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January 25, 2011

Amanda Joynt
Fish Habitat Biologist
Department of Fisheries and Oceans
P.O. Box 1871
Inuvik, NT
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Dear Ms. Joynt:

RE: The Use of Frozen River Sediment as a Source of Backfill for the Unipkat I-22 Sump Remediation on Arvoknar Channel
DFO file No.: 10-HCAA-CA6-00097

Further to our recent conversations, we would like the Department of Fisheries and Oceans to approve a plan to use frozen bar sediments from Arvoknar Channel as a source of backfill for the remedial excavation of the Unipkat I-22 sump. This letter is intended to provide DFO with the rational for approval of this proposal.

1. PROPOSED PLAN

During the Unipkat I-22 sump remediation program we propose to remove approximately 3000 m^3 of sediment from the surface of exposed, frozen sandbars in Arvoknar Channel for use as backfill in the riverside remedial excavation. Besides the desire of the surrounding communities to avoid leaving a depression and pond at Unipkat I-22, there are tangible environmental benefits and margins of confidence gained by completely backfilling the proposed excavation. The idea of using channel bars as a source of backfill was suggested to Shell Canada during community consultations with the Inuvik Hunters and Trappers Committee.

The proposed methodology for the sediment removal is to select channel bars that are exposed and frozen. Approximately 0.3 m of sediment would be ground off of the upper surface of the bars using an Iron Wolf excavator.

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2. REQUEST FROM DFO

During our discussions, DFO requested that we provide details on how the removed surfaces of sandbars would affect hydraulics during breakup and high water flows with and without ice cover; information on bed loads and a prediction of the time required for the bars to recover their previous shape.

3. ANALYSIS OF AVAILABLE INFORMATION

The Mackenzie River Delta is subject to large movements of sediment. The volume of the proposed sediment removal for backfill at Unipkat I-22 is minimal compared to natural sediment movement. Although volumes of water and sediment movement in Arvoknar Channel are not known, Arvoknar is one of five main branches of Middle Channel and is similar in size to East Channel. Each year, East Channel in the Mackenzie River transports an estimated average of 1.4 billion tonnes of suspended sediment into the delta from June through September (based on available Canada Water Survey data for 1974, 1975 and 1994). Using a conservative estimate of flow in Arvoknar Channel would be in the range of 50% of the flow in East Channel. Based on these estimates, the volume of suspended sediment transport in Arvoknar Channel would be 700 million tonnes (annually June through September). A generous estimate for the proposed volume of borrowed material is approximately 5400 tonnes which is 0.0008% of the estimated suspended load. The channel is also likely to contain significant volumes of bed load.

Past experience at other locations has indicated that sedimentation rates in the Mackenzie Delta are high. Dredged channels such as those at the Kittigazuit S-bends have been rapidly in-filled by sediment. Scouring of sediments and erosion by strudelling are additional mechanisms of sediment displacement in the Delta and further indicate that the natural environment is accustomed to the processes of large sediment movements.

While features such as point bars may be a relatively consistent size and shape over time, they are likely subject to periods of both erosion and deposition. Fundamentally however, point bars are depositional features in rivers and it is likely that wherever sediment is removed from space for deposition of new material.

Studies in other channels in the Mackenzie Delta have found that these channels can be highly dynamic and undergo rapid erosion and sedimentation rates. Bank erosion rates of approximately 6 m per year have been measured in Kumak Channel and corresponding sediment deposition was recorded downstream (Whalen et. al. 2009).

Studies on Arvoknar Channel have demonstrated that there is a significant rate of cut bank erosion, averaging 1 m/year at the Unipkat I-22 site (Komex 2002, IEG 2009, IEG 2010). The cut bank erosion is a source of bed load in the channel and past studies of

channel cross sections have suggested that in-channel deposition does occur downstream of rapidly eroding banks (Whalen et. al. 2009). Studies conducted at the mouth of Arvoknar Channel have found that there has been major reorganizing of the mouth bars (Solomon, 2011). These observations support the hypothesis that significant volumes of sediment are naturally moving in the channel and that material eroded from upstream cut banks would provide sediment for deposition on bars where sediment was removed.

By completely backfilling the remedial excavation with sediment from the river there is likely a net benefit to the channel's natural morphology over time. By using native material to completely backfill the excavation on the eroding river bank, permafrost and erosion rates are more likely to resemble the original site conditions and less likely to increase bank erosion rates that may otherwise be increased if a void was left in the excavation.

Table 1 summarizes the information that would be required and is available to develop a model for flow and sediment characteristics on channel bars in Arvoknar Channel.

Table 1: Information Required to Model Flow Characteristics and Predict Sediment Deposition on Bars in Arvoknar Channel

Information	Available Y/N?	Source	Alternative
Flow Rates	No	The Canada Water Survey (CWS) does not have data for Arvoknar Channel	CWS has water level (stage) data for a point upstream of the site and flow rates for Middle Channel. May be possible to estimate the volume of flow that branches off of middle channel. The estimate would be inaccurate. Winter flow velocities could be collected but would not reflect peak flow or break up conditions.
Channel Bathymetry	No	Darwin Monita of Aquatics Environmental Services indicated that detailed bathymetry had not been conducted on Arvoknar because barges are able to pass	There is a Channel cross section from the 1990's in Shell's I-22 file. A winter field program could provide additional channel cross sections
Historic Channel Morphology	Yes	Can be analysed from historic air photos	
Break-up Sequence	No		Could be estimated from other studies in the region and estimated from satellite imagery but likely to be highly variable.
Sediment Loads	No		Could be estimated from other studies in other channels in the Delta.
Sediment Characteristics and Sheer Stress	Possible	Canada Water Survey may have data for samples collected up stream.	A field investigation could collect samples

The information in Table 1 demonstrates that there is insufficient data to produce or calibrate a reliable model. Any model generated would rely upon a large array of assumptions that could not be field calibrated. The flow dynamics of break-up are complex and highly variable over time.

4. PRECEDENT

The removal of sediment from river channels is generally conducted as a dredging operation to increase water depth for transportation. In the case of channel deepening, the spoil material is a waste by-product that must be disposed of. Local examples of this can be seen in the dredging of the Kittigazuit S-bends and removal of bar/bank material during Shell Canada's 2007 Niglintgak Foundation Trial on the bank of Middle Channel. The sourcing of fill from channel deposits is uncommon for several reasons that include its relative inaccessibility and the general poor quality of silt for engineering purposes.

In the case of Unipkat I-22, river sediments from the local environment are an ideal borrow source. There is a recognized positive benefit to maintaining permafrost by backfilling the excavation; a scarcity of suitable alternative fill; the quantity required is minimal compared to the abundant potential supply; the channel bars are renewable, the geotechnical characteristics of the fill are relatively unimportant; and, the material is similar to surrounding soils and will be returned to the channel environment in the course of natural channel morphology. These benefits are site specific and uncommon. The unusual circumstances of this site are unlikely to be replicated in many cases.

5. CONCLUSIONS

There are large data gaps that restrict the development of model that would predict sediment and flow characteristics in Arvoknar Channel. Any modelled predications on bar morphology would be speculative and based on large assumptions that would devalue the results.

A wide range of observations and studies indicate that Arvoknar Channel transports sufficient sediment loads to replenish the proposed volume of removed bar material. It is also likely that the natural flow of the river would deposit new sediment on the bars.

The Mackenzie River is subject to significant natural and human displacements of sediment for a variety of reasons. The proposed shallow scallops that would be formed by the removal of sediment for this program are relatively minor compared with natural sediment dynamics in the Mackenzie Delta. Because the removed sediment would be

frozen and would be replaced by subsequent spring or summer flows, there is unlikely to be negative effects on fish or fish habitat.

We would appreciate the input of DFO on the selection of bars and, should the Department see fit, would welcome DFO supervision of the operation.

If you have any questions please feel free to contact me at (403) 990-1382 or at sbird@ieg.ca.

Yours truly,
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Sam Bird

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