# Memorandum

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| **Project:** | Jericho Diamond Project | **File No.:** | 04006 |
| **From:** | Rick Pattenden | **Date:** | 28 May 2004 |
| **To:** | Department of Fisheries and Oceans, Iqaluit Nunavut | **Page:** | 1 of 11 |
| **cc:** | Tahera Corporation | | |
| **Re:** | Memorandum A – Response to outstanding items to allow DFO to conclude EA | | |

Fisheries and Oceans Canada (DFO) has requested information from Tahera regarding outstanding items associated with the Jericho Diamond Project Final Environmental Effects Statement (email dated 21 May 2004 4:43 PM EDT). The information is needed to allow DFO to conclude the EA.

The specific project activities that require further documentation related to project impacts are as follows:

1. Impacts to the flow regime of Stream C3
2. Impacts to the flow regime in Stream C1
3. Indirect impacts associated with the Causeway

DFO Policy for the Management of Fish Habitat incorporates a hierarchy of preferences that are used in their review of project-related impacts on fish habitat. They include in order of preference, relocation, redesign, mitigation, and compensation. It is the position of DFO that Tahera needs to demonstrate that the most preferred options in the hierarchy of preferences have been discarded, with documentation of supporting rationale, prior to considering less preferred options. DFO states: "Provided the habitat is not critical, and once it has been demonstrated that relocation, redesign and mitigation options are ineffective in fully reducing the impacts to fish habitat, the compensation of the residual impact (after fully applying all mitigation) will be considered" and "DFO will consider the application of habitat compensation only if the consideration of relocation, redesign and mitigation options proves impossible or impractical". In summary, DFO has requested that Tahera "provide the necessary documentation justifying why relocation, redesign and mitigation options are ineffective in mitigating the impacts fully".

The following response provides the necessary information for DFO to conclude the Jericho Diamond Project EA for the three outstanding items.

**1.0 Impacts to the Flow Regime of Stream C3**

Stream C3 is the main outflow from Long Lake, a relatively small headwater lake that has been selected as the site of the Processed Kimberlite Containment Area (PKCA). The PKCA will be used to store fine processed kimberlite (PK), seepage and runoff from the mine area, and treated wastewater from the camp during mining operations. Water will need to be discharged from the PKCA on a seasonal basis because the site has a positive water balance.

Stream C3 will be used as a conduit to discharge water from the PKCA during construction and mine operations. Impacts to water quality will occur during operations and to a much lesser extent during closure. Impacts to flow will occur during construction, operations and closure.

The PKCA facility, water management plan, and water and load balance were described in detail in Technical Memoranda E, F and G (SRK 2003) and additional information will be provided in the water licence application.

Construction

Development of the PKCA would entail construction of a series of dams and dikes and partial draining of Long Lake following a pre-determined schedule (Technical Memorandum E [SRK 2003]). Frozen core dam foundations would be excavated and dams constructed in the winter. The West, East and Southeast dams are required initially. The North Dam is not required until Year 3. Refinement of dam design is pending and will be provided to support submission of a water licence application for the project. In the early winter of Year One of construction, a dam would be placed at the outlet of Long Lake. During the first summer (prior to dam construction) water flows in Stream C3 would remain natural until August when lake pump out would commence. At that time flows in Stream C3 would increase. The lake would then be pumped down to a predetermined level (estimated 100,000 $m^3$ removed). The pump rate would not exceed the estimated pre-construction flow of Stream C3 at the Long Lake outlet (23.5 L/s; see Table 1). Dam construction would follow lake dewatering (Technical memorandum pending as part of water licence application).

Table 1. Draft estimates of monthly flows at the outlet location of Long Lake (Estimates to be finalized and presented in Technical memorandum pending as part of water licence application

| Flow in L/s | | | |
|---|---|---|---|
| **Month** | **Pre-Construction** | **Operation** | **Post-closure** |
| May | 1.4 | 0.0 | 0.4 |
| June | 23.5 | 116.5 | 24.2 |
| July | 5.6 | 27.6 | 4.2 |
| August | 6.6 | 28.0 | 6.2 |
| September | 3.4 | 13.9 | 3.2 |

*Effects on Fish Habitat*

Effects on fish habitat during construction caused by the change in flow regime are expected to be neutral or positive. First, the water flows would be within the expected annual discharge capacity of Stream C3; therefore, there would be no increased potential for stream bank erosion. Second, the potential for fish use, habitat quality, and habitat quantity of Stream C3 would temporarily increase. Stream C3 is a small stream that exhibits base water flows of < 7L/s during July, August and September (Technical Memorandum F [SRK 2003). As a consequence of this flow regime, fish habitat quantity, habitat quality, and fish use of the system are presently limited (Appendix H in NIRB Document 231di Section [RL&L 1997]; 3.4.2.2, Tables 3.15 and 3.16, Appendices B4 and D6 in NIRB Document 23diii [RL&L 2000a]; Section 3.3.1.2, Table 3.9, Figure 3.16, Appendix D6 in NIRB Document 231dviii [RL&L 2000b]). Augmentation of stream flow via pumping during August and September will enhance habitat conditions for fish in Stream C3; therefore, the effect would be positive. Only water with natural background quality will be pumped out; pumping will cease once disturbance of bottom sediments in Long Lake begins to effect water quality.

*Hierarchy of Preferences*

The effect on Stream C3 flow during construction would be neutral or positive; therefore, there is no requirement for further consideration.

Operation

Discharge from the PKCA would be released into Stream C3 during the non-winter months at a controlled rate by pumping (see Table 1; Technical Memoranda F and G [SRK 2003]; a refinement will be submitted as part of the water licence application). While it will be of necessity to meet project water licence discharge criteria, the discharges are not expected to meet CCME guidelines for receiving waters.

The amount released would depend on the volume stored in the PKCA and quality of the discharge. The operational goal would be to maintain the freestanding water level near the current natural elevation by pumping out water that meets discharge criteria. This is the practice at the Ekati Diamond Mine™'s PKC facility. Preliminary estimates of monthly discharge volumes are presented in Table 1. These estimates will be finalized in the final water balance to be submitted in support of the project's water licence application.

Discharge scenarios include the following:

1. Discharge to Stream C3 would occur each year during the open water period if water meets project water licence criteria (this is the expected base case).
2. If monitoring indicates that the water will not meet discharge criteria, pumping will be temporarily discontinued. Pumping would resume as soon as the monitoring indicates discharge criteria can be met.
3. Under the unlikely scenario where discharge is not possible for a given year, there is sufficient capacity to store the maximum expected inflows until the following year. During the time period of storing water for one year if discharge criteria are not met, Tahera would have the time to conduct a pilot spray irrigation test. Current indications are that the spray irrigation system would provide a viable means of removing nutrients and metals from the discharges. Therefore, it is assumed that a full scale spray irrigation system could be implemented in the second year of operations, if treatment is still required to meet discharge criteria.
4. The next level of contingency for the PKCA is a designed capability to store maximum predicted water inflows for a second consecutive year. Two years of natural runoff added to the PKCA would provide additional dilution, settling and attenuation, which may result in improved water quality.
5. If water still continues to be not sufficient quality to discharge and spray irrigation is demonstrated to be ineffective by the test work program, other contingencies will be investigated. There will be a minimum of one year beyond spray irrigation pilot studies to develop other contingencies, should they be required. For example, a water treatment system to deal with known parameters could be procured and installed during this time period. It must be noted that neither a treatment plant, nor any other practical treatment alternative will achieve CCME guidelines in discharge water.

These scenarios were presented in the Final EIS and supplemental information provided in response to government review of the Final EIS (Tahera Supplemental Report October 2003) and will be presented in the project application for a water licence to Nunavut Water Board.

*Effects on Fish Habitat*

During operation, Stream C3 fish habitat will be temporarily altered because water quality is not expected to meet CCME guidelines. During PKCA operation, the potential effect of the altered flow regime on fish habitat would be dependant on the discharge scenario. Under some scenarios water will be available to fish; however, there is the potential that the estimated flow rate may result in bank erosion and degradation of fish habitat. Stream C3 is a small, ill-defined watercourse dominated by large rock materials that underlie a shallow organic layer (Table 3.16, Appendix B4 in NIRB Document 23diii, [RL&L 2000a]). The estimated 10 year return period pre-development flood flows are 280 L/s at the PKCA outlet, which is twice the expected operation peak discharge of 137.1 L/s (supplemental water balance to be presented as part of the project water licence application). Given that the bank materials are dominated by large rock and the watercourse is regularly subjected to higher flows, it is unlikely that the operational flows would cause bank erosion. In the event erosion is observed, discharge can be temporarily stopped and additional armouring placed on stream banks.

Depending on water quality, discharge maybe suspended for a temporary time period. This is not expected to be the case but there could be a temporary loss of water flow from the PKCA during a season for a defined period of time, due to storing water instead of discharging. There would still be some natural

flows into Stream C3 from the watershed downstream of the outlet dam. The reduction in flows is expected to be temporary and water pumping would continue as soon as quality standards are met and if suspended for an entire season would recommence the following season. Under this scenario there would be temporary loss of fish habitat caused by the lack of water.

*Hierarchy of Preferences*

**Relocation:** A process of alternate analysis resulted in the selection of Long Lake as the best PKCA location from environmental impact and environmental control considerations (Jericho Final EIS, Appendix A.1, Project Description, Section 22.5, p. 88). Previous alternatives were located lower in an alternate drainage basin that would, in addition to affecting an additional drainage basin (Lynne Lake draining into Contwoyto Lake), would have resulted in a larger volume of water to treat and control.

The alternative suggested by KIA's Final EIS reviewer (Rescan alternative) was discounted early in the alternatives analysis prior to submission of the draft EIS because it would have resulted in the elimination of Lake C1 which is more valuable fish habitat than Long Lake based on aquatic studies conducted for baseline (NIRB Document 231diii [RL&L 2000a]) and provides only one half the storage capacity of the proposed Long Lake facility.

**Redesign:** There is no practical way of redesigning the PKCA (e.g., for storage of all water in perpetuity since the facility will be in an area with a positive water balance [precipitation exceeds evaporation on an annual basis]). Over time, water must spill from the PKCA regardless of its storage capacity. A redesign would therefore be limited to providing incremental storage beyond the 2-year amount that is proposed for the early stages of operation. The 2-year limit that is currently proposed is sufficient as it comes early in the mine life when additional storage is most justifiable and provides sufficient time to react to possible variations in the water quality in the PKCA. Any increases beyond the 2-year storage amount lack reasonable justification and would necessitate increases in the heights of the various dams and dykes around the PKCA perimeter, as well as a significant increases in the length of the containment dams/dikes. Increases in height and length of the dams/dikes lead to increases in the risk of failure, which are unwarranted relative to the storage currently proposed. In addition, increases in the height and length of the dams/dikes leads to the need for more borrow materials and increased surficial disturbance.

**Mitigation:** Mitigation to prevent erosion is possible through the following measures:

1. Identify sections of Stream C3 that are potentially sensitive to erosion and monitor.
2. Use bank protection to eliminate potential for erosion.
3. Provide end of discharge pipe riprap to dissipate energy from concentrated water flow.

Mitigation of potential temporary lack of water flow in C3 as a result of no discharge from the PKCA could include artificial pumping of water from a clean water source such as Carat Lake This measure is not considered practical because water volume requirements to mimic natural peak seasonal flows exiting Long Lake are ten times the capacity of the planned Carat Lake water supply. This would necessitate a much larger pumping system then is planned.

**Compensation:** Compensation is the preferred option for water quality effects because there is no mitigation for alternation of fish habitat. Compensation is also the preferred option for a potential temporary loss of fish habitat due to restricted water flows. A conceptual No Net Loss Plan has identified compensation options for consideration (Final EIS, Appendix B.3.1, Attachment 4.1). These include creation of similar fish habitats in area streams and lakes.

Post-Closure

On mine closure, the dry portions of the PKCA would be reclaimed in its entirety. The completed portions of the PKCA will be capped with a combination of mine rock and coarse PK and with esker if reclamation trials indicate esker material is necessary for plant growth (Jericho Final EIS, Appendix B.3.2, Reclamation Plan, Section 5.3.3, p. 14 and Supplemental Report prepared in response to government comments on the Final EIS [Tahera 2003, Sections 2.1.17, 2.2.6, 2.3.16, 2.3.17]). A conceptual abandonment and reclamation plan will be submitted as supporting documentation for the project water licence application. During post-closure, the catchment area will approximate the pre-development area and no run-off will be directed to the PKCA from the mine site area. As such, the flow regime of Stream C3 will approximate pre-development conditions during post-closure.

Water quality during post-closure is predicted to meet CCME guidelines with the exception of the provisional guideline for cadmium (supplemental material to be presented as part of the project water licence application). Post closure monitoring and the data collected during mining will assist in determining and predicting long-term water quality post closure in Stream C3.

*Effects on Fish Habitat*

The flow regime will return to post-closure conditions and water quality is expected to approach CCME guidelines for the protection of aquatic life; therefore, there would be no negative effects on fish habitat when compared to pre-development conditions.

*Hierarchy of Preferences*

There would be no negative effects on Stream C3 flow regime and water quality post-closure; therefore, there is no requirement for further consideration.

## 2.0 Impacts to the Flow Regime of Stream C1

The Stream C1 diversion is required to change the channel location of the stream from its natural course, which will intersect the open pit in the pit's final configuration. A diversion will be constructed by cutting a channel from downstream of Lake C1 through bedrock and overburden to re-intersect the natural channel approximately 160 metres above Carat Lake (Conceptual fish friendly diversion design drawings attached [Figures C1-Diversion W2 and W3]; final design is pending and will be included as supporting documentation for the project water licence application). The upper part of the channel will be in bedrock; the lower part will be in overburden. The lower channel will have meanders built into the channel to provide a longer flow path and to more nearly mimic the lower channel's natural morphology and it will be designed to accommodate fish friendly features such as riffles and boulder gardens. A dam will be constructed at the upper diversion end to direct water out of the natural channel. Two energy dispersion ponds will be constructed in the diversion to reduce the risk of erosion during high flows: at the break between bedrock and overburden and where the diversion re-enters the natural channel. The channel will be lined and armoured as necessary to prevent erosion, but will be made as fish friendly as practical given the constraints associated with the need for structural stability.

Construction

The diversion will be constructed in winter. It is not needed until Year 3 and the natural channel will remain largely undisturbed until the winter of that year when there is no water flow. Because water will be required for camp operations, the intake pipe to Carat Lake will cross Stream C1 at the proposed dam site. This will be facilitated using a rock berm and culvert. Winter construction of these components constitutes the proposed mitigation of impacts to water flow.

*Effects on Fish Habitat*

There will be no effects on fish habitat during construction, which will occur during winter when the stream is frozen to the channel bottom. Some sediment will be exported during the first freshet after construction, which will temporarily affect fish habitat in the lower reaches of Stream C1. Because this

effect will be ephemeral, short duration, and will occur in early spring the effects on fish habitat would be negligible.

*Hierarchy of Preferences*
**Relocation:** The diversion is required to construct the open pit to the extent necessary to mine the kimberlite resource.

**Redesign:** The diversion has been redesigned from the concept presented in the Jericho Final EIS through discussion with DFO to address the concerns expressed by the Department.

**Mitigation:** Mitigation of impacts to the natural channel have been incorporated into the design. From an engineering perspective, a direct channel cut through bedrock from Lake C1 to Carat is the most effective and efficient method of water diversion. This would result in the elimination of Stream C1 habitat used by fish in the lower 100 m (Section 3.4.2.2, Tables 3.15 and 3.16, Appendices B4 and D6 in NIRB Document 23diii RL&L 2000a). Additional mitigation will consist of making the diversion as fish friendly as practical, consistent with prevention of sediment export to the lower reaches of Stream C1.

**Compensation:** Compensation is described under the operation phase.

Operation
Based on modelling, flows in Stream C1 during operations are predicted to be approximately 30% less than pre-construction flows at the diversion, and 53% less than pre-construction flows at the mouth [Table 2]. Because of concerns about water quality, it is not possible to discharge flows from the mine site area into Stream C1, which is the primary reason for the reduction. Removal of the drainage area associated with the mine pit also accounts for portion of this loss.

Table 2. Draft estimates of monthly flows in Stream C1 (Estimates to be finalized and presented in Technical memorandum as part of water licence application)

| Month | Flow at Stream C1 Diversion (L/s) | | | Flow at Mouth of Stream C1 (L/s) | | |
|---|---|---|---|---|---|---|
| | Pre-Construction | Operation | Post-closure | Pre-Construction | Operation | Post-closure |
| May | 4.5 | 3.2 | 3.2 | 6.2 | 3.2 | 3.2 |
| June | 67.1 | 47.4 | 47.4 | 90.5 | 48.3 | 48.3 |
| July | 19.4 | 13.4 | 13.4 | 26.5 | 13.7 | 13.7 |
| August | 20.4 | 14.3 | 14.3 | 27.6 | 14.5 | 14.5 |
| September | 10.2 | 7.2 | 7.2 | 13.9 | 7.3 | 7.3 |

It should be noted that runoff water that meets CCME guidelines will be allowed to flow naturally into the Stream C1 drainage basin.

*Effects on Fish Habitat*
Since the lower reaches of Stream C1 will be maintained as natural fish habitat, the flow regime will remain close to natural, and there would be no effect on water quality, there would be marginal negative effects on fish habitat. These effects would be associated with loss of food production areas in the upper reaches of the stream and a reduction in the surface area of fish habitat in the lower reach downstream of the diversion. Based on results recorded during field investigations that documented fish use of Stream C1 under a similar flow regime, the reduction in fish habitat surface area should not significantly affect fish use (NIRB Document 23diii [RL&L 2000a]; NIRB Document 231dviii, [RL&L 2000b]). In addition, the upper reaches of Stream C1 that will be diverted are not used by fish (NIRB Document 23diii [RL&L 2000a]).

*Hierarchy of Preferences*
**Relocation:** The diversion is required to construct the open pit to the extent necessary to mine the kimberlite resource.

**Redesign:** The diversion has been redesigned from the concept presented in the Jericho Final EIS through discussion with DFO to address the concerns expressed by the Department.

**Mitigation:** Mitigation will consist of making the diversion as fish friendly as practical, consistent with prevention of sediment export to the lower reaches of Stream C1. Due to engineering constraints associated with the topography and underlying rock materials, it is not possible to redesign the entire diversion channel to accommodate fish-friendly components. The conceptual design of the diversion can accommodate creation of approximately 210 m of fish habitat (conceptual fish friendly design drawings attached). Because the reaches of Stream C1 that will be diverted are not used by fish (NIRB Document 23diii, [RL&L 2000a]) the diversion will cause loss of food production areas, but will not cause loss of fish bearing waters.

**Compensation:** Because the removal of fish habitat from the upper reaches Stream C1 can be partially mitigated by modifying the design of the diversion channel and the area of habitat available to fish in the lower reaches will be reduce, some fish habitat compensation would be required. A conceptual No Net Loss Plan has identified compensation options for consideration for other stream systems affected by the project (Final EIS, Appendix B.3.1, Attachment 4.1). These options can be applied to habitat loss associated with Stream C1.

Closure
At closure, the C1 diversion will be maintained until the pit naturally fills (estimated at 15 to 20 years if all minesite runoff is directed to the pit [Technical Memorandum F, Site Water Balance, SRK 2003]). When the pit has filled there are a number of scenarios for discharge, depending on pit water quality:

1. Redirection of Stream C1 back into its natural channel and discharge from the pit to Stream C1.
2. Maintenance of the diversion and discharge through an open channel to Carat Lake east of Stream C1.
3. Maintenance of the diversion, in pit treatment and discharge through an open channel to Carat Lake east of Stream C1.

Scenario 1 assumes that pit water will meet CCME guidelines after the pit fills. Scenario 2 assumes that untreated pit water would meet CCME guidelines near the shore of Carat Lake with diffusion. Scenario 3 assumes that pit water would require treatment plus require further dilution in Carat Lake to reach CCME guideline levels. Scenario 1 is preferred option from an environmental impact perspective (SRK memorandum to Tahera Corporation, 6 May 2004, Post Closure Pit Lake Quality). However, current estimates of pit water quality indicate that it may not be possible to meet CCME guidelines in the pit lake. Monitoring of seepage and runoff during the first few years of operations is required to further refine the water quality predictions. Until this data is available, Tahera can not say with certainty that the pit lake will meet fish habitat criteria.

As an option, the Jericho Final EIS proposed the pit filling could be accelerated by diverting some of the spring freshet from Stream C1 from the diversion into the natural channel by means of a weir. This would reduce the time to fill the pit somewhat but also would reduce the flow to Stream C1, which is not the preferred option for DFO. Pursuant to concerns expressed by DFO, this option can be dropped without significantly affecting conclusions about post-closure filling of the pit. The issue will be addressed during revisions of the closure plan during operation of the mine.

*Effects on Fish Habitat*
Under Scenario 1 near pre-mining flows of Stream C1 will be maintained during closure. Water from the pit will not be directly discharged into Stream C1 unless CCME guidelines are met and thus closure scenarios will not significantly affect fish habitat. If mine pit water quality does not meet CCME guidelines (scenarios 2 or 3) then the discharge would be diverted away from Stream C1, which would reduce flows. Under these scenarios there would be an adverse effect on fish habitat.

*Hierarchy of Preferences*
**Relocation:** The base case, preferred scenario, is to redirect Stream C1 back into its natural channel on closure which will completely naturalize flows. Stream C1 cannot be left in its natural course for the entire mine life without sterilizing a significant portion of the resource and render the project uneconomic.

**Redesign:** The current scenarios, as previously discussed, are designed to protect fish habitat from water that does not meet CCME guidelines.

**Mitigation:** Mitigation for effects on fish habitat will be re-direction and treatment of water that does not meet CCME guidelines when the open pit fills. Design is pending and will be included as support documentation for the project water licence application.

**Compensation:** If water from the pit lake cannot be re-directed to Stream C1 then compensation for permanently altered flows, and therefore, lost fish habitat will be required. As per compensation under the operation phase, a conceptual No Net Loss Plan has identified compensation options for consideration for other stream systems affected by the project (Final EIS, Appendix B.3.1, Attachment 4.1). These options can be applied to habitat loss associated with Stream C1.

## 3.0 Indirect Impacts of the Causeway

A causeway is proposed for the water intake. The causeway will be approximately 90 m long and will be located approximately 200 m west of the mouth of Stream C1 (see attached water intake figures 1 and 2; final design is pending and will be included as supporting documentation for the project water licence application). The location is approximately 250 m west of the location proposed in the Jericho Final EIS (Appendix A.1, Section 10.0 and Map A). Between the draft and final EIS reports, the causeway design was shortened from 170m to 90m in response to concerns about effects on water circulation and littoral drift.

Construction
The causeway will be constructed the first winter as water will be required as soon as possible at the site for camp accommodations and potable water use. Water will temporarily be trucked from the existing exploration camp supply until the permanent supply is functional. Clean rock will be placed either on the ice or the ice will be broken prior to placement as appropriate. This approach was used at EKATI™ for the Grizzly Lake water intake causeway. If required, a silt curtain will be placed around the causeway once lake ice melts.

The causeway will be built with clean coarse rock and as such will be pervious. Culverts can be placed in the shallow end of the causeway to allow fish and additional water passage, thus addressing the concern about effects on water circulation.

The intake pump well casing will be surrounded by rock at the end of the causeway creating an environmental friendly and maintenance-free barrier to fish. The original design was for a screened intake, which would have required maintenance and risked increased velocity at the intake if screens potentially resulting in impingement of fish.

*Effects on Fish Habitat*
Shallow water habitats used by slimy sculpin and juveniles of large-fish species will be lost due to the footprint of the causeway. (Jericho Final EIS, Appendix B.2.3, Aquatic Biota Impacts, Section 4.2.3, p. 49). However, no important fish habitats occur within the causeway footprint. Some temporary sedimentation effects on shallow water fish habitat could occur during and immediately following construction.

*Hierarchy of Preferences*
**Relocation:** The causeway is required because it provides a reliable method of water withdrawal for operation of the Jericho Diamond Mine. The final location was chosen to provide a combination of minimum length (minimum disturbance of aquatic habitat) and minimum additional upland disturbance. By moving the causeway to the west of the stream C1 outlet there is less impedance to any lake currents created by Stream C1 water flows. The access road and pipeline would for the most part parallel existing facilities and will twin with the C1 diversion when it is built in Year 3. Moving the intake further west would not result in shortening of the causeway until significantly west of the proposed location. Access further to the west also becomes problematic since a road would have to be blasted out from bedrock and the amount of upland disturbance would be increased. Sediment export from the road into Carat Lake would also then become a greater risk.

**Redesign**: At the request of DFO, a buried water intake line was evaluated. A buried line would result in significantly more environmental disturbance during construction and much higher sedimentation because lake bottom sediments would have to be physically removed rather than having rock simply placed onto them. From an operations point of view, a buried intake pipe would represent a much greater operational risk be much more difficult to maintain and greatly increases the risk of significant plant shutdowns and further environmental disturbance while repairs were effected, particularly in winter.

**Mitigation:** Mitigation would be principally as discussed above. In addition:

- An increase in fish habitat can be realized by modifying the type of rock materials placed along the causeway sides. Large materials would improve fish habitat quality in the mitigated area (from 400 - 600 $m^2$ of rock shoal).
- The minimum, length of the causeway will be used to put the intake below winter ice.

**Compensation:** Compensation is not required for the construction phase because the potential effects on fish habitat can be mitigated.

<u>Operation</u>
*Effects on Fish Habitat*
Modification of along-shore currents has the potential to impact fish by altering the velocity characteristics of spawning sites within the zone of causeway affect. Potential spawning sites are located 500 m east and 700m west of the causeway (Figure 3.4 in B.2.3 Aquatic Impacts Assessment, *op. cit.*). A general rule of thumb indicates that the zone of influence is equal to the length of the structure (Paul Greisman, pers. comm.). The causeway is 90 m in length; therefore, both potential spawning sites are located several times the distance of the expected zone of influence. As such, the potential adverse effects caused by modification of along-shore currents by the causeway on potential fish spawning areas are expected to be negligible].

Upwelling of water from the deepest part of the lake can influence fish habitat by altering the vertical temperature and nutrient regime within the lake. Existing lake conditions presently enable light winds to

drive upwelling from 10 to 20 m depth (Greisman 2003[1]). Because frequent upwelling presently occurs under natural conditions the Carat Lake fish are pre-adapted to the effect. As such, upwelling caused by the causeway is expected to have negligible effects on fish habitat in Carat Lake.

The third potential effect would be changes to littoral drift, or physical processes that influence shore line development and maintenance. The presence of the causeway may prevent wave action from scouring the shoreline, thereby allowing settling of fine materials. This in turn could alter fish habitat. The Carat Lake shoreline in the vicinity of the causeway is dominated by large rock materials interspersed with small amounts of sands (Zones 2 to 8 in Appendix E3, NIRB Document 231diii [RL&L 2000a]). These characteristics indicate that littoral drift and active shoreline development do not presently occur in the vicinity of the causeway. Fine substrates (i.e., organic materials, clays, and silts) that are easily suspended by wave action or water currents do not exist along the shore. Nor are they present in the lake as total suspended sediments (Jericho Project Final EIS, Appendix B.1.1, Baseline Summary Report, Section 6.4, p. 14, ff + Table 6.3). Typically these materials are located at water depths below the ice scour zone (approximately 5 m); therefore, they are not available to be mobilized as part of the littoral drift. This position is supported by results recorded during sedimentation monitoring (Table 3.1 in NIRB Document 231dv [RL&L 2001]). Very little sedimentation was recorded at the Carat Lake site located at the mouth of Stream C1 (average deposition of 3.4 gm of sediment) and the material that was deposited consisted primarily of sands mobilized by wave action against the local shore. Lake sediments composed of finer materials that would comprise littoral drift in Carat Lake (i.e., organic materials, clays, and silts or <0.005mm) accounted for a small fraction of the materials recorded during that study.

Based on this information the occurrence of littoral drift processes in the vicinity of the causeway are highly unlikely. As such, the potential effect of the causeway on littoral drift is negligible to nonexistent.

*Hierarchy of Preferences*
Relocation and redesign were discussed under construction above.

**Mitigation:**

- An increase in fish habitat can be realized by modifying the type of rock materials placed along the causeway sides. Large materials would improve fish habitat quality in the mitigated area (from 400 - 600 $m^2$ of rock shoal).
- The minimum, length of the causeway will be used to put the intake below winter ice.
- A culvert or culverts can be placed in the shallow part of the causeway to allow increased water flow and fish passage.

**Compensation:** The footprint of the causeway can be fully mitigated by modifying the rock material used along its perimeter. The causeway will not influence lake circulation patterns to the extent that adjacent fish habitats would be negatively affected and littoral drift is not an issue. As such, compensation for the causeway should not be required. In the unlikely event that DFO requests compensation for the causeway, options for compensation of lake fish habitats have been presented (Final EIS, Appendix B.3.1, Attachment 4.1).

[1] Greisman, Paul. 2003. Upwelling generated by the causeway. Report prepared for Tahera Corporation. 4.p.

Closure

The causeway can be removed, or partially removed on closure. The Jericho Final EIS proposed two alternatives in the Reclamation Plan (Appendix B.3.2, Section 5.3.10, p. 16) which included:

1. Grading down the causeway to water surface level thereby creating additional fish habitat.
2. Pushing the above water section of the causeway up onto the foreshore to a suitable, stable location.
3. In addition to the previously presented alternatives, bridging (creating gaps) in the causeway which will result in reefs providing fish habitat and re-establish pre-mining water circulation patterns.

The scenario chosen by the Jericho Mine on closure would depend on discussions with DFO and Environment Canada on water quality and fish habitat issues.

*Effects on Fish Habitat*

The effects of scenario 1 would be to modify fish habitat next to the causeway. The effect would be neutral or positive in that more varied habitat would be created. The effects of scenario 2 would be neutral with respect to fish habitat. If scenario 3 is implemented, the effects on fish habitat would be positive due to the creation of additional fish habitat.

*Hierarchy of Preferences*

Closure effects would be neutral or positive; therefore, there is no requirement for further consideration.