Fisheries and Oceans
Canada

Pêches et Océans
Canada

Fish Habitat Management
Suite 301, 5204-50th Avenue
Yellowknife, Northwest Territories
X1A 1E2

Gestion de l'Habitat du Poisson
Suite 301 5204, 50e Avenue
Yellowknife (Territoires du Nord-Ouest)
X1A 1E2

Your file *Votre référence*
EA0809-001

Our file *Notre référence*
07-HCAA-CA6-00126

July 11th, 2012

Mackenzie Valley Environmental Impact Review Board
#200 Scotia Centre
5102-50th Avenue
Yellowknife, NT
X1A 2N7

Via e-mail to:
aehrlich@reviewboard.ca
pmercredi@reviewboard.ca

RE: Fisheries and Oceans Canada – Technical Submission for Giant Mine Remediation Project

Fisheries and Oceans Canada (DFO) would like to provide the following technical submission to the Mackenzie Valley Environmental Impact Review Board (Review Board) for the Giant Mine Remediation Project.

If you have any questions, please do not hesitate to contact Sarah Olivier at (867) 669-4919, by fax (867) 669-4940, or email at Sarah.Olivier@dfo-mpo.gc.ca.

Sincerely,

Larry Dow
A/Area Director
Western Arctic Area
Fisheries and Oceans Canada

cc Morag McPherson, Fisheries and Oceans Canada
Rick Walbourne, Fisheries and Oceans Canada
Kelly Burke, Fisheries and Oceans Canada
Julie Dahl, Fisheries and Oceans Canada
Bev Ross, Fisheries and Oceans Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

FISHERIES AND OCEANS CANADA TECHNICAL REPORT

Giant Mine Remediation Project

Submitted to:
Mackenzie Valley Environmental Impact Review Board
July 11th, 2012

MVEIRB Code: EA0809-001
DFO File No.: 07-HCAA-CA6-00126

Canada

PLAIN LANGUAGE SUMMARY

DFO is participating in the environmental assessment for the Giant Mine Remediation Project (the project) as a regulator for the construction related to Baker Creek, the historic foreshore tailings and the diffuser and outfall, as well as an expert advisor to the Review Board on potential physical impacts of the development on fish and fish habitat. The following technical comments and recommendations are based upon our departmental mandate under the *Fisheries Act*, specifically related to the management of fish and fish habitat. DFO is also a science-based expert support department within the Federal Contaminated Sites Action Plan (FCSAP) program. As such, DFO provides project-specific advice to Custodians to assist in assessing ecological risks, developing sampling and analysis plans and evaluating remediation and/or risk management activities. DFO has worked with the Giant Mine Remediation Team as part of the FCSAP program.

DFO's technical review for the environmental assessment of the project proposal is divided into four main categories: Baker Creek, Outfall and Diffuser, Historic Foreshore Tailings and Monitoring. The following is a summary of DFO's conclusions for Giant Mine Remediation Project.

The proposed re-routing of portions of Baker Creek and potential removal or covering of sediments will disrupt the currently functioning fish habitat and will require ss.35(2) *Fisheries Act* Authorization. Baker Creek has been heavily altered over time as a result of mining operations at the Giant Mine site and must be stabilized both physically and chemically in order to meet the stated objectives of the remediation plan. Overall, the remediation project is expected to result in a gradual increase in numbers and diversity of fish and native vegetation present in the drainage area of the creek (DAR Section 6.1.2), as well as an improvement in the overall health of the Baker Creek aquatic system.

Additional details on the proposed outfall and diffuser need to be provided to DFO in order to conduct a site specific review and make a determination pursuant to the *Fisheries Act* related to potential impacts and the extent of the physical disturbances in these areas. In terms of the potential impacts from the operation of the diffuser in relation to water quality objectives, Environment Canada administers section s.36 of the *Fisheries Act* and the application of the Metal Mining Effluent Regulations. It is also DFO's expectations that any water being discharged out of the diffuser must meet water quality limits, as set out in a water license, and would include conditions and standards that would ensure that no significant impacts will occur in the aquatic environment.

The final cover design and footprint, as well as construction details, have not been put forward for the proposed remediation of the historic foreshore tailings in Yellowknife Bay. A site specific review is still required and additional details need to be provided in order for DFO to make a determination under ss.35(2) of the *Fisheries Act* on construction and footprint of potential physical disturbance to the area.

A fish habitat monitoring plan for the restoration effort on Baker Creek will be a requirement for the *Fisheries Act* Authorization. Monitoring associated with the Baker Creek restoration will not only provide information to allow for an assessment of the recovery and productivity of fish habitat in the creek, it will also provide information to evaluate the success of the stated remediation goals/objectives "to restore Baker Creek to a condition that is as productive as possible, given the constraints of hydrology and climate" (DAR Section 1.2.1) and "physically stabilize the creek and improve both the quantity and quality of habitat" (DAR Section 6.1.2).

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background

After Royal Oak Mines Inc. went into receivership in 1999, responsibility for the Giant Mine property was transferred to the federal department of Aboriginal Affairs and Northern Development Canada (AANDC). In addition, the Government of the Northwest Territories (GNWT) also assumed responsibility for various aspects of the project as the administrator of the lands upon which Giant Mine is located. AANDC and GNWT, hereafter referred to as the Giant Mine Remediation Team (GMRT), is proposing to remediate the abandoned Giant Mine site located approximately 5 kilometres north of Yellowknife. The proposed development includes:

- freezing the arsenic trioxide dust storage areas in place through ground freezing;
- cleaning up and stabilizing other underground mine components;
- disposing of waste materials and waste rock;
- sealing of mine openings;
- backfilling B1 pit, Brock pit and controlling access to remaining open pits;
- covering tailings and sludge containment areas;
- covering submerged tailings;
- constructing a new water treatment plant and discharging treated mine water with an outfall and diffuser into Yellowknife Bay;
- realigning portions of Baker Creek and managing contaminated sediments;
- excavating and treating contaminated soils; and,
- removing all hazardous materials and demolishing buildings.

The Department of Fisheries and Oceans (DFO) has completed its technical review of the proposed development, taking into consideration the information supplied by GMRT through their correspondence with DFO, their Developer's Assessment Report (DAR), the Technical session, responses to Information Requests, the Environmental Management System Working Group, the Pre-Technical Report Workshop and other pertinent documents submitted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB). DFO is submitting the following comments for the environmental assessment of the Giant Mine Remediation Project based on our mandate and areas of expertise. The main components of the project that have direct interactions with the fish and fish habitat include activities related to Baker Creek Remediation, the construction and operation of the Diffuser and Outfall, as well as capping of the Historic Foreshore Tailings. DFO will also require monitoring associated with *Fisheries Act* authorization.

1.2 Mandate

DFO's guiding legislation includes the *Fisheries Act*, which confers responsibility to the Minister for the management of fisheries, habitat and aquaculture. The *Fisheries Act* provides DFO with its regulatory powers to conserve and protect fish and fish habitat. This is accomplished through the administration of the Habitat Protection provisions and other sections of the *Fisheries Act* which are binding on all levels of government and the public. These include the following sections:

- the prohibition against the harmful alteration, disruption or destruction (HADD) of fish habitat unless authorized by DFO – **section 35**
- the provision of sufficient water flows – **section 22**
- passage of fish around migration barriers – **sections 20 and 21**
- screening of water intakes – **section 30**
- prohibition against the destruction of fish by means other than fishing unless authorized by DFO – **section 32**

Of note, Environment Canada (EC) is responsible for the administration and enforcement of the pollution prevention provisions of the *Fisheries Act* on behalf of DFO (section 34 and sections 36-42). Subsection 36 (3) of the *Fisheries Act* prohibits the deposit of deleterious substance into fish bearing waters unless authorized by a regulation under the Act or by another law of Parliament. Environment Canada, on behalf of the Minister of DFO, administers section 36 of the *Fisheries Act*. DFO relies upon advice provided by Environment Canada regarding issues pertaining to water quality.

With respect to the Authorization of a HADD, direction is provided in the *Policy for the Management of Fish Habitat (*1986)[1] (the Policy), and supporting documents such as the *Practitioner's Guide to Risk Management Framework*[2]. The Policy and supporting documents outline the decision framework and criteria to be used when reviewing specific development proposals. Generally, Proponents are to avoid or minimize HADDs to fish habitat through relocation, redesign, and/or mitigation techniques. It is only after these steps are taken that any remaining HADD to fish habitat is considered for Authorization by the Minister. If it is determined to be acceptable, the Minister may issue a subsection 35(2) Authorization for a HADD resulting from the project. The Policy generally requires that fish habitat be created to off-set the loss incurred as a result of the HADD such that there is a no net loss of fish habitat resulting from the authorized HADD. The Policy and the *Practitioner's Guide to Habitat Compensation* provide further direction in the form of a hierarchy of preferences for deciding upon the level, type and location of compensation works.

In addition to responsibilities under the habitat provisions of the *Fisheries Act*, DFO is also a science-based expert support department within the Federal Contaminated Sites Action Plan (FCSAP) program. As such, DFO provides project-specific advice to federal Custodians of contaminated sites to assist in assessing ecological risks from contamination, developing sampling programs and evaluating remediation and/or risk management activities. DFO has worked with the GMRT as part of the FCSAP Expert Support program.

---

1. The Department of Fisheries and Oceans Policy for the Management of Fish Habitat http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155/fhm-policy/index-eng.asp
2. *Practitioner's Guide to Risk Management Framework* http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155/risk-risque/page03-eng.asp

2.0 TECHNICAL COMMENTS – BAKER CREEK

2.1 Baker Creek Remediation

The proposed remediation of Baker Creek will include re-routing or realigning portions of the creek channel to improve stability and flood capacity and it may include removal or covering of contaminated sediments in areas of the creek (DAR Section 6.9). DFO has identified the requirement for a *Fisheries Act* authorization for a HADD of fish habitat resulting from the realignment and reconstruction of portions of Baker Creek. The recommendations made in this section, including any other provisions considered appropriate by DFO, would be included within the conditions of our authorization.

2.1.1 Documents Reviewed

- Developer's Assessment Report (DAR), October 2010:
  - Section 5.8
  - Section 6.9
  - Section 7.1 & 7.4
  - Section 8.4 & 8.7
  - Section 12
  - Appendix A – Giant Mine Remediation Plan (RAP)
  - Appendix B – Supporting Documents to the RAP-A1, A3, A4, A5, A6, G1, G2, G3, N1
  - Appendix C – Additional Supporting Documents
- IR Response (Round 1) to Review Board IR_18, Alternatives North IR_06, YKDFN IR_14
- Technical Session October 17-21, 2011: Transcript – Day 2 (October 18, 2011)
- IR Response (Round 2) to Review Board IR_01, IR_02, IR_03, IR_04, IR_05, IR_08

2.1.2 Developer's Assessment and Conclusions

Baker Creek flows through the Giant Mine site and has been heavily altered to accommodate historic mining, ore processing and highway development. The key concerns related to the current condition of Baker Creek on the site include impacted water and sediment quality as well as channel alterations and diversions that limit habitat development and flood capacity (DAR Section 6.9.1).

The proposed remediation activity related to Baker Creek involves realigning portions of the creek to reduce flood risk, improving hydraulic performance, enhancing physical habitat and managing contaminated sediments (DAR Table ES.2.1). In the DAR, GMRT has identified the potential for adverse impacts to the aquatic environment of Baker Creek from physical disturbances associated with the relocation of the creek channel, sediment removal or capping and removal of existing riparian habitat. The alteration of Baker Creek (earthworks and vegetation clearing), includes an assessment of impacts to hydrology, surface water quality, sediment quality, aquatic habitat and biota.

GMRT has identified a number of mitigation measures in the DAR to minimize the potential impacts to fish and fish habitat in Baker Creek, specifically:

- erosion, sediment and drainage controls to minimize impacts to hydrology (DAR Table 8.4.2);
- surface water quality (DAR Table 8.4.5) and the aquatic environment (DAR Table 8.7.2);
- reducing mobilization of contaminants from sediments (DAR Table 8.4.6);

- working under dry conditions (DAR Table 8.4.6);
- collection of contaminated water for treatment, as required (DAR Table 8.4.6);
- timing of construction to avoid sensitive life stages of Valued Component (VC) species (DAR Table 8.7.2);
- minimizing the footprint of areas requiring removal of vegetation to avoid impacts to hydrology (DAR Table 8.4.2) and limiting the removal of aquatic vegetation to the extent possible to avoid impacts to the aquatic environment (DAR Table 8.7.2).

GMRT has identified several residual adverse environmental effects to surface water quality, sediment quality and the aquatic environment in Baker Creek (DAR Table 12.2.2) from activities associated with the remediation project. These residual effects were evaluated as Minor Adverse Effects (Not Significant), as outlined in Table 12.3.1.

GMRT has also indicated that many of the mitigation measures associated with preventing or minimizing potential adverse impacts to aquatic VCs in Baker Creek are associated with the restoration of Baker Creek itself on the mine site. The proposed remediation approach will physically stabilize the creek and improve both the quantity and quality of habitat (DAR Section 6.1.2).

In addition to improving the creek both physically and chemically, one of the objectives of the Giant Mine Remediation Project is to "restore Baker Creek to a condition that is as productive as possible, given the constraints of hydrology and climate" (DAR Section 1.2.1). The remediation project supports the enhancement of fish habitat in Baker Creek (DAR Section 1.7.3). Measures will be implemented to optimize the aquatic habitat of the creek. Some of the proposed Baker Creek rehabilitation concepts include the creation of new habitat, "in-design" channel features and terminal wetlands or deposition areas to minimize effects to hydrological features, and creation of new riparian habitat and vegetation for various aquatic and semi-aquatic species (DAR Table 8.4.2).

Overall, GMRT has considered the remediation of Baker Creek as a positive effect of remediation, "In particular, a key objective for the realignment and naturalization of Baker Creek is the enhancement of aquatic habitat. In this regard, instead of having an adverse effect on fish habitat within Baker Creek, the Remediation Project is expected to result in substantive improvements. Detailed design considerations for the restoration of Baker Creek will continue to be developed…to ensure that adverse impacts to fish habitat are prevented and, where such impacts are unavoidable, that they are minimized and compensated for." (DAR Section 8.7.2.1)

2.1.3 DFO's Conclusions and Recommendations

The proposed re-routing of portions of Baker Creek and potential removal or covering of sediments will disrupt the currently functioning fish habitat and will require *Fisheries Act* Authorization for a HADD.

As outlined in the DAR and supporting documents, Baker Creek has been heavily altered over time as a result of mining operations at the Giant Mine site. The creek must be stabilized both physically and chemically in order to meet the stated objectives of the remediation plan, therefore the impacts from remediation activity to fish and fish habitat within Baker Creek are unavoidable.

Background and historical context

Baker Creek was originally an isolated natural area with virtually no impacts from human intervention. As evident from historical aerial photos (1937), Baker Creek historically flowed through a series of ponds/wetland areas prior to retaining a defined meander channel with densely vegetated banks controlled by bedrock outcrops. In areas where the creek channel was confined by outcrops, bedrock cascades and associated cobble riffles existed over several hundred meters of the creek and likely provided potential suitable spawning habitat for several species of fish historically known to migrate from the lake (Supporting Document A6 - Dillon 1998).

The Yellowknives Dene Traditional Knowledge Report (Supporting Document A1) for Giant Mine provides some additional information on Baker Creek prior to mine development. “Before Giant Mine was built, the Yellowknives Dene had traditional camps where the mine is currently situated. What was important was the water, the fish and the game (moose, beaver and muskrat). The YKDFN fished at the mouth of Baker Creek (Jackfish River)”.

DFO involvement and role

During the water licensing process in 1997, restoration and reclamation studies for Baker Creek were put forward by Royal Oak Mines which were targeted towards regaining the functions that Baker Creek once had in providing migratory and resident fish habitat, as well as wildlife habitats, secluded from Yellowknife Bay (Supporting Document A6 - Dillon 1998).

Since the Government of Canada took responsibility for Giant Mine, DFO has worked with the GMRT to improve our understanding of the existing conditions in Baker Creek in order to inform the assessment and the selection of final remediation and restoration options.

As per the DFO Fish Habitat Policy, our goal is to ensure that the current functionality of Baker Creek fish habitat is maintained and/or enhanced as a result of the final Baker Creek remediation activity. The remedial works alone (realigning reaches or removing/capping contaminated sediments) do not equate to restoration of functioning fish habitat within the creek. It is our understanding and expectation that efforts, in the form of a Baker Creek restoration plan (fish habitat compensation), will be required to develop, restore and enhance fish habitat within the remediated portions of the creek channel. Baker Creek is currently functioning fish habitat and disrupting that function through the remediation activity will be subject to *Fisheries Act* authorization. Restoration of fish habitat in Baker Creek is not only stated as a goal of the remediation project, but will be a requirement of any DFO authorization to offset the fish habitat impacts.

The Baker Creek Restoration Concepts report (nhc 2005) was developed to provide potential restoration concepts that are complimentary to the long-term final remediation alternatives for the site. This report provides an initial discussion on options to restore fish habitat functions, or off-set, fish habitat loss associated with the required remediation activity. “With isolation or removal of contaminants, improved water quality, and physical channel restoration, ecological restoration is the expected outcome for the section of Baker Creek through the mine site” (Supporting Document G2 - nhc 2005).

DFO continues to provide input into the assessment of sediments to inform decision-making related to the remediation options for the reaches in Baker Creek where realignment is not required or proposed in the DAR (Reach 0, 2, 5 and 6). The assessment and evaluation of the sediments, as well as the design options for the remediation of Baker Creek, are still ongoing. Further consultation with DFO and the public regarding selection of remediation and restoration options is required. As part of this ongoing evaluation and discussion, additional details will be required regarding the quality and quantity of fish habitat to be included in the overall channel design and restoration plan for the creek.

Baker Creek fish and fish habitat

Since the realignment of reach 4 of Baker Creek in 2006, monitoring has been conducted on fish use and habitat within the creek. Arctic grayling (*Thymallus arcticus)* spawning habitat enhancements were monitored to evaluate the success of these fish habitat compensation measures as suitable spawning and rearing habitat (Golder 2008, 2009, 2010). These reports also identified other fish species that migrate into and use the creek in the spring. In 2010, a fish use and habitat survey was conducted to document seasonal fish use, species composition, life stages and map fish habitat in reaches 0 to 6 of Baker Creek, as well as to photograph the creek from reach 0 to Lower Martin Lake (Golder 2011a). Additional fish monitoring was conducted in the spring of 2011 to determine the state of fish use of habitat in Baker Creek following the spring 2011 overflow event (Golder 2011b).

The results of these studies indicate that although portions of Baker Creek have been heavily altered by historic activities, the existing aquatic system has been recovering over time. Reaches 0 to 6 provide a variety of habitats for numerous fish species. A total of 14 species of fish have been captured or observed using portions of Baker Creek on the mine site. Arctic grayling spawning and rearing habitat has been documented in all reaches (from 1 to 6) on the mine site. Northern pike (*Esox lucius)* slimy sculpin (*Cottus cognatus)* and ninespine stickleback (*Pungitius pungitius*) are known to be resident species. The creek provides northern pike spawning, rearing and overwintering habitat, spawning habitat for longnose sucker (*Catostomus catostomus)* and slimy sculpin, overwintering habitat for other fish species, such as northern pike, burbot (*Lota lota)* and lake whitefish (*Coregonus clupeaformis)* and feeding and rearing habitat for a number of other species.

Mitigation and restoration of fish habitat

DFO anticipates that the impacts from the proposed remediation activity in Baker Creek will have effects on existing fish habitat that will extend throughout the duration of the remediation phase of the project. During construction, there will be loss and alteration of habitat, alteration of hydrology, increased sedimentation, and loss of vegetation, organic inputs, nutrients and food sources. After remediation, it is anticipated that there will be reduced biological attributes within the new creek channel until the natural system recovers. DFO does not consider these impacts to be significant provided that mitigation measures are implemented, along with the required development, implementation and monitoring of an approved Baker Creek restoration plan to offset, or compensate for, the HADD of fish habitat.

Fisheries Act Authorizations typically include conditions requiring specific mitigation for impacts to fish and fish habitat, monitoring and reporting of mitigation measures, a fish habitat compensation plan and monitoring and reporting of habitat compensation results. Common types of mitigation conditions include, but are not limited to:

- timing windows;
- construction site control measures for erosion and sediment control;
- description of fish salvage operations; and,
- mitigation features to maintain fish passage.

In Section 14.1.2 of the DAR, Environmental Management Plans (EMPs) are proposed as the primary method of controlling, managing and monitoring environmental risks. GMRT indicates that EMPs will be developed to address environmental and social objectives, targets and commitments with respect to the Giant Mine Remediation Project. In response to Alternatives North and YKDFN Round 2 IR#03 and through information provided at the EMS Working Group meetings, additional information was provided related to the development of EMPs for each component of the remediation project. Baker Creek is one of the remediation project components, restoration of Baker Creek is a specific objective of the proposed remediation plan and fish and fish habitat are valued components within the environmental assessment. An EMP for the Baker Creek remediation outlining mitigation measures and monitoring for fish and fish habitat in Baker Creek should be developed.

In Table 12.3.1 of the DAR, GMRT evaluates the likely residual adverse effect of removing riparian vegetation as a consequence of surface disturbances along Baker Creek's channel. In the discussion of significance, GMRT indicate that, "at the completion of remediation, vegetation in disturbed areas is anticipated to re-establish quickly." However, after remediation and restoration activity is complete at Baker Creek, DFO expects the restoration of natural creek functions and a stream ecosystem to be a slow process. Ecological succession in the Arctic is slow (Jones et al. 2003). The creation of new streams or long stream reaches may require longer periods of time to provide productive fish habitat, as these newly constructed reaches need to accrue organic matter required by benthic macro invertebrates, which are, in turn, needed to support fish production (Minns 2006).

Studies conducted on the functionality of fish habitat within the Panda Diversion Channel at Ekati Mine revealed significant differences in biological attributes of the constructed stream compared to a suite of nearby, physically similar natural streams during the first three years after construction. A longer-term examination took place in 2011, 14 years post-construction, and results indicate that many biotic attributes of the constructed stream remained significantly different from quantities in reference streams. There were notable improvements in the amounts of riparian vegetation and coarse particulate organic matter however, it is requiring more than 14 years for convergence (Tonn et al. 2012). Although the barrenlands are a colder, lower productivity environment, the studies conducted on the constructed stream provide results suggesting that a greater focus on organic characteristics and vegetation within the stream and its riparian zone could accelerate compensation (Jones et al. 2008).

Experience from the reach 4 Baker Creek realignment in 2006 has shown that while well designed and constructed in-stream habitat enhancements can be a success, the natural succession and development of aquatic and riparian vegetation along the creek channel can be challenging, require time and potentially active intervention to assist in natural recovery. During remediation, protection, to the extent possible, of some of the existing biological attributes within the creek, particularly in those reaches with well developed aquatic vegetation and riparian areas, will be important for the short, medium and long-term recovery of the creek.

DFO anticipates that the remediation activity will have effects on the current functionality of fish habitat in Baker Creek due to the reduced biological attributes in the new sections of the creek channel. It is expected that there will be reduced primary production, benthic invertebrate and algal assemblages, macrophytes and riparian vegetation (e.g. cover, regulation of water temperature and flow, organic inputs, food and nutrient sources) compared to the existing creek conditions. This reduced productive capacity is expected to affect Baker Creek until the natural stream ecosystem recovers. DFO does not consider these effects to be significant provided that an approved restoration plan designed to off-set habitat losses and improve habitat quality and quantity is implemented and monitored to measure long-term recovery and restoration success.

Overall, the remediation project is expected to result in a gradual increase in numbers and diversity of fish and native vegetation present in the drainage area of the creek (DAR Section 6.1.2), as well as an improvement in the overall health of the aquatic system. Undisturbed creek habitat in upper Baker Creek, in reference streams, as well as in the existing creek habitats on the mine site, should be reviewed to develop natural analogs, which would guide the development of restoration options in the design reaches of the creek.

Proper planning, consultation and design are required to ensure the long-term success of the Baker Creek remediation and restoration as part of the Giant Mine remediation project. Long-term, the proposed Baker Creek remediation is anticipated to provide an overall increase in fish habitat quality and quantity and, therefore provide a net positive effect.

Recommendation#1: **DFO recommends the completion of a sediment assessment and the development of associated remedial options to assist in selecting final remediation plans for reaches O, 2, 5 and 6 of Baker Creek. DFO will require this information in order to determine the overall scale of the HADD for Baker Creek.**

Recommendation #2: **DFO recommends that the restoration plan (habitat compensation) and design that will achieve the offsetting of fish habitat for Baker Creek be developed as part of the overall remediation design for the creek. The restoration plan and channel designs must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization.**

Recommendation #3: **DFO recommends the development of an EMP for the remediation and restoration of Baker Creek that outlines the required mitigation measures and monitoring plans. The mitigation measures and monitoring plan will be a requirement of the *Fisheries Act* Authorization. The plan should include details on:**

- **mitigation measures to be implemented to manage and minimize downstream impacts to fish and fish habitat during remediation;**
- **how the mitigation measures will be monitored; and,**
- **a monitoring plan to evaluate the restoration of Baker Creek as functioning fish habitat.**

Recommendation #4: **DFO recommends that the commitments made to engage the public and aboriginal groups on the Baker Creek remediation options and restoration plan (as outlined in The Consultation and Engagement Plan, response to Round 1 RB_IR_18 and YKDFN IR 13) be completed prior to finalizing the remediation options, channel designs and fish habitat**

restoration plan. DFO will use the results of the public and aboriginal engagement when developing its regulatory tool (Authorization).

2.2 Relocation of treated mine water discharge

2.2.1 Document Reviewed

- Developer's Assessment Report (DAR), October 2010
  - Section 4.7, p. 101-106
  - Section 8.4 & 8.7
- IR Response (Round 1) to EC_10, City of Yellowknife IR_08, Alternatives North IR_06

2.2.2 Proponent's Assessment and Conclusions

Under existing conditions on the Giant Mine site, the discharge of treated minewater to Baker Creek has resulted in an unnatural hydrological regime during the summer months (July and August). The movement of the discharge point for treated minewater to Great Slave Lake will, therefore, return the hydrology of the creek to a state that is more representative of natural conditions (DAR Section 8.4.2.1).

Movement of the discharge point for treated minewater from Baker Creek to Great Slave Lake has the advantage of reducing exposure of potential contaminants from the site to fish and fish habitat within the creek. A detailed design for Baker Creek will ensure that the hydrology of the creek is returned to a more natural condition (DAR Section 8.4.2.4). However, the movement of the discharge point may have an adverse effect on any aquatic species that have colonized the creek due to the presence of flows throughout the summer (DAR Table. 8.7.2).

The additional flows associated with the current practice of discharging treated minewater to Baker Creek are not directly relevant to Arctic grayling use of the creek as spawning habitat. A similar relationship is expected to apply to other spring spawners such as longnose and white suckers *(Catostomus commersoni),* and northern pike. Based on the above, removal of the treated minewater discharge from Baker Creek is not expected to have an adverse effect on spring fish spawning and outmigration of young-of-year fish. However, there is a potential that benthic invertebrates, resident fish species (e.g., ninespine stickleback) and any species spawning late in the summer would be affected during years in which natural flows reduce to low levels following movement of the minewater discharge point. This is not considered to be an adverse effect of the remediation project because the creek will be returned to a more natural condition (DAR Table. 8.7.2).

2.2.3 DFO's Conclusions and Recommendations

The reach 4 Baker Creek fish habitat designs and the Baker Creek restoration concepts, developed to date, are based on the assumption that treated mine effluent would no longer be discharged in to the system (i.e. that water and sediment quality of Baker Creek will improve post-remediation). The intent is to fit into the long-term concept of restoring the biological function and stream processes of Baker Creek. The discharge of minewater to Baker Creek artificially elevates summer flows and contributes to the degradation of water and sediment quality relative to flows coming from the upper watershed above Baker Creek Pond (reach 6). The proposed cessation of the current discharge of mine drainage and treated effluents to the

creek is expected to improve primary and secondary productivity – algae and benthos – and utilization by resident and migratory freshwater fish. (Supporting document G2 – nhc 2005)

DFO agrees with the assessment outlined in the DAR that the removal of the treated minewater discharge to Baker Creek will not have an effect on migratory fish that move into the creek for spawning, feeding and rearing in spring (May and June). The current summer flows (July and August) are artificially elevated by the annual minewater discharge and proposed removal of this discharge will return Baker Creek to its natural hydrologic regime.

Because the existing summer conditions in Baker Creek have been artificially maintained by the minewater discharge, there may be some affects to the habitat availability in the summer by removing this additional discharge. Lower base flows during summer months, may result in a reduction of habitat availability for summer, fall and winter resident fish species currently using Baker Creek. Lower summer flows may reduce migratory access and habitat availability at various creek locations by lowering the water levels in pools, ponds and slow moving wetland areas, resulting in reduced spawning habitat for adult fish and reduced foraging and rearing habitat for larval and juvenile fish. Reduced summer flow may also affect dissolved oxygen levels and the availability of food resources in the creek (Supporting Document A6 - Dillon 1998).

The removal of this direct discharge of treated mine water to Baker Creek will reduce overall flows during the summer months, but it will return the creek to a more natural state and reduce exposure of aquatic biota to contaminants. This will reduce contaminant loading to the aquatic environment and improve water and sediment quality in lower Baker Creek, along with returning the creek to its natural hydrologic condition (DAR Section 6.8.7, Table 8.4.5 and Table 8.4.6). DFO does not consider the removal of treated minewater discharge into Baker Creek to be an adverse impact to fish and fish habitat

It is expected that during low flow conditions, migratory access at various creek locations may be restricted by reduced flow and resulting channel barriers. This being the case, the enhancement of in-stream creek habitat needs to be completed with knowledge of potential base flows and creek elevations at specific locations where potential habitat structures are proposed (DAR Supporting Document A6 - Dillon 1998).

> ***Recommendation #5:*** **DFO recommends that the final designs of any future Baker Creek channel realignments and in-stream habitat features be developed with a clear understanding of potential seasonal base flows to minimize the potential for channel barriers and impacts to fish passage. The habitat restoration plan and supporting channel designs must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization.**

3.0 TECHNICAL COMMENTS – OUTFALL AND DIFFUSER

3.1 Construction and operation of mine water outfall and diffuser

3.1.1 Documents Reviewed

- Developer's Assessment Report, October 2010
  - Section 6.8.6
  - Section 7.4.2
  - Section 8.4
  - Section 13.2
- Technical Session October 17-21, 2011
  - Transcript – Day 2 Water Treatment and Management
  - Undertakings 3 and 9
- IR Response (Round 1) to RB_IR_24, EC_IR_16, EC_IR_17, City of Yellowknife_IR_04, 06, Alternatives North_IR_14, YKDFN_IR_11, 12, 21
- IR Response (Round 2) to Alternatives North_IR_10, YKDFN_IR_04

3.1.2 Proponent's Assessment and Conclusions

In the DAR, GMRT identified 3 locations that are under consideration for the location of the diffuser (DAR Section 6.8.6). Detailed designs and the method of construction for the outfall and diffuser have yet to be finalized (DAR Table 8.4.5). During Day 2 of the Technical Session (October 18, 2011) and Day 1 of the Pre-Technical Report Workshop (June 27, 2012), a preliminary outfall pipeline alignment and diffuser location was presented along with a preliminary diffuser port configuration (Slides 49-50). The preferred alignment put forward is close to Location 2 identified in the DAR. The current proposal is to use a 28cm diameter pipeline approximately 1500m in length (underwater) and a diffuser 81m in length, with 28 ports at 1m in height off of the lake bottom. Each port diameter is proposed to be 0.013m (0.5 inch) and would have an estimated exit velocity of 6-10 m/s. The minimum depth of the diffuser would be 9m below the water surface. The influence of the mixing zone is anticipated to extend in a 15m radius from each of the diffuser ports.

The DAR described that during construction it is anticipated that the diffuser will be anchored with weights except near the shoreline area which will be installed in an excavated trench covered with riprap in the ice scour zone (DAR Table 8.4.5). The design will be selected to minimize disruption of fish habitat during construction (DAR Section 8.4.4) and there will be future workshops to discuss locations (DAR Table 13.12.1).

Underwater video and some in-situ water chemistry were collected in October 2009 to provide information on habitat characteristics (sediment type and aquatic vegetation) along the proposed outfall and diffuser locations (DAR Section 7.4.2). The video analysis was qualitatively compared for preferential spawning and foraging habitat of known fish species. There were difficulties with the quality of the video footage; therefore the assumptions taken from the video regarding substrate, etc. were made using only a few seconds of video. The nearshore area produced clearer video where substrate was evaluated to be predominantly sandy, with mostly silt/clay substrate observed along the potential outfall alignment which

was easily disturbed and hindered video footage. The areas evaluated were largely devoid of large macrophytes. The habitat analysis undertaken with the available video identified potential spawning habitat for spottail shiner (*Notropis hudsonius)*, and to a lesser extent, emerald shiner *(Notropis atherinoides)*, walleye (*Sander vitreus)* and white sucker, as well as potential foraging habitat for lake chub (*Couesius plumbeus)*, lake whitefish, ninespine stickleback, northern pike, and trout perch (*Percopsis omiscomaycus)*, which are known to associate with those substrates.

GMRT identified in the DAR Section 7.4.2 that additional video studies are proposed along with fish studies (larval and adult) to better characterize fish and their habitat including the riparian zone. In response to the City of Yellowknife Information Request #06 GMRT proposed to collect additional underwater video to verify the previous video, upon selection of preferred outfall alignment and before the end of summer 2012. During Technical Session (Day 2) and the Pre-Technical Report Workshop, GMRT outlined some of the additional information that they have collected and that they intend to collect in Yellowknife Bay to support the assessment and design of the diffuser, which includes collection of standard aquatic parameters under ice and then through open water season to support the modelling, and at the same time, support the habitat assessment. Parameters will likely include water quality samples at depth and at surface, water quality profiles, sediment quality, sediment composition and benthic invertebrates (October 18, 2011 transcript p.188). Additional information on sampling locations, samples collected to date and plans for water quality, currents, ice thickness monitoring, as well as planned sediment and fish habitat studies to support detailed design were presented in Day 1 of the Pre-Technical Report Workshop (June 27, 2012).

Potential environmental effects that were evaluated in the DAR during the construction phase of the outfall and diffuser include impacts to:

- surface water from increased turbidity and mobilization of contaminants (short-term and localized) (DAR Table 8.4.5);
- sediment quality from physical disturbance and remobilizing existing contamination (DAR Table 8.4.6);
- aquatic environment from physical disturbance to sediments, benthic invertebrates and aquatic vegetation (DAR Table 8.7.2).

GMRT identified mitigation measures in the DAR to minimize the potential impacts to fish and fish habitat associated with the construction of the outfall and diffuser, specifically:

- silt curtains to isolate area and minimize area of turbidity associated with disturbance of sediments (DAR Table 8.4.5);
- detailed designs and location will be selected to minimize potential sediment disturbances and disruption of fish habitat (DAR Table 8.4.6);
- timing of construction activity to avoid key life stages of VC species (e.g., spring and fall spawning periods) (DAR Table 8.7.2);

The potential environment effects that were evaluated by the GMRT during operation of the proposed diffuser include:

- water quality – water quality parameters and thermal effects (anticipated temperature of effluent at 2-8C with the Bay water at 2-4C) adjacent to the diffuser (DAR Table 8.4.5)
- sediment quality – potential for contaminant exchange with sediments (DAR Table 8.7.2);
- aquatic environment (biota and habitat)

- changes in water quality parameters and temperature has implications to aquatic biota in the area (DAR Table 8.4.5)
- mobilization of existing contaminants into the water column and impacts to aquatic receptors (DAR Table 8.7.2)

GMRT has identified mitigation measures in the DAR to minimize the potential impacts to fish and fish habitat associated with the diffuser, specifically:

- design details and location will be selected to minimize potential sediment disturbances and disruption of fish habitat (DAR Table 8.4.6);
- design diffuser to optimize mixing of effluent and minimize effect of the discharge (both chemical and thermal) (DAR Table 8.4.5);
- minimizing zone of influence of the discharge plume to reduce potential impact area to sediments (DAR Table 8.4.6);
- design diffuser ports to be located 1 m above the bottom to minimize sediment entrainment from port jets and ports angled towards water surface to avoid direct contact of port jets with bay bottom (Technical Session Day 2 - Presentation – slide 59).

While Section 12 of the DAR concludes that minor residual adverse effects to water quality, sediment quality and the aquatic environment would result from construction and operation of the diffuser, the additional assessments proposed above will be gathered to finalize the design and to support these conclusions.

3.1.3 DFO's Conclusions and Recommendations

While there is inconsistent quality in habitat data obtained to date, preliminary results indicate that higher quality habitat may exist along the outfall alignment rather than at the proposed diffuser locations. Additional information is still required in order to make a determination of potential impacts from the outfall and diffuser on fish and fish habitat. Some of the outstanding information includes site-specific data on the fish habitat along the preferred outfall alignment and at the diffuser location, including an assessment of:

- Shoreline and aquatic vegetation;
- Substrate type and habitat features; and,
- Potential impacts to fish movement and overwintering habitat.

DFO has also noted that there is a potential for physical changes to fish habitat and fish use within the mixing zone (turbulence) of the diffuser, which has not been assessed. DFO has collected baseline ecological data at 3 locations in Yellowknife Bay as part of the Cumulative Impact Monitoring Program (CIMP) and investigated fish species composition and habitat use during the winter. DFO will share these results once available, but initial findings show that fish are utilizing the areas near the proposed diffuser locations. Additional baseline habitat and fish use work will be required once the final route of the outfall and diffuser location is chosen.

The final design and location, as well as construction details have not been put forward for the proposed outfall and diffuser; therefore no determination can be made regarding impacts to fish and fish habitat. A site specific review will be required as well as additional details to be provided to DFO in order to make a

determination pursuant to the *Fisheries Act* of potential impacts and the extent of the physical disturbances in the area around the diffuser.

In terms of the potential impacts from the operation of the diffuser in relation to water quality objectives, Environment Canada administers section s.36 of the *Fisheries Act* and the application of the Metal Mining Effluent Regulations. It is also DFO's expectations that any water being discharged out of the diffuser must meet water quality limits, as set out in a water license, and would include conditions and standards that would ensure that no significant impacts will occur in the aquatic environment.

Recommendation #6: **DFO recommends the completion of the fish habitat assessment in Yellowknife Bay along the proposed route of the outfall and at the location of the diffuser.**

Recommendation #7: **DFO recommends the development of an EMP which outlines the mitigation and monitoring measures for the construction and operation of the proposed outfall and diffuser in Yellowknife Bay to ensure adverse physical impacts to fish and fish habitat are avoided.**

Recommendation #8: **DFO will require the final design and associated mitigation measures for the outfall and diffuser to inform a review pursuant to the habitat provisions of the *Fisheries Act*.**

4.0 TECHNICAL COMMENTS – HISTORIC FORESHORE TAILINGS

4.1 Historic Foreshore Tailings

4.1.1 Documents Reviewed

- DAR, October 2010
  - Section 5.6
  - Section 6.7
  - Section 8.0
  - Section 12.3 (Table 12.3.1)
  - Supporting Documents F1, F2, F3
- IR Response (Round 1) to YKDFN_IR_18 and YKDFN_IR_19 and 20
- Technical Session – Oct. 19, 2011 - Day 3 (slides 48-49)

4.1.2 Proponent's Assessment and Conclusions

The proposed remediation option for the beached tailings is further stabilization by extending the existing geotextile and rip-rap cover below the lake surface to cover the tailings where they occur in the littoral zone. This will minimize the potential for continued erosion of the tailings into Yellowknife Bay and would also likely stimulate benthic invertebrate production and improve aquatic habitat (DAR Section 6.7).

The effects assessment evaluated impacts to water quality, sediment quality and aquatic environment (benthic invertebrates and macrophytes) and focused on impacts from physical disturbance, increases in turbidity and the mobilization of contaminants (DAR Section 8.0).

Mitigation measures identified in the DAR to minimize the potential impacts to fish and fish habitat include:

- erosion and sediment controls, including silt curtains (DAR Table 8.4.6);
- collection of contaminated water for treatment, as required (DAR Table 8.4.6)

In DAR Table 12.3.1, the potential residual adverse effects associated with the remediation of the historic foreshore tailings were evaluated as "Minor" (not significant) as they are limited spatially to Site Study Area. The physical disturbance to the sediment in the area of the proposed cap is expected to be irreversible, but will lead to an overall improvement of sediment quality in the impacted foreshore area.

4.1.3 DFO's Conclusions and Recommendations

Studies undertaken on the area of historical mine tailings deposition in Yellowknife Bay have shown that over the years the submerged tailings have been carried and re-distributed along the western side of North Yellowknife Bay by wave action and lake currents. Investigations conducted on the historic tailings in Yellowknife Bay showed that overall the impacts of arsenic in sediments do not affect the entire

Yellowknife Bay and that the water column above the submerged tailings currently meets the federal Canadian Council for Ministers of the Environment (CCME) water quality guidelines for protection of freshwater aquatic life. However, as also noted in previous studies of the area, the results indicated that there was a continued effect to the benthic invertebrate community structure exposed to elevated arsenic concentrations in the sediments. The studies also documented that lake sediments made up predominantly of tailings offered poor habitat for fish spawning and rearing (Supporting Document F1 - SRK 2004).

As outlined in DFO's response to YKDFN Round 1 Information Request #19, the extension of a geotextile liner and a rip-rap cover over the submerged tailings would assist in preventing erosion and exposure of tailings (i.e. in low water years) and minimize the potential for continued migration of tailings. Provided it fully neutralizes the potential contaminant mobilization from the tailings, the cover would eliminate the direct exposure of the benthic community to elevated arsenic levels in the sediment and provide a clean substrate layer for benthic invertebrates. Depending on the extent of the area to be covered and the size of the rip-rap material to be used, it could also improve habitat available to fish in the area. Monitoring of the stability of the submerged tailings cover, as well as monitoring of chemical and biological parameters on the new substrate provided by the tailings cover would evaluate it's effectiveness in achieving erosion control and limiting tailings re-suspension in addition to its ability to provide suitable habitat for aquatic life.

The final cover design and footprint, as well as construction details, have not been put forward for the proposed remediation of the historic foreshore tailings in Yellowknife Bay. Additionally, no assessment of the area has been completed to determine the quality of fish habitat. This information is required in order to make a determination regarding impacts to fish and fish habitat. A site specific review is still required and additional details need to be provided for DFO to make a determination under ss.35(2) of the *Fisheries Act* on construction and footprint of potential physical disturbance to the area.

Recommendation #9: **DFO recommends the completion of a fish habitat assessment in Yellowknife Bay in the area of the historic tailings, including the extent of the proposed tailings cover.**

Recommendation #10: **DFO recommends the development of an EMP that outlines measures to mitigate adverse impacts to fish and fish habitat during construction of the cover for the historic foreshore tailings area and to monitor to ensure that the cover is functioning as intended.**

Recommendation #11: **DFO requests the final design and mitigation measures for the submerged tailings cover be provided to inform a review pursuant to the habitat provisions of the *Fisheries Act.***

5.0 TECHNICAL COMMENTS – MONITORING

5.1 Environmental Monitoring

5.1.1 Documents Reviewed

- Giant Mine Remedial Action Plan (RAP), July 2007
- DAR, October 2010:
  - Section 14.0
- IR Round 1: Response to RB_IR_27, EC_IR_15, City of YK_IR_08, Alternatives North_IR_02, 19, 20; YKDFN_IR_12, 13, 14, 20, 22, 23,
- IR Round 2: Response to YKDFN_IR_03, Alternatives North_IR_02, Alternatives North_IR_03
- Technical Sessions – Day 5, October 21, 2011
- Environmental Management System Working Group meeting notes and documents (March 5, April 25 and June 20, 2012)

5.1.2 Proponent's Assessment and Conclusions

GMRT has proposed an Environmental Monitoring and Evaluation Framework (EMEF) and a Long-Term Environmental Monitoring Program (LTEMP) for the Giant Mine Remediation Project (DAR Section 14.0). The framework, as outlined, recognizes that various aspects/components of environmental monitoring remain to be determined through the EA process and as required through regulation and licensing.

The proposed EMEF includes development and implementation of an Environmental Management System (EMS) which includes Environmental Management Plans (EMPs), evaluation of environmental performance and monitoring and evaluation of regulatory requirements.

In Section 14.1.2 of the DAR, Environmental Management Plans (EMPs) are proposed as the primary method of controlling, managing and monitoring environmental risks, as well as addressing implementation and monitoring aspects of the project. GMRT indicates that EMPs will be developed to address environmental and social objectives, targets and commitments with respect to the Giant Mine Remediation Project. In response to Alternatives North and YKDFN Round 2 IR#03, additional information was provided related to the development of EMPs for each component of the remediation project.

An Environmental Management System Working Group consisting of Parties to the EA has been established and 3 meetings have been held to date. Information on the proposed EMS framework and the approach to the EMS and EMP development has been provided. Parties are working with the GMRT to input into the development of objectives, targets and criteria for remediation components, as well as the format and content of the proposed EMPs.

The LTEMP proposes to evaluate both the physical performance of remediation infrastructure and environmental quality in the site and local study area. Components identified in the DAR related to the LTEMP include aquatic ecology (aquatic vegetation, benthic invertebrates, sediments and fish).

An Aquatic Effects Monitoring Program (AEMP) is also referenced in the DAR as an existing policy or guidelines for the development of management plans. AANDC has made a commitment to develop an AEMP for the Giant Mine Remediation in responses to various Information Requests (Alternatives North R1_IR_02, R2_IR_01and YKDFN R1_IR_12).

5.1.3 DFO's Conclusions and Recommendations

Baker Creek

The various monitoring programs, as identified in the DAR, identify that there will be requirements for monitoring and evaluation related to potential regulatory requirements. The remediation of Baker Creek is one of the proposed remediation components, restoration of Baker Creek is a specific objective of the proposed remediation plan and fish and fish habitat are valued components within the assessment.

As outlined in Section 2.1.3 of this submission, there are mitigation, monitoring and reporting requirements associated with *Fisheries Act* Authorizations that relate to mitigation during construction as well as fish and fish habitat monitoring. These monitoring requirements will need to be incorporated into the overall environmental monitoring framework for the Giant Mine remediation.

Construction monitoring evaluates the effectiveness of mitigation measures in avoiding impacts to fish and fish habitat. This monitoring would focus on mitigation measures such as erosion and sediment controls (e.g. regular inspections and turbidity monitoring) and fish salvage efforts implemented during remediation works requiring *Fisheries Act* Authorizations (e.g. Baker Creek realignments).

A fish habitat monitoring plan will evaluate the success or productivity of the habitat restoration works. As referenced in Section 2.1.3, the proposed remedial options and restoration concepts for Baker Creek must be developed not only to provide potential restoration options that are complimentary to the long-term remediation goals for the site, but also to provide a basis for discussion on options to restore fish habitat in the realigned sections of Baker Creek to off-set any fish habitat loss associated with the remediation activity.

Similar to the monitoring program associated with the Reach 4 Baker Creek realignment, a fish habitat monitoring plan for the restoration effort on Baker Creek would be a requirement of the *Fisheries Act* Authorization. Monitoring associated with the Baker Creek restoration would not only provide information to allow for an assessment of the recovery and productivity of fish habitat in the creek, it will also provide information to evaluate the success of the stated remediation goals/objectives "to restore Baker Creek to a condition that is as productive as possible, given the constraints of hydrology and climate" (DAR Section 1.2.1) and "physically stabilize the creek and improve both the quantity and quality of habitat" (DAR Section 6.1.2).

Very few habitat compensation and restoration projects are adequately monitored and evaluated (Pearson et al. 2005). Despite the overwhelming importance of habitat compensation measures to ensure the

maintenance of fish habitat in Canada and elsewhere, surprisingly few studies have evaluated the ecological effectiveness of mitigation measures or have devised monitoring programs capable of determining success or failure (Reeves et al. 1991).

A restoration (or fish habitat)monitoring plan for Baker Creek should have "clearly stated objectives, performance criteria and goals which are well defined, quantitative, measurable and linked to the achievement of productive habitat"(Quigley et al. 2006). The monitoring program should be quantitative and scientifically defensible, using experience from existing guidance documents (e.g. Pearson et al. 2005) and recent experimental designs used for monitoring other habitat compensation projects in the north (e.g. Jones et al. 2008 and Tonn et al. 2012). Lessons learned from the Reach 4 monitoring program, as well as other fish habitat compensation projects in the north, can be used to guide the monitoring and assessment for the remediation and restoration of Baker Creek.

The effectiveness of the 3.4-km Panda Diversion Channel at Ekati mine was examined using reference streams as standards against which gains and losses in productive capacity of fish habitat (stream function) could be quantified (Jones et al 2003). The recent 14 year assessment of ecological attributes in the Panda Diversion Channel provides a number of recommendations on monitoring the productive capacity of constructed streams. Our ability to ensure that habitat compensation efforts are achieving their ecological and regulatory objectives requires that compensation efforts are evaluated using a suite of ecological measures (Jones et al. 2008). Assessments of environmental degradation and restoration need to include evaluations of multiple biological attributes, including algal, benthic macroinvertebrate and fish assemblages (Wang et al. 2007). Findings from recent compensation monitoring results in the north, suggest that a long-term monitoring program to quantify improvement in the condition of the constructed stream should focus on macroinvertebrate assemblage structure and function, macro- and micro-vegetation and organic matter. Post-project monitoring duration should be linked to rates of habitat change and life-cycle duration of target species. It should also be linked to project size, complexity and/or potential for negative effects and ideally extend for over 10 years or two life cycles of target species (Quigley et al 2006).

> ***Recommendation #12:*** **DFO recommends that a fish habitat or restoration monitoring program be developed for the Baker Creek remediation and restoration and be incorporated into the overall monitoring framework and EMPs for the Giant Mine remediation. This monitoring plan must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization. DFO recommends that this monitoring program:**
> - **clearly state the objectives, performance criteria and goals for the habitat restoration, which are well defined, quantitative and measureable;**
> - **use appropriate scientific method and experimental designs (e.g. before-after-control-impact), include reference sites, baseline data and replicates to measure habitat productivity;**
> - **include measures of both habitat quantity and quality using a range of physical and biotic attributes; and, have a sufficient frequency and duration to detect and measure ecological recovery over time**

Aquatic Effects Monitoring Program

An AEMP should be developed to provide measureable and defensible results and assess changes occurring in the aquatic environments associated with the Giant Mine remediation activities. In order to be effective, acceptable thresholds, triggers and actions need to be identified. A robust AEMP should be conducted within an adaptive management framework, so that appropriate actions can take place quickly and effectively. The focus of monitoring programs should include a multitrophic approach (Spencer et al.2008).

As mentioned in the Proponent's Assessment section, the GMRT has committed to developing an AEMP for the Giant Mine Remediation.

> ***Recommendation#13:*** **DFO recommends that GMRT develop and implement an Aquatic Effects Monitoring Program (AEMP) in accordance with the June 2009 "Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories" to monitor and detect change in the aquatic ecosystems associated with the Giant Mine Remediation Project. A multitrophic approach should be used. The AEMP should be within an adaptive management framework, where thresholds, triggers and management actions are identified.**

6.0 SUMMARY OF RECOMMENDATIONS

Recommendation#1: **DFO recommends the completion of a sediment assessment and the development of associated remedial options to assist in selecting final remediation plans for reaches O, 2, 5 and 6 of Baker Creek. DFO will require this information in order to determine the overall scale of the HADD for Baker Creek.**

Recommendation #2: **DFO recommends that the restoration plan (habitat compensation) and design that will achieve the offsetting of fish habitat for Baker Creek be developed as part of the overall remediation design for the creek. The restoration plan and channel designs must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization.**

Recommendation #3: **DFO recommends the development of an EMP for the remediation and restoration of Baker Creek that outlines the required mitigation measures and monitoring plans. The mitigation measures and monitoring plan will be a requirement of the *Fisheries Act* Authorization. The plan should include details on:**

- **mitigation measures to be implemented to manage and minimize downstream impacts to fish and fish habitat during remediation;**
- **how the mitigation measures will be monitored; and,**
- **a monitoring plan to evaluate the restoration of Baker Creek as functioning fish habitat.**

Recommendation #4: **DFO recommends that the commitments made to engage the public and aboriginal groups on the Baker Creek remediation options and restoration plan (as outlined in The Consultation and Engagement Plan, response to Round 1 RB_IR_18 and YKDFN IR 13) be completed prior to finalizing the remediation options, channel designs and fish habitat restoration plan. DFO will use the results of the public and aboriginal engagement when developing its regulatory tool (Authorization).**

Recommendation #5: **DFO recommends that the final designs of any future Baker Creek channel realignments and in-stream habitat features be developed with a clear understanding of potential seasonal base flows to minimize the potential for channel barriers and impacts to fish passage. The habitat restoration plan and supporting channel designs must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization.**

Recommendation #6: **DFO recommends the completion of the fish habitat assessment in Yellowknife Bay along the proposed route of the outfall and at the location of the diffuser.**

Recommendation #7: **DFO recommends the development of an EMP which outlines the mitigation and monitoring measures for the construction and operation of the proposed outfall and diffuser in Yellowknife Bay to ensure adverse physical impacts to fish and fish habitat are avoided.**

Recommendation #8: **DFO will require the final design and associated mitigation measures for the outfall and diffuser to inform a review pursuant to the habitat provisions of the *Fisheries Act.***

Recommendation #9: **DFO recommends the completion of a fish habitat assessment in Yellowknife Bay in the area of the historic tailings, including the extent of the proposed tailings cover.**

Recommendation #10: **DFO recommends the development of an EMP that outlines measures to mitigate adverse impacts to fish and fish habitat during construction of the cover for the historic foreshore tailings area and to monitor to ensure that the cover is functioning as intended.**

Recommendation #11: **DFO requests the final design and mitigation measures for the submerged tailings cover be provided to inform a review pursuant to the habitat provisions of the *Fisheries Act.***

Recommendation #12: **DFO recommends that a fish habitat or restoration monitoring program be developed for the Baker Creek remediation and restoration and be incorporated into the overall monitoring framework and EMPs for the Giant Mine remediation. This monitoring plan must be submitted to DFO for approval as a requirement of the *Fisheries Act* Authorization. DFO recommends that this monitoring program:**

- **clearly state the objectives, performance criteria and goals for the habitat restoration, which are well defined, quantitative and measureable;**
- **use appropriate scientific method and experimental designs (e.g. before-after-control-impact), include reference sites, baseline data and replicates to measure habitat productivity;**
- **include measures of both habitat quantity and quality using a range of physical and biotic attributes; and, have a sufficient frequency and duration to detect and measure ecological recovery over time**

Recommendation#13: **DFO recommends that GMRT develop and implement an Aquatic Effects Monitoring Program (AEMP) in accordance with the June 2009 "Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories" to monitor and detect change in the aquatic ecosystems associated with the Giant Mine Remediation Project. A multitrophic approach should be used. The AEMP should be within an adaptive management framework, where thresholds, triggers and management actions are identified.**

7.0 REFERENCES

Golder Associates Ltd. 2008. Baker Creek Results of Fish Monitoring in Reach 4, Spring 2007. Prepared for Indian and Northern Affairs Canada. +83p.

Golder Associates Ltd. 2009. Final Report: Baker Creek, Results of Fish Monitoring in Reach 4, Spring 2008. Prepared for Indian and Northern Affairs Canada. +148p.

Golder Associates Ltd. 2010. INAC Baker Creek Grayling Project. Prepared for Indian and Northern Affairs Canada. +69p.

Golder Associates Ltd. 2011a. Final Update on Baker Creek Aquatic Studies – Fish and Fish Habitat Project. Prepared for Indian and Northern Affairs Canada. +47p.

Golder Associates Ltd. 2011b. Report on Baker Creek Reach 7 Overflow Fish Monitoring Program. Prepared for Public Works and Government Services Canada. +28p.

Harper, D.F., Quigley, J.T. 2005. No net loss of fish habitat: a review and analysis of habitat compensation in Canada. Environmental Management 36:343-355.

Jones, N.E., Tonn, W.M., Scrimgeour G.J., Katopodis C. 2003. Productive capacity of an artificial stream in the Canadian Arctic: assessing the effectiveness of fish habitat compensation. Canadian Journal of Fisheries and Aquatic Sciences 60:849-863.

Jones, N.E., Tonn, W.M. 2004. Enhancing productive capacity in the Canadian Arctic: assessing the effectiveness of instream habitat structures in habitat compensation. Transactions of the American Fisheries Society 133:1356-1365.

Jones, N.E., Tonn, W.M., Scrimgeour, G.J. 2008. Assessing the effectiveness of a constructed arctic stream using multiple biological attributes. Environmental Management 42:1064-1076.

Minns, C.K., Kelso, J.R.M., Randall,R.G. 1996. Detecting the response of fish to habitat alterations in freshwater systems. Canadian Journal of Fisheries and Aquatic Sciences 53(Suppl 1):403-414.

Minns, C.K. 2006. Compensation ratios needed to offset timing effects of losses and gains and achieve no net loss of productive capacity of fish habitat. Can. J. Fish. Aquat. Sci. 63: 1172-1182.

Pearson, M.P., Quigley, J.T., Harper, D.J., Galbraith, R.V. 2005. Monitoring and assessment of fish habitat compensation and stewardship projects: study design, methodology and example case studies. Can. Manuscr. Rep. Fish. Aquat. Sci. 2729: xv + 124p.

Quigley, J.T., Harper, D.J., Galbraith, R.V. 2006. Fish habitat compensation to achieve no net loss: review of past practices and proposed future directions. Can. Tech. Rep. Aquat. Sci. 2632: vi + 22p.

Reeves, G.H., Hall, J.D., Roelofs, T.D., Hickman, T.L., Baker, C.O. 1991. Rehabilitating and modifying stream habitats. In: Meehan WR (ed) Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Special Publication 19, Bethesda, Maryland, pp 519-557.

Spencer, P., Bowman, M.F., Dube, M.G. 2008. A multitrophic approach to monitoring the effects of metal mining in otherwise pristine and ecologically sensitive rivers in northern Canada. Integrated Environmental Assessment and Management 4(3):327-343.

Tonn, W.M., Scrimgeour, G.J., Jones, N.E., Landry, F. 2012. A preliminary assessment of short-term vs. 14-year changes in the ecological attributes and productive capacity of a constructed Arctic stream, the Panda Diversion Channel. Report to Fisheries and Oceans Canada. 32p.

Wang, L., Roberts, D.M., Garrison, P.J. 2007. Linkages between nutrients and assemblages of macroinvertebrates and fish in wadeable streams: implications to nutrient criteria development. Environmental Management 39:194-212.