SUSITNA-WATANA HYDRO

Meeting Notes

Geomorphology Technical Team Meeting

Assessment of the Potential for Changes in Sediment Delivery to Watana Reservoir Due to Glacial Surges – Technical Memorandum Glacial (Study 7.7) and Geomorphology (Study 6.5)

December 4, 2014

LOCATION: **Teleconference**

TIME: **10:00 am to 11:00 am AKST**

SUBJECT: **Potential changes to sediment delivery to Watana Dam due to glacial surges. (Study 6.5 RSP Section 6.5.4.8.2.1 and Study 7.7 RSP Section 7.7.4.4)**

GoTo MEETING: https://attendee.gotowebinar.com/register/1742658123022120450
1-888-585-9008 CODE: 810-056-852

GOAL: **Describe the results of the glacial surge evaluation and provide opportunity for discussion.**

PARTICIPANTS: **Betsy McGregor** AEA, **Doug Ott** AEA, **Julie Anderson** AEA, **Bill Fullerton** Tetra Tech, **Mike Harvey** Tetra Tech, **Lyle Zevenbergen** Tetra Tech, **Renee Vandermause** Tetra Tech, **Dave McLean** Northwest Hydraulic Consultants, **Dave Kroto** Tyonek Native Corporation, **Sue Walker** National Marine Fisheries Service, **Tyler Rychener** Louis Berger/FERC, **Fred Winchell** Louis Berger, **Becky Long** Susitna River Coalition, **Jan Konigsberg** Alaska Hydro Project, **Jay Stallman** Stillwater Sciences, **Dirk Pederson** Stillwater Sciences, **Joe Klein** Alaska Department of Fish and Game, **Leann Hanson** U.S. Geological Survey, **Greg Aubel** U.S. Geological Survey, **Betsy McCracken** U.S. Fish and Wildlife Service, **Bob Henszey** U.S. Fish and Wildlife Service, **Dara Glass** CIRI

Meeting Notes:

Betsy McGregor opened the meeting and described the purpose of meeting which was to discuss the Glacier Surge Technical Memorandum filed with FERC on November 14, 2014. Bill Fullerton introduced the presentation by explaining that Mike Harvey would present the Glacier Surge Tech Memo and that there was no additional presentation material.

Mike Harvey began the presentation with why the topic of glacial surge was included in the Revised Study Plan (RSP). It was based on a submission to FERC from Dr. Harrison (University Alaska Fairbanks)

that pertained to the potential for glacial surge to increase sediment loading to the proposed Watana reservoir.

Mike reviewed the Objectives from page 2 of the Glacier Surge Tech Memo and then presented some highlights from the literature review conducted as part of the study objectives. He then talked about surging glaciers and described that this process [i.e., surging] rebalances the glacier. Surging can result in that short term increases in sediment and water yields. Mike discussed the Variegated Glacier near Yakutat, AK and the West Fork Glacier in the Susitna basin. Both are surging glaciers that have been analyzed during surge periods and when surging the sediment and water measurements increased.

He then discussed if this increase in sediment due to glacial surging could be delivered to the proposed reservoir. From surges there could be up to 30 times the suspended sediment yield to the reservoir if sediment production equals sediment delivery. However he explained, this is not the case in the Susitna basin due to sediment storage zones between the glaciers and the reservoir 90 miles downstream.

Mike said that he could not find in the general literature what global warming would do to the frequency of surging or if glacial surging would be necessary to retain glacial balance due to global warming. Mike mentioned that Dr. Harrison had speculated glacial warming may eliminate or reduce surging. Along these lines, based on the periodicity of surging the West Fork Glacier should have surged in the 2000s but it has not yet occurred and there have not been signs that it is in preparation to surge. The lack of surging so far may be due to fluctuations in periodicity of surging, or it could be an indication of Dr. Harrison's hypothesis that surging may not occur under the current climatic regime.

Mike went on to explain that within the Susitna basin there are two surging glaciers: the West Fork and Susitna. The East Fork Glacier is non-surging and the Eureka and Maclaren glaciers (in the McLaren basin), if surge occurs they are weak. Overall, if the West Fork Glacier and Susitna Glacier surge, they could have an impact. And that is what was investigated in the Glacier Surge Tech Memo.

Mike presented the periodicity of glacier surge in the Susitna basin as:

- The Susitna Glacier surged in 1951 or 1953 (depending on when the surge period is defined) and has a periodicity of about 50 or 60 years.
- The West Fork Glacier surged in the late 1930s and again in the 1980s. While the 1980s surge was being studied at the time not much of the data were published and what was published consisted of rough notes.

The potential suspended sediment concentrations resulting from surges were discussed. There can be a large increase in suspended sediment concentrations in the mainstem river due to a surging glacier. Mike referred to the suspended sediment record from the Denali Highway gage on the Susitna River and its reasonable record of sediment yield (i.e., sediment rating curves) in non-surge periods. Mike showed Figure 4 (suspended sediment rating curves) of the Glacier Surge Technical Memorandum. The figure illustrates that under most conditions the suspended sediment concentrations are under 2,000-3,000 mg/L (ppm) – this is background level. Based on the USGS measurements, roughly 50% of the suspended sediment is silt and clay and the remainder is sand. Mike indicated this is an important ratio as the

system is transporting sand at the hydraulic capacity of the river and therefore it is the silt and clay fraction that will be delivered to the reservoir.

Dilution is known to influence sediment concentration so an analysis was performed to identify the dilution factor on the Susitna River between the base of the glaciers and Watana Reservoir. A dilution ratio was identified that could then be used to upscale the suspended sediment concentration up to the glaciers. This was performed in two ways: 1) by ratio of areas and 2) by ratio of flow volumes. At the glacier, suspended sediment concentration is roughly 3,000 ppm during non-surge periods. During a surge period, the suspended sediment concentration is a factor of 10 times greater than when the glacier is not surging. If the suspended sediment concentration during a glacial surge is used over the entire open water year then there would be 55 years of total sediment load to the proposed Watana reservoir in a 50 year period. This represents a long term increase in sediment loading of 10 percent and consequently would reduce the reservoir life by about 10 percent. This is a very conservative estimate but provides an upper bound on the increase in sediment loading to the reservoir from glacial surge. A less conservative approach would be to analyze the sediment load assuming there were two weeks of higher suspended sediment concentration. This would result in a loss of reservoir life of about 1 percent.

Mike indicated there is a need to look at the hydrologic component associated with glacier surges. That is, do glacial surges appreciably increase the discharge? From Gold Creek gage data there are two periods in the record that glaciers surged: the Susitna Glacier surge in the 1950s and the West Fork Glacier surge in the 1980s. The next part of analysis was to identify if the surging provided an abnormally large amount of flow. If there were increased flows then there would be a corollary increase in sediment loading to the proposed reservoir. The hydrologic analysis is illustrated in Figure 6 of the Glacial Surge Technical Memorandum. The figure illustrates that there is nothing unusual about the surging flows, or in other words, there appears to be no significant impact on flows, at least at the Gold Creek gage. To identify whether or not the time of the glacial surge was during overall low flows in the basin and thus possibly masking increased flows from surging, the flows at the Talkeetna and Gold Creek Gage were compared and shown in Table 1 of the Tech Memo. Only the glacial surge in the 1980s was evaluated because the record does not cover hydrologic data from the 1950s at the Talkeetna gage. In terms of the ratio of the Gold Creek to Talkeetna flows, the analysis shows that the surge years do not stand out as being significantly different than the rest of the record. If the ratios had changed, then that could have been an indication of unusual flows in the Susitna.

Mike concluded based on the analysis conducted in the Technical Memorandum that there may be few surges, maybe none, but they will not produce significant increased sediment loading to the reservoir, and that this analysis is sufficient to rest this issue. There is no need to include estimates of glacial surging into modeling of the reservoir.

Questions and Answers:

Dave McLean asked a question on whether the analysis included only one surge that reduced the reservoir life in the 800-year proposed reservoir life. Lyle Zevenbergen answered that the analysis included one surge every 50 years over the approximate 800-year reservoir life. Dave McLean replied, OK, this analysis seemed reasonable.

Becky Long asked about the length of the reservoir life and if anything would be different if the reservoir life was 400 years versus 800 years. Mike responded that percent reduction in reservoir life would be the same whether it was 400 years or 800 years and asked why she chose 400 years for the length of the reservoir life. Becky Long responded that she was just trying to get an understanding because this was the first time she has seen information on the duration of the reservoir life.

Bill Fullerton responded that the 800-year reservoir duration was the approximate *dead pool life*. The *time to fill the entire storage of the reservoir* has been estimated at several thousand years. The reservoir will be modeled in the Water Quality Study (Study 5.6) using the EFDC model which includes a much more rigorous determination of trap efficiency which will be used to refine the effects of sedimentation on the reservoir life. Lyle Zevenbergen added that the 850 year project reservoir life assumes the trap efficiency is very high and that it is actually a minimum estimate of the reservoir life.

Dave McLean asked for a clarification of the statement on page 2 of the TM regarding Clark and Harrison's estimate of annual total sediment load in which they estimate 30 years' worth of sediment produced from a surge. Why are the estimates developed in the TM much less in terms of the impact on the reservoir?

Mike Harvey responded that the two estimates are very different. He indicated that the concern over increased sediment loading from glacier surge first shows up in a paper by Clark and Harrison in the 1980s and is based on transposing some values that were estimated out of the Variegated Glacier. In the Variegated Glacier there was a sub-ice bed under the affected area that reduced 0.3 meters over the 20 year cycle. Of the 0.3 meters, a majority of the material was released over a short period of time. These data were taken and applied to the West Fork and Susitna glaciers and assumes that if the glaciers surge they would produce roughly 30 times the annual sediment yield at the Gold Creek gage. It was recognized that this was an upper level limit in the document and took no account of sediment sources and sinks.

Dave McLean said he understood but was wondering if there were any comments regarding sediment waves, sourced from a glacial surge, that may take years or decades to propagate.

Mike Harvey responded that yes this had been considered because sediment has to move throughout the system but at what rate is the question. He continued that the baseline is the data collected at the Denali Gage and from personal field experience on the Susitna, the bed is composed of sand, and based on known hydraulics and flows only so much sand can be transported.

Dave McLean responded that there could still be waves propagating sediment downstream. Mike Harvey responded that the concept of waves propagating downstream assumes the wave can transport the material downstream and looking at the area sediment would have to move through, there are huge sediment traps. Based on these constrictions and contractions in the Susitna, maintaining the hydraulic conditions to allow the sediment slug to move through the system is highly unlikely. Lyle Zevenbergen added that the main meter to sediment propagation is the braid plain that occurs directly below the glacier.

Dave McLean responded that he's not asking to do a fancy model of sediment propagation but it would be of academic interest to know when the reservoir fills, whether that be in 820 years or 850 years.

Dave McLean asked if changes to sediment yield in the basin due to climate change is being evaluated? Bill Fullerton replied that no, that is not currently part of the effort.

Becky Long asked if it was scientifically defensible to compare the Gold Creek gage to the Talkeetna gage in reference to the hydrologic comparison illustrated in Table 1. Lyle Zevenbergen explained why this analysis was performed. He said the reason the comparison was performed was to see if surge years are unusual in terms of amount of flow and then gave a quick reiteration of the analysis performed. Mike then added that the reason hydrologic comparison of the gages was performed was due to the question, "Did the glacial surges in the Susitna basin have a detectable hydrologic signature?" A similar comparative analysis was done in the 1980s by Labelle et al. in an effort to see if there was a hydrologic signature from the 1950s surge. LaBelle's 1980s analysis was not able to identify an impact of the surge hydrology.

Bob Henszey asked if the reservoir was not there what sediment would get down into the Middle Susitna River Segment? Lyle Zevenbergen responded that there would be a higher concentration of the *silt-sized* fraction. Over a few weeks during the surge one could see a 10 fold increase in suspended sediment concentrations *at the glacier* but this would be diluted, so by the time it made it to the Middle River, it would not be a 10 fold increase [about 30,000 ppm] but maybe closer to 800 ppm for brief periods and this would be the *silt size fraction* not sand fraction.

Lyle explained that the area of each of the major glaciers is on the order of 100 square miles and that the drainage area at Gold Creek is on the order of 5,000 square miles, there is considerable dilution of the silt load produced at the glaciers. He then said the vast amount of silt fraction is glacially produced.

Mike Harvey added that the glaciated portion of flow is roughly 13% of the flow at the Gold Creek gage. He noted that is considerable dilution by the time you reach Gold Creek gage and Figure 4 in the Tech Memo shows this. Moving from the green data points representing the Denali gage down to the blue data points at Gold Creek gage one is moving down to lower suspended sediment concentrations by moving downstream.

Betsy McGregor then asked if there were any more questions or comments related to the Glacial Surge Technical Memorandum. There were no additional questions or comments presented. The meeting was adjourned.