Fisheries & Oceans Canada

INTERVENTION COMMENTS

Jericho Diamond Mine Project

2003-11-12

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1. Introduction

This document summarizes Fisheries & Oceans Canada's (DFO) comments with respect to the proposed development of the Jericho Diamond Mine project. These comments stem from a detailed review of the Final EIS and supplemental information provided by Tahera Corporation. The purpose of these comments is to provide expert advice to the Nunavut Impact Review Board (NIRB) to help in its assessment of potential environmental impacts associated with this project. DFO's comments relate primarily to impacts on fish, fish habitat and navigation.

DFO's responsibility with respect to this project also includes the administration of several key pieces of environmental legislation including the *Fisheries Act*, the *Navigable Waters Protection Act*, the *Species at Risk Act* and the *Canadian Environmental Assessment Act*.

The recommendations presented in this submission may be modified as additional information is brought forward by the proponent or identified during the public hearing. Should new information be obtained, any changes in DFO's recommendation will be brought to the attention of the NIRB.

2. Review of Environmental Impact Assessment

2.1. Stream C1 Diversion

The project calls for the realignment of 541 m of Stream C1 to maintain the drainage capacity of the basin and direct water around the mine pit to prevent flooding. This 541 m of natural stream is proposed to be replaced by a 425 m diversion that will be lined with rip rap and include an energy dissipation pond within the channel at the downstream end where flow re-connects with the original stream. No ice-rich soils are expected to be encountered during the construction of the diversion channel. The energy dissipation pond is not expected to allow passage of fish at low summer flows and is expected to require regular maintenance as sediment accumulates. The report concludes that the section of stream that is to be diverted does not support fish and therefore is not considered fish habitat. Also, because flows will be maintained below the diversion, no impacts to the lower 100 m of the natural stream is expected.

Discussion

DFO disagrees with the report's conclusion that only the lower 100 m of Stream C1 is fish habitat and that this stream section will be unaffected by the diversion. Fish have been identified upstream within Lake C1, and downstream within 200 m (1995 survey by RL & L Environmental Services) of Carat Lake. This lends to the conclusion that fish can and do utilize this middle section of Stream C1, at least during certain times within or between years. The discrepancy between fish surveys conducted in 1995 and 2000, reporting observations of fish within 200 m and 100 m, respectively, of the confluence with Carat Lake, suggests that fish passage and instream fish habitat may have already been compromised by berm construction during the exploratory phase of

this project. Furthermore, DFO's interest in fish habitat includes not only those area where fish are found, but also elements of the environment which play a supporting role in maintaining fish populations. In this case, surveys conducted in 1995 showed Stream C1 supporting nine genera of aquatic macroinvertebrates. Aquatic insects are an important source of food for fish, especially in northern environments where food is often a limiting factor in fish production.

The rip rap lined channel that is being proposed for the diversion channel will offer little in the way of replicating the fish habitat that will be lost, and may interfere with fish movements through this area. The energy dissipation pool will also impede fish movement and is located in an area that RL&L has recognized as good rearing habitat.

Sedimentation and erosion are also of concern regarding the construction of the C1 diversion channel. Reference is made to the possibility of excavation in ice rich soils. Excavation in ice rich soils is of considerable concern based on previous experience in constructing diversion channels in permafrost areas. There is a need for mitigation for sediment release, other than the use of geotextile and rockfill, to protect against erosion, and detailed monitoring to track permafrost integrity. The report suggests regular maintenance in the form of sediment removal from the dissipation pool. This pre-supposes that sediment releases will be a problem. It is not clear why the dissipation of flows will even be necessary or why the design calls for a pond with its outlet at a 90 degree angle to the inflow of the natural stream.

The proposed diversion will be 116 m or approximately 20% shorter than the natural stream channel it will replace. The loss of stream features, including pools and ponds in the diversion will likely result in greater velocities in this section and unmoderated flows to the lower, natural stream. The diversion will also likely have lower benthic production thereby affecting its contribution of food to the lower, natural stream.

Summary

Stream C1 in its entirety is considered fish habitat and the diversion of the stream will need to be included in the accounting of losses to fish habitat. A more natural channel needs to be designed, one that includes features that enhance fish habitat, ensures no impediments to fish passage and prevents erosion and the discharge of sediments. Ideally the diversion channel should emulate the stream being lost in capacity, characteristics, and substrate. The release of sediment to fish habitat can not be authorized and thus the potential for sediment discharge must be mitigated. Proper channel design should preclude the need for an energy dissipation pond within the stream channel. Even with these improvements, the diversion channel may not entirely compensate the loss of the existing functioning stream channel and the reduction in stream length.

The post-closure flow characteristics of the stream should be modeled to account for the fraction of the catchment area drainage that will be withdrawn by the pit. This will help ensure that the recharge of Lake C1 and flow in the diversion channel will be maintained such that productive capacity of stream is preserved.

The berm that was constructed across Stream C1 in 1995 appears to be interfering with the movement of fish within the stream. This problem will need to be remedied, possibly through the removal of the berm and remediation of the surrounding area.

2.2. PKCA Facility

The processed kimberlite containment area (PKCA) will be constructed in the Long Lake basin and will consist of two cells and one polishing pond. The combined berm construction, storage of fine kimberlite fractions and sediment deposition in the PKCA will ultimately result in the destruction of fish habitat throughout the entirety of the Long Lake system. This system includes Long Lake and three smaller proximal waterbodies, for a combined loss of approximately 11 hectares of lake habitats.

PKCA discharge will be to the west via Stream C3 and eventually into Lake C3. During the construction and operation of the PKCA flow throughout the entire 1080 m of Stream C3 will experience drastic manipulations and local fish habitat will be disrupted. Upon mine closure flow to Stream C3 would be lowered and possibly discontinued. Tahera concludes that due to the small size of Stream C3 the effects of effluent discharge are not significant.

Tahera also states that fish habitat within Stream C3 is restricted to the lower 300 m due to dispersed and subsurface water flow. The stream is deemed to provide marginal fish habitat and the area requiring compensation is calculated to be 181 m^2.

Discussion

Details on how the drawdown of water and salvage of fish are to be accomplished from Long Lake were not provided. Tahera plans to affect the drawdown when the lake is ice covered to limit the mobilization of sediment. They have not been able to reconcile this with the salvage of fish, but have suggested the possibility of a fish salvage operation the summer prior to draining the lake. This unresolved aspect of the project design needs further consideration

Stream C3, together with the Long Lake system that feeds it, provides habitat to the fish of Lake C3. The current plan calls for initially dewatering Stream C3 and then increasing the flow by 50% over natural conditions. Ideally DFO would prefer that stream flow match the natural hydrograph. If this is not possible habitat accounting needs to be undertaken to quantify the habitat losses for the entire length of Stream C3 and the transitional zone extending into Lake C3. More consideration needs to be given for the potential for increased erosion and sedimentation arising from increased flows into Stream C3.

Characterizing the use of the stream as opportunistic is not a unique quality but rather one that describes Arctic streams in general. Arctic streams tend to be distinguished by peaks in flows with intermittent periods of no or very low flow, have boulder substrate and be braided in nature. Variations in precipitation from dry to wet years generally dictate which streams in a system will preferentially be used. Streams are

critical to the completion of life stages for many northern species and can not be discounted based on their seemingly limited capacity to provide habitat.

Additionally, changes in water quality due to discharge from the PKCA have not been adequately considered in terms of the alterations to habitat quality and potential use by fish.

Summary

The Long Lake system consists of Long Lake, two adjacent ponds, connecting streams and Stream C3. All of these components need to be accounted for in the habitat compensation for this project.

Stream flow alterations need to be properly assessed for the resulting changes in stream and habitat function for both operation and closure phases, and impacts to the important stream/lake transition zones need to be adequately characterized.

Details on how the drawdown of water in Long Lake will be carried out need to be provided. DFO will require that a fish-out/salvage be undertaken and can provide its protocol for fish-outs to Tahera. Even with the most stringent relocation measures, fish are still expected to be destroyed as part of the operation of the tailings facility and a section 32 authorization will be required.

2.3. Carat Lake Causeway

The construction of a 90 m long causeway in Carat Lake is proposed to protect water intake and effluent lines from ice damage. The proposed construction area is used by several fish species including lake trout, Arctic char, burbot, round whitefish, and slimy sculpin. The shallow-water shelf zone is used for rearing and feeding, and spawning occurs in the vicinity of the causeway. At closure, the water intake pipe would be sealed and the causeway graded to ice level. The dislodged material would be placed onshore or allowed to sink to the bottom.

Discussion

Causeway construction and rehabilitation will physically cover fish habitat, introduce sediment into the water, and alter nearshore water circulation in Carat Lake. The causeway will result in the direct loss of fish habitat through 1395 m^2 of infilling in the lake. Impacts to fish habitat could also result indirectly by alteration of water movement patterns in the vicinity of the causeway. This could cause sedimentation of nearby spawning and feeding habitats and reduced water movement in spawning areas to such a level that fish may no longer use these sites.

Shortening the causeway length will lower impacts on fish habitat by reducing its footprint and lessening the effect on nearshore currents. Tahera's suggestion that the water intake pipe be buried in the lake bottom to protect it from ice damage was not examined in detail but warrants serious consideration. This option would be less damaging to fish habitat in that it would avoid altering nearshore currents and

alleviate the need for infilling. Appropriate measures, such as the use of sediment curtains, would need to be implemented to reduce sediment releases during trenching, especially considering that sediments may contain elevated concentrations of arsenic, chromium and copper.

Summary

Due to the likelihood of the causeway interfering with nearshore processes, the proximity to and impact on suspected spawning areas, and the direct loss of habitat from the causeway footprint, DFO requests that changes to the causeway design be implemented to avoid these impacts altogether. Design changes might include allowing for flow-through along the length of the causeway or burying the intake pipe. DFO's preference would be to bury the pipe, thereby eliminating both the concern of disrupting nearshore currents and the direct loss of fish habitat through infilling.

DFO would prefer that the causeway be removed at the time of mine closure rather than simply grading the causeway to ice level, as is currently being proposed. Complete removal of the causeway will help to ensure no long-term residual impacts to either fish or fish habitat within Carat Lake.

Tahera has committed to applying DFO's guidelines for fish intake screens. DFO recommends the use of screening with a maximum opening of 2.5 mm, or 1/10 inch (Cott, P.A. and J.P. Moore. 2003. Working Near Water, Considerations for Fish and Fish Habitat).

2.4. Road Construction

Tahera is proposing a network of permanent and winter roads. The permanent road alignment (6.9 km) will traverse one defined stream channel (Stream C2) which is reported to contain no fish at the proposed crossing location. The road will end at Contwoyto Lake where it will require a ramp to facilitate vehicle access to the lake during winter and emergency boat access during summer. A winter road would be used during the first year of construction and would cross two watercourses (Streams D1 and D2) and Lynne Lake but would not require permanent structures. The proposed routes will be constructed largely over bedrock or thin soil deposits to avoid sedimentation and erosion and to minimize interruptions of the natural drainage system. Consideration has also been given to permafrost, with a commitment to leave any soils in place and cover them with waste rock to prevent the melting of permafrost. Tahera intends to further mitigate potential impacts of sedimentation arising from drainage alterations and ditching by following DFO's stream crossing guidelines (DFO 1995b)

Upon closure of the mine, all permanent roads and culverts will be removed, and the sites rehabilitated.

Discussion

Ephemeral streams have shown an incredible, and previously under-credited, capacity to support fish. Arctic grayling are especially well adapted to navigating up seemingly impassable streams. These drainages also supply critical recharge of water and nutrients to receiving environments. Interfering with the flow of these streams often results in water management issues, undesirable flooding, erosion and occasional road washouts.

Construction of a ramp on Contwoyto Lake will result in the harmful alteration and disruption of fish habitat. These impacts will need to be accounted for and offset through the design of the ramp and perimeter or elsewhere in the site compensation plan. Mitigation measures, consistent with all other aspects of projects construction and operation will also need to be applied to prevent the entry of sediments and other deleterious substances from entering the water.

Summary

All drainages should be mapped and assessed for their potential use by fish. Techniques should be employed to ensure unimpeded surface drainage can occur, and where necessary, be designed for fish passage. Road construction must take into consideration altered surface drainage patterns that will result once mine infrastructure is in place. Detailed plans for the road crossing at Stream C2 will need to be provided to ensure fish passage is not compromised.

The impacts associated with the Contwoyto Lake ramp will need to be included in the accounting of impacts to fish habitat. Detailed designs and scheduling will be required by DFO to complete a review.

2.5. Compensation Plan

Tahera identifies four sites within the bounds of this project that will result in harmful alteration, disruption or destruction of fish habitat and that will require the issuance of a *Fisheries Act* section 35(2) authorization. These four sites include the access ramp on Contwoyto Lake (150 m^2); the water intake causeway on Carat Lake (1395 m^2); the introduction of suspended sediments during construction and maintenance of the diversion into Stream C1 (387 m^2) and Carat Lake (40 m^2); and altered flow of Stream C3 from the PKCA (181 m^2). When combined these aspects of the project will result in a total loss of approximately 2,153 m^2 of fish habitat. The majority of these areas were characterized as rearing habitats for fish residing in the affected water bodies, although spawning and feeding habitats will also be affected. A fifth element of the project, the construction of the PKCA, will destroy several water bodies in the Long Lake System. Tahera estimates the losses associated with this project element to be approximately 92,500 m^2 of marginal habitat.

The fish habitat compensation being proposed consists of a combination of fish habitat improvements and the removal of suspected fish passage barriers.

Habitat enhancements will involve the addition of rock material at five sites within close proximity to the project area. These sites include the perimeter of the causeway, the southeast shore of Carat Lake, as well as Lakes O1 and O2 and Stream O9, which are situated to the north of the mine site. The material for lake enhancement will consist of large waste rock available from the mine site, which will be placed on the ice, to sink to the bottom in the spring. In Stream O9 boulder clusters and small gravels will be distributed on the channel bottom in select locations. Improved access to fish habitat focuses on two fish passage barriers in the form of a cascade on Stream O18 and a shallow ill-defined section of Stream O21.

Discussion

Of the five project components that Tahera has concluded require compensation impacts to stream C1 have not been included. As discussed previously, DFO does not agree that impacts will be mitigated with the proposed diversion; hence compensation for the lost natural stream channel still needs to be addressed. As well, the introduction of suspended sediments to water bodies can not be authorized and must be mitigated.

The concept of enhancing fish habitat through the addition of rocks has merit in certain situations, but the documentation does not demonstrate, to the confidence of DFO, that rocks will be effective in this case. Expecting rock to fall through ice is unpredictable and experience has shown problems with attaining the desired configuration. The proposal to use large waste rock does not appear to be supported by substrate type and size requirements of the target fish species and lifestages. Shallow, sheltered rearing habitat was identified as being limited at the project site and it is not clear how the addition of rock may address this. It is important to recognize as well, the extreme difficulty in offsetting losses to fish habitat arising from permanent destruction by merely enhancing existing habitats. Long Lake as it currently exists supports a viable, self sustaining population of fish, which will be completely and permanently lost. It is much more practical to look at other compensation options that can, in and of themselves, offer new self sustaining fish populations.

The removal of fish migration barriers may also be of some value in increasing fish access to currently isolated locations, but this must be approached with extreme caution. Species such as Arctic char move into isolated lakes during the spring freshet and remain there to spawn and overwinter, returning downstream the following spring. Removing certain barriers may improve access by predatory fishes to these hitherto protected spawning and nursery areas. It is also possible that the existing barriers may only represent partial barriers, and improved access through these sites may offer only a marginal benefit to the fish utilizing those systems. A greater level of effort would need to be offered in developing the rationale behind these options before they could be considered.

The idea of rehabilitating the pit lake was only briefly considered, but in DFO's opinion this may have the greatest potential for locally compensating for the loss of fish habitat. However, it would require considerable work to rehabilitate the pit to a

state where it is suitable for fish production. This would include the construction of littoral benches, introduction of a diversity of substrates, establishment of connections with surrounding watercourses and establishment of primary and secondary producers. Estimates would need to be provided on the annual amount of water available from Carat Lake that could be pumped to facilitate filling of the pit, without causing any impact to the fish habitat of Carat Lake. The total percentage of the drainage basin that would be, or could be, captured by a pit lake would have to be determined and managed such that the Stream C1 diversion would be maintained. The permanence of the Stream C1 diversion would also have to be reassessed under the scenario of a pit lake being established, to determine the suitability of a connection to downstream systems. Monitoring would be required to confirm water quality.

Notwithstanding the previous discussion of a possible end pit lake, it is important to note that no empirical data currently exist to support the concept of an end pit lake as providing productive fish habitat in the North. As such, DFO does not automatically accept end pit lakes as compensation for impacts to lakes associated with diamond mining. DFO has however, expressed its support for efforts which focus on demonstrating this potential and may consider end pit lakes as compensation once their success has been demonstrated.

Summary

The compensation plan that has been provided is presently inadequate to meet DFO's policy of achieving no net loss of productive capacity. The potential to reduce the impacts to fish habitat, such as eliminating the Carat Lake causeway, or finding an alternative to using Long Lake as a PKCA facility should continue to be explored.

Before additional consideration can be given to the use of rock placement or the barrier removal options as compensation, more information will need to be provided to demonstrate that they will, in actuality, offer some benefit.

Whatever compensation options are ultimately accepted, there will be a need for monitoring to ensure that compensation was constructed as intended and functioning properly, with the possibility of follow-up measures needed to rectify unforeseen complications.

2.6. Water Quality

Several components of the mine site are sources of runoff, including waste rock dumps, overburden stockpile, ore stockpiles, coarse processed kimberlite stockpile and the mine pit. Surface runoff from permanent roads may also contain elevated levels of suspended sediments. Effects from suspended sediments from these runoff sources are considered minor since ditches or the tundra would contain the sediments and hence, were not assessed.

Supplemental documents released in October 2003 identified surprisingly large revisions to the water balance presented in the Final EIS. They include an increase in

the total annual discharge of water from the PKCA from 300,000 m^3 to 1,000,000 m^3 and adjustment of the estimated ammonia concentration in the PKCA from 30 mg/L to 2.9 mg/L. These changes result from corrections to the data on regional hydrology and re-assessment of whether nitrogen release data from the exploratory mining is applicable to the pit. Filling time for the pit was also revised to 20 years from the initial estimate of 150-200 years. The mean annual precipitation was corrected to 330 mm and the mean annual runoff at the outlet of Carat Lake was estimated at 210 mm. The overall load of ammonia was predicted to decrease from about 9,000 to 3,000 kg/y.

Subsequent to the release of the Final EIS, cadmium was identified as a contaminant of potential concern. Concentrations in the PKCA effluent were predicted to exceed Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for freshwater aquatic life at the outlet of Stream C3 (plus 100 m), under average flows and at the Lake C3 outlet under low flows. Cadmium concentrations in the pit shortly after closure were also predicted to exceed the CCME guidelines for freshwater aquatic life.

A number of options for the treatment of runoff and process water were examined in the Final EIS. These include, in particular, routing of contaminated runoff from the collection ponds and pit to the PKCA and spray irrigation to reduce ammonia discharge to the Carat Lake system. The implementation of both options appears to be contingent on the level of contamination that occurs once mine operations begin.

Effluents from sedimentation ponds A, B and C may also be directly discharging to the environment, bypassing the PKCA, should their quality be proven to meet discharge criteria.

Discussion

There is clearly wide uncertainty in the water and nitrogen balances, given the highly different estimates provided. Based on this uncertainty, it is difficult to properly assess the potential adverse impacts of the mining operation or the adequacy of proposed mitigation. This uncertainty must be recognized in the assessment phase. If the project proceeds to the regulatory phase, provisions will need to be included to ensure that any significant underestimates of the nitrogen loading are promptly and correctly remedied.

The residual effects of elevated cadmium in the PKCA effluent and sediments were not addressed in the Final EIS. The predicted concentrations may not be toxic to fish but could adversely affect zooplankton, which are sensitive to concentrations as low as 0.0002 mgCd/L. Impacts to zooplankton can have cascading, negative effects on the upper trophic levels that rely on them. Cadmium is more toxic in water where calcium and magnesium levels are low and its toxic effects may be increased in the presence of copper. Mitigation of cadmium contamination in water is difficult and addressing it via dilution is often undesirable. The minimum dilution predicted at the outlet of Carat Lake is 40:1. While cadmium is rapidly lost from the epilimnion of Shield lakes in northwestern Ontario, such that it seldom exceeds 0.0002 mg/L, it

accumulates in the sediments and in long-lived biota can reach potentially toxic levels. Introduction of cadmium can also have a negative impact on benthic communities and in turn, the fish that rely on them as a food source. Consideration for mitigating cadmium concentrations should be assessed. This may include water management practices and flocculation of suspended solids in the PKCA. Post-treatment cadmium concentrations will need to be monitored carefully in the effluent, receiving waters, and biota if the project proceeds. Monitoring of tissue metal concentrations of fishes in Lake C3 may also be required under the aquatic effects monitoring program.

Prior to the water balance revisions, the ammonia concentrations in runoff from the stockpiles were predicted to exceed CCME receiving water guidelines from May through October in most years (Note: in the FEIS text Section B 2.1:12 it says May and October). Centralizing waste treatment in the PKCA makes good sense. Spray irrigation has not been thoroughly tested in a tundra wetland environment but may offer a simple and effective method of reducing ammonia in effluent from the PKCA. Perhaps the water atomization project being piloted at BHP Billiton's (BHPB) Ekati mine would offer some insight as to the effectiveness of this method of treatment for ammonia. It should be noted however, that BHPB's proposal is to atomize the water, thereby increasing the surface area of the water to be treated to facilitate oxidation. Spraying the water is unlikely to facilitate volatilization and will incorporate a large component of land treatment. Volatilization of ammonia, which occurs at significant rates above air temperatures of approximately 10ºC, should also be encouraged in the PKCA through maximizing residence time and aeration. Because these measures are contingent on contaminant levels in runoff, these levels must be monitored regularly throughout the season. Thresholds should be set for the implementation of various treatment alternatives before mining is allowed.

Additional approaches to managing various undesirable components of the PKCA supernatant should also be explored.

Use of a diffuser to effect quick dilution of contaminants being routed directly into Carat Lake was mentioned in the Draft EIS but references to this method of meeting water quality objectives were largely removed from the Final EIS. However, supplemental documents suggest that a diffuser may still be used where contaminated runoff is not routed to the PKCA. This technology does not remove contaminants, it simply dilutes them faster and does nothing to reduce total loading.

In the Draft EIS, Tahera touched on the ideas of nutrient enrichment or artificial stocking as a form of habitat compensation. In general, DFO only considers these options as short term solutions used to "kick start" a system, since once these measures stop there is typically a crash in what ever components of the system have increased.

The numerical simulation of the dilution of polishing pond effluent in Lake C3 was run for one discharge period (i.e. 155 days). There are no indications of how the effluent will behave under ice cover conditions. As well, the report assumes water quality in Lake C3 will be maintained at baseline conditions and does not account for the potential for effluent constituents to accumulate from year to year.

The EIS calls for directing the runoff from the site to the pit lake at the time of closure. This could significantly alter the ability of the pit lake to be used as fish habitat.

Summary

Options for water management and mitigating contaminant levels in the mine water discharge need to be fully explored and assessed. Metal concentrations, including cadmium and copper should be monitored carefully in the effluent, receiving waters, and biota and related to changes in biotic parameters.

The predicted water quality changes due to the decant of the PKCA need to be assessed for their impacts on food resources (i.e. benthos, periphyton) in Stream C3 and the potential for impacts on sensitive life stages of fish.

Those water quality impacts that are predicted must be mitigated to the extent possible and monitored, to eliminate adverse impacts on fish and fish habitat as these types of impacts cannot be permitted through a *Fisheries Act* authorization.

2.7. No Fishing Policy

Tahera acknowledges the potential detrimental effect recreational angling by its workers may have on fish populations in water bodies at the Jericho Site and proposes to implement a no angling policy for lakes in the vicinity of Carat Lake. This ban on angling includes all lakes and streams except Contwoyto Lake and will be in effect for the life of the proposed mine.

Discussion

This approach is consistent with what DFO has required to be undertaken at other diamond mining operations.

Summary

DFO supports and insists on this approach.

2.8. Use of Explosives

Explosives would be the primary method of excavating waste rock and kimberlite ore during construction and operation of the open pit. Tahera has compared its anticipated blasting plan against the guidelines developed by DFO and concluded that this activity could cause some level of adverse environmental effect, but only on a much localized scale.

Discussion

During operations, explosives use could cause fish mortality and dissuade fish from using the nearshore area of Carat Lake and Stream C1. Operationally, DFO uses a more protective threshold of 50 kPa in the North for overpressure. Shockwaves could negatively impact on fish and fish habitat in a manner that is difficult to quantify and could preclude the use of stream enhancement or causeway enhancement efforts aimed at offsetting physical habitat losses.

Estimates of the instantaneous pressure change resulting from explosives use do not appear to have considered intensifying effects of winter ice cover. Surface ice reflection of the pressure wave from an explosion can double the instantaneous pressure change on fish under ice.

Summary

Since explosives will be used between April and December, the effects of ice cover should be considered when the effects of instantaneous pressure changes on nearby under-ice fish populations are estimated.

DFO will need an analysis of the blast zone and how this may decrease as the pit deepens, such that the duration of the impacts can be assessed. This is consistent with what DFO has required to be undertaken at other diamond mining operations.

Since the DFO guidelines for particle velocity will be exceeded, a *Fisheries Act* section 32 authorization will likely be required.

2.9. Aquatic Effects Monitoring

Tahera has provided details of the proposed aquatic effects monitoring program (AEM) in the Final EIA. This is a condition for project approval by the Nunavut Water Board. The program needs to verify compliance with regulatory standards and to evaluate effectiveness of the mitigation measures as they relate to monitoring effects on water quality and aquatic biota. Lake trout and round whitefish were chosen as receptors because they have the potential to bioaccumulate some metals and they have a higher social value than invertebrates. Other organisms, such as phytoplankton and zooplankton, were deemed unsuitable as receptors for monitoring for two reasons. Firstly, both groups exhibit high levels of natural variability, making it difficult to identify change. Secondly, neither receptor is stationary within the context of this project.

Discussion

Zooplankton and phytoplankton are primary and secondary producers that are very sensitive to changes in environment. As such, they may serve as early indicators of adverse impacts in the receiving environment. While DFO agrees that plankton does

exhibit variability, gross changes or losses in taxa and shifts in abundance of keystone species would be useful monitoring tools.

Benthic invertebrates are also a suitable receptor for metal contamination, as many metals adhere to suspended solids and become integrated into the benthic food chain. Changes in benthic community characteristics relative to metals in sediment and total loading will be important, and lends support to the suggestion of adding a sedentary fish species to the monitoring plan. Monitoring would benefit from the inclusion of relatively stationary forage species, such as slimy sculpin, as a potential early indicator of contamination in fish further up the food chain. By shifting the focus of the monitoring on sculpin, the monitoring requirement for lake trout and whitefish could be reduced. Tissue samples taken from fish should be done in such a way as to alleviate the need to kill those fish sampled.

Metallothionein should be included as an indicator of exposure to metals since fish do not generally show elevated metallothionein in response to other stressors. Metal concentrations and loadings are needed to correlate those metals and levels found in the target fish species and consequently, these data should be included in the monitoring program.

The level of change to be detected through the monitoring program will have to be determined based on baseline data, the sample size upon which the values are based, effluent discharge limits and background levels of constituents of concern. Far more fish will need to be captured to detect a 10% change versus a 100% change; therefore, a need to assess the level of concern (sensitivity) is required in the sampling protocol. Also, annual sampling should not be necessary unless effluent parameters far exceed background concentrations.

Winter oxygen levels (under ice) have not been determined and this baseline data will be necessary to assess changes in response to effluent discharge in both Carat Lake and Lake C3. It will be necessary to model for increased primary and secondary production and the associated oxygen demand arising from increased nutrients settling to the bottom.

The inconsistent sampling timing and locations for water quality parameters, and lack of winter sampling makes it difficult to establish baseline conditions and natural variability to which operations can be compared.

Tahera proposes to use periphyton as a receptor in the AEM, however, the lack of seasonal data leads one to question how monitoring data on periphyton will be used to detect project-related effects. As well, the data on phytoplankton is not very informative due to the inconsistent sampling locations over the four sampling years. This makes determination of baseline seasonality and natural variability near impossible.

Benthos was only sampled in two years for Carat Lake and Jericho Lake even though these lakes will likely receive mine waste as either discharge or runoff. As well, there is only one year of data from the control lake and this occurred in a different year than when the other two lakes were sampled. This data does not give an indication of seasonal variability and local variability among lakes and by lake type

Summary

Zooplankton and phytoplankton should be added to the monitoring program as early indicators of unfavorable aquatic environment alteration.

Sculpin should replace lake trout and whitefish as the primary indicator fish species. Monitoring of lake trout and whitefish should be done on a less frequent basis or in response to elevated contaminants in benthos and/or sculpin,

Adequate baseline data to detect project impacts will be required before construction activities commence.

2.10. Navigation

This project involves several aspects that will have a direct effect on Navigable Waters, including the berm construction and ultimate loss of Long Lake, and the causeway on Carat Lake.

Discussion

As indicated in the letter from Rick McLean, of the Canadian Coast Guard, dated October 31, 2000, permits under the *Navigable Waters Protection Act* will be required for certain components of the project before the commencement of construction. Drawings complete with dimensions will be required for the polishing pond berm and infilling, infilling and berm crossing of Long Lake and the Carat Lake causeway.

Summary

From a navigational perspective DFO-CCG has no objections to the project proceeding to detailed design, providing commitments are made to incorporate appropriate mitigation to maintain the public's right to safe and unimpeded navigation.

3. Conclusion

DFO finds Tahera's EIS documents lacking the necessary detail to allow for the full assessment of potential environmental impacts and the mitigation of those impacts. Alternatives to PKCA discharge (treatment options) and control of sediment need to be further investigated. A complete characterization of all waste streams is needed as is the assessment of impacts on the receiving environment. As well, the AEM should be designed to provide a sensitive tool for detecting change and allow for the early implementation of adaptive management.

Tahera will need to undertake a complete accounting for impacts to fish habitat and develop a compensation plan that will meet the No Net Loss guiding principle of DFO's habitat management policy.

DFO encourages NIRB to consider and include those suggestions offered above.

DFO will require final design details for all aspects of the project, prior to issuing a *Fisheries Act* subsection 35(1) authorization.