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July 5, 2021

Walter Nelson
Native Village of Napakiak

RE: Erosion reaching W. Miller Memorial School

To Walter Nelson:

The Alaska Division of Geological & Geophysical Surveys (DGGS) is charged by Alaska state statue to determine the potential geologic hazards that impact Alaska's people and infrastructure. DGGS traveled to Napakiak from June 27 to July 2, 2021 to investigate erosion and flood hazards and collect bathymetric and topographic data to support the Native Village of Napakiak's ongoing Kuskokwim River morphology study. We write this letter to highlight the urgent situation unfolding in Napakiak. The following are DGGS's interpretations based on historical and modern shoreline change measurements, on-site observations, and the community-based monitoring efforts by Napakiak.

W. Miller Memorial School

The east edge of the W. Miller Memorial School is 79 feet from the eroding riverbank as of June 29, 2021 (fig. 1). There is a reasonable likelihood that erosion will reach the school before the end of this year, 2021. There is a very high likelihood erosion will reach the school within two years. Since 1952 (69 years ago), this section of riverbank has eroded on average 33 to 42 feet per year. This rate would suggest there is at most 2 to 3 years before the Kuskokwim River reaches the school. However, in 2018, one storm eroded 30 feet (the usual annual distance) and an additional 82 feet eroded over the rest of the year (totaling 112 feet of erosion in one year). From July 2019 to July 2021 (two years), 140 feet has eroded (70 feet per year). Since May 2021 (one month), 13 feet has eroded without any notable storm activity.

These events demonstrate the possibility that the river could reach the school at any time. We recommend immediate action to move school buildings, lest they fall into the Kuskokwim River. Preliminary conceptual erosion models from Golder suggest there is a possibility of a sudden and seemingly unexpected erosion event (rather than gradual and anticipated). We recommend the school district discuss the safety of occupying the building with Golder.

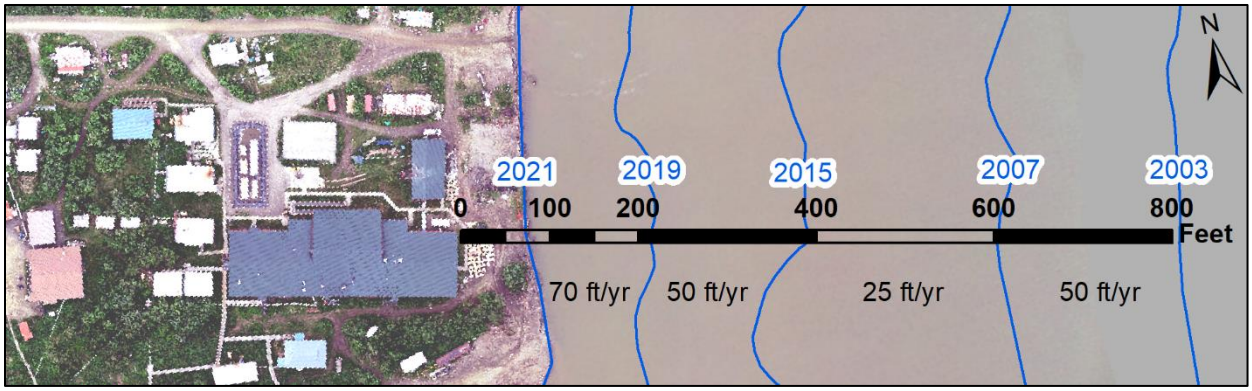

Figure 1. Kuskokwim River shorelines (blue) in relation to the school. The image is from the June 29, 2021 drone survey. The average erosion rate from 2003 to 2021 is 40 feet per year. Recent rates are 50 to 70 feet per year. The school is 79 feet from the bank and about 260 feet long.

New School Site

It is our understanding that construction of the new school has halted due to erosion concerns of the Kuskokwim River. Even considering recent erosion, we found no compelling evidence to suggest the new school site will be eroded in the foreseeable future. We explain our interpretation below. Golder is developing a river morphology report that will vastly improve the understanding of ongoing and possible future changes. We urge planners to consider our interpretation for now and refer to the results by Golder when their report is published.

As of July 2, 2021, the new school site is located 6000 feet from the Kuskokwim River (fig. 2). Despite recent events, the erosion rate from 2003 to 2021 is still 40 feet per year, matching the average since 1952. If this rate continues, the new school will be safe for 150 years. DGGS is publishing an erosion forecast for Napakiak and several other Alaska communities this summer. Fig. 2 shows results of that study. Erosion rates would have to increase 3 to 6 times to reach the new school in 60 years. We have no reason to believe erosion would or could accelerate to such sustained rates.

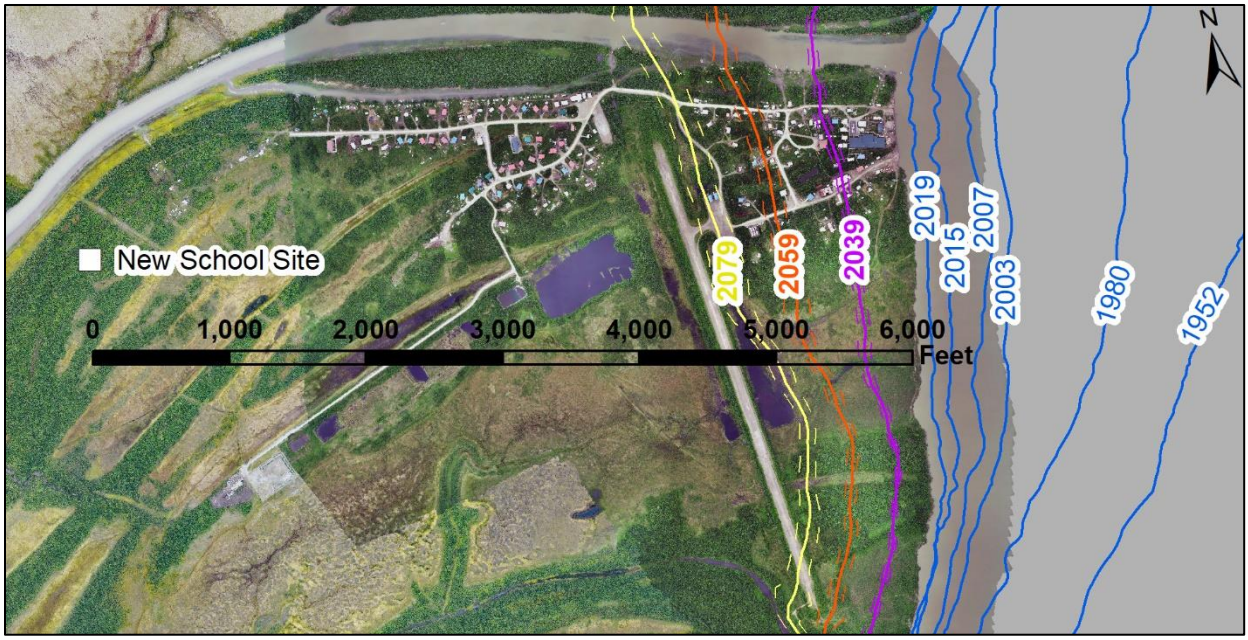

Figure 2. Forecast erosion from 2019 to 2079 based on the weighted linear regression rate of shoreline change from 1952 to 2019. The June 29, 2021 image is shown (darker image) along with the 2015 image (lighter image to the left) in areas beyond the newest image's boundary. Forecast uncertainty is at a 90 percent confidence interval.

Erosion Forecast by Two Bears Environmental Consulting, LLC

Two Bears Environmental Consulting, LLC (Two Bears) forecast erosion rates of 100 feet per year in Napakiak (beginning in 2017), and further accelerates rates to 150 feet per year by 2050. The Two Bears results show that what would normally erode in 58 years will instead erode within 9 years. We find these results unrealistic and unsubstantiated.

Two Bears does not explain the computational link between climate models and erosion acceleration. It is well understood that climate change in Alaska is likely to accelerate erosion. The clearest examples are due to permafrost thaw and less sea ice (higher annual wave energy and probability of storms developing during open water). Unfortunately, there is no simple equation to link climate projections to erosion rates. In other words, one cannot say, "X increase in temperature equals Y increase in erosion." In fact, Napakiak has a remarkably linear erosion rate despite significant changes in climate since 1952.

Two Bears claims permafrost thaw (or increased days above freezing) drives 55 percent of the erosion forecast (roughly accelerating 30 to 55 feet per year above current average). However, Napakiak has little if any permafrost to thaw, so frozen ground appears to play a negligible role in erosion rates. Two Bears fails to explain how increased temperature alone would cause erosion rates to double in Napakiak.

One of the most plausible explanations for future accelerated erosion in Napakiak is related to changes in river morphology. Two Bears evaluated precipitation and sea level rise but did not include several other river variables like discharge, tides, or changes to the thalweg. Napakiak is situated on a cut bank of the Kuskokwim River that has been eroding for at least 69 years. It is

possible that erosion rates will accelerate beyond the long-term average. It is also possible that the river will change course and erosion rates will decrease. The method by Two Bears cannot predict this morphological change. Even linear erosion forecasts do not adequately identify this possibility. The upcoming report by Golder will become the best available information on river change for Napakiak.

A fundamental rule of scientific writing is reproducibility: a separate group of researchers should be able to follow the same methods and arrive at the same conclusions. Two Bears failed to write methods in a way that is repeatable. This failure, along with implausible results, forces DGGS to cast major doubt on the merit of their report. This doubt also extends to the flood forecast, which we will not discuss in this letter. DGGS is currently investigating a flood impact history for Napakiak that will help in evaluating the flood analysis conducted by Two Bears.

Conclusion

The purpose of this letter is to support Napakiak with informed planning. The current school has a high likelihood of eroding into the Kuskokwim River. We recommend discussing with Golder about the safety of occupying the building this year. The new school site is very far from the Kuskokwim River and current evidence suggests erosion could not reach it over the next 150 years.

The erosion and flood forecast report by Two Bears lacks scientific merit and should not be relied upon for planning purposes. DGGS is publishing an erosion forecast and flood impact history for Napakiak. Golder is working on a river morphology study that will provide greater insights than any existing work.

These analyses were conducted as quickly as possible to support immediate decisions regarding the school and to prepare for the impending 2021 fall storm season. If identified, please report any errors.

Respectfully,

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