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January 18, 2011

Project No. 2-1587

Yakima County Public Services
Surface Water Management Division
128 North Second St.
Fourth Floor Courthouse
Yakima Washington
98901

Attention: Mr. Jeff Legg

Dear Mr. Legg:

Subject: Review of River Geomorphology and Sediment Transport Study Gap to Gap Reach, Yakima, WA

1. Background

Northwest Hydraulic Consultants (NHC) was retained by Yakima County Public Services to review hydraulic and geomorphic studies being undertaken as part of a plan to reconfigure levees and restore floodplain conveyance along portions of the Yakima River. The County's letter of March 4, 2009 identified three main tasks for NHC:

1. Review field data and model development and provide input for improving the data collection and model development and model validation. The analysis will identify limitations of the modeling with regard to the predictive response of the river to natural and infrastructure change;
2. Review the river/floodplain geomorphic analyses and assess whether these studies are consistent or disagree with the findings of the modeling investigations with regard to river response. Recommend means to resolve any conflicts, if they exist;
3. Provide a technical memo summarizing Tasks 1 and 2 and identify the potential uses and applicability of the sediment models and geomorphic information in establishing the predictive response of the future design of levee reconfiguration, floodplain and habitat enhancement and improving or maintaining the function of existing infrastructure.

The draft report "*Yakima River Geomorphology and Sediment Transport Study: Gap to Gap Reach, Yakima WA*" dated March 2010, prepared by Robert C. Hilldale and Jeanne E. Godaire of the Bureau of Reclamation, US Department of the Interior was provided by the County for review. I subsequently discussed the findings with Joel Freudenthal and Karen Hodges of Yakima County, particularly sections related to the historical analysis of cross section surveys and geomorphic assessment. I submitted review comments on the draft report to the County in a letter report dated May 10, 2010. The review indicated several areas where the report could be strengthened. We subsequently received an updated version of the report on December 8, 2010, along with two sets of SRH-1D model runs. This letter report summarizes our comments on the updated report. I have also provided some recommendations on further hydraulic design studies that should

be undertaken.

2. Review of Updated Report

The updated report has addressed most of the issues that were identified in the earlier review. Additions to the updated report include:

- More detailed assessment of historical channel trends, including a re-assessment of cross section survey comparisons, incorporating new information and analysis conducted by the County;
- An assessment of the upstream extent of influence of Wapato Dam;
- A description of sediment model limitations;
- Predictions of flood level changes due to levee set-backs for the simulated case 25 years in the future;
- Predictions of potential locations of future channel erosion and avulsion hazard using a stream-power assessment as well as geomorphic-based observations;
- More detailed comments and discussion on the potential impacts of levee set-backs on channel instability, sedimentation patterns, scour and upstream degradation;
- Recommendations on future studies and monitoring work.

No additional information was provided to justify combining the Engelund-Hansen and Wilcock sediment transport equations. To my knowledge this approach has not been verified extensively using field or laboratory data. However, I don't believe further model runs using different sediment transport equations or different assumptions about bed material loads would fundamentally change the main findings of the report. I believe the team has gone about as far as one can go with one-dimensional (1d) sediment modeling, given the limited data for calibration and verification. The main limitations of any 1d model for conditions on the Yakima River are:

- Can't represent the flow or sediment transport patterns in bends or complex flow spills onto the floodplain or breaches of levees into gravel pits;
- Can't represent different mechanisms for transporting or re-distributing the sand and gravel sediment from the main channel onto the floodplain;
- Can't represent bank erosion processes or avulsions.

Another site-specific limitation is that there is very little historic data available for verifying the 1D sediment model predictions. Although historic cross section data exists, at least five gravel pits excavated on the floodplain have been captured by the river during the period of the surveys. These limitations have been overcome as much as possible by supplementing the model predictions with other geomorphic-based methods or field observations.

The study provides useful information to assist in assessing the overall benefits of the proposed levee set-backs. For example, the study has shown that under existing conditions, the overall pattern of sediment deposition / degradation in the study reach will be relatively small in the future, provided no new re-alignment of the channel occurs due to an avulsion. The predicted average annual sediment loads along the river were relatively small, amounting to approximately 8,000 tons/year of gravel and around 9,000 tons/year of sand (17,000 tons/year of bed material). After setting back the DID No. 1 levee, the flood level was predicted to decrease by between 3 to 5 feet. This reduction in flood levels was shown to be nearly the same after 25 years of simulated flows and sediment transport. Degradation was predicted to occur

upstream due to the reduced backwater effect, which could cause bed lowering at the SR24 Bridge and the Beech Street gravel pit.

One of the most important sections of the report deals with the effect of setting back DID No 1 levee on the river's stability. Much of this assessment has been based on previous experience and site observations rather than the model predictions. Following removal of DID No. 1 levee the main channel could avulse into the existing gravel pits on the left bank. This avulsion could cause additional headcutting and degradation upstream and could affect the integrity of the SR24 Bridge abutment and foundation. The report recommends that a plan should be in-place to prevent an avulsion into the gravel pit.

The report also refers to the case study by Norman (1998)[1] concerning the 1996 avulsion of the Yakima River into the gravel pits just upstream from the study area at Selah Gap. Some of the key findings by Norman were as follows:

- Large ice jams played an undefined but likely significant role;
- About 6 to 8 feet of incision occurred after the avulsion immediately upstream of the pits. There was local knickpoint migration as evidenced by a migrating standing wave and increased bank erosion as the river tried to re-establish its grade;
- At least 300,000 cubic yards (roughly 450,000 tons) of gravel was scoured from the river bed and deposited as 6 foot thick layer in the excavated pit;
- More than 100,000 cubic yards (150,000 tons) was moved from the river bed during the flood and deposited on gravel bars and private lands upstream of the pits.

The magnitude of these channel changes (both the bed level changes and quantities of gravel transport) are far greater than the computed bed level changes and sediment loads estimated by the sediment model over a 25 year simulation period. A single avulsion or channel shift may induce very large changes in the river's behaviour and may completely alter the pattern of sediment transport that occurs under stable channel configurations.

3. Conclusions and Recommendations

I believe the updated report is substantially complete and has fulfilled its main objectives. Some minor typo corrections were noted, which should be incorporated into the final document.

Additional hydraulic design investigations should be carried out to design appropriate river training measures to prevent an avulsion of the river into the existing gravel pits after the DID levee is set-back. The scope of the hydraulic design studies should include (1) design of measures to prevent an avulsion into the existing pits near the DID No. 1 levee, (2) mitigating potential scour or erosion at the SR24 Bridge and (3) mitigating upstream degradation to prevent an avulsion into the Beech Street gravel pit. The additional investigations should include gathering topographic surveys in the gravel pits and the adjacent floodplain and more detailed channel bathymetry. It would be useful to develop a 2 dimensional numerical model of the reach extending from upstream of the SR24 Bridge down past the DID No. 1 levee. The 2D model would be used to assist in designing river training / channel stabilization works and to verify that the anticipated flood level reduction due to setting back the levee can still be achieved.

[1] Norman, D., Cederholm, C. and W. Lingley Jr. (1998): Flood Plains, Salmon Habitat and Sand and Gravel Mining, Washington Geology, vol 26, no.2/3 September 1998.

Consideration should be given to using a mobile-bed physical hydraulic model to test the performance of the bank stabilization designs. This would significantly increase the confidence that the proposed measures will prevent an avulsion into the gravel pit and prevent any adverse impacts to the SR24 Bridge, while still achieving the desired reduction in flood levels.

If you have any questions on these comments or wish to discuss the scope of any further hydraulic investigations, please feel free to contact me by email at dmclean@nhc-van.com or by phone at 250-754-6425.

Sincerely,

northwest hydraulic consultants

{*original sent by email*}

Dave McLean, Ph.D., P.Eng.
Principal