reports and computer files..” This would be the 1923 Stewart Report whose figures are quoted in Water Supply papers 612 and 1527. But what happens when **Additional information can be obtained from newspaper files** and that information conflicts with what is contained in the USGS files? Over 1,000 historic newspaper articles are published for public perusal on [www.skagitriverhistory.com](http://www.skagitriverhistory.com). Many of those articles deal with the four floods in question as well as flooding events prior and subsequent to 1897. (*See 10/21/1895 The Skagit News, 11/16/1896 TSN, 11/19/1896 SCT, 11/22/1897 The Skagit News Herald (“TSN-H”), 11/16/06 The Journal (“TJ”), 11/19/06 TSN-H, 11/19/06 TSN-H, 11/19/06 TSN-H, 11/22/06 SCT, 11/23/06 The Journal, 11/26/09 Argus, 12/3/09 Argus, 12/3/09 Argus, 12/3/09 The Journal, 12/3/09 B.J., 12/10/09 Argus, 12/10/09 Argus, 12/17/09 Argus, 12/17/09 Argus, 11/24/10 SCT, 12/20/17 MVH, 1/3/18 MVH, 1/3/18 MVH, 1/4/18 Argus, 1/4/18 B.J., 1/4/18 B.J., 1/10/18 MVH, 12/15/21 MVH, 12/15/21 Argus, 12/16/21 B.J., 12/17/21 C.H., 12/17/21 C.H., 12/17/21 C.H., 12/22/21 Argus, 12/22/21 CT, 12/22/21 CT, 12/24/21 C.H., 12/31/21 C.H.*)

The above articles tell us that the 1909 flood was larger than the 1897 flood (*See 12/3/09 The Journal and 2/10/09 Argus*) both in the lower and upper valley. WSP’s 612 and 1527 both based on the 1923 Stewart Report have the 1897 flood as the largest flood since the settlement of the valley began all the way from Diablo to the lower valley. The Argus article is significant because it was an article clearly reviewed by Mr. Stewart and for whatever reason ignored by Mr. Stewart. The Argus article states in part:

*Mr. Costello is a prominent logger of the upper Skagit, where the high water of the past two weeks compelled the suspension of all logging operations on the*



river. He says that the recent flood was the highest he had ever seen on the river. The oldest inhabitants on the river declare that the high water mark attained during the recent flood was at least 22 inches higher than it had ever reached during a period of 22 years.

On December 12, 1922, at page 122 in Stewart's handwritten field journal, he makes the following notation: *M. Costello came to Mt. Vernon shortly after 1909 flood. Prominent logger. He states that oldest settlers up there state that 1909 flood at least 22 inches higher than any flood in 22 years.*

Validity is given to the article when one reads the following passage in a local historical book concerning the 1909 flood event:

Glee Davis of Sedro Woolley has written his memories of these years. When he was five years old in 1890 his mother, Lucinda Davis, came with her three children to a homestead on the Cascade River a mile above where it enters the Skagit. One of her brothers had been drowned before she came; the other, Will Leach, was with the family quite a bit, but the pioneer woman and her young children had to depend mainly on themselves to meet emergencies. Here are his memories:

November 29, 1909. The Skagit River had the highest water of record in most of the valley. Two river bridges in the canyon were washed away and much of the trail destroyed. At Benson flat, four miles below Goodell Creek, the flood of 1897 had left a silt mark on a cedar tree which I marked by a driven spike the following year and made a note of it so passers-by might see it well above their heads on the trail. Now this 1909 flood left its mark on the tree but 22 inches higher.

*Source: Skagit Settlers, Trials and Triumphs 1890-1920 (1975)*

Casting further doubt on Stewart's work is the [12/17/09 Argus](#) article which suggest that during the 1909 flood event, Edison was not inundated by flood waters while the 1917 flood ([See 1/4/18 Argus](#)) and the 1921 flood ([See 12/17/21 C.H.](#)) did in fact inundate Edison.

Further, the [12/17/21 C.H.](#) states that the 1921 flood on the Sauk was the "greatest height ever known"; and both the [12/22/21 CT](#) and the [12/31/21 C.H.](#) have the 1921 flood as the largest of the four historic floods:

The flood of 1921 is the biggest flood in the history of the Skagit, according to old timers, who recall the floods of 1879, 1888, 1897 and on up to the big flood of 1909 and the 1917 freshet. Mrs. Dreyer, who lives west of town, tells of the big flood of 1888, when in some places the river backed up higher than this year. She says that not so much damage was done then because there were practically no dikes and the water spread over the lowlands more gradually. **Measurements at the Dalles, near Concrete, show that the flood water this year reached a point two feet higher than at any previous time in the memory of the oldest settler.** Charley Moses says that it was the biggest flood, with the biggest volume of water ever carried in the Skagit. At Van Horn the water was 14½ inches higher than it had ever been. In 1909 the river in the upper valley was only about two-thirds as wide as it is now. Hundreds of acres of land are being washed away every year, by both Skagit and Sauk rivers. W. A. Ellison says he has been on the upper river for 21 years and this is the biggest flood he has seen or heard old timers tell about. (Emphasis added) (Source: [12/22/21 CT](#))



**Old timers in the Skagit valley, who have seen all the floods in the Skagit valley since the early 80's say that the recent flood carried a greater volume of water than any previous flood since the county was settled, surpassing even the famous high water of 1897.** The fact that the river did not reach marks set in former years at some points in the upper valley is accounted for by the widening of the river since that time. In all places where the banks of the river have remained unchanged the **1921 mark is considerably above that of any previous flood known to settlers.** *(Emphasis added)*  
*(Source: [12/31/21 C.H.](#))*

The Courier Times article [12/22/21 CT](#) is particularly significant not only from the standpoint as it states the water at The Dalles (the location of the current gage) was **two feet higher** than it had ever been but it also quotes a gentleman by the name of Charlie Moses. At the end of Mr. Stewart's handwritten field notebook there is a long list of "Things To Do" that clearly were never done. One of those things was to interview Charlie Moses. One has to wonder that if Mr. Stewart had interviewed Charlie Moses, and/or reviewed the dozens of historical newspaper articles heretofore referenced like he intended to do according to his long list of "Things To Do" in his handwritten field notebook, how different his report might have been.

Throw into the mix that the [12/24/21 C.H.](#) article states that "*Only a few houses in the main part of town escaped the muddy waters of the flood, which reached its highest point about midnight Monday*", one of those houses was the "Smith House" which was constructed in 1908 and never had floodwater in it until 1995 and you have to wonder how a home in Hamilton escaped having floodwater in it with a reported flow of 260,000 cfs in 1909 and 240,000 cfs in 1921 but had two inches in it in 1995 with a flow of only 160,000 cfs? *(See [Declaration of Fred W. Slipper](#))*

In speaking with now three government officials I am told that "Newspaper articles are not a very reliable source of information." This is of course contrary to the verbiage contained in 17B. If I was relying on one newspaper article or for that matter one newspaper for all the articles, then that statement might carry some validity, however, as quoted herein, there are over 3 dozen local newspaper articles from 5 different newspapers, in 4 different locations in Skagit County, and not a one of them support Mr. Stewart's findings for the 4 historic floods.

So what we are left with are a few very important questions. Why did Mr. Stewart choose to ignore local history in his flood computations? Why are current federal agencies accepting the work product of an individual who never completed his research and who was not here during any of the flood events? Why are federal agencies ignoring historical research whose usage is "suggested and encouraged" by 17B? Most importantly, doesn't the failure to utilize the historic information violate the spirit and intent of 17B section cited to above?

### **COMPARISONS WITH SIMILAR WATERSHEDS**

When it comes to comparing one set of data on a given water body with that of another stream or river in order to compute and/or check the accuracy of one set of data, 17B suggest, recommends and encourages the following:



### C. Comparison With Similar Watersheds

Comparisons between computed frequency curves and maximum flood data of the watershed being investigated and those in a hydrologically similar region are useful for identification of unusual events and for testing the reasonableness of flood flow frequency determinations. Studies have been made and published [e.g., (1), (2), (3), (4)]\* which permit comparing flood frequency estimates at a site with generalized estimates for a homogeneous region. Comparisons with information at stations in the immediate region should be made, particularly at gaging stations upstream and downstream, to promote regional consistency and help prevent gross errors.

(Source: 17B at Page 5)

USGS by letter dated 10/26/06 stated the following:

Mr. Kunzler also noted the fact that the magnitude of the historical floods has not been repeated since 1921. This may be unusual; however, this pattern is also shown in the annual peak flow series in other large rivers in the Pacific Northwest (fig. 1) where the largest floods in a long record appear to have occurred near the turn of the century, and lower annual peaks appear to have occurred since that time. (Source: [USGS Response to Updated Whitepaper](#))

Although providing no additional verbiage USGS submitted graphs for the **Elwha** River near Port Angeles, Wa. (located in a rain forest), and for the **Willamette** River at Salem Oregon. Why these two rivers were chosen remains a mystery. However, in accordance with 17B, when one compares rivers “in a similar region” as in those near the Skagit River basin one finds further reasons to doubt the figures delineated by Mr. Stewart.

The **Nooksack** a completely uncontrolled river system which you would have expected would have equaled the Skagit since like the Baker River also drains Mt. Baker, between 1945 and 2003 recorded 33 peak flows over flood stage. The Skagit 36 for the same time frame. Also interesting on the Nooksack is that the 1917 and 1921 flood gage heights have been equaled or exceeded 4 times. With the exception of the 2003 event they’ve never been even close on the Skagit. I think this shows us not only the importance of the dams on flood flows on the Skagit but just how wrong Mr. Stewart’s calculations are.

The **Snohomish** at the town of Snohomish between 1941 and 1966 recorded 25 peak flows over flood stage. The Skagit during the same time recorded only 15. The “Big Floods” on the Snohomish have been estimated during 1906 (10 ft over flood stage), 1917 (6.5 feet over flood stage and 1921 (5.8 feet over flood stage). The 1921 flood was almost equaled or exceeded 4 times during that time period. On the Skagit, Stewart has the 1917 flood at 17 feet over flood stage and the 1921 flood at 19.6 feet over flood stage. On the Skagit, only during the 2003 event when the Sauk had over a 100 year event and we had more storage behind the dams have we even come close to repeating the 1921 event and I am sure that we would have equaled or



exceeded the 1917 event using his 1923 flows. If you use Stewarts 1918 flood flows, in 2003 we exceeded the 1897, 1909 and 1917 flood events. The point I think this shows is that the 1917 event using Stewarts 1923 figures repeated itself once in 86 years which if we had accurate data to work from would make the 2003 event far greater than a 30 year flood event if it was not for the skewing of the frequency curve by using Stewart's historic flows.

The point I am trying to make is that just because another river has a flood event doesn't mean that the Skagit will be the same in either occurrence or intensity. Also, just because other rivers had major floods during 1897, 1909, 1917, and 1921, doesn't mean that Stewart got the flows right, especially since on other river systems the flows during some of those events have been equaled or exceeded several times.

I firmly believe based on the evidence above that the 2003 flood event (estimated by the Corps of Engineers to have carried "unregulated" 209,000 cfs at The Dalles, 202,000 cfs at Sedro-Woolley) equaled or exceeded the 1897 flood event. The greatest error in Stewarts 1923 work product is that he did not take into account the flows that he had previously taken into account and was published by USGS in WSP 612 and 1527 on the Baker and Sauk rivers. You simply cannot reach the 1923 values given to flows at The Dalles by using the 1918 data, again that was published in both USGS WSP's 612 and 1527.

Using the Elwha and Willamette Rivers to justify the Stewart data instead of "rivers in a similar region" (i.e. the Nooksack and Snohomish), violates the spirit and intent of 17B.

### **WATERSHED CHANGES**

17B states the following with respect to Watershed Changes:

#### **C. Watershed Changes**

It is becoming increasingly difficult to find watersheds in which the flow regime has not been altered by man's activity. Man's activities which can change flow conditions include urbanization, channelization, levees, the construction of reservoirs, diversions, and alteration of cover conditions.

...

Special effort should be made to identify those records which are not homogeneous. Only records which represent relatively constant watershed conditions should be used for frequency analysis.

(Source: 17B Page 7)

Mr. Stewart's four historic flows were "estimated" when the Skagit River was a totally uncontrolled/unregulated river system. Beginning in 1924-25 all of the subsequent floods have been influenced by the Skagit River dams. (See [Historical Dam Building And Their Impacts On Floods - PDF \(1924-1969\)](#)). Unless all of the subsequent flows are "unregulated", use of the Stewart historic flows violates the spirit and intent of 17B.



## **MIXED POPULATIONS**

17B addresses “Mixed Populations” by stating the following:

### **D. Mixed Populations**

At some locations flooding is created by different types of events. For example, flooding in some watersheds is created by snowmelt, rainstorms, or by combinations of both snowmelt and rainstorms. Such a record may not be homogeneous and may require special treatment.

*(Source: 17B Page 7)*

I have always been concerned that the flood frequency analysis for the Skagit River contains 4 populations of flood events. Rain, rain on snow, short duration and long duration flood events. All of the four populations are currently being treated as one type of event on the Skagit River. While I’m not qualified to suggest what kind of “special treatment” each type of flood event should be accorded, surely the argument could be made that the current flood frequency analysis by using the mixed populations is comparing apples to oranges. We do know through historical analysis that the 1909 flood ([11/26/09 Argus](#)), the 1917 flood ([12/20/17 MVH](#)), and the 1921 flood ([12/17/21 C.H.](#)), were all “double-pump” flood events which strongly suggest that there was little or no overbank storage for the second flood event which gives concerns as to the amount of water Mr. Stewart had at the Dalles and to what he had at Sedro-Woolley. Mr. Stewart has the differences between The Dalles and Sedro-Woolley for the 1909, 1917 and 1921 flood events at 40,000 cfs, 25,000 cfs, and 30,000 cfs. respectively. Since these were double pump events and the overbank areas would have already been used, where did the water go? Remember, these were unregulated events. By comparison, as previously stated the Corps of Engineers when unregulating the flood flows for the 2003 event (also a double pump event), came up with flows at The Dalles of 209,000 cfs and at Sedro-Woolley at 202,000 cfs. A difference of only 7,000 cfs. By not separating out the different populations of flood events on the Skagit River, the computation of the flood frequency analysis is skewed and would appear to violate the spirit and intent of 17B.

## **RELIABILITY OF FLOW ESTIMATES**

Remember that Stewart’s flood flows by his own admission were in fact “estimates”. 17B addresses the reliability of flow “estimates” as follows:



#### E. Reliability of Flow Estimates

Errors exist in streamflow records, as in all other measured values. Errors in flow estimates are generally greatest during maximum flood flows. Measurement errors are usually random, and the variance introduced is usually small in comparison to the year-to-year variance in flood flows. The effects of measurement errors, therefore, may normally be neglected in flood flow frequency analysis. Peak flow estimates of historic floods can be substantially in error because of the uncertainty in both stage and stage-discharge relationships.

At times errors will be apparent or suspected. If substantial, the errors should be brought to the attention of the data collecting agency with supporting evidence and a request for a corrected value. A more complete discussion of sources of error in streamflow measurement is found in (7).

*(Source: 17B Pages 7 & 8.)*

*“Errors exist in streamflow records, as in all other measured values. Errors in flow estimates are generally greatest during maximum flood flows.” . . . “Peak flow estimates of historic floods can be substantially in error because of the uncertainty in both stage and stage-discharge relationships.”* The four major historic flood flow “estimates” as computed by Mr. Stewart are the maximum flood flows on the Skagit River. This has got to be more than just a coincidence.

The irony here is that the 4 flood events have been brought to the attention of the “data collecting agency” with “supporting evidence” much of which has been previously quoted herein, and it has been ignored. The use of the 4 historic flood events, all estimates, all qualifying as maximum flows, violates the spirit and intent of 17B due to the lack of reliability of said flows.

### **HISTORICAL FLOOD DATA**

With respect to using historical flood data 17B states the following:



10. Historic Flood Data - Information which indicates that any flood peaks which occurred before, during, or after the systematic record are maximums in an extended period of time should be used in frequency computations. Before such data are used, the reliability of the data, the peak discharge magnitude, changes in watershed conditions over the extended period of time, and the effects of these on the computed frequency curve must all be evaluated by the analyst. The adjustment described in Appendix 6 is recommended when historic data are used. The underlying assumption to this adjustment is that the data from the systematic record is representative of the intervening period between the systematic and historic record lengths. Comparison of results from systematic and historically adjusted analyses should be made.

The historic information should be used unless the comparison of the two analyses, the magnitude of the observed peaks, or other factors suggest that the historic data are not indicative of the extended record. All decisions made should be thoroughly documented.

[\(Source: 17B Page 19\)](#)

*“Before such data are used, the reliability of the data, the peak discharge magnitude, changes in watershed conditions over the extended period of time, and the effects of these on the computed frequency curve must all be evaluated by the analyst.”* As previously stated herein, the data is unreliable as it does not comport with local history; the watershed has changed dramatically since the original estimates for the historic flows were estimated; and the magnitude of the estimated discharges are skewing the rest of the results for the flood frequency analysis. To the best of my knowledge no “adjustment” has been attempted to be made in accordance with the 17B recommendation. Thus, the use of the historic data due to the reliability of the data not supported by historical documents, the peak discharge magnitude, changes in watershed conditions over the extended period of time, and the effects of these on the computed frequency curve all without any kind of an “adjustment” in accordance with Appendix 6, combine to violate the spirit and intent of 17B.

## CONCLUSION

Any one of the individual pieces of evidence would probably not be enough to rise to a level of doubt about using the Stewart historic flows, however, cumulatively they raise more than a reasonable doubt that Mr. Stewart’s work product is questionable and the evidence submitted herein should be evaluated in accordance with 17B.