APPENDIX I

GLOSSARY OF TERMS AND DEFINITIONS

GLOSSARY

The following terminology is utilized in this document following the definitions provided in the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2007) and the DDMI Class "A" Water License [License Number: W2007L2-0003])

"A154 Pit": The developed open pit and underground mine workings for the mining of the A154 North and South Kimberlite Pipes.

"A21 Pit": The developed open pit for the mining of the A21 Kimberlite Pipe.

"A418 Pit": The developed open pit and underground mine workings for the mining of the A418 Kimberlite Pipe.

Abandonment: The permanent dismantlement of a facility so it is permanently incapable of its intended use. This includes the removal of associated equipment and structures.

Abiotic: Non-living factors that influence an ecosystem, such as climate, geology and soil characteristics.

Acid Rock Drainage: The production of acidic leachate, seepage or drainage from underground workings, pits, ore piles, rockwaste, tailings, and overburden that could lead to the release of metals to groundwater and surface water during the life of the mine and after closure.

Active Layer: The layer of ground above the permafrost which thaws and freezes annually.

Adsorption: The surface retention of solid, liquid or gas particles by a solid or a liquid.

Alkalinity: A measure of the buffering capacity of water, or the capacity of bases to neutralize acids.

Ambient: The conditions surrounding an organism or area.

Ambient: The air in the surrounding atmosphere.

Anthropogenic: Caused by human activity.

"Aquatic Effects Monitoring Program": A monitoring program designed to determine the short and long-term effects in the water environment resulting from the Project, to evaluate the accuracy of impact predictions, to assess the effectiveness of impact mitigation measures and to identify additional impact mitigation measures to reduce or eliminate environmental effects.

Aquitard: A material of low permeability between aquifers. An aquitard allows some measure of leakage between the aquifers it separates.

Backfill: Material excavated from a site and reused for filling the surface or underground void created by mining.

Background: An area near the site under evaluation not influenced by chemicals released from the site, or other impacts created by onsite activity.

Baseline: A surveyed condition and reference used for future surveys.

Bathymetry: Measurement of the depth of an ocean or large waterbody.

Bedrock: The body of rock that underlies gravel, soil or other subregion material.

Benthic Invertebrate: Invertebrate organisms living at, in or in association with the bottom (benthic) substrate of lakes, ponds and streams. Examples of benthic invertebrates include some aquatic insect species (such as caddisfly larvae) that spend at least part of their lifestages dwelling on bottom sediments in the waterbody. These organisms play several important roles in the aquatic community. They are involved in the mineralization and recycling of organic matter produced in the water above, or brought in from external sources, and they are important second and third links in the trophic sequence of aquatic communities. Many benthic invertebrates are major food sources for fish.

Berm: A mound of rock or soil used to retain substances or to prevent substances from entering an area.

Biodiversity: The variety of plants and animals that live in a specific area.

Biotic: The living organisms in an ecosystem.

Biotite schist: A metamorphic rock containing a significant proportion of biotite (black) mica flakes, which are aligned in one main direction.

Board: The Mackenzie Valley Land and Water Board established under Part 4section 57.1 of the *Mackenzie Valley Resource Management Act*.

Boreal Forest: The northern hemisphere, circumpolar, tundra forest type consisting primarily of black spruce and white spruce with balsam fir, birch and aspen.

Canadian Dam Safety Guidelines: The Canadian Dam Association's Dam Safety Guidelines (January 1999) or subsequent approved editions. The scope and applicability of the DSG referred to in this Licence, is presented in Section 1 of the DSG.

Carat: A unit weight for precious stones: 1 carat = 200 mg.

Care and maintenance: A term to describe the status of a mine when it undergoes a temporary shutdown.

Closure: When a mine ceases operations without the intent to resume mining activities in the future.

Closure Criteria: Detail to set precise measures of when the objective has been satisfied.

Conductivity: A measure of the ability of water to pass an electrical current, which is affected by the presence of inorganic dissolved solids and organic compounds.

Construction: Activities undertaken to construct or build any components of, or associated with, the development of the Diavik Diamond Mine.

Contaminant: Any physical, chemical, biological or radiological substance in the air, soil or water that has an adverse effect. Any chemical substance with a concentration that exceeds background levels or which is not naturally occurring in the environment.

Contouring: The process of shaping the land surface to fit the form of the surrounding land.

County Rock: The rock surrounding an intrusive igneous rock such as kimberlite.

Criteria: Detail to set precise measures of when an objective has been satisfied.

Cryoconcentration: Concentration of solutes due to exclusion by ice.

Cryosols: An order of mineral or organic soils that generally have permafrost within 1 m of the ground surface and soil layers that are frequently disrupted by freezing.

Cryoturbation: Mixing of soil due to freezing and thawing.

Decommission: The process of permanently closing a site and removing equipment, buildings and structures. Reclamation and plans for future maintenance of affected land and water are also included.

Dewatering: The removal or draw down of water from any water body or from ground water table by pumping or draining.

Diabase: A dark-gray to black, fine-textured igneous rock composed mainly of feldspar and pyroxene.

Dike: Temporary water-retaining structure designed for water control to enable safe open-pit and underground mining.

Dike Seepage: Any water which passes through a dike.

Discharge: The release of any water or waste to the receiving environment.

Disposal: The placement, containment, treatment or processing of unwanted materials. This may involve the removal of contaminants or their conversion to less harmful forms.

Drainage: Excess surface or ground water runoff from land.

Drainage Basin: A region of land that eventually contributes water to a river or lake.

Dredging: Excavating and moving lake-bottom sediments and glacial till below the high watermark and from the bottom of Lac de Gras in the area of the footprints of the dikes.

"East Island": The large eastern-most island in Lac de Gras.

Ecodistrict: A subdivision of an ecoregion which is characterized by distinctive assemblages of relief, geology, landforms, soils, vegetation, water and fauna.

Ecoregion: A subdivision of an ecozone which is characterized by distinctive regional ecological factors, including physiography, climate, soil, vegetation, water and wildlife.

Ecosystem: An ecological unit consisting of both biotic (living) and abiotic (nonliving) environment that interacts within a defined physical location.

Ecozone: An area at the earth's surface representative of large and very generalized ecological units characterized by various abiotic (nonliving) and biotic (living) factors.

Edaphic: Referring to the soil. The influence of the soil on plant growth is referred to as an edaphic factor.

Effluent: Treated or untreated liquid waste material that is discharged into the environment from a treatment plant.

Electrical Conductivity: The capability of a solution to transmit an electrical current. A capability closely related to the concentration of salts in soils.

End Land Use: The allowable use of disturbed land following reclamation. Municipal zoning and/or approval may be required for specific land uses.

Engineered Structures: Any constructed facility which was designed and approved by a Professional Engineer registered with the Association of Professional Engineers, Geologists, and Geophysicists of the Northwest Territories.

Environment: The components of the Earth, and includes: land, water and air, including all layers of the atmosphere; all organic and inorganic matter and living organisms; and the interacting natural systems that include the aforementioned components.

Environmental Assessment (EA): An assessment of the environmental effects of a project that is conducted in accordance with the Canadian Environmental Assessment Act and its regulations.

Erosion: The wearing away of rock, soil or other surface material by water, rain, waves, wind or ice.

Esker: Glaciofluvial landform that occurs when meltwater deposits are left behind after glacier melts, resulting in long winding ridges of sediment.

Evaporation: The process by which water is changed from a liquid to a vapour.

Extensometer: An instrument used to monitor ground displacements.

Fish: Fish as defined in the *Fisheries Act*, includes parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fish Habitat: Areas used by fish for spawning, nursery, rearing, foraging and overwintering.

Footprint: The proposed development area that directly affects the soil and vegetation components of the landscape.

Freeboard: The vertical distance between the water line and the effective water containment crest on a dam's or dike's upstream slope.

Freshet: An increase in surface water flow during the late winter or spring as the result of rainfall, and snow and ice melt.

Geotechnical Engineer: A professional engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories and whose principal field of specialization is the design and construction of earthworks in a permafrost environment.

Glacial Till: Unsorted and unlayered rock debris deposited by a glacier.

Glaciofluvial Deposits: Material moved by glaciers and subsequently sorted and deposited by flowing glacial meltwater. Consist primarily of course to medium grained sands, gravels, cobbles, and boulders.

Glaciolacustrine Deposits: Material moved by glaciers and deposited in glacial lakes. Consist primarily of fine sands, silts and clay.

Groundwater: All subsurface water that occurs in rocks, soil and other geologic formations that are fully saturated.

Groundwater Recharge: Water that enters the saturated zone by a downward movement through soil and contributes to the overall volume of groundwater.

Habitat: The place where an animal or plant naturally lives and grows.

Habitat Unit: Generally, used in Habitat Suitability Index models. A habitat is ranked in regards to its suitability for a particular wildlife species. This ranking is then multiplied by the area (hectares) of the particular habitat type to give the number of habitat units (HU) available to the wildlife species in question.

Home Range: The area within which an animal normally lives, and traverses as part of its annual travel patterns.

Hummock: A bulging mound of soil having a silty of clay core that often develops in wet and/or permafrost conditions and shows evidence of movement due to regular frost action.

Hydrogeology: The study of the factors that deal with subsurface water (groundwater) and the related geologic aspects of surface water. Groundwater as used here includes all water in the zone of saturation beneath the earth’s surface, except water chemically combined in minerals.

Hydrology: The science that deals with water, its properties, distribution and circulation over the Earth’s surface.

Hydraulic Conductivity: Measure of the capacity of an aquifer to transmit water.

Igneous Rock: Rock formed when molten rock cools and solidifies.

Inclinometer: A tilt sensor used to monitor the angle of an object with respect to gravity.

In Situ Treatment: A method of managing, treating or disposing of material "in place" in a manner that does not require the material to be physically removed or excavated from where it is located.

Inspector: An Inspector designated by the Minister under Section 35(1) of the Northwest Territories *Water Act*.

Kame: An irregularly shaped hill or mound composed chiefly of poorly sorted sand and gravel deposited by a sub-glacial stream as an alluvial fan or delta.

Kimberlite: A type of ancient rock that travelled up to the earth's surface where it formed mini-volcanoes.

Kimberlite Pipes: Volcanic deposits contained in steep-walled, cone-shaped cylinders.

Landfill: An engineered waste management facility at which waste is disposed of by placing it on or in land in a manner that minimizes adverse human health and environmental effects.

Leachate: Water or other liquid that has washed (leached) from a solid material, such as a layer of soil or water; leachate may contain contaminants.

Leaching: The removal, by water, of soluble matter from any solid material lying on top of bedrock (e.g., soil, alluvium or bedrock).

Lithology: The systematic description of sediment and rocks, in terms of composition and texture.

Littoral Zone: The zone in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about 1% of the surface light) for rooted aquatic plants and algae to colonize the bottom sediments.

Local Study Area: Defines the spatial extent directly or indirectly affected by the project.

Metal Leaching: The mobilization and migration of metals from underground workings, pitwalls, ore piles, waste rock, tailings, and overburden.

Meteoric Water: Groundwater that has recently originated from the atmosphere.

Migration: The movement of chemicals, bacteria, and gases in flowing water or vapour.

Mine Design: The detailed engineered designs for all mine components stamped by a design engineer

Mine Plan: The plan for development of the mine, including the sequencing of the development.

Mine Water: Any water that accumulates in any underground working or open pits.

Mitigation: The process of rectifying an impact by repairing, rehabilitating or restoring, the affected environment, or the process of compensating for the impact by replacing or providing substitute resources or environments.

Monitoring: Observing the change in geophysical, hydrogeological or geochemical measurements over time.

Nitrogen Dioxide: One of the component gases of oxides of nitrogen which also includes nitric oxide. In burning natural gas, coal, oil and gasoline, atmospheric nitrogen may combine with molecular oxygen to form nitric oxide, an ingredient in the brown haze observed near large cities. Nitric oxide is converted to nitrogen dioxide in the atmosphere. Cars, trucks, trains and planes are the major source of oxides of nitrogen in Alberta. Other major sources include oil and gas industries and power plants.

No Net Loss: A term found in Canada's Fisheries Act. It is based on the fundamental principle of balancing unavoidable losses of fish habitat with habitat replacement on a project-by-project basis in order to prevent depletion of Canada's fisheries resources.

"North Inlet Facility": The containment facility that is constructed within the North Inlet of East Island of Lac de Gras.

"North Inlet Treatment Facility: Includes the treatment plant designated for the treatment of waters associated with the North Inlet Facility and mine workings.

Nutrient Regime: The relative supply of nutrients available for plant growth at a given site.

Objectives: Objectives describe what select activities are aiming to achieve.

Oligotrophic: Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).

Outliers: A data point that falls outside of the statistical distribution defined by the mean and standard deviation.

Parent Material: Material (generally bedrock) from which soils typically obtain structure and minerals. Consolidated (rock) or unconsolidated (e.g., river deposits) material that has undergone some degree of physical or chemical weathering.

Particulate Matter: A mixture if small particles and liquid droplets, often including a number of chemicals, dust and soil particles.

Passive Treatment: Treatment technologies that can function with little or no maintenance over long periods of time.

Pegmatite: A very coarse-grained igneous rock that has a grain size of 20 mm or more;

Permafrost: Ground that remains at or below zero degrees Celsius for a minimum of two consecutive years.

Permafrost Aggradation: A naturally or artificially caused increase in the thickness and/or area extent of permafrost.

Permeability: The ease with which gases or liquids penetrate or pass through a soil or cover layer.

pH: A measure of the alkalinity or acidy of a solution, related to hydrogen ion concentration; a pH of 7.0 being neutral.

Piezometer: An instrument used to monitor pore water pressure.

Pit water: Water that seeps into and/or is collected within the pit.

Pore Water Pressure: The pressure of groundwater held within the spaces between sediment particles.

Pore Water: The groundwater present within the spaces between sediment particles.

Post-Closure: The period of time after closure of the mine.

Processed Kimberlite (PK): Processed material rejected from the process plant after the recoverable minerals have been extracted.

Processed Kimberlite Containment (PKC): A storage area for the kimberlite remaining after diamonds have been removed during processing.

Progressive Reclamation: Actions that can be taken during mining operations before permanent closure, to take advantage of cost and operating efficiencies by using the resources available from mine operations to reduce the overall reclamation costs incurred. Progressive reclamation enhances environmental protection and shortens the timeframe for achieving the reclamation objectives and goals.

Project: The Diavik Diamond Mines Project, a joint venture between Harry Winston Diamond Corporation and Diavik Diamond Mines Inc.

Quaternary Glaciation: Glaciation that occurred during Quaternary period or the geologic time period from the end of the Pliocene Epoch roughly 1.8-1.6 million years ago to the present.

Rare Plants: A native plant species found in restricted areas, at the edge of its range or in low numbers within a province, state, territory or country.

Reclamation: The process of returning a disturbed site to a condition consistent with the original natural state or one for other productive uses that minimizes any adverse effects on the environment or threats to human health and safety.

Regional Study Area: Defines the spatial extent related to the cumulative effects resulting from the project and other regional developments.

Rehabilitation: Activities to ensure that the land will be returned to a form and productivity in conformity with a prior land use plan, including a stable ecological state that does not contribute substantially to environmental deterioration and is consistent with surrounding aesthetic values.

Relative Humidity: The ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation.

Remediation: The removal, reduction, or neutralization of substances, wastes or hazardous material from a site in order to minimize any adverse effects on the environment and public safety now or in the future.

Restoration: The renewing, repairing, cleaning-up, remediation or other management of soil, groundwater or sediment so that its functions and qualities are comparable to those of its original, unaltered state.

Revegetation: Replacing original ground cover following a disturbance to the land.

Riparian: Refers to streams, channels, banks and the habitats associated with them.

Risk assessment: Reviewing risk analysis and options for a given site, component or condition. Risk assessments consider factors such as risk acceptability, public perception of risk, socio-economic impacts, benefits, and technical feasibility. It forms the basis for risk management.

Runoff: Water that is not absorbed by soil and drains off the land into bodies of water.

Scarification: Preparation of a site to make it more amenable to plant growth.

Security deposit: Funds held by the Crown that can be used in the case of abandonment of an undertaking to reclaim the site, or carry out any ongoing measures that may remain to be taken after the abandonment of the undertaking.

Sedge: Any plant of the genus *Carex*, perennial herbs, often growing in dense tufts in marshy places. They have triangular jointless stems, a spiked inflorescence and long grass-like leaves which are usually rough on the margins and midrib. There are several hundred species.

Sediment: Solid material, both mineral and organic, that has been moved by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Seepage: Slow water movement in subsurface. Flow of water from constructed retaining structures. A spot or zone, where water oozes from the ground, often forming the source of a small spring.

Sewage: All toilet wastes and greywater.

"Sewage Treatment Plants": Comprises the engineered structures that are designed to contain and treat sewage at the North and South Camps during the construction period, and the main accommodations complex during operations,

Sentinel Species: Species that can be used as an indicator of environmental conditions.

Shoals: A shallow but submerged area isolated from the shorelines of a body of water.

Shoreline Habitat: Area extending from the high water mark to the low water mark of a given water body.

Slurry: A mixture of fine rock and water that can be pumped.

Soil: The naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth.

Soil Horizon: A layer of mineral or organic soil material approximately parallel to the land surface that has characteristics altered by processes of soil formation. A soil mineral horizon is a horizon with 17% or less total organic carbon by weight. A soil organic horizon is a horizon with more than 17% organic carbon by weight.

Solar Radiation: The principal portion of the solar spectrum that spans from approximately 300 nanometres (nm) to 4,000 nm in the electromagnetic spectrum. It is measured in W/m^2, which is radiation energy per second per unit area.

Solifluction: The slow creeping of soil down a slope promoted by the presence of permafrost and caused by a combination of frost creep and the downslope movement of wet, unfrozen soil.

Spawning Habitat: A particular type of area where a fish species chooses to produce and deposit its eggs.

Spillway: An engineered structure to facilitate the release of water from a water retention facility, often in an emergency. The spillway elevation is the elevation at which water begins to flow through the spillway structure.

Substrate: The material that comprises the bottom of a water body.

Sulphur Dioxide: Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, natural gas processing plants are responsible for close to half of the emissions of this gas. Oil sands facilities and power plants are also major sources. Others include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

Surficial material: Deposits on/at the earth's surface.

Sump: A catch basin where water accumulates before being pumped elsewhere for storage, treatment or release.

Surface Waters: Natural water bodies such as rivers, streams, brooks, ponds and lakes, as well as artificial watercourses, such as drainage ditches and collection ponds.

Sustainable Development: The design, development, operation and closure of all mining activities so as to ensure the optimisation of post closure outcomes in terms of social, environmental and economic development needs and expectations.

Tailings: Material rejected from a mill after most of the recoverable valuable minerals have been extracted.

Taliks: Unfrozen zones that can exist within, below, or above permafrost layers. They are usually located below deep water bodies.

Temporary Shutdown: The cessation of mining and diamond recovery for a finite period due to economic or other operational reasons, with the intent to resume operations under more favourable conditions.

Thermistor: An instrument used to monitor temperature change.

Thermokarst: A landscape characterized shallow pits and depressions caused by selective thawing of ground ice, or permafrost.

Till: Sediments laid down by glacial ice.

Total Dissolved Solids (TDS): A measure of the amount of dissolved substances in a waterbody:

Total Organic Carbon: Total organic carbon is composed of both dissolved and particulate forms. Total organic carbon is often calculated as the difference between Total Carbon (TC) and Total Inorganic Carbon (TIC). Total organic carbon has a direct relationship with both biochemical and chemical oxygen demands, and varies with the composition of organic matter present in the water. Organic matter in soils, aquatic vegetation and aquatic organisms are major sources of organic carbon.

Total Suspended Particulate: A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter less than 30 μm (microns) in diameter.

Total Suspended Solids (TSS): A measure of the particulate matter suspended in the water column.

Traditional Knowledge: A cumulative, collective body of knowledge, experience, and values built up by a group of people through generations of living in close contact with nature. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.

Trophic: Pertaining to part of a food chain, for example, the primary producers are a trophic level just as tertiary consumers are another trophic level.

Turbidity: The degree of clarity in the water column typically reflected as the amount of suspended particulate matter in a waterbody.

Understorey: Trees or other vegetation in a forest that exist below the main canopy level.

Waste Rock: All unprocessed rock materials produced as a result of mining operations that have no economic value.

Waste Rock Storage Facilities: Includes the engineered facilities for the disposal of rock and till, which are designated as the North and South Wasterock piles.

Waterbody: A general term that refers to ponds, bays, lakes, estuaries and marine areas.

Waterfowl Staging Area: Waterbodies used by waterfowl to gather, rest and feed before or during migration.

Watershed: A region or area bordered by ridges of higher ground that drains into a particular watercourse or body of water.

Wetland: A swamp. Marsh, bog, fen or other land that is covered by water during at least three consecutive months of the year.

Wildlife: Under the *Species at Risk Act*, wildlife is defined as a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus that is wild by nature and is native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.

APPENDIX II

LIST OF ACRONYMS

ACRONYMS

Acronym	Description
AEMP	Aquatics Effects Monitoring Program
ARD	acid rock drainage
BHPB	BHP Billiton
Ca	Calcium
CCME	Canadian Council of Ministers of the Environment
Cl	Chloride
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPK	Course Processed Kimberlite
DDMI	Diavik Diamond Mines Inc.
DFO	Department of Fisheries and Oceans (Fisheries and Oceans Canada)
DIAND	Department of Indian Affairs and Northern Development (Indian and Northern Affairs Canada)
DTC	Diavik Technical Committee
EA	Environmental Assessment
EER	Environmental Effects Report
EMAB	Environmental Monitoring Advisory Board
EMPR	Department of Energy Mines and Petroleum Resources
ESWG	Ecological Stratification Working Group
FeSi	Ferro-Silicon
FPK	Fine Processed Kimberlite
HADD	Harmful alteration, disruption or destruction (of fish habitat)
HCO_3	Bicarbonate
HSEQMS	Health, Safety and Environment Quality Management Systems
HW	Harry Winston Diamond Limited Partnership
ICRP	Interim Closure and Reclamation Plan
INAC	Indian and Northern Affairs Canada
LSA	Local Study Area
Mg	Magnesium

Acronym	Description
MLch	Metal Leaching
MVLWB	Mackenzie Valley Land and Water Board
Na	Sodium
NI	North Inlet
NIWTP	North Inlet Water Treatment Plant
NKSL	Nishi Khon-SNC Lavalin
NTU	Nephelometric Turbidity Unit
NWT	Northwest Territories
PK	Processed Kimberlite
PKC	Processed Kimberlite Containment
RA	Regulatory Authorities
ROM	Run of Mine
RSA	Regional Study Area
SARA	*Species at Risk Act*
SGP	Slave Geological Province
SNP	Surveillance Network Program
TDS	total dissolved solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSP	Total Suspended Particulate
TSS	total suspended solids
UCAF	Underhand cut and fill
VLC	vegetation/land cover
WLWB	Wek’èezhìi Land and Water Board
WTA	Waste Transfer Area
WWF	World Wildlife Fund
ZOI	Zone of Influence

APPENDIX III

LIST OF ABBREVIATIONS

ABBREVIATIONS

Abbreviation	Description
EBA	EBA Engineering Consultants Ltd.
Golder	Golder Associates Ltd.
Kennecott	Kennecott Canada Inc.
The Mine	Diavik Diamond Mine

APPENDIX IV

LIST OF UNITS AND SYMBOLS

UNITS

Unit	Description
%	percent
<	less than
>	greater than
° ’	degrees, minutes
°C	degrees Celsius
µg/m^3	microgram per cubic metre
µS/cm	micro Siemens per centimetre
BTU	British Thermal Units
cm	centimetre
FeSi	ferro-silicon
ha	Hectare
kg $CaCO_3$/tonne	kilograms calcium carbonate per tonne
km	kilometre
km/hr	kilometres per hour
km^2	square kilometres
kV	kilovolts
m	metre
m/s	metres per second
m^3	cubic metres
m^3/day	cubic metres per day
m^3/s	cubic metres per second
masl	metres above sea level
mg/dm^2/yr	milligrams per square decimetre per year
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
ML	Million litres
mm	millimetre
Mm^3	Million cubic metres
Mt	Million tonnes (1 tonne = 1,000 kilograms)
MW	Megawatts
NTU	Nephelometric Turbidity Units
wt%	percent by weight

APPENDIX V

DETAILED TABULATION OF CLOSURE OBJECTIVES AND CRITERIA

Appendix V Detailed Tabulation of Closure Objectives and Criteria

Version 1.1 Notes:

- Removed modifiers with the rationale that the objective must be “achievable” and that this term includes reasonable, practical, possible, feasible, economic, etc. If based on more detailed analysis or monitoring an objective or criteria is not achievable then it can be revised. This is consistent with WLWB direction and intent.
- Simplification – have tried to reduce the number of objectives by making site wide objectives and combining common objectives.
- In general DDMI will use available standards or guidelines as initial closure criteria – for example CCME Water Quality Guidelines. These standards/guidelines are understood to be conservative (erring on the side of caution) and as such will be used as initial criteria unless it has been identified that the there are specific site conditions (for example presence of more sensitive species). If it is determined at some point that these initial criteria are not achievable or are not appropriate (for example exposure pathway not applicable) then DDMI may conduct a site-specific risk assessment to derive a site-specific risk-based closure criteria. Once derived, DDMI would apply to have the risk-based criteria accepted as revised closure criteria. Within the following tables DDMI has identified where it is anticipated that risk-based criteria may be derived.
- Table V-7 – Closure water quality criteria. Table has modified to have all water quality criteria in one table. Three types of criteria are included: criteria for water entering Lac de Gras, criteria for the protection of aquatic life and criteria for protection of drinking water. The values presented for water entering Lac de Gras are concentrations in a runoff or seepage water entering Lac de Gras, that once mixed with Lac de Gras water would not impact on water uses in Lac de Gras (i.e. aquatic life or drinking water). They are initial planning values. In the absence of specific mixing characteristic information for each anticipated seepage/runoff discharge point, DDMI has used a dilution factor of 23 for initial planning purposes. The area of Lac de Gras where a 23 times dilution factor (mixing zone) is achieved will be different for each anticipated discharge point depending upon the actual mixing characteristics at each location. DDMI will assess the mixing characteristics for each anticipated discharge point. In the future DDMI will consult with WLWB, government and communities regarding the maximum acceptable aerial extent of closure mixing zones. All of this information will then be used to revise the values in Table V-7, as required, to consider discharge specific mixing conditions.
- North Inlet criteria have been revised and simplified to focus on the goal of reconnection. The Objectives and criteria are for reconnection. If at some point it is determined that reconnection is not achievable then the objectives and criteria will be revised.

Version 1.2 Notes

- DDMI notes that reviewers recommended changes to some objectives. Recommendations in INAC-8, INAC-44, INAC-45, INAC-46, EMAB-44, DFO-2 DFO-7, TG-5 and YKDFN 25 of the online comment table for Version 3.1 of the ICRP should be discussed further as closure planning progresses. As work on improving closure criteria and finalizing closure activities progresses, the need to change objectives may arise. The Board has indicated that DDMI or any other party may recommend a change to the objectives, with supporting rationale, and that in general all parties should have the opportunity to provide input on proposed changes.

Table V-1 Closure Objectives and Criteria – Site Wide

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
SW1. Surface runoff and seepage water quality that is safe for humans and wildlife.	Human – Table V-7 drinking water criteria or site-specific risk-based criteria met. Wildlife – Site-specific risk-based criteria met.	Post-closure sampling of runoff/seepage at representative locations where human/wildlife consumption is likely.	Appendix VIII-6	Appendix VI-2
SW2 Surface runoff and seepage water quality that will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River.	Table V-7 water entering LDG criteria or site-specific risk-based criteria met.	Post-closure sampling of runoff/seepage at locations where seepage/runoff enters Lac de Gras.	N/A	Appendix VI-2
SW3. Dust levels safe for people, vegetation, aquatic life, and wildlife.	Mean TSP concentrations less than 60 *u*g/m^3 annual and 120 *u*g/m^3 24 hr maximum acceptable (Canadian Ambient Air Quality Objectives and NWT Ambient Air Quality Standards) or site-specific risk-based criteria met.	Post-closure TSP and dust deposition/quality measurements show a declining trend from operational levels.	Appendix VIII-6	Appendix VI-1
SW4. Dust levels do not affect palatability of vegetation to wildlife.	Monitoring evidence of post-closure wildlife use of area.	Post-closure monitoring of wildlife use in area	N/A	Appendix VI-1
SW5. Re-vegetation targeted to priority areas.	▪ Final re-vegetation procedures applied to priority areas as established with communities and approved by WLWB. ▪ Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%.	Submission of Final As Built drawings. Post-closure assessment of change in biodiversity.	Appendix VIII-1 Appendix VIII-6	Appendix VI-2
SW6. Ground surface designed to drain naturally	▪ Pre-development drainage channels re-	Drainage construction inspected and as-built	N/A	Appendix VI-2

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
follow pre-development drainage patterns.	established at Ponds 1,2 3,4,5,7,10,11,12,and 13 ▪ Satisfactory final inspection of drainage construction by a professional engineer.	drawing signed-off by a Professional engineer.		
SW7. Areas in and around the site that are undisturbed during operation of the mine should remain undisturbed during and after closure.	Mine footprint area less than 13 km^2 post-closure. (Footprint is the directly disturbed area as used in the Wildlife Effects Monitoring Program for direct habitat/vegetation loss.)	Post-closure assessment of final mine footprint size.	N/A	N/A
SW8. No increased opportunities for predation of caribou compared to pre-development conditions.	Caribou predation directly attributable to a landscape feature unique to this area does not result in increased overall predation on the herd.	Post-closure monitoring of wildlife use in area. Post-closure assessment of predation rates.	N/A	Appendix VI-5
SW9. Landscape features (topography and vegetation) that match aesthetics and natural conditions of the surrounding natural area.	▪ Surface of scarified native material (rock or till). ▪ Mine footprint area less than 13 km^2 post-closure. ▪ Final re-vegetation procedures applied to priority areas. ▪ Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%. ▪ No surface visible buildings, equipment or non-local materials.	Submission of Final As Built drawings. Post-closure assessment of change in biodiversity. Post-closure assessment of final mine footprint.	Appendix VIII-1 Appendix VIII-6	Appendix VI-5
SW10. Safe passage and use for caribou and other wildlife.	No repeated harm to caribou as a direct result of passage through or use of the area. (i.e. if a	Post-closure monitoring of caribou use in area. Post-closure assessment	N/A	Appendix V-5

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
	feature/area is confirmed as being a hazard based on more than one incident then objective is not met for that feature/area)	of area hazards to caribou.		
SW11. Mine areas are physically stable and safe for use by people and wildlife.	Satisfactory final inspection by a professional engineer.	Area inspected and as-built drawing signed-off by a professional engineer.	N/A	Appendix VI-1

Table V-2 Closure Objectives and Criteria - Open Pit, Underground and Dike Areas

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
M1. Water quality in the flooded pit and dike area that is similar to Lac de Gras or at a minimum protective of aquatic life.	Table V-7 aquatic life and drinking water criteria or site-specific risk-based criteria met.	Post-closure sampling of water quality in previously diked off areas.	N/A	Appendix VI-1
M2. Pit and dike closure do not have adverse effects on water uses in Lac de Gras, the Coppermine River or on groundwater use.	Water license discharge criteria (EQC) or site-specific risk-based criteria met.	Post-closure sampling of flooded pit area prior to breaching dikes.	N/A	Appendix VI-1
M3. Enhanced lake-wide fish habitat to off-set fish habitat temporarily lost during operations.	Ratio of fish habitat units gains to fish habitat units lost of 1.2:1 or better as per Fisheries Authorization.	Submission of as-built drawings signed by a Professional engineer.	Appendix VIII-1 Appendix VIII-2	Appendix VI-1
M4. Safe small craft navigation through dike and pit area.	Breaks in dikes to be a minimum of 30m wide by 2 m deep as per Transport Canada approval.	Submission of as-built drawings signed-off by a Professional engineer.	N/A	Appendix VI-1
M5. Physically stable pit walls and shorelines to limit risk of a failure impacting people, aquatic life or wildlife.	Satisfactory final inspection by a professional engineer.	Area inspected and as-built drawing signed-off by a professional engineer.	N/A	Appendix VI-1
M6. Pit fill rate that will not cause adverse effects on water levels in Lac de Gras and Coppermine River.	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural fluctuations.	Monitoring of fill rate and calculation of change to lake level.	N/A	N/A
M7. Pit fill rate that will not cause adverse effects on fish or fish habitat in Lac de Gras and Coppermine	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural	Monitoring of fill rate and calculation of change to lake level.	N/A	N/A

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
River.	fluctuations.			
M8. Wildlife safe during filling of pits	No mortalities to wildlife VEC caused by filling of pits.	Monitoring of wildlife in pit area during filling.	N/A	Appendix VI-1

Table V-3 Closure Objectives and Criteria - Wasterock and Till Area

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
W1 Physically stable slopes to limit risk of failure that would impact the safety of people or wildlife.	Satisfactory final inspection by a professional engineer	Area inspected and as-built drawing signed-off by a professional engineer.	N/A	Appendix VI-2
W2 Rock and till pile features (shape and appearance) that match aesthetics of the surrounding natural area.	▪ Maximum pile elevation of 500 m ▪ Surface of native material	Submission of Final As Built drawings.	N/A	NA
W3 Contaminated soils and waste disposal areas that cannot contaminate land and water.	CCME contaminated sites guidelines or site-specific risk-based criteria for hydrocarbons are met.	Post-closure Environmental Site Assessment Post-closure sampling of runoff/seepage/soil at representative locations where human/wildlife consumption of water/vegetation/soil is likely.	Appendix VIII-6	Appendix VI-2

Table V-4 Closure Objectives and Criteria - Processed Kimberlite Containment Area

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
P1. No adverse affects on people, wildlife or vegetation.	Human – Table V-8 criteria or site-specific risk-based criteria met. Wildlife – Site-specific risk-based criteria met	Post-closure sampling of runoff/seepage/vegetation/dust deposition at representative locations where human/wildlife consumption of water/vegetation/dust is likely.	Appendix VIII-6	Appendix V-3
P2. Physically stable processed kimberlite containment area to limit risk of failure that would affect safety of people or wildlife.	Satisfactory final inspection by a professional engineer	Area inspected and as-built drawing signed-off by a professional engineer.	N/A	Appendix V-3
P3. Prevent processed kimberlite from entering the surrounding terrestrial and aquatic environments.	▪ Erosion protection placed over PK material. ▪ Filter drain constructed. ▪ Satisfactory final inspection of erosion protection and filter drain construction by a professional engineer.	Cover and filter drain construction inspected and as-built drawing signed by a Professional engineer.	N/A	Appendix V-3

Table V-5 Closure Objectives and Criteria - North Inlet Area

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
NI1. Reconnect the North Inlet with Lac de Gras.	North inlet east dam deconstructed to leave a minimum 30m wide by 2 m depth of water opening.	Ecological risk assessment of NI sediment quality prior to deconstructing dam. Submission of as-built drawings signed by a professional engineer.	Appendix VIII-5	N/A
NI2. Water quality and sediment quality in the north inlet that is safe for aquatic life, wildlife, and people.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	Water and sediment monitoring of the North Inlet prior to reconnection.	Appendix VIII-5	N/A
NI3. Suitable fish habitat in the north inlet.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	Water and sediment monitoring of the North Inlet prior to reconnection	Appendix VIII-5	N/A
NI4. Water quality in the north inlet that is as similar to Lac de Gras as possible.	Monitoring results indicate that drawing more Lac de Gras water into the NI and treating and releasing more NI water will not significantly improve water quality.	Monitoring change in NI water quality over time.	N/A	Appendix VI-4
NI5. Water and sediment quality in the North Inlet that will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	Water and sediment monitoring of the North Inlet prior to reconnection	Appendix VIII-5	N/A
NI6. Physically stable banks of the North Inlet to limit risk of failure that would impact the safety of people or wildlife.	Satisfactory final inspection of area by a professional engineer.	Final landscape inspected and submission of an as-built drawing signed by a Professional engineer.	N/A	Appendix VI-4

Table V-6 Closure Objectives and Criteria - Mine Infrastructure Areas

Closure Objective	Closure Criteria	Actions - Measurements	Reclamation Research Reference	Monitoring Reference
I1. Opportunities for communities to re-use infrastructure, allowable under regulation, and where liability is not a significant concern.	Conditions of Socio-Economic Monitoring Agreement and Participation Agreements met.	Third-party post closure audit to confirm.	N/A	N/A
I2. On-site disposal areas are safe for people, wildlife, and vegetation.	CCME contaminated sites guideline or site-specific risk-based criteria are met.	Post-closure sampling of runoff/seepage/soil at representative locations where human/wildlife consumption of water/vegetation/soil is likely. Post-closure Environmental Site Assessment of on-site disposal area.	Appendix VIII-6	Appendix VI-5
I3. Prevent remaining infrastructure from contaminating land or water.	CCME contaminated sites guidelines or site specific risk-based criteria are met.	Post-closure Environmental Site Assessment	N/A	N/A

Table V-7 Closure water quality criteria.

Parameter	Units	Water Entering LDG*	Criteria Source*	Aquatic Life	Drinking Water
Total dissolved solids	mg/L				500
Chloride	mg/L			230	250
Sodium	mg/L				200
Sulphate	mg/L				500
Total suspended solids	mg/L	92	1	+5 (24hr to 30 Days) +25 (24hr period)	
Turbidity	NTU	46	1		
Total ammonia	mg/L	49.8	1	4.73	
Nitrate	mg/L			30.1	10
Nitrite	mg/L	1.31	1	0.06	
Total phosphorus	kg/yr	1000	2	0.005	
Aluminum	mg/L	0.179 (t)	1	0.088(d)	0.1/0.2 (t)
Antimony	mg/L				0.006
Arsenic	mg/L	0.110	1	0.05	0.005
Cadmium	mg/L	0.0015	2	0.0001	0.005
Copper	mg/L	0.0207	1	0.002	1.0
Chromium	mg/L	0.0292	1	0.001 (Cr iv)	0.05
Lead	mg/L	0.0184	1	0.001	0.01
Manganese	mg/L	1.11	1		0.05
Mercury	*u*g/L			0.026 (inorganic) 0.004 (methyl)	
Molybdenum	mg/L	1.64	1	0.073	0.25
Nickel	mg/L	0.437	1	0.025	
Selenium	mg/L	0.0207	1	0.001	0.01

Thallium	mg/L			0.0008	0.0017
Uranium	mg/L	2.3	1		0.02
Zinc	mg/L	0.552	1	0.03	5
pH		5.0 to 8.4	2	6.5 to 9.0	6.5 to 8.5
Dissolved Oxygen	mg/L			9.5 (early life stages) 6.5 other life stages	
Acute toxicity		LC50 >100	2		

*Source for Water Entering LDG Criteria:

1. Effects-Based EQC from Table 2 Comparison of Effects-Based EQCs to BATT-Based EQCs (Technical Advisory Committee April 2000).
2. Water License W2007L2-0003.

APPENDIX VI

POST-CLOSURE MONITORING AND REPORTING

VI-1 Open Pit, Underground and Dike Areas

VI-2 Waste Rock and Till Area

VI-3 Processed Kimberlite Containment Area

VI-4 North Inlet Area

VI-5 Mine Infrastructure Areas

Appendix VI-1 Post Closure Monitoring and Reporting - Open Pit, Underground And Dike Areas

DDMI anticipates that there would be two types of post-closure monitoring programs: performance monitoring specific to the open-pit, underground, dike areas and environmental effects monitoring which would include combined effects from all post-closure areas. The scope of the performance monitoring would include:

- Surface water quality in mine areas and depth profiles;
- TSP and dust deposition/quality measurement;
- Geotechnical inspections including observations of subsidence, erosion, thermal condition, etc..; and
- Wildlife use of the area.

In addition to area specific monitoring, environmental effects post-closure would be monitored through a continuation of a Post-Closure Aquatic Effects Monitoring Program in Lac de Gras and a Post-Closure Wildlife Effects Monitoring Program. Monitoring methods would be drawn from the operations monitoring programs and revised along with the monitoring frequency as appropriate to focus on post-closure monitoring questions.

Results of all monitoring and inspections would be documented in post-closure monitoring and inspection reports. These reports would include any recommendations for future corrective actions or changes to monitoring programs.

The anticipated monitoring and reporting schedule for this area is as follows:

Activity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Performance Monitoring										
Engineering Inspections										
Effects Monitoring										
Reporting										

Appendix VI-2 Post Closure Monitoring and Reporting - Wasterock and Till Area

DDMI anticipates that there would be two types of post-closure monitoring programs: performance monitoring specific to the wasterock and till area and environmental effects monitoring which would include combined effects from all post-closure areas. The scope of the performance monitoring would include:

- Seepage quality and quantity using a system similar to the Surveillance Network Program;
- Geotechnical inspections including observations of settlement, erosion, surface drainage, thermal condition, etc. as described above;
- TSP and dust deposition/quality measurement of any dust generated from the closed wasterock and till area; and
- Wildlife use of the area.

In addition to area specific monitoring, environmental effects post-closure would be monitored through a continuation of a Post-Closure Aquatic Effects Monitoring Program in Lac de Gras and a Post-Closure Wildlife Effects Monitoring Program. Monitoring methods would be drawn from the operations monitoring programs and revised along with the monitoring frequency as appropriate to focus on post-closure monitoring questions.

Results of all monitoring and inspections would be documented in post-closure monitoring and inspection reports. These reports would include any recommendations for future corrective actions or changes to monitoring programs.

The anticipated monitoring and reporting schedule for this area is as follows:

Activity	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Performance Monitoring																					
Engineering Inspections																					
Effects Monitoring																					
Reporting																					

Appendix VI-3 Post Closure Monitoring and Reporting - Processed Kimberlite Containment Area

DDMI anticipates that there would be two types of post-closure monitoring programs: performance monitoring specific to the PKC area and environmental effects monitoring which would include combined effects from all post-closure areas. The scope of the performance monitoring would include:

- seepage and runoff quality and quantity using a system like the Surveillance Network Program;
- TSP and deposition/quality measurement of any dust generated from the closed PKC;
- Geotechnical inspections including observations of settlement, erosion, surface drainage, thermal condition, etc.; and
- Wildlife use of the area.

In addition to area specific monitoring, environmental effects post-closure would be monitored through a continuation of a Post-Closure Aquatic Effects Monitoring Program in Lac de Gras and a Post-Closure Wildlife Effects Monitoring Program. Monitoring methods would be drawn from the operations monitoring programs and revised along with the monitoring frequency as appropriate to focus on post-closure monitoring questions.

Results of all monitoring and inspections would be documented in post-closure monitoring and inspection reports. These reports would include any recommendations for future corrective actions or changes to monitoring programs.

The anticipated monitoring and reporting schedule for this area is as follows:

Activity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Performance Monitoring										
Engineering Inspections										
Effects Monitoring										
Reporting										

Appendix VI-4 Post Closure Monitoring and Reporting - North Inlet Area

DDMI anticipates that there would be two types of post-closure monitoring programs: performance monitoring specific to the North Inlet area and environmental effects monitoring which would include combined effects from all post-closure areas. The scope of the performance monitoring would include:

- Water and sediment quality using a system similar to the Surveillance Network Program;
- Geotechnical inspections including observations of settlement, erosion, thermal condition, etc.;
- TSP and deposition/quality measurement of any dust generated from the closed North Inlet area; and
- Wildlife use of the area.

In addition to area specific monitoring, environmental effects post-closure would be monitored through a continuation of a Post-Closure Aquatic Effects Monitoring Program in Lac de Gras and a Post-Closure Wildlife Effects Monitoring Program. Monitoring methods would be drawn from the operations monitoring programs and revised along with the monitoring frequency as appropriate to focus on post-closure monitoring questions.

Results of all monitoring and inspection would be documented in post-closure monitoring and inspection reports. These reports would include any recommendations for future corrective actions or changes to monitoring programs.

The anticipated monitoring and reporting schedule for this area is as follows:

Activity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Performance Monitoring										
Engineering Inspections										
Effects Monitoring										
Reporting										

Appendix VI-5 Post Closure Monitoring and Reporting - Mine Infrastructure Areas

DDMI anticipates that there would be two types of post-closure monitoring programs: performance monitoring specific to mine infrastructure areas and environmental effects monitoring which would include combined effects from all post-closure areas. The scope of the performance monitoring would include:

- Re-vegetation success;
- TSP and dust deposition/measurements of dust generated from mine infrastructure areas;
- Monitoring of levels of reuse, recycle versus landfill;
- Runoff water quality;
- Geotechnical inspections including observations of cracking, erosion, thermal condition, etc.; and
- Wildlife use of the area.

In addition to area specific monitoring, environmental effects post-closure would be monitored through a continuation of a Post-Closure Aquatic Effects Monitoring Program in Lac de Gras and a Post-Closure Wildlife Effects Monitoring Program. Monitoring methods would be drawn from the operations monitoring programs and revised along with the monitoring frequency as appropriate to focus on post-closure monitoring questions.

Results of all monitoring and inspection would be documented in post-closure monitoring and inspection reports. These reports would include any recommendations for future corrective actions or changes to monitoring programs.

The anticipated monitoring and reporting schedule for this area is as follows:

Activity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Performance Monitoring										
Engineering Inspections										
Effects Monitoring										
Reporting										

APPENDIX VII

EXPECTED COST OF CLOSURE AND RECLAMATION

<u>VERSION 3.2 NOTES:</u>

- WLWB directed that the cover designs for the PKC and waste rock area remain, for the interim as approved in ICRP 2001.
- Closure cost estimates for these two facilities have been revised for Version 3.2 by:
    - Assuming quantities and unit costs for rock and till for PKC cover are as per INAC 2011
    - Assuming quantities and unit costs for rock, till and re-slope for waste rock pile are as per INAC 2011

SUMMARY OF COSTS

CAPITAL COSTS

COMPONENT TYPE	COMPONENT NAME	TOTAL COST	LAND LIABILITY	WATER LIABILITY
OPEN PIT		$1,751,823	$58,821	$1,693,002
UNDERGROUND MINE		$1,182,098	$1,182,098	$0
TAILINGS		$31,827,045	$34,062	$31,792,984
ROCK PILE		$23,066,005	$575,153	$22,490,853
BUILDINGS AND EQUIPMENT		$14,984,746	$13,369,853	$1,614,893
CHEMICALS AND SOIL MANAGEMENT		$1,492,549	$726,274	$766,274
WATER MANAGEMENT		$1,352,910	$0	$1,352,910
	SUBTOTAL	**$75,657,176**	**$15,946,260**	**$59,710,916**
		PERCENTAGES	**21%**	**79%**
MOBILIZATION/DEMOBILIZATION		$277,196	$58,425	$218,772
MONITORING & MAINTENANCE		$16,741,292	$3,528,561	$13,212,731
PROJECT MANAGEMENT	5%	$3,782,859	$797,313	$2,985,546
ENGINEERING	5%	$3,782,859	$797,313	$2,985,546
CONTINGENCY	20%	$15,131,435	$3,189,252	$11,942,183
GRAND TOTAL - CAPITAL COSTS		**$115,372,817**	**$24,317,124**	**$91,055,693**

Open Pit Name: *A154 &A418* **Pit #**

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
OBJECTIVE: CONTROL ACCESS TO DYKE CREST								
Fence	m	300	fh	180.00	$54,000	100%	$54,000	$0
Signs	each	3	sh	35.64	$107	100%	$107	$0
Block roads	m3	900	sb1h	5.24	$4,714	100%	$4,714	$0
Other			#N/A		$0		$0	$0
OBJECTIVE: FLOOD PIT by SIPHON then BREACHING DYKE								
Excavate 7 breaches in dyke shell	m3	84200	sc1h	8.262	$695,660	0%	$0	$695,660
Excavate plastic concrete cutoff wall	m3	2576	sc1s	19.46	$50,129	0%	$0	$50,129
Supply/install Nos. 6 syphons	m	1950	#N/A	369	$719,550	0%	$0	$719,550
Silt curtain	each	6	#N/A	11,731	$70,386	0%	$0	$70,386
Remove pipelines	m	9590	ppll	1.08	$10,357	0%	$0	$10,357
Remove pumps	each	4	pll	5400.00	$21,600	0%	$0	$21,600
Remove power lines	m	5552	POWRL	22.57	$125,320	0%	$0	$125,320
Other			#N/A	0	$0		$0	$0
OTHER ITEMS								

		Pct Land	Total Land	Total Water
Subtotal	$1,751,823	3%	$58,821	$1,693,002

Underground Mine Name ***A154 & A418*** UG Mine

ACTIVITY/MATERIAL	Unit	Qty	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
OBJECTIVE: CONTROL ACCESS								
Fence	m	100	fh	180	$18,000	100%	$18,000	$0
Signs	each	4	sh	35.64	$143	100%	$143	$0
Berm	m3	300	sb1h	5.238	$1,571	100%	$1,571	$0
concrete bulkhead, Nos 3 portals	m3	216	clfh	442.8	$95,645	100%	$95,645	$0
concrete bulkhead, Nos 4 vent raises	m4	151	clfh	442.8	$66,739	100%	$66,739	$0
Remove decline surface infrastructure	allow	1	#N/A	$1,000,000	$1,000,000	100%	$1,000,000	$0
other			#N/A	0	$0		$0	$0
OBJECTIVE: HAZARDOUS MATERIALS								
Costs allocated to "Chemicals" and "Bld	each		#N/A	0	$0		$0	$0
Other			#N/A	0	$0		$0	$0
SPECIALIZED ITEMS								
other			#N/A	0	$0		$0	$0

	Cost	Pct Land	Total Land	Total Water
Subtotal	$1,182,098	100%	$1,182,098	$0

Tailings Impoundment Name: ***Processed Kimberlite Containment Area*** Pond

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
OBJECTIVE: CONTROL ACCESS								
Fence	m	160	fh	180	$28,800	100%	$28,800	$0
Signs	each	8	sh	35.64	$285	100%	$285	$0
Block roads	m3	1440	sb1l	3.456	$4,977	100%	$4,977	$0
Other			#N/A	0	$0		$0	$0
OBJECTIVE: STABILIZE EMBANKMENT								
Construct East PKC dam toe berm	m3	39000	sb1h	5.238	$204,282	0%	$0	$204,282
Other			#N/A	0	$0		$0	$0
OBJECTIVE: COVER TAILINGS								
Remine/Load/Haul/Place Till cover	$/m3	1416000	INAC 2011	$4.46	$6,315,360	0%	$0	$6,315,360
Remine/Load/Haul/Place Rock cover and dome	$/m3	6122000	INAC 2011	$3.60	$22,039,200	0%	$0	$22,039,200
OBJECTIVE: TREAT SUPERNATANT								
Pump water	m3	500,000	#N/A	0.23	$115,000	0%	$0	$115,000
Operate treatment plant	m3	500,000	ddmi	0.1	$50,000	0%	$0	$50,000
Other			#N/A	0	$0		$0	$0
OBJECTIVE: UPGRADE SPILLWAY to EXPULSION OUTLET								
Excavate channel, rock	m3	9,000	rr3h	6.2424	$56,182	0%	$0	$56,182
Construct monitoring pond and pump back system	allow	1		3,000,000	$3,000,000	0%	$0	$3,000,000
Other			#N/A	0	$0		$0	$0
OBJECTIVE: REMOVE TAILINGS DISCHARGE								
Pipeline	m	12000	ppll	1.08	$12,960	0%	$0	$12,960
Remove reclaim barge	each		#N/A		$0		$0	$0
SPECIALIZED ITEMS								
Other		1	#N/A		$0			$0
				Subtotal	$31,827,045	0%	$34,062	$31,792,984
						Pct Land	Total Land	Total Water

Rock Pile Name: *North Country Rock Pile* **Rock Pile #:**

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
OBJECTIVE: STABILIZE SLOPES								
Flatten rock slopes with dozer	m3	1,501,500	INAC 2011	0.71	$1,066,065	50%	$533,033	$533,033
Other			#N/A	0	$0		$0	$0
OBJECTIVE: COVER DUMP (3.0 m T1 over exposed T2/T3 slopes, at repose)								
Rock cover	$/m3	4290000	INAC 2011	$3.96	$16,988,400	0%	$0	$16,988,400
Caribou ramps	m3	50000	dsl	0.8424	$42,120	100%	$42,120	$0
Till cover	$/m3	1031000	INAC 2011	$4.82	$4,969,420	0%	$0	$4,969,420
SPECIALIZED ITEMS								
other			#N/A	0	$0		$0	$0
				Subtotal	$23,066,005	2%	$575,153	$22,490,853
						% Land	Total Land	Total Water

Building / Equip Name: *Infrastructure* **Bldg / Equip #:**

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
OBJECTIVE: DISPOSE STATIONARY EQUIP. (DISMANTLE PROCESS EQUIP.)								
Labour	hr	31964	lab-sh	41.04	$1,311,803	50%	$655,901	$655,901
Equipment	hr	1643	excavh	189	$310,527	50%	$155,264	$155,264
Other	each		#N/A	-	$0		$0	$0
OBJECTIVE: DECONTAMINATE TANKS & BUILDINGS								
site wide allowance	each	1	#N/A	75,000	$75,000	50%	$37,500	$37,500
explosives facility	each	1	#N/A	50000	$50,000	50%	$25,000	$25,000
Other			#N/A	-	$0		$0	$0
OBJECTIVE: DECONTAMINATE MOBILE EQUIPMENT								
heavy	each	100	#N/A	2,000	$200,000	50%	$100,000	$100,000
light	each	125	#N/A	750	$93,750	50%	$46,875	$46,875
Other			#N/A	-	$0		$0	$0
OBJECTIVE: REMOVE BUILDINGS - ALL BUILDING AREAS SCALED TO ACCOUNT FOR HEIGHT (5 m per floor)							$0	$0
Process Plant	m2	61,381	brs1h	57.024	$3,500,218	100%	$3,500,218	$0
Main Accomodation Complex	m2	15,359	brs1l	38.016	$583,896	100%	$583,896	$0
Maintenance Building	m2	27,282	brs1h	57.024	$1,555,718	100%	$1,555,718	$0
Paste Plant	m2	20,735	brs1h	57.024	$1,182,420	100%	$1,182,420	$0
Ammonia Nitrate Building	m2	9,259	brs1l	38.016	$352,008	100%	$352,008	$0
Power House #1	m2	7,385	brs1h	57.024	$421,129	100%	$421,129	$0
Power House #2	m2	6,864	brs1h	57.024	$391,404	100%	$391,404	$0
(NEW) Mine Dry	m2	3,259	brs1l	38.016	$123,877	100%	$123,877	$0
Boiler House	m2	3,561	brs1h	57.024	$203,075	100%	$203,075	$0
Lube Oil Storage	m2	2,914	brs1l	38.016	$110,775	100%	$110,775	$0
NIWTP Acid Storage	m2	3,705	brs1l	38.016	$140,833	100%	$140,833	$0
MAC E Wing	m2	1,283	brs1l	38.016	$48,783	100%	$48,783	$0
North Inlet Water Treatment Plant	m2	3,150	brs1h	57.024	$179,626	100%	$179,626	$0
North Inlet Water treatment Expansion	m2	2,796	brs1h	57.024	$159,451	100%	$159,451	$0
LDG Offices	m2	993	brs1l	38.016	$37,744	100%	$37,744	$0
Sewage Treatment Plant	m2	1,471	brs1h	57.024	$83,903	100%	$83,903	$0
UG Mine Dry	m2	954	brs1l	38.016	$36,273	100%	$36,273	$0
Emulsion Plant	m2	1,413	brs1h	57.024	$80,550	100%	$80,550	$0
Crusher Building	m2	4,633	brs1h	57.024	$264,167	100%	$264,167	$0
Surface Operations Welding Shop	m2	1,098	brs1l	38.016	$41,725	100%	$41,725	$0
Surface Operations Building	m2	1,076	brs1l	38.016	$40,920	100%	$40,920	$0
Dorm 2	m2	1,353	brs1l	38.016	$51,431	100%	$51,431	$0
Dorm 1	m2	1,338	brs1l	38.016	$50,876	100%	$50,876	$0
North Construction Offices	m2	547	brs1l	38.016	$20,776	100%	$20,776	$0
Pit Muster	m2	485	brs1l	38.016	$18,430	100%	$18,430	$0
Mine Rescue Fire Hall	m2	449	brs1l	38.016	$17,056	100%	$17,056	$0
LDG Muster	m2	328	brs1l	38.016	$12,456	100%	$12,456	$0
LDG Offices	m2	273	brs1l	38.016	$10,396	100%	$10,396	$0
A21 Offices	m2	238	brs1l	38.016	$9,054	100%	$9,054	$0
Tank 4	m2	4,653	brs1l	38.016	$176,907	100%	$176,907	$0
Tank 5	m2	4,653	brs1l	38.016	$176,907	100%	$176,907	$0
Tank 3	m2	4,653	brs1l	38.016	$176,907	100%	$176,907	$0
Tank 2	m2	4,653	brs1l	38.016	$176,907	100%	$176,907	$0
Tank 1	m2	4,653	brs1l	38.016	$176,907	100%	$176,907	$0
Tank 6	m2	4,654	brs1l	38.016	$176,945	100%	$176,945	$0
Arctic corridors	m2	6,372	brs1l	38.016	$242,238	100%	$242,238	$0
Incinerator	m2	1,000	brs1h	57.024	$57,024	100%	$57,024	$0
consolidate & dump boneyard debris	each	1	#N/A	125,000	$125,000	100%	$125,000	$0
Other			#N/A	0	$0		$0	$0
OBJECTIVE: LANDFILL FOR DEMOLITION WASTE							$0	$0
Place soil cover	m3	187,500	sb1h	5.238	$982,125	50%	$491,063	$491,063
OBJECTIVE: GRADE AND CONTOUR MILL & PLANT SITE								
Grade mill area	m2	30,750	drl	0.918	$28,229	50%	$14,114	$14,114
Place crushed rock cover	m2	34,050	sb1h	5.238	$178,354	50%	$89,177	$89,177
other	m3		#N/A	0	$0		$0	$0
OBJECTIVE: GRADE AND CONTOUR SITE							$0	$0
Haul roads, A154 & A418 lease	ha	3.7	scfyl	3807	$14,124	100%	$14,124	$0

Building / Equip Name: *Infrastructure* **Bldg / Equip #:**

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
Service roads, A154 and A418 lease	ha	1.6	scfyl	3807	$6,091	100%	$6,091	$0
haul roads, A21 lease	ha	1.8	scfyl	3807	$6,853	100%	$6,853	$0
Service roads, A21 lease	ha	1.7	scfyl	3807	$6,282	100%	$6,282	$0
Haul roads, PKC dumps lease	ha	10.1	scfyl	3807	$38,565	100%	$38,565	$0
Service roads, PKC & dumps lease	ha	23.2	scfyl	3807	$88,322	100%	$88,322	$0
Haul roads, infrastructure lease	ha	14.9	scfyl	3807	$56,534	100%	$56,534	$0
Service roads, infrastructure lease	ha	5.4	scfyl	3807	$20,558	100%	$20,558	$0
Service roads, airport lease	ha	2.9	scfyl	3807	$11,040	100%	$11,040	$0
other			#N/A				$0	$0
SPECIALIZED ITEMS								
Scarify airstrip	ha	11	scfyl	3807	$41,877	100%	$41,877	$0
YK landfill disposal fees	allow	1	#N/A	250,000	$250,000	100%	$250,000	$0
Other			#N/A	0	$0		$0	$0
				Subtotal	$14,984,746	89%	$13,369,853	$1,614,893
						Pct Land	Total Land	Total Water

1 Chemicals and Soil Contamination:

ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
HAZARDOUS MATERIALS AUDIT								
Contam. soil investigation ESA (1,2, 3) - tecl	each	1	#N/A	68,393	$68,393	50%	$34,196	$34,196
Contam. soil investigation - drilling & samplir	each	1	#N/A	277,143	$277,143	50%	$138,571	$138,571
other								
LABORATORY CHEMICALS								
Prep and handle	pallet	10	lcrh	2,506	$25,056	50%	$12,528	$12,528
other			#N/A	-	$0		$0	$0
TANK DECONTAMINATION								
Flushing	ls	1	#N/A	223,737	$223,737	50%	$111,869	$111,869
other			#N/A	-	$0		$0	$0
WASTE OIL								
Oils/lubes ship off site	litres	650000	#N/A	0.027	$17,550	50%	$8,775	$8,775
Gylcol ship off site	litres	20000	#N/A	1.25	$25,000	50%	$12,500	$12,500
BATTERIES, PAINTS & SOLVENTS								
remove batteries	kg	25000	#N/A	1	$12,500	50%	$6,250	$6,250
remove paints	litres	1500	#N/A	0	$405	50%	$203	$203
remove solvents	litres	7500	#N/A	1	$5,625	50%	$2,813	$2,813
other			#N/A	-	$0		$0	$0
Suphuric Acid Removal								
Transfer to tanker trucks	litres	80,000	pcrl	0.38	$30,240	50%	$15,120	$15,120
Haulage site to disposal facility	loads	2	#N/A	12,000	$24,000	50%	$12,000	$12,000
Disposal fee	litres	80,000	#N/A	1	$80,000	50%	$40,000	$40,000
Other	each		#N/A	-	$0		$0	$0
CONTAMINATED SOIL REMOVAL					$0		$0	$0
Type 1, light fuel	m3	5000	CSRL	42	$207,900	50%	$103,950	$103,950
Type 2, heavty fuel and oil	m3	2500		100	$250,000	50%	$125,000	$125,000
Type 3, metals	m3	0		-				
Technician & analysis	each	1		110,000	$110,000	50%	$55,000	$55,000
Drilling	each	1		75,000	$75,000	50%	$37,500	$37,500
Reporting	each	1	#N/A	20,000	$20,000	50%	$10,000	$10,000
OTHER							$0	$0
Remove nuclear densiometer from mill	each	10	#N/A	4,000	$40,000		$0	$40,000

	Cost	Pct Land	Total Land	Total Water
Subtotal	$1,492,549	49%	$726,274	$766,274

1 Water Management :

	ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
A	OBJECTIVE: BREACH NORTH INLET EAST DYKE								
	Excavate dyke shell	m3	15,000	sb1h	5.238	$78,570	0%	$0	$78,570
	Excavate jet grout columns (1.38 Mpa)	m3	200	sc1s	19.46	$3,892	0%	$0	$3,892
	Other			#N/A	0	$0		$0	$0
B	OBJECTIVE: BREACH POND DAMS (Nos. 10 total)								
	Excavate breaches	m3	88,130	sb1l	3.456	$304,577	0%	$0	$304,577
	place geotextile	m2	60,000		10	$600,000	0%	$0	$600,000
	place rock over geotextile	m3	60,000		5.65	$339,000	0%	$0	$339,000
	Other			#N/A	0	$0		$0	$0
B	OBJECTIVE: DITCHES								
	Excavate breaches	m3	8,000	dsh	3.3588	$26,870	0%	$0	$26,870
	Other			#N/A	0	$0		$0	$0
C	OBJECTIVE: TREAT DRAINAGE								
	Build treatment plant	LS		#N/A	0	$0		$0	$0
	build sludge containment facility	LS		#N/A	0	$0		$0	$0
					Subtotal	$1,352,910	0%	$0	$1,352,910
							Pct Land	Total Land	Total Water

1 Mobilization:

	ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
A	MOBILIZE HEAVY EQUIPMENT--ALL IS BURIED								
	Equipment to regional centre								
.	Excavators	km	0	mherh	9.0936	$0		$0	$0
.	Dump trucks (Nos 11 830E's)	km	0	mherh	9.0936	$0		$0	$0
	Dump trucks (Nos 8 785's)	km	0	mherh	9.0936	$0		$0	$0
	Dozers	km	0	mherh	9.0936	$0		$0	$0
	Front End loader	km	0	mherh	9.0936	$0		$0	$0
	Crane	km	0	mherh	9.0936	$0		$0	$0
	Light duty vehicles	km	0	mherl	3.0348	$0		$0	$0
.	Drill	km	0	mherh	9.0936	$0		$0	$0
	Service Vehicles & Buses	km	0	mherh	9.0936	$0		$0	$0
	Boats	km	0	mherh	9.0936	$0		$0	$0
	Snowmobiles	km	0	mherh	9.0936	$0		$0	$0
	demolition shears	km	0	mherh	9.0936	$0		$0	$0
.	Other	km		#N/A	0	$0		$0	$0
	Equipment, regional centre to site								
.	Excavators	km		#N/A	0	$0		$0	$0
.	Other	km		#N/A	0	$0		$0	$0
B	MOBILIZE CAMP								
.		allow		#N/A		$0		$0	$0
C	WORKERS--3 PERSON CREW FOR 3 MONTHS TO BURY EQUIPMENT (see Table 1 berlow)								
	crew travel time	hr	576	operl	48.6	$27,994	50%	$13,997	$13,997
	dispose of mobile equipment	hr	4320	operl	48.6	$209,952	50%	$104,976	$104,976
.	crew transportation	each	48	mm<l	208.44	$10,005	50%	$5,003	$5,003
D	MOBILIZE MISC. SUPPLIES								
.	Fuel	litre		#N/A	0	$0		$0	$0
.	Minor tools and equipment	allow	1	#N/A	10000	$10,000	50%	$5,000	$5,000
.	Truck tires	allow		#N/A	0	$0		$0	$0
E	WORKER ACCOMODATIONS								
.		man months	9	accmh	2138.4	$19,246	50%	$9,623	$9,623
F	WINTER ROAD							$0	$0
.	Full winter use	km		#N/A	0	$0		$0	$0
.	Limited winter use	km		#N/A	0	$0		$0	$0
.	other			#N/A	0	$0		$0	$0
G	INTERIM CARE & MAINTENANCE								
	on-site caretaker	annual		#N/A	0	$0			
	fuel and misc. supplies	annual		#N/A	0	$0			
	electrician	days		#N/A	0	$0			
	mechnaic	days		#N/A	0	$0			
	pick-up truck	yr		#N/A	0	$0			
	small dozer	allow		#N/A	0	$0			
	small excavator	allow		#N/A	0	$0			
	snow machine	allow		#N/A	0	$0			
	communications	allow		#N/A	0	$0			
	Water licence sampling & reporting	each		#N/A	0	$0			
	Geotechnical assessment	each		#N/A	0	$0			
	Other	each		#N/A	0	$0			
			sub-total annual C&M cost			$0			
	Total C&M cost	years		#N/A		$0		$0	$0
					Subtotal	$277,196	50%	$138,598	$138,598
							Pct Land	Total Land	Total Water

1 Post-Closure Monitoring & Maintenance:

	ACTIVITY/MATERIAL	Units	Quantity	Cost Code	Unit Cost	Cost	% Land	Land Cost	Water Cost
A	OBJECTIVE: MONITORING & INSPECTIONS (7 YEARS; 4 months per year; camp cost 3 years- other 7 with "C&M")								
	Annual geotechnical insp.	each	7	RPTH	$11,880	$83,160	10%	$8,316	$74,844
.	Survey inspection	each	7	#N/A	$50,000	$350,000	10%	$35,000	$315,000
.	Surface water sampling	each	70	wsh	$9,720	$680,400		$0	$680,400
	Groundwater Sampling	each	35	wsh	$9,720	$340,200		$0	$340,200
	Receiving/downstream water sampling	each	70	wsh	$9,720	$680,400		$0	$680,400
	labour	hrs	10220	lab-ush	$38	$386,316	10%	$38,632	$347,684
	Camp staff (3 person)	hrs	30660	lab-usl	$35	$1,059,610	10%	$105,961	$953,649
	operator	hrs	6720	operh	$59	$399,168	10%	$39,917	$359,251
	mechanic	hrs	6720	tradeh	$65	$435,456	10%	$43,546	$391,910
	electrician	hrs	6720	tradeh	$65	$435,456	10%	$43,546	$391,910
	environmental coordinator	hrs	14000	env-coh	$65	$907,200	10%	$90,720	$816,480
	transporation to site (charter cost)	each	224	#N/A	$2,500	$560,000	10%	$56,000	$504,000
	camp costs	man m(	280	accmh	$2,138	$598,752	10%	$59,875	$538,877
	hercules support	each	21	#N/A	$23,000	$483,000	10%	$48,300	$434,700
	equipment fuel (4 p/u; 1 dozer; 1 grader; 1 hc	l	486,360		$2	$972,720	10%	$97,272	$875,448
B	OBJECTIVE: STAFFING FOR CARE & MAINTAINANCE (3 YEARS)								
.	Site Manager	$/year	6000	Smanh	$86	$518,400	10%	$51,840	$466,560
	labour	hrs	13140	lab-ush	$38	$496,692	10%	$49,669	$447,023
	Camp staff (3 person)	hrs	39420	lab-usl	$35	$1,362,355	10%	$136,236	$1,226,120
	operator	hrs	8640	operh	$59	$513,216	10%	$51,322	$461,894
	mechanic	hrs	8640	tradeh	$65	$559,872	10%	$55,987	$503,885
	electrician	hrs	8640	tradeh	$65	$559,872	10%	$55,987	$503,885
	environmental coordinator	hrs	6000	env-coh	$65	$388,800	10%	$38,880	$349,920
	transporation to site (charter cost)	each	312	#N/A	$2,500	$780,000	10%	$78,000	$702,000
	camp costs	man m(	720	accmh	$2,138	$1,539,648	10%	$153,965	$1,385,683
	hercules support	each	18	$N/A	$23,000	$414,000	10%	$41,400	$372,600
	equipment fuel (4 p/u; 1 dozer; 1 grader; 1 hc	l	208,440	$N/A	$2	$416,880	10%	$41,688	$375,192
	Other			#N/A	$0	$0		$0	$0
C	OBJECTIVE: MAINTENANCE								
.	Repair erosion - infill gullies	allow	500	sb1h	$5	$2,619	10%	$262	$2,357
	Clear spillway	m3	3	cswh	$5,702	$17,107	10%	$1,711	$15,396
	Other			#N/A	$0	$0		$0	$0
E	OBJECTIVE: POST-CLOSURE WATER TREATMENT								
	Annual water treatment cost, from Ongoing w	m3	7,572,250	ddmi	$0.10	$757,225		$0	$757,225
	Pump water	month	12	mpl	$3,564	$42,768		$0	$42,768
	Subtotal, Annual post-closure costs					$16,741,292	9%	$1,424,030	$15,317,262
							Pct Land	Total Land	Total Water

APPENDIX VIII

RECLAMATION RESEARCH PLANS

INTRODUCTION

VIII-1 Community Traditional Knowledge and Community Participation

VIII-2 Open Pit, Underground and Dike Areas Reclamation Research Plan

VIII-3 Waste Rock Pile Research (Seepage Quality, Quatity and Permafrost Development

VIII-4 Processed Kimberlite Containment Reclamation Research Plan

VIII-5 North Inlet Area Reclamation Research Plan

VIII-6 Infrastructure Area Reclamation Research Plan

Appendix VIII Introduction

1. Introduction

This Appendix contains Version 1.0 of six research plans: one for each of the five closure areas (waste rock and till, processed kimberlite containment, North Inlet, infrastructure and the pit, underground and dike area), and one specific to community engagement and Traditional Knowledge.

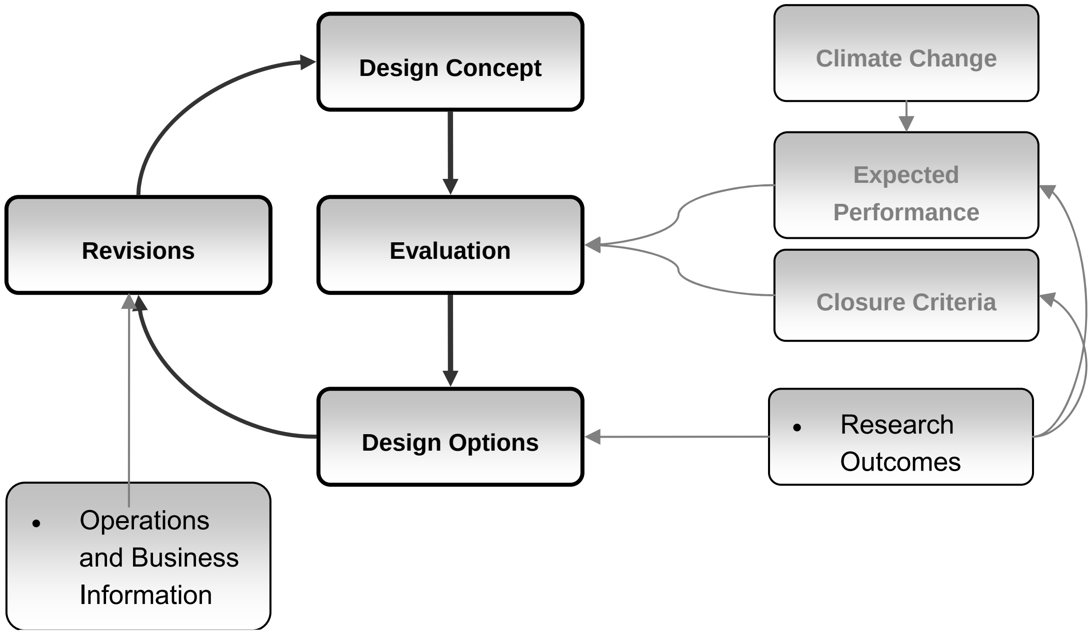
Reclamation Research Plans are used to reduce identified uncertainties associated with specific aspects of the closure plan. Generally the uncertainties identified in the Interim Closure and Reclamation Plan Version 3.1 fall into the following three categories:

- Final land use – Communities' preferences regarding final land use need to be understood to advance the closure plan. Specifically, community and Traditional Knowledge inputs are required for wildlife routes, target areas for re-vegetation, fish habitat design details and landform shapes.
- Chemical stability – There are uncertainties around how mine components will perform post-closure with respect to the release of chemical constituents. Closure design improvements will be in part guided by understanding of the long-term physical and chemical behaviour of these facilities.
- Closure criteria - There is uncertainty with the proposed closure criteria. Specifically, the criteria for chemical stability need to be defined to describe accurately exposure conditions that do not pose an unacceptable risk to people, wildlife and aquatic life.

Reclamation Research Plans are not an inclusive description of all the closure planning activities or tasks to be undertaken, they are specifically research plans.

Linkages between the research plans and the closure planning framework that Diavik Diamond Mines Inc. (DDMI) will use to guide the closure designs for the facilities are shown in Figure 1. The framework shows an iterative process of taking a design concept, evaluating the expected performance of the design against objectives and criteria, and considering options to improve the design. Information from the research plans will improve understanding of the expected performance of a specific design concept, focus closure criteria, and identify possible design options or alternatives. The design review iteration may identify requirements to revise Restoration Research Plans based on changes to uncertainties or risk.

Figure 1 Closure Planning Framework – Linkage with Reclamation Research Plan

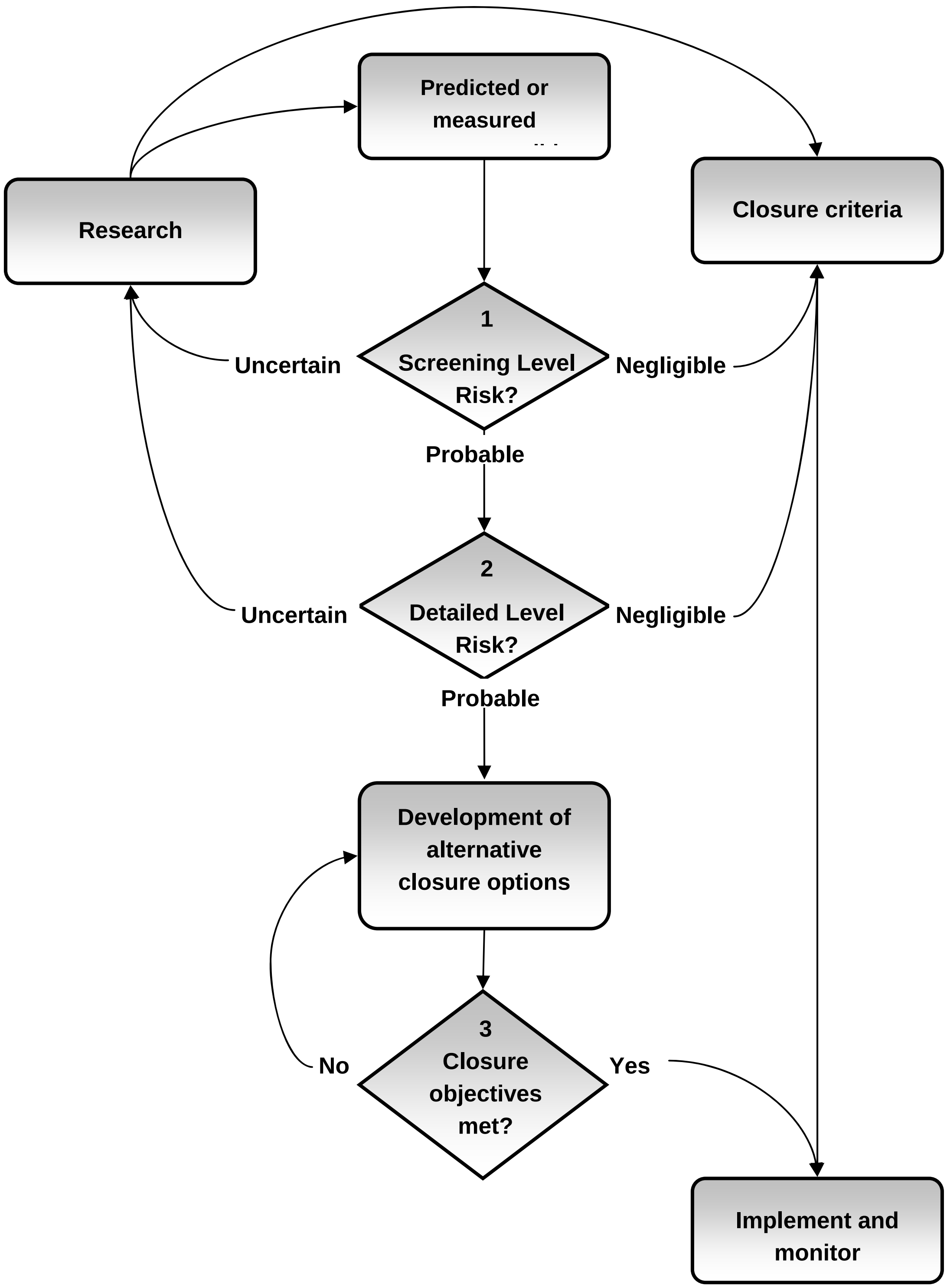


- Mine plan
- Net environmental

The Evaluation component of Figure 1 compares the expected performance of a closure concept with closure criteria. A closure objective that applies to all areas is that water/sediment/soil in the area is chemically safe for people, wildlife and aquatic life. A risk-based approach will be used for these evaluations.

The risk framework is shown schematically in Figure 2. It starts with either a predicted or measured exposure condition (i.e., expected performance). For example, this could be the quality of seepage from the Processed Kimberlite Containment (PKC), quality of sediments in the NI or quality of soils in the Waste Transfer Area. A Screening Level Risk Assessment is conducted to compare exposure concentrations with initial closure criteria for exposure to people, wildlife and aquatic life. Initial closure criteria are typically national standards or guidelines for protection of water or land use and are developed to be conservative (i.e., erring on the side of caution). This process provides a screening level indication of parameters of concern, parameters where additional monitoring or research may be required, and parameters where the risks are negligible. Parameters of concern are then evaluated in more detail.

Figure 2 Risk Assessment Framework Schematic



A Detailed Level Risk Assessment would move beyond the use of national standards or guidelines to use directly toxicological research literature. Receptor-specific and area-specific receptor parameters such as the amount of time an animal/person might spend in an area, food/water ingestion rates and body weight would be developed and applied. Where negligible risks from the Detailed Level Risk Assessment are determined, results will be used to revise the closure criteria. Uncertainties may be identified with the toxicological information, exposure concentrations or receptor parameters that may need to be resolved through research or monitoring before the actual risk can be determined. Alternatively, probable risks may be identified that require the development of alternative closure options or the adoption of contingency options.

Through this process closure options can be assessed and closure criteria developed concurrently. Initially the assessments will rely, in many cases, on predictions of post-closure exposure conditions. Ultimately, the assessments will use post-closure performance monitoring results as verification.

Included in Appendix VIII are Reclamation Research Plans that are designed to provide the required information based on today's knowledge and understanding of closure uncertainties and risks. As new research information is obtained and closure plans evolve, uncertainties and risks will also change, resulting in different research requirements. The Reclamation Research Plans are intended to be dynamic and are expected to change as new information becomes available.

Part L Item 3(f) of the Water License specifies that the research plan should describe how metal uptake in re-vegetated plant communities will be monitored. At this point in the closure planning, it is premature to emphasize research related to monitoring methods particularly when it has yet to be determined which areas will be targeted for re-vegetation or if metal up-take in plants is likely to pose an unacceptable risk to people or wildlife. Research related to monitoring methods is more appropriately defined when closure concepts have been finalized and closure criteria are better defined through risk-based criteria (see Appendix VIII-6).

DDMI will attempt to incorporate relevant information that may become available from other closure research work including closure research local to the Lac de Gras area. DDMI will specifically seek opportunities to collaborate on closure research with the Ekati operations. Opportunities for formal collaboration can only properly begin when both operations have approved closure research plans.

A summary of results and activities carried out under the Reclamation Research Plans will be reported by March 31 each year in the Annual Water License Report as per Water License Part B Item 4(r). The research plans will evolve to fit changing closure planning requirements. Modified research plans will also be submitted by March 31 each year as per Water License Part L Item 4.

Appendix VIII-1 Traditional Knowledge and Community Participation

1. Uncertainty

Many aspects of closure would benefit from community input and Traditional Knowledge (TK). These aspects were identified by community members when development of the mine was being considered. Some key aspects also present uncertainty from a scientific perspective, making input from community members increasingly important. These key aspects include wildlife movement, areas for re-vegetation, fish habitat and landforms.

1.1 Wildlife Movement

The main uncertainty to address is how and where wildlife should use or move through the area of the mine post-closure. The primary wildlife species of interest is caribou and it will be the focus of wildlife research, however other valued wildlife species will also be include. Preferred routes and habitat features, or deterrent mechanisms for wildlife need to be determined. Questions regarding possible attraction features for predators and prey, options to assist wildlife to avoid or move through old mine infrastructure, and potential for renewed use of, or man-made extensions to, historic trails are all matters of primary interest to community members. The safety of wildlife moving through the area of the mine is a key consideration for addressing these uncertainties and how best to assess this will be considered as part of the research plan.

1.2 Areas for Re-vegetation

Related to Wildlife Movement, areas for re-vegetation will be partially based on the need to attract or deter wildlife to/from various areas of the mine. Preferred routes and habitat features, or deterrent mechanisms for wildlife need to be determined to establish the areas and type of vegetation best suited for the identified purpose.

1.3 Fish Habitat

Fish habitat features will be constructed in the area behind the A154 and A418 dikes so that at closure, when the area is flooded, it will be used by fish from Lac de Gras. Diavik has developed designs for the fish habitat based on scientific knowledge. It is uncertain if Traditional Knowledge information regarding habitat designs might change or confirm the proposed designs.

1.4 Landforms

Aesthetic and technical considerations related to the final landscape at the mine need to be addressed for closure. The final shape and structure of some landforms at the mine site may influence both the aesthetic view of the area, as well as the functional use of those landforms. Uncertainties relating to water flow, areas for re-vegetation and wildlife movement, as well as the general appearance of the former mine site need to be accounted for when determining the preferred closure options for any development on the land.

Attaining community participation and incorporating community input and TK into the closure planning process is challenging. The main challenges associated with this process are ensuring representation of each Aboriginal group and obtaining agreement on recommendations that are suited to the Project. The preferred structure for obtaining this level of participation with each of the Aboriginal organizations has not yet been determined, but Diavik is working towards this goal (see Section 2.4, Community Engagement).

2. Research Objectives

Research objectives associated with each of the aspects identified in the Uncertainty section include the following.

- What are the key landforms that need to be assessed from a community perspective as they relate to wildlife movement?
- Where are the historic trails that caribou used approaching, leaving and on East Island?
- What is the preferred route(s) for caribou to move around or through the area of the mine?
- Are there any areas where prey may be more vulnerable to predation?
- What are the habitat features (either natural or man-made) that could assist in achieving the preferred routing, or reducing opportunities for predation – either to attract or deter animals from any area?
- What would be the appropriate closure specifications for the safe movement of wildlife?
- What types of vegetation are most suitable for the different species of wildlife?
- What are the areas of the mine that should be re-vegetated?
- What should the former mine infrastructure look like at closure to assist or deter wildlife passage and suit the surrounding landscape – includes rock piles, PKC, pit, dikes and roads?
- What are the preferred features for fish habitat from a Traditional Knowledge perspective?
- Is there an appropriate Traditional Knowledge approach to determining fish use for different habitats?
- Are there any considerations or recommendations that Aboriginal organizations feel should be taken into account for breaching the dikes?
- What has been done in the past to attain community participation and incorporate community input and Traditional Knowledge in to the closure planning process? What can DDMI learn and improve on from this?
- What is a suitable arrangement for obtaining direction and support on closure activities for Diavik with the Aboriginal organizations?

3. Research Plan

3.1 Tasks Completed (Before 2011)

Completed tasks related to wildlife movement include the following:

- workshop at the mine site with community members;
- review of closure considerations for mine site;
- tour of the site focusing on key landform features;
- helicopter survey of access areas to East Island for caribou; and
- discussion of options for wildlife to move around/through the mine site.

Completed tasks related to community engagement protocols include the following:

- initial meetings with leadership of each Aboriginal organization to explain idea;
- draft template developed that outlines the purpose of each topic;
- Diavik has identified lead contacts to Aboriginal organizations; and
- two Aboriginal organizations have identified their lead contacts.

Completed tasks related to fish habitat and reef design include the following:

- constructed shelf areas for reef development inside the dikes; and
- developed science-based designs.

3.2 Tasks to be Started (2011 to 2013)

Tasks related to community engagement protocols include the following:

- obtain information on lead contacts for all Aboriginal organizations;
- formalize engagement protocol with each Aboriginal organization;
- obtain sign off from Chiefs/Presidents on final document; and
- work with the key contact from each Aboriginal organization to establish the preferred method of engagement relating to closure; determine if proposed approach from Section 2.4 is acceptable.

Planned tasks related to the establishment of a Traditional Knowledge Panel include:

- consult with Environmental Monitoring Advisory Board regarding existing provision in the Environmental Agreement for a TK Panel; and
- determine structure, representatives and terms of reference for a Panel.

Planned tasks related to wildlife movement include:

- conduct desktop review of available TK on caribou in the Slave Geologic Province;
- discuss the options generated from the site workshop with each of the Aboriginal organizations;
- record recommendations from each Aboriginal organization on their preferred option for wildlife movement and methods for deterring wildlife post-closure;
- work to develop appropriate closure specifications for the safe movement of wildlife; and

- distribute for review to Aboriginal organizations and the TK Panel.

Planned tasks related to determining areas for re-vegetation include:

- conduct a desktop review of available TK on vegetation in the Slave Geologic Province;
- summarize the results of the 5-year re-vegetation study at Diavik;
- establish the preferred options for wildlife movement post-closure;
- in consideration of the above point, determine the areas of the mine site most suitable for re-vegetation;
- record recommendations from each Aboriginal organization on preferred areas and species for re-vegetation;
- determine the need for any additional studies relating to re-vegetation; and
- distribute for review to Aboriginal organizations and the TK Panel.

Planned tasks related to possible final landforms include the following:

- review the conceptual closure picture introduced during the Environmental Assessment;
- after wildlife and re-vegetation recommendations have been received from the Aboriginal organizations, assess the technical feasibility and material availability to meet these recommendations for key landforms;
- in light of above considerations, construct a model to best represent the final look of the land in relation to natural areas around the mine and remaining landforms associated with the mine;
- present the model to communities to obtain any further feedback and recommendations on possible further changes at the landscape level; and
- document and distribute for review to Aboriginal organizations and the TK Panel.

Planned tasks related to community engagement include:

- focus on community-based, facilitated workshops to develop more specific recommendations relating to closure options; and
- encourage the development of a Traditional Knowledge Panel under the Diavik Environmental Agreement.

3.3 Remaining Tasks (After 2013)

Planned tasks are relating to fish habitat and reef design:

- work with Aboriginal organizations to obtain recommendations on the design of reefs inside the dikes, external edges of dikes and any habitat considerations to take in to account when breaching the dikes; and
- document and distribute for review to Aboriginal organizations and the TK Panel.

4. Findings of Research Completed

4.1 Wildlife Movement

Caribou will occasionally use disturbed areas such as roads, airstrips and tailings ponds to rest (Gunn 1998), returning to these areas after foraging on nearby tundra. This behaviour has been observed at other mines in the Bathurst range, such as Lupin and Ekati. It has been suggested that this is to take advantage of the view and to make it difficult for predators to conceal themselves, similar to their habit of bedding on frozen lakes in the winter. Further, these areas have fewer mosquitoes and blackflies (Gunn 1998). Although it is not clear that these disturbed areas are used preferentially compared to undisturbed areas (Gunn 1998), it is possible that the waste rock piles and PKC area may be used by caribou in this manner post-closure.

Eventually, it is possible that the waste rock piles and PKC will revegetate, providing forage for caribou and other wildlife. During winter, caribou forage primarily on lichen, which is slow to recover. Studies of caribou behaviour in relation to forest fires indicate that caribou select areas which have remained un-burnt for at least 50 years (Dalerum et al. 2007; Joly et al. 2007). Shrubs and forbs may colonize the waste rock piles in a much shorter period, and these may be used by caribou during the late summer and fall months.

In many respects, the waste rock piles and PKC dams are similar to the boulder associations present in the Lac de Gras area and the larger central Canadian Arctic (described and mapped in Matthews et al. 2001). Both Traditional Knowledge and aerial surveys in the Lac de Gras area have indicated that caribou avoid these boulder association areas.

At the initial site workshop in 2009 three options in particular were developed during the discussions by the Participants:

- Leave the rock piles and PKC as they are now. Participants stated that they view the East Island as “dead” because of the development so caribou will not return. Also, the current rock pile and PKC dams prevent access to most caribou due to the steep sides and large rocks.
- Cover the entire surface of the waste rock pile and PKC with fine, smooth gravel. This would allow access for caribou to pass freely over the waste rock piles and PKC. Further, the waste rock piles should be contoured to mimic the surrounding landscape.
- Design passages or corridors over or around the waste rock pile and PKC area. This would allow movement of caribou around, over and across the structures, but at specific locations. It was recommended that the general layout of these corridors should correspond to historic caribou trails on the island.

4.2 Fish Habitat – Reef Designs

Fish habitat has been designed for the A154/A418 pit area (Golder 2003, 2008 – see Appendix X-1 and X-2). The designs were prepared by fisheries biologists and engineers and reviewed by the Fisheries and Oceans Canada (DFO). Communities have provided general comment on the fish habitat designs.

4.3 Engagement Protocols

DDMI has developed a template for an Engagement Protocol for each of the Aboriginal organizations in order to clarify engagement needs and identify the appropriate contacts. Initial meetings have been held with leadership of each Aboriginal organization, with the concept being well received. Progress is being made to identify lead contacts for each organization.

5. Remaining Scope to be Completed

5.1 Detailed Scopes of Work (2011 to 2013)

5.1.1 Wildlife Movement

A desktop study is planned for 2011 that will involve a review of available TK on caribou and other wildlife in the Slave Geologic Province. Results from this work are expected to provide insight on traditional caribou trails in the area, and potentially information relating to vegetation preferences. This information can be used in combination with the options identified during the 2009 workshop to determine the best areas for caribou trails across the mine site.

In addition to the review, options generated during the 2009 workshop will need to be discussed in more detail with members from each of the Aboriginal organizations. The intent is to obtain more specific recommendations on preferred options and where/how to best incorporate those recommendations in the final closure design, while still taking into account technical considerations. DDMI would also like to work with the Aboriginal organizations to define appropriate closure specifications for the safe movement of wildlife including possible methods to deter wildlife from using areas if this is identified as a need.

DDMI hopes to discuss these topics in community-based, facilitated workshops as referred to in Section 2.4 of this report. The results of these workshops and the outcome of the recommendations will be recorded and distributed for review to Aboriginal organizations and the TK Panel.

5.1.2 Re-vegetation

A desktop study is planned for 2011 that will involve a review of available TK on vegetation in the Slave Geologic Province. Results from this work are expected to provide insight on the different types of plants and habitat in the area, and potentially information relating to wildlife use and/or consumption. This information may be used to determine the preferred plant species for re-vegetation from a wildlife use and consumption perspective, as well as identification of preferred habitat features and growing conditions for plant species.

The 5-year re-vegetation study conducted at Diavik also provides some insight on which types of plants, substrates and amendments are best suited to re-vegetation efforts. A summary of this data will be provided to Aboriginal organizations and it is expected that this information can be compared to Traditional Knowledge views on which of those species are suited to re-vegetation or are beneficial for wildlife.

A need for the Aboriginal organizations to identify the preferred options for wildlife to move around or through the mine site post-closure was noted above. The decision on which areas to re-vegetate will be linked to plans for wildlife movement or deterrence in the area of the mine site. Therefore, in addition to highlighting preferred routes for wildlife, Aboriginal organizations will also have to consider which areas of the mine site are most suitable or should be avoided for re-vegetation, with these movements in mind.

Similar to the process for Wildlife Movement, DDMI hopes to discuss these topics in community-based, facilitated workshops referred to in Section 2.4 of this report. The results of such workshops and the outcome of the recommendations would be recorded and distributed for review to Aboriginal organizations and the TK Panel described below.

5.1.3 Landforms

The aesthetic view of the land is important to community members who use the area. During the Environmental Assessment, Diavik provided a conceptual picture of what the mine site would look like after closure. It is worthwhile to use this picture as a starting point in discussing what Aboriginal organizations envision for the look of a closed mine site. With improved technology now available, DDMI can also work with Aboriginal organizations to begin developing more detailed images to assist community members in understanding what the site might look like. These images can incorporate different rock features, vegetation, or wildlife trails that community members may recommend.

After recommendations on wildlife movement, re-vegetation areas and general aesthetics have been received from the Aboriginal organizations, DDMI will assess the technical feasibility and material availability to meet these recommendations for key landforms. A model that best represents the final look of the land in relation to natural areas around the mine and remaining landforms associated with the mine would then be constructed. The model would be shared with each Aboriginal organization to obtain any further feedback and recommendations on possible further changes at the landscape level.

Again, DDMI hopes to discuss these topics in community-based, facilitated workshops referred to in Section 2.4 of this report. The results of such workshops and the outcome of the recommendations would be recorded and distributed for review to Aboriginal organizations and the TK Panel described below.

5.1.4 Community Engagement

As described in Section 2.4, DDMI plans to focus on community-based, facilitated workshops to develop more specific recommendations relating to closure options. The focus areas of these workshops would include wildlife movement, re-vegetation, landforms and fish habitat.

In addition to these workshops, DDMI is encouraging the development of a TK Panel under the Diavik Environmental Agreement.

Although the final decision on the structure and purpose of a TK Panel rests with the Aboriginal organizations, DDMI envisages a TK Panel that can be available to provide review, advise and make recommendations regarding closure aspects of the Diavik mine brought to the Panel. More specifically, what DDMI envisions for the TK Panel includes:

- a Panel consisting of two members from each of the five Aboriginal organizations that are a Party to the Environmental Agreement;

- preferably, 1 of the 2 members is considered a wildlife expert and the other an expert on water and fish;
- fees for the Panel would be fixed at a per diem rate, plus travel costs;
- the Panel would be accessible to any group requiring TK expertise; in this way, it would not only be available to DDMI and the Environmental Monitoring Advisory Board (EMAB), it could also be accessed by other mines, Boards and even government (should they require it);
- whichever group was requesting access to the Panel (e.g., DDMI vs. EMAB vs. Government) would pay the cost of the meetings; and
- groups would be required to use a facilitator when accessing the Panel, with the responsibility of bringing forward ideas to the Panel, recording opinions/outcomes and providing suggestions to all parties on how best to implement any opinions/outcomes from the Panel.

Current panels, such as those for Snap Lake and Colomac mines, provide good working examples and an opportunity to evaluate the strengths and weaknesses of each panel in developing the Terms of Reference for a TK Panel under the Diavik Environmental Agreement. It is DDMI's goal to learn from and build on past examples of efforts to obtain community participation and input into closure planning.

5.2 Conceptual Scopes of Work (After 2013)

5.2.1 Fish Habitat - Reef Designs

Construction of habitat features within the A418 and A154 dikes following the engineering design has started. Specifics of the reefs have not been finalized and will not be constructed until immediately before flooding. The design features of reefs being constructed inside the dikes would be reviewed by Aboriginal organizations to determine any habitat considerations that could be identified through TK. Recommendations would be recorded and considered in the final design of the reefs.

Additionally, DDMI is interested in working with Aboriginal organizations to identify any TK methods that may exist for determining fish use in different habitat areas. This information would be applied specifically for the outer edges of the dike and surrounding shoals.

Lastly, DDMI is interested in hearing any considerations or recommendations that Aboriginal organizations feel should be taken into account when the dikes are breached at closure.

DDMI hopes to discuss these topics in community-based, facilitated workshops referred to in Section 2.4 of this report. The results of such workshops and the outcome of the recommendations would be recorded and distributed for review to Aboriginal organizations and the TK Panel described below.

5.2.2 All Other Topics

Work scopes for tasks anticipated beyond 2013 are yet to be determined. Other scopes of work may be identified based on the results of tasks completed before 2013.

6. Linkages to Other Research and Life of Mine Plan

Specific linkages identified between other research and the Life of Mine (LOM) Plan include:

- Research from the test piles, including measurements of the thermally active zone depth in waste rock and PKC, may be used as information to be considered in the landform, wildlife movement and any re-vegetation of the rock pile and PKC areas.
- Information developed in support of closure criteria may be applicable to other closure management areas.
- Research on aspects of re-vegetation methods and materials conducted by DDMI.
- Further research on aspects of re-vegetation methods can potentially be coordinated with Ekati.
- Decision-making and planning relating to stockpiling of various wastes (vegetation, top soil, sewage sludge, North Inlet sludge and fine PK).

7. Project Tracking and Schedule

Projects are tracked by task. The expected task schedule is shown in Table 1.

Table 1 Planned Project Activities

Year	Activities
2011	• Desktop study on TK in SGP region – wildlife, vegetation. • Workshops with Aboriginal organizations re: wildlife movement/deterrence. • Summary of 5-year re-vegetation study at Diavik completed and communicated. • Engagement Protocols complete with each Aboriginal organization. • TK Panel established.
2012	• Workshops with Aboriginal organizations re: vegetation and landforms.
2013	• Construction of a closure model for the Diavik site. • Develop closure specifications for the safe movement of wildlife. • Identify any additional research that may be required.

8. Costs

Expected costs to complete the tasks described above are:

- Tasks completed (before 2011) – $250,000 plus in-kind costs;
- Task to be completed (2011-2013) – $400,000 plus in-kind costs; and
- Tasks remaining (after 2013) – to be determined.

9. References

Dalerum, F., S. Boutin and J. Dunford. 2007. *Wildfire effects on home range size and fidelity of boreal caribou in Alberta, Canada*. Canadian Journal of Zoology 85: 26-32.

Gunn, A. 1998. *Summer behaviour of Bathurst caribou at mine sites and responses of caribou to fencing and plastic deflector (July 1997)*. Final report to the West Kitikmeot Slave Study Society. http://www.enr.gov.nt.ca/_live/documents/documentManagerUpload/WKSS_Bathurst_Caribou_Behavior_2002.pdf

Joly, K., P. Bente and J. Dau. 2007. *Response of overwintering caribou to burned habitat in Northwest Alaska*. Arctic 60:401-410.

Matthews, S., H. Epp and G. Smith. 2001. *Vegetation classification for the West Kitikmeot Slave study region*. Final report to the West Kitikmeot Slave Study Society.

Appendix VIII-2 Open Pit, Underground and Dike Area Reclamation Research Plan

1. Uncertainty

Post-closure use of the open pit, underground and dike areas will be as aquatic habitat. Physical features, such as water depth, velocity and substrate type, and water quality conditions combine to define aquatic habitat. This Reclamation Research Plan examines aspects of both to obtain improved information regarding aquatic habitat requirements and expected post-closure conditions.

Final water quality in the flooded A418 and A154 pits were calculated to be similar to Lac de Gras water quality (Blowes and Logsdon 1998) based on information available at that time. Final water quality was governed by the water quality of Lac de Gras because the very large volume of this water reduced any influence from other contributing sources. The other contributing sources are primarily groundwater inflow and geochemical loading from the exposed pit wall surfaces and underground mine workings.

The initial water quality calculations were simple mass balance calculations. These calculations did not examine the vertical mixing conditions that will be expected to occur once the pits have been filled and the dikes breached, allowing circulation with Lac de Gras.

The initial calculations were also based on assumed distributions of different rock lithologies in the pit walls, initial geochemical reactivity estimates, and initial mine infiltration water quality, and did not include any geochemical loading associated with the underground mine workings. As these were initial estimates, there is a higher level of uncertainty in this information.

Fish habitat has been designed for the A154/A418 pit area inside the dikes (Golder 2003, 2008 - see Appendix X-1 and X-2). The designs were prepared by qualified fisheries biologists and engineers and reviewed by Fisheries and Oceans Canada. Communities have provided comment on the fish habitat work in general. A review to obtain any recommended modifications to the proposed fish habitat designs from a Traditional Knowledge (TK) perspective is include in the Community Engagement and Traditional Knowledge Reclamation Research Plan (Appendix VIII-1).

The exterior edges of the A154 and A418 dikes provide aquatic habitat during operations and also post-closure. The actual fish use of these exterior slopes has not been verified and is therefore a current uncertainty.

2. Research Objectives

The research plan is designed to answer the following questions:

- To what extent is vertical mixing expected to occur in the flooded area behind the dikes post-closure and would this impact on aquatic use of the surface (20 to 30 m depth) waters?
- What is the expected water quality of the pit and dike area a) after filling but before breaching the dikes and b) post-closure?
- Does the rate of flooding, within a practical range, impact significantly on expected water quality after filling or post-closure?
- Are fish using the exterior slopes of the A154 and A418 dikes?

3. Research Plan

Tasks completed (before 2011) include:

- Initial water quality predictions (Blowes and Logsdon 1998).
- Modelling of vertical mixing conditions (Appendix X-3).
- Water Quality Evaluation – Type III Waste Rock for Backfill (Appendix X-9).
- Initial water quality criteria for closure (Appendix V-Table V3).
- Ongoing monitoring of mine water inflow water quality and quantity (SNP Reporting).
- Ongoing research on estimating geochemical loading by rock sulphur content (Appendix VIII-3).

Tasks to be started (2011 to 2013) include:

- Complete pit wall lithology maps;
- Measure geochemical loading from pit wall;
- Review science and possible Traditional Knowledge methods to evaluate fish use of dike exterior slopes; and
- Evaluate fish use of exterior slopes of A154 and A418 dikes.

Remaining Tasks (after 2013) include:

- Update predictions of final pit water quality using the modelling framework (Appendix X-3) with updated information on geochemical loading.
- Water quality modelling will include all parameters that can be reasonably estimated using conservation of mass assumptions. The modelling will not include geochemical speciation, nitrification/denitrification, biological uptake, pH or dissolved oxygen.
- Use model to evaluate impact of fill rate on water quality.
- Use model to describe effects of groundwater flows into the flooded pit/dike area on post-closure water quality in the pit/dike area.

- Conduct and document screening level risk assessment of predicted pit water quality.

Other tasks will be determined based on outcomes of current tasks.

4. Findings of Research Completed

Blowes and Logsdon (1998) provides predicted water quality for the A154 and A418 open pits in comparison with Lac de Gras water quality in Table 7 (copy attached). These initial estimates showed that the predicted water quality in the flooded pits is similar to Lac de Gras.

Initially mathematical modelling was completed of the vertical mixing processes that are expected to drive vertical mixing conditions in the pit area post-closure. Key findings were that the depth of vertical mixing was shallow relative to the pit depths and that the surface waters (top 20 m) became very similar to Lac de Gras water quality, effectively isolating the deep water in the pit area. It appears unlikely that events would occur where deep pit water would mix with surface water (see Appendix X-3). This modelling framework will be used in the future to update flooded pit water quality predictions.

Ongoing monitoring results from mine water inflows are included with the Surveillance Network Monitoring (SNP) regulatory reporting and Annual Water License Reports. Results continue to support initial estimates that show that mine inflow water will not be a significant determinant of surface water quality in a flooded pit. Ongoing monitoring will determine any changes from contact with underground mine workings, including Type III cemented backfill. Initial estimates indicate that the effect of using Type III versus Type I rock for backfill on water quality is minimal (see Appendix X-9). This information will be used to update flooded pit water quality predictions.

The research program for the waste rock area (Appendix VIII-3) is examining geochemical loading rates by rock type (% sulphur). When complete, these geochemical relationships will update the relationships originally used by Blowes and Logsdon (1998) to predict geochemical loadings from the flooded pit walls.

5. Remaining Scope to be Completed

Detailed Scopes of Work (2011 to 2013) include:

- Geochemical loadings from the walls of the pit and underground workings are expected to be greater from areas with exposed biotite schist than areas with exposed granite. The walls of the open pit represent the larges surface are of rock that will washed by the flooding of the pit. The relative areas of granite versus biotite schist will be measured using photo imagery techniques and the results will be available for future updates to flooded pit water quality predictions.
- Actual geochemical loading rates from pit or underground walls during flooding will be measured by spraying water over small sections of exposed granite and biotite schist and collecting and analyzing the wash water. These results will be compared with estimates from waste rock geochemical testing. The results will be available for future updates to flooded pit water quality predictions.
- DDMI is working with Fisheries and Oceans Canada on a survey method for verifying fish use of the exterior slopes of the A418 and A154 dikes. This work may also be an

opportunity to combine TK approaches. The information will be used to verify expected post-closure fish habitat use.

Conceptual Scopes of Work (after 2013) include:

- Beyond 2013 the anticipated tasks relate to applying the results of reclamation research to update predictions of flooded pit water quality using the established mathematical modelling framework. The model is also expected to be used to evaluate the effect of different fill rates on flooded pit water quality and effects of post-closure groundwater flows on flooded pit water quality.
- Predicted water quality conditions would then be used as the basis for a screening level risk assessment to determine if the predicted water quality is expected to pose an unacceptable risk to aquatic life. Outcomes from the assessment could include revisions to closure criteria, identification of additional research tasks and/or the need for a more detailed risk assessment (See Appendix VIII Introduction).
- Other scopes of work may be identified based on the results of tasks completed before 2013.

6. Linkages to Other Research and Life of Mine Plan

Specific linkages identified include:

- Risk assessment framework is the same as general framework that will be applied to other closure management areas. Findings and information from this specific application may be applicable to other areas and the final closure assessment.
- Information developed in support of closure criteria may be applicable to other closure management areas.
- Information on impact of fill rates on water quality will be used in developing the pit fill plan.

7. Project Tracking and Schedule

Projects are tracked by task. The expected task schedule is shown in Table 1.

Table 1 Planned Project Activities

Year	Activities
2011	• Review science and possible Traditional Knowledge methods to evaluate fish use of dike exterior slopes. • Evaluate fish use of exterior slopes of A154 and A418 dikes. • Ongoing monitoring of mine water inflow water quality and quantity. • Ongoing research on estimating geochemical loading by rock sulphur content.
2012	• Complete pit wall lithology maps. • Ongoing monitoring of mine water inflow water quality and quantity. • Ongoing research on estimating geochemical loading by rock sulphur content.

2013	• Measure geochemical loading from pit wall. • Ongoing monitoring of mine water inflow water quality and quantity. • Ongoing research on estimating geochemical loading by rock sulphur content.

8. Costs

Expected costs to complete the tasks described above are:

- Tasks completed (before 2011) - $125,000.
- Task to be completed (2011-2013) - $75,000.
- Tasks remaining (after 2013) – to be determined.

9. References

Blowes, W.D and M.J. Logsdon. 1998. *Site Water Quality Estimates for the Proposed Diavik Project*. Prepared for Diavik Diamond Mines Inc. September 1998.

Golder. 2003. *Fish Habitat Design for the Pit Shelf Areas at the Diavik Diamond Mine*. Submitted to Diavik Diamond Mines Inc. March 2003.

Golder. 2008. *Fish Habitat Design for the A418 Pit Shelf Area at the Diavik Diamond Mine*. Submitted to Diavik Diamond Mines Inc. December 2008.

Golder. 2010. *Preliminary Pit Lake Mixing Study.* Technical Memorandum. December 9, 2010. Prepared for Diavik Diamond Mines Inc.

Appendix VIII-3 Waste Rock Pile Research (Seepage Quality, Quantity and Permafrost Development)

1. Uncertainty

This research plan is designed to improve understanding of the expected performance of the waste rock pile closure concept. The three areas of uncertainty are:

- quantity of water (seepage) that may be released from the dump;
- quality of any seepage water; and
- the rate, extent and persistence of permafrost development.

Characterizing better the seepage quantity and quality, and permafrost development in the dump will permit a more accurate prediction of closure performance. A more accurate prediction will ensure the closed dumps will not pose an unacceptable risk to people, wildlife or aquatic life.

The primary focus of closure research related to seepage and permafrost characteristics of waste rock is the Diavik Waste Rock Test Piles Project (Test Piles project). The Test Piles Project is a complementary laboratory and field study to measure and compare low sulphide waste rock and drainage characteristics. The project is a University-lead collaborative, multidisciplinary, multi-year project. The field portion is hosted by DDMI with researchers from the University of Waterloo, University of Alberta, and University of British Columbia. Additional funding is provided through the mining industry group International Network for Acid Prevention (INAP), Canadian government funding through the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Mine Environment Neutral Drainage (MEND) program.

Research from the Test Piles Project is focused on characterizing thermal regimes, gas transport, hydrology, microbiological populations and geochemical behaviour of low sulphide waste rock. The thermal regime (permafrost formation) is intimately linked to geochemical behaviour, and the hydrologic and gas transport regimes. The overall Test Piles research program includes academic research questions in addition to research specific to the behaviour and closure of the Diavik waste dumps. A summary of the Test Piles research related to closure is presented here.

2. Research/Study Objectives

Test Piles research related to dump closure aims to answer the following questions:

- How much drainage/seepage from the waste rock pile can be expected post-closure? What drainage quality can be expected?
- To what extent is water able to infiltrate through an unsaturated, coarse grained rock mass where interior temperatures may be below the freezing point of pure-phase water?

- If (discontinuous) zones of ice form within the pore spaces of the waste rock, how much water can percolate downward beneath the active zone that will form each summer on the top surface of a waste rock pile?
- If infiltration occurs, what are the flow mechanisms and what proportion of flow will report as seepage?
- For waste rock with an acid generation potential approximately equal to its neutralization potential, to what degree are the rates of oxidative dissolution of sulphide minerals and rates of dissolution of carbonates and aluminosilicate minerals influenced by the thermal state within the test piles?
- What will be the thermal evolution of the waste rock piles? How will permafrost development impact geochemical reactions and, therefore, drainage quality? What impact do a thermal and/or lower permeability cover have on permafrost and active development within the piles (and therefore drainage quality and quantity) of the piles?
- How effective are a Type I cover and a lower-permeability till layer in modifying hydrologic, thermal and geochemical conditions inside a waste rock pile?

3. Research Plan

3.1 Tasks Completed (Before 2011)

Completed tasks of the Diavik Waste Rock Test Piles studies related to closure include:

- Construction and instrumentation of six 2-m-scale experiments and three 15-m-high waste rock piles completed in 2007. One pile consists of Type I material, one pile consists of Type III material, and the third pile consists of a Type III core re-sloped and capped with 1.5 m of till and 3 m of Type I material as per the previous ICRP. Instruments and their purpose are listed in Table 1.
- Collection and analysis of waste rock samples for physical and geochemical characteristics.
- Tracer and applied rainfall tests for hydrologic characterization.
- Permeameter construction and experimentation to constrain hydrologic parameters.
- Ongoing data collection from installed instrumentation and initial interpretation of all data types (hydrology, geochemistry, thermal regime, gas transport regime).
- Instrument installation in three 40 m deep boreholes in the Type III dump. Instruments include air permeability probes, thermistors, gas sampling lines, suction lysimeters, and thermal conductivity probe access lines.

Table 1 Instrumentation and Measurement Purpose

Instrument	Target Measurement/Purpose
Air permeability probes	Internal test pile permeability to air flow
Basal drain collection lysimeters	Discrete collection of basal water flow (quantity) and quality
Basal drain collection lines	Bulk waster flow (quantity) and quality
Gas sampling lines	Internal test pile gas phase composition
Microbiology access ports	Internal test pile microbial populations (to answer academic questions rather than closure questions)
Suction lysimeters	Internal test pile water quality
TDR probes	Internal test pile moisture content / wetting front movement
Tensiometers	Internal test pile matrix water potential (unsaturated rock moisture tension)
Thermal conductivity probe access lines	Internal test pile thermal conductivity characteristics
Thermistors	Bedrock and internal test pile temperatures
2-m-scale experiments	Active zone (upper 2 m) water flow (quantity) and quality

3.2 Tasks to be Started (2011 to 2013)

In 2011 the Project will begin to transition from a focus on data collection and initial characterization to a focus on data interpretation and integration. Tasks include the following:

- ongoing data collection from all instrument types in the test piles and the waste rock pile
- installation of additional instrumentation in the waste rock pile;
- interim characterization of geochemical loading rates for test piles;
- interim characterization of gas transport regime and transport mechanisms in test piles;
- interim characterization of hydrologic regime in test piles;
- interim characterization of thermal regime in test piles and waster rock pile;
- initial estimate of seepage water quantity and quality for a covered and un-covered waste rock pile under current and future climate change scenarios.

Task completion is dependent on timely delivery of data and interpretation by the University researchers.

3.3 Remaining Tasks (After 2013)

Data collection from all instrument types (led by University researchers) will continue through 2015, with interpretation and analysis extending beyond that time. Tasks to be completed after 2013 include:

- complete data collection from all instrument types in the test piles and the waste rock pile;
- deconstruction and sampling one of the Test Piles and direct observation of permafrost formation;
- prepare instrumentation in waste rock pile for long-term monitoring;
- final characterization of geochemical loading rates for test piles;
- final characterization of gas transport regime and transport mechanisms in test piles;
- final characterization of hydrologic regime in test piles;
- final characterization of thermal regime in test piles and waster rock pile;
- final estimate of seepage water quantity and quality for a covered and non-covered waste rock pile under current and future climate change
-

Similar to the tasks to be initiated from 2011 to 2013, task completion is dependent on timely delivery of data and interpretation by the University researchers. Results from specific tasks will be incorporated into closure plans when and where practicable.

Changes to these tasks may occur if the preceding tasks change because of budgetary, logistical or other factors, or results suggest different tasks are required to answer the research questions.

4. Findings of Completed Research

Data collection started in May 2007. Field data collection is an ongoing activity led by the University research group. Analysis and interpretation is often delayed. Preliminary interpretations of the available data include the following (University of Waterloo et al. 2009):

- the test piles are cooling but freezing and thawing annually;
- the till layer on one of the test piles acts as a thermal blanket, dampening thermal responses to ambient temperature changes;
- Type I and Type III piles are permeable to air with wind-induced gas transport enhancing oxygen transport;
- oxygen supply does not limit sulphide mineral oxidation;
- Type I pile sulphur concentrations are low and sulphide oxidation is balanced by acid neutralization (seepage remains circum-neutral);
- Type III sulphur concentrations are low, but at levels where sulphide oxidation rates exceed acid neutralization rates (pH fluctuates seasonally with near-neutral pH in the spring/early summer, dropping to pH ~4 towards the end of the summer);
- preliminary hydrology regimes indicate preferential flow is limited to high-intensity rainfall events; and

- the test piles have not attained dynamic equilibrium with to date, but are expected to by 2014.

Initial characterization and interpretations have been presented in numerous academic papers, conference proceedings and conferences, listed in the reference section. The 2009 progress report (University of Waterloo et al. 2009) was provided in early 2010. The research agreement between DDMI and the University, and the publisher's copyrights prevents DDMI from distributing data or reports directly. Data interpretations are available to the public upon publication of theses, peer-reviewed journal articles, and conference proceedings. DDMI can use the data and reports for internal purposes, including closure planning.

5. Remaining Scopes to be Completed

5.1 Detailed Scopes of Work (2011 to 2013)

In 2011 the Project will begin the transition from a focus on data collection and initial characterization to a focus on data interpretation and integration. Work scopes linked to tasks described in Section 3.2 are summarized below. Note tasks associated with water quality, water quantity and the thermal regime are dependent on timely delivery of data and interpretation by the University researchers. Results from specific tasks will be incorporated into closure plans when and where practicable.

Thermal:

- based on the monitoring results from the test piles and waste rock pile as well as possible mathematical modelling, provide an interim estimate of the depth of annual thaw for the waste rock pile;
- provide this estimate for scenarios assuming both a cover and no cover;
- determine the effect of a climate change scenario on these initial estimates; and
- revise estimates with any changes in monitoring information, mathematical modelling or cover design parameters.

Hydrological:

- based on the monitoring results from the test piles and thermal analysis provide an interim estimate of the fraction of rainfall and snow melt expected to travel within the annual thaw zone and exit the waste rock pile as seepage;
- provide this estimate for scenarios assuming both a cover and no cover;
- determine the effect of a climate change scenario on these initial estimates; and
- revise estimates with any changes in monitoring information or cover design parameters.

Geochemical:

- based on the monitoring results from the test piles, thermal analysis and hydrological analysis provide an interim estimate of the geochemical loading rates in seepage from the waste rock;
- provide this estimate for scenarios assuming both a cover and no cover;

- determine the effect of a climate change scenario on these initial estimates; and
- revise estimates with any changes in monitoring information or cover design parameters.

Changes to these tasks may occur if the preceding tasks change because of budgetary, logistical or other factors, or results suggest different tasks are required to answer the research questions. Furthermore, new research questions could arise that would require new tasks.

5.2 Conceptual Scopes of Work (After 2013)

Work scopes for the task to be conducted after 2013 have not yet been defined but the tasks include the following:

- finalize estimates of post-closure thermal, hydrological and geochemical conditions for the waste rock pile;
- final evaluation of the expected performance of a Type I and till cover, as compared with no cover, on seepage water quality and quantity;
- evaluation of cost-benefit of a waste rock pile cover; and
- document the results and interpretations from test pile program through scientific publications;

Other scopes of work may be added or amended as data is collected and reviewed.

6. Linkages to Other Research/Studies and Life of Mine Plan

Research associated with the Diavik Test Piles Waste Rock Project is related to long-term waste rock management, seepage management and dump closure. Information from this research may:

- support closure criteria for other closure management;
- identify progressive reclamation opportunities;
- contribute to optimizing pile aesthetics and/or wildlife access/exclusion; and/or
- influence waste and/or water management.

7. Project Tracking and Schedule

Progress reports are provided by the University research team annually (e.g., Appendix X-6). The research team meets with DDMI personnel at the beginning of each field season to discuss upcoming activities, and conference calls are held weekly during the field season to ensure task are being completed and research objectives are being met. The research team and DDMI mutually agree upon a comprehensive list of Project milestones and deliverables, which are required for ongoing funding.

A general project schedule for the field portion of the Project from Project inception is provided in Table 4.

Table 4 Field Activities From Project Inception

Year	Activities
2004	Preliminary earthworks and project planning
2005	Initiation of construction and finalization of design
2006	Construction of test piles and 2-m-scale experiment
2007	Completion of test pile construction and first season of data collection
2008	Data collection and installation maintenance
2009	Data collection and installation maintenance
2010	Installation of instruments in the full-scale dump, data collection and installation maintenance
2011	Data collection and installation maintenance; data analysis and interpretation
2012	Data collection and installation maintenance, data analysis and interpretation
2013	Deconstruction of one test pile, data collection and installation maintenance, data analysis and interpretation
2014	Data collection and installation decommissioning
2015	Data collection and compilation

8. Costs

In-kind costs and direct cash costs to DDMI from the Project initiation in 2004 to the end of 2008 were approximately CAD$ 3,680,000. Additional funding contributed by other sponsors (CFI, NSERC, INAP, MEND) is not included in this cost estimate.

An additional CAD$ 1,735,000 (approx.) has been committed by DDMI for 2009 to 2014, the expected completion date. Additional funding contributed by other sponsors is not included in this cost estimate.

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A description of the Diavik project was incorporated into Birdsall-Dreiss lectures presented at approximately 25 academic institutions in Canada, the United States, Australia and Germany.

Appendix VIII-4 Processed Kimberlite Containment Area Reclamation Research Plan

1. Uncertainty

This research plan is designed to improve understanding of the expected geochemical and geotechnical performance of the Processed Kimberlite Containment (PKC) closure concept. The two areas of uncertainty are:

- quality of the water that will be released through both the design outlet and seepage; and
- surface stability.

Characterizing better the geochemical and geotechnical properties will permit a more accurate prediction of closure performance. A more accurate prediction will ensure the closed PKC facility will not pose an unacceptable risk to people, wildlife or aquatic life.

DDMI has questioned the ability of a till layer within the approved PKC cover design to perform as an impermeable barrier given the unconsolidated nature of the material it is to cover. This research plan will also address this question.

2. Research Objectives

The research plan is designed to answer the following questions:

- To what extent are the slimes of the Fine Processed Kimberlite (FPK) able to consolidate? What is the proportion and influence of clay minerals in the FPK slimes?
- What is the thermal evolution of the PKC beaches?
- What is the water quality of the water in the slimes? Does the water chemistry change spatially and/or temporally? To what extent will this water be expelled during consolidation?
- What is the expected water quality of surface water that travels through the unsaturated PK beaches?
- What is the expected water quality and quantity in the engineered outlet and any seepage pathways?
- Would expected outlet and/or seepage water quality pose an unacceptable risk to people, wildlife or aquatic life?
- Will the till layer in the 2001 ICRP cover design perform adequately as an impermeable barrier?

3. Research Plan

3.1 Tasks Completed (Before 2011)

Completed tasks related to geotechnical characterization include:

- engage competent consultants (AMEC);
- data review of available geotechnical data related to consolidation and thermal regime;
- piezocone testing of the PKC beach; and
- piezocone testing of the PKC slimes.

Completed tasks related to geochemical characterization include:

- geochemical characterization of Diavik kimberlites (Blowes and Logsdon 1998);
- engaged competent consultants: Alberta Innovates Technology Futures (AITF) and CANMET Mining and Mineral Sciences Laboratory (CANMET);
- preliminary sampling and instrument installation in FPK for pore water chemistry characterization;
- sampling for FPK mineralogical characterization related to in situ geochemical reactions and pore water chemistry;
- water sample collection from standpipe piezometers;
- preliminary interpretation of PKC geochemical mass balance;
- core sample collection for pore water sampling and mineralogical studies;
- pore water sampling from FPK beach sediments (core squeezing); and
- initial mineralogical evaluation of beach FPK for primary and secondary mineralogy.

Completed tasks related to water quality criteria include:

- Developed initial water quality criteria (Appendix V, Table V7).

3.2 Tasks to be Started (2011 to 2013)

Tasks related to geotechnical characterization include:

- interpretation and analysis of piezocone testing of the PKC slimes;
- laboratory tests for slimes characterization, as required; and
- installation of thermistors in the beach and/or slimes and collection of thermal data.
- Contract an engineering review of the 2001 cover design performance, particularly the till layer.

Tasks related to geochemical characterization include:

- annual or semi-annual sample collection from surviving/accessible standpipe piezometers (as accessible);

- pore water chemistry trend analysis and interpretation; and
- laboratory and/or small-scale field leaching experiments.

Tasks related to water quality criteria include:

- conduct and document screening level risk assessment of outlet and seepage water; and
- update water quality closure criteria, as required.

3.3 Remaining Tasks (After 2013)

- thermal modelling including modelling of climate change scenario;
- hydrological modelling;
- predictions of seepage and outlet water quality;
- conduct and document detailed level risk assessment, if required;
- continued pore water chemistry sampling;
- conduct and document detailed level risk assessment, if required; and
- update closure criteria, as required.

4. Findings of Research Completed

4.1 Geotechnical Characterization

Results from the geotechnical characterization program are limited to interpretations from the 2008 piezocone program that characterized beach sediments. The 2008 work was conducted by Contec under the direction of Golder. Results include the following:

- FPK near the dams (beach deposits) are sand to silty sand with some minor zones of silty sand to sandy silt;
- in situ dry densities are typically around 1,000 kg/m^3, with occasional higher in situ densities measured (1,400 kg/m^3 and 1,990 kg/m^3) in frozen layers;
- frozen layers exist within the FPK beach deposits however the thickness of these layers were not identified;
- a marginal increase in density in the FPK beach with depth.

Results from the 2009 piezocone sampling in the slimes are not yet available. The work was conducted by Contec, under the direction of AMEC.

4.2 Geochemical Characterization

Results from the geochemical characterization program conducted are not complete but include:

- Geochemical characterization of the Diavik kimberlites (baseline) by Blowes and Logsdon (1998):
    - Kimberlite material contains xenoliths of sedimentary material (mudstone and siltstone); sedimentary material comprises 2 to 5%, with the remaining comprised

primarily of the ultramafic minerals olivine and pyroxenes and the weathering products of these minerals.

  - Whole rock analyses indicated that kimberlite material contains greater concentrations of nickel (Ni), cobalt (Co), chromium (Cr), and magnesium (Mg) than the adjacent country rock.
  - The mean sulphide content of the kimberlite samples was 0.34 wt%S and most pyrite is present as framboids.
  - Abundant calcite is present in the samples and the kimberlites and are unlikely to generate acidic drainage, however framboidal pyrite has the potential to release sulphate, iron (Fe), and possibly other metals if exposed subaerially.
  - pH values of greater than 8.5 generated in leach tests suggest that some dissolution of the mafic aluminosilicate minerals is occurring.
  - Kinetic testing indicated a persistence of near neutral pH, sulphate concentrations of Ni, Co, copper (Cu), zinc (Zn) and sulphate that would require monitoring, a decline in calcium (Ca) (and the likely precipitation of gypsum), low Fe concentrations (and the likely precipitation of Fe-oxyhydroxides).

- Preliminary mineralogical investigation of Fine Processed Kimberlite (FPK) by Canada Centre for Mineral and Energy Technology (CANMET):
  - Most abundant mineral is olivine, followed by lizardite with biotite, calcite, quartz and garnet and an amorphous magnesium-silica-aluminum phase.
  - Pyrite is present as grains and framboids.
  - High neutralization potential and very unlikely to become acid generating.
- Preliminary results from field sampling conducted by AITE (additional information collected during pore water program):
  - The active frost-free zone is below 1 m on the beach and the active zone increased over the course of the summer.
  - No frost was encountered in the slimes (from the reclaim barge).
  - Groundwater flow across the East Beach of the PKC is downward at the toe of the dam and upward near the pond.
  - There is an upward gradient in the slimes.
- Pore water chemistry from cores and from piezometers installed in the beach and in the slimes:
  - Highest concentration of dissolved metals, major cations and sulphate were measured in the unsaturated zone; elevated ion concentrations are likely due to weathering processes.
  - Pore water collected from the piezometers installed in the slimes had the lowest concentration of dissolved ions.

- Concentrations of dissolved metals in the slimes were below the current Effluent Quality Criteria (except zinc, which exceeded the criteria at the deepest sampling location).
- Isotope analysis suggest sulphate in the pore water is derived from sulphide mineral oxidation.

4.3 Initial Water Quality Criteria

The Water Quality Criteria developed for closure are provided in Appendix V, Table V-7 and were based on criteria for drinking water and protection of aquatic life. The criteria were developed primarily from Canadian Council of Ministers of the Environment (CCME) Guidelines (CCME 1999) with some site specific adaptation. Values in Table V-7 in the column titled "Waters Entering Lac de Gras" have an assumed mixing factor of 23 (value used for operations discharge criteria) to illustrate how closure criteria should be developed. The mixing factor of 23 was also used to develop the operations discharge criteria and represents concentrations that Lac de Gras can reasonably accommodate such that surface runoff water quality that may be above water quality standards as it drains from the mine site, but ends up below water quality standards some reasonable distance into Lac de Gras.

5. Remaining Scopes to be Completed

5.1 Detailed Scopes of Work (2011 to 2013)

Geotechnical:

- Interpretation and analysis of piezocone testing of the PKC slimes to determine consolidation rates and magnitudes. An estimation of consolidation rates and magnitudes can provide an indication of final landscape/topography, and the volume of pore water that may be expelled during consolidation.
- Laboratory tests for additional slimes characterization, could contribute to estimates of consolidation rates and magnitudes.
- Installation of thermistors in the beach and/or slimes and collection of thermal data can provide an indication of permafrost development and the propensity for thermokarst topography.
- Contract a qualified engineer to review the 2001 cover design for the PKC. Specifically to provide expert opinion on the expected performance of the till layer as an impermeable layer over an unconsolidated PK material and provide a written report.

Geochemical:

- Annual or semi-annual sample collection from surviving/accessible standpipe piezometers (as accessible); to monitor changes to pore water chemistry and identify any potential elements of concern.
- Pore water chemistry trend analysis and interpretation; to identify any changes in pore water chemistry over time and identify any potential elements of concern.
- Laboratory and/or small-scale field leaching experiments to monitor accelerated and in situ weathering of FPK and the resultant water quality.

- Pore water chemistry modelling based on pore water chemistry trends, and laboratory experiments and/or small-scale field experiments that may include predictive/reactive transport modelling.
- A screening level risk assessment using available PKC pond monitoring (SNP 1645-16) information, pore water chemistry information, and laboratory and/or field experiment preliminary results to estimate possible outlet and seepage water quality. This risk assessment will identify parameters of potential concern and may help focus characterization of sources (e.g., pore water, beach runoff) or processes (e.g., freezing, oxidation) governing the concentrations in the outlet and seepage water.

Water Quality Criteria:

- A screening level risk assessment will be completed based on initial estimates of probable ranges of outlet and seepage water quality and quantity. Water quality criteria from Appendix V, Table V7 will be used as the basis for screening. Areas where exposure concentrations will be estimated include the streams and or inland lakes along any outlet or seepage pathway and areas of Lac de Gras.
- Update water quality criteria, if required.
- Other scopes of work may be identified based on the results of the analysis described above.

5.2 Conceptual Scopes of Work (After 2013)

Work scopes for the task to be conducted after 2013 have not yet been defined but the tasks include:

- thermal modelling including modelling of climate change scenario;
- hydrological modelling;
- predictions of seepage and outlet water quality;
- conduct and document detailed level risk assessment, if required;
- continued pore water chemistry sampling;
- update closure criteria; and
- other scopes of work may be identified based on the results of tasks completed prior to 2013.

6. Linkages to Other Research and Life of Mine Plan

Specific linkages identified include:

- information developed to support closure criteria for other closure management areas may be applicable to the PKC area and vice versa;
- information from this research may alter the operations plan for the PKC; and
- information from this research may alter the closure design concept for the PKC.

7. Project Tracking and Schedule

Projects are tracked by task. The expected task schedule is shown in Table 1.

Table 1 Planned Project Activities

Year	Activities
2011	**Geotechnical** Interpretation and analysis of piezocone testing of the PKC slimes; Laboratory tests for slimes characterization, as required; and Installation of thermistors in the beach and/or slimes and collection of thermal data. Engineering review of till layer in cover design. **Geochemical** Annual or semi-annual sample collection from surviving/accessible standpipe piezometers (as accessible). Pore water chemistry trend analysis and interpretation. Laboratory and/or small-scale field leaching experiments.
2012	**Geotechnical** Collection of thermal data. **Geochemical** Annual or semi-annual sample collection from surviving/accessible standpipe piezometers (as accessible). Pore water chemistry trend analysis and interpretation. Laboratory and/or small-scale field leaching experiments. **Water Quality Criteria** Conduct and document screening level risk assessment of outlet and seepage water. Update water quality closure criteria.
2013	**Geotechnical** Collection of thermal data. **Geochemical** Annual or semi-annual sample collection from surviving/accessible standpipe piezometers (as accessible). Pore water chemistry trend analysis and interpretation. Laboratory and/or small-scale field leaching experiments.

8. Costs

Expected costs to complete the required tasks are:

- Tasks completed (before 2011) - $300,000;
- Task to be completed (2011-2013) - $370,000; and
- Tasks remaining (after 2013) – to be determined.

9. References

Blowes, D.W. and M.J. Logsdon. 1998. *Diavik Geochemistry Baseline Report*. Prepared for Diavik Diamond Mines Inc. September 1998.

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Appendix VIII-5 North Inlet Reclamation Research Plan

1. Uncertainty

The North Inlet Water Treatment Plant (NIWTP) removes particulate material and phosphorus from mine water before discharging the water to Lac de Gras. The removed material forms a sludge that is disposed, via pipeline, at the bottom of the North Inlet (NI). There is uncertainty associated with the ecological characteristics of this accumulated sludge and the risk associated with reconnecting the NI and Lac de Gras. Results of this research will be used to guide closure planning for the NI.

2. Research Objectives

The research plan is designed to answer the following questions:

- What is the level of ecological and human health/safety risk for the disposal of NIWTP sludge in the NI now and at closure? Is management action required?
- What are the disposal alternatives for the NIWTP sludge?
- What NI sediment and water quality concentrations would be acceptable for exposure of people, wildlife and aquatic life?

3. Research Plan

Tasks completed (before 2011) include:

- initial ecological characterization of NIWTP Sludge (de Rosemond and Liber 2005);
- sludge disposal alternatives (Golder 2010 - Appendix X-5); and
- field sampling for 2010 characterization of NI sediments and NIWTP sludge.
- analysis and Interpretation of results from 2010 NI sediment and NIWTP sludge characterization;

Tasks to be started (2011 to 2013) include:

- follow-up studies and testing from 2010 characterization program to isolate the source of measured biological responses.;
- conduct and document screening level risk assessment for NI water and sediment quality;
- conduct and document detailed level risk assessment, if required;
- develop risk management strategy, if required; and
- updated water and sediment closure criteria.

Remaining Tasks (after 2013) include:

- characterization of NI sediments and NIWTP sludge (2015);
- conduct and document screening level risk assessment – NI water and sediment quality;
- conduct and document detailed level risk assessment, if required; and
- finalize water quality and sediment criteria.

4. Findings of Research Completed

The initial ecological characterization of the NIWTP sludge (de Rosemond and Liber, 2005) did not identify any material properties that would be expected to prohibit the establishment of productive aquatic habitat. de Rosemond and Liber (2005) conducted standard toxicological and chemical testing of the sludge, sludge leachates and sludge pore water. Ammonia was identified as the main constituent of toxicological concern in the sludge, sludge pore water and sludge leachate with concentrations ranged from 15 to 30 mg/L in the pore-water

A second investigation was initiated in 2010 to characterize the sludge material in the laboratory and the field (Golder 2011 - Appendix X-10). The study design involved sampling five stations within the North Inlet and three reference stations in Lac de Gras. Surface sediments from each station were assessed for sediment chemistry, toxicity and benthic invertebrate structure; sub-surface sediments from the NI stations were assessed for sediment chemistry. NIWTP sludge was also assessed for sediment chemistry and toxicity. Field work was completed in August and laboratory testing with laboratory testing and analysis was expected to be complete by the end of 2010

Results of this assessment indicate that the NIWTP sludge, four of the five NI samples, and all three reference samples contained elevated concentrations of some parameters that were identified as being potentially toxic to aquatic life. However, elevated concentrations present in reference sediments were not associated with adverse biological effects and therefore corresponding elevated concentrations could not always be clearly associated with the adverse biological effects that were observed for the sludge and NI sediments. Results of the sediment toxicity tests and benthic taxonomy analyses showed that NIWTP sludge was toxic in standard sediment toxicity tests, and that sediments from 4 of the 5 NI stations were also classified as toxic and had impoverished benthic invertebrate communities.

The adverse biological effects observed for the NIWTP sludge and sediments from the NI were not attributable to a single stressor. It appears that a combination of organic or nutrient enrichment contributed adverse biological effects at some NI stations whereas metals may have been a contributing factor at other NI stations. The lack of suitable benthic habitat in areas of the NI where the layer of unconsolidated material on the sediment surface was relatively thick was also a factor. Despite the adverse biological effects associated with NI sediments, there was evidence of a resident zooplankton community in the water column within the NI.

Although effects were observed within the NI, it is unlikely that opening the NI to Lac de Gras would adversely affect the water quality of Lac de Gras. However, with respect to whether the NI could be opened up at mine closure and allowed to return naturally to fish habitat, the results obtained from the 2010 study were insufficient to adequately address this question.

Golder (2010) (Appendix X-5) conducted a preliminary review of alternatives to depositing the sludge in the North Inlet. The alternatives included the following:

- disposal within the waste rock pile;
- disposal in PKC Facility;
- disposal within a new on-land facility;
- disposal by mixing with cover soils or hydrocarbon contaminated soils;
- disposal within underground mine back fill mix; and
- disposal into the North Inlet followed by selective dredging.

Further investigations of alternatives will be dependent upon results from current or future the sludge characterization studies.

DDMI initiated a more extensive characterization in 2010. The field component included sampling of the NIWTP sludge, sediments and benthic invertebrates within the NI and sediments and benthic invertebrates from a reference location (Site FF1 from the Aquatic Effects Monitoring Program). Sediment and sludge samples were submitted for standard toxicity, chemical and particle size testing. Benthic invertebrate samples were submitted for taxonomic enumeration. Results are not yet available.

5. Remaining Scope to be Completed

Detailed Scopes of Work (2011 to 2013):

- As follow-up from Golder (2011): a) estimate leaching potential of contaminants from NI sediment, b) confirm sediment chemistry and toxicity in NI sediment, c) conduct additional chemical and toxicological testing on NIWTP sludge, d) conduct zooplankton sampling in NI, and e) model acceptable NI water quality conditions for a partial breach to Lac de Gras as a closure alternative.
- Chemistry, toxicology and benthic invertebrate results for the sludge and NI sediment will be compared to results from the reference area and national standards/guidelines for aquatic sediments. Results will be interpreted by applying guidance from the Fisheries and Oceans Canada *Framework for Addressing and Managing Aquatic Contaminated Sites Under the Federal Contaminated Sites Actions Plan* (Chapman 2010).
- The framework follows the risk assessment approach of: 1) Problem Formulation; 2) Screening Levels Risk Assessment; 3) Detailed Level Risk Assessment; and 4) Risk Management. The framework is specifically designed for aquatic sediments and follows a stepwise approach using results from one step to determine subsequent steps. The results from the 2010 study should be sufficient for the first two steps and possibly a preliminary Detailed Level Risk Assessment, if required.
- This analysis is expected to answer the first research question “Does the disposal of NIWTP sludge in the North Inlet pose an unacceptable human or ecological risk, now or at closure, such that management action is required?”

- If it is determined that immediate operational management action is required, the preliminary review of disposal alternatives (Golder 2010 – Appendix X-5) will be used as a starting point to develop a possible risk management strategy. If risks are identified for closure, appropriate management action would also include alternative closure designs that would mitigate risks.
- Results of the risk analysis will also be used to develop initial closure criteria for NI sediment and water quality. Inherent in each level of the risk assessment framework is the explicit consideration of sediment and water quality conditions that do not pose unacceptable risks. This information will be used as a basis to define initial closure criteria for the NI and will answer the third research question: “What are the NI sediment and water quality concentrations that would not pose an unacceptable risk to people, wildlife and aquatic life?”
- Other scopes of work may be identified based on the results of this risk analysis.

Conceptual Scopes of Work (after 2013) include:

- Work scopes for tasks anticipated beyond 2013 include repeating the field and laboratory study conducted in 2010 and updating the risk assessment, risk management strategy and closure criteria as appropriate, based on the results.
- Other scopes of work may be identified based on the results of this risk analysis.

6. Linkages to Other Research and Life of Mine Plan

Specific linkages identified include:

- the risk assessment framework is based on the general framework that will be applied to other closure management areas. Findings and information from this specific application may be applicable to other areas and the final closure assessment;
- information developed in support of closure criteria may be applicable to other closure management areas;
- information from the NI sediment characterization of ammonia oxidizing microbial communities may be a source of information for the risk assessment; and
- outcomes of any risk management strategy may alter the operations plan for the NIWTP and/or the closure plan for the NI.

7. Project Tracking and Schedule

Projects are tracked by task. The expected task schedule is shown in Table 1.

Table 1 Planned Project Activities

Year	Activities
2011	• Implement follow-up studies and testing from the 2010 NI Sediment Investigation
2012	▪ Conduct and document screening level risk assessment – NI water and sediment quality. ▪ Conduct and document detailed level risk assessment, if required. ▪ Develop risk management strategy, if required. ▪ Updated water and sediment closure criteria.
2013	• No tasks currently scheduled.

8. Costs

Expected costs to complete the tasks described above are:

- Tasks completed (before 2011) - $150,000;
- Task to be completed (2011-2013) - $150,000; and
- Tasks remaining (after 2013) – to be determined.

9. References

de Rosemond, S. and K. Liber. 2005. *Ecological Characterization of the Effluent Produced by the North Inlet Water Treatment Plant at the Diavik Diamond Mine*. Prepared for Diavik Diamond Mines. April 1, 2005.

Chapman, P.M. 2010. *Framework for Addressing and Managing Aquatic Contaminated Sites Under the Federal Contaminated Sites Actions Plan (FCSAP)*. Prepared for Fisheries and Oceans Canada by Golder Associates Ltd.

Golder (Golder Associates Ltd.). 2010. *Alternatives for North Inlet Water Treatment Plant Sludge*. Prepared for Diavik Diamond Mines Inc. December 2010.

Golder (Golder Associates Ltd.). 2011. *North Inlet Sediment Investigation*. Prepared for Diavik Diamond Mines Inc. April 1, 2011.

Appendix VIII-6 Infrastructure Area Reclamation Research Plan

1. Uncertainty

1.1 Re-vegetation Methods

Complementary field and laboratory (greenhouse) studies lead by the University of Alberta, are ongoing. Funding for the project has been provided by Diavik and the National Science and Engineering Research Council (NSERC). Little research has been conducted on re-vegetation of disturbed mine sites in the North American arctic. Establishment of native plant cover is often slow in arctic environments, particularly if adjacent native seed sources are not present (Bishop and Chapin III 1989). Research is focused on improving knowledge of soil and plant characteristics and processes on disturbed and reference sites at the mine to develop ecologically and economically effective methods to enhance the re-establishment of tundra communities following mine closure (Naeth and Wilkinson 2008).

1.2 Contaminated Soils

During normal mine site operation spills from heavy equipment and vehicles, primarily of diesel fuel and heavy hydraulic oils, and occasional antifreezes results in some finer hydrocarbon-contaminated materials being collected for land-farming in the Waste Transfer Area. An approach to managing and disposing of hydrocarbon-contaminated materials is required in support of closure planning. An uncertainty relates to the contaminant levels and disposal approaches that would not pose an unacceptable risk to human and ecological receptors.

1.3 Closure Reference Concentrations

Specific closure criteria are not available in the form of NWT or Federal Standards for some parameters, mediums or valued ecosystem components. Where there are NWT and/or Federal Standards they may or may not be relevant to the Diavik site. Reference concentrations can be developed using a standardized approach. Reference concentrations once developed can be compared with predicted or measures post-closure concentrations and assist in understanding the significance of a result.

1.4 Post-Closure Vegetation Metals Level Risk

Communities and the Environmental Monitoring Advisory Board have identified a potential concern that post-closure vegetation that colonizes naturally or that has been established through a closure re-vegetation program may accumulate metals to a level that would pose an unacceptable risk to wildlife or people. Metal uptake in vegetation that would cause an unacceptable risk to wildlife and people is currently uncertain.

2. Research Objectives

The research plan was designed to answer the questions in Sections 2.1 to 2.3.

2.1 Re-vegetation Methods

- Which substrates are most effective for enhancing soil properties and native plant community development?
- Which soil amendments are most effective at enhancing substrate properties (texture, organic matter and nutrient contents and water holding capacities), native plant establishment and community development?
- Which groups and individual native plant species can establish and survive on a variety of soil substrates and amendments?
- What is the effect of microtopography including boulders, rocks, soil mounds and pockets on plant emergence and establishment?
- Which methods are most effective in establishing native shrubs with wild collected seed and stem cuttings?
- What is the effect of stem cuttings collection time on shrub establishment and survival?
- Is there an effect on stockpiling salvaged topsoil on its prospective use as a soil amendment and source of native propagules for reclamation of disturbed sites?

2.2 Contaminated Soils

- Can petroleum hydrocarbon-contaminated soil be disposed of on-site in a manner that would not pose an unacceptable risk to human and ecological receptors?

2.3 Closure Reference Concentrations

- What are appropriate site-specific risk based reference concentrations for water, soil, dust, plants and prey that will not pose unacceptable risks to wildlife or people post-closure?

2.4 Post-Closure Vegetation Metals Level Risk

- How likely is it that post-closure vegetation (naturally colonized and revegetated) would have metals levels greater than the risk-based closure reference concentrations?
- If it is likely, how can post-closure metal levels in vegetation be better quantified?
- If post-closure metals levels in vegetation remains as a high risk contaminant pathway, how can post-closure metals levels be monitored?

3. Research Plan

3.1 Tasks Completed (Before 2011)

Re-vegetation:

- establishment of re-vegetation research plots;
- initial testing of substrates, amendments and plant species;
- installation of climate stations;
- collection and testing of softwood cuttings; and
- soil sampling and vegetation assessment.

Closure Reference Concentrations:

- initial reference concentrations; and
- initial closure criteria.

3.2 Tasks to be Started (2011 to 2013)

Re-vegetation:

- continued monitoring of re-vegetation research plots;
- interpretation and documentation of field and laboratory monitoring results;
- assess information availability and applicability from Ekati;
- assess confidence in developing re-vegetation procedure; and
- identify any additional research that may be required and long-term monitoring scope for existing re-vegetation research plots.

Contaminated Soils:

- conduct and document risk assessment for options for management and disposal of petroleum hydrocarbon contaminated materials.

Closure Reference Concentrations

- develop site-specific, risk-based closure reference concentrations;
- document and distribute for review; and
- update closure criteria.

Post Closure Vegetation Metals Level Risk

- literature review to determine potential metals levels in plant that may be used for re-vegetation and that are expected to colonize naturally;
- compare these literature values with risk-based closure reference concentrations; and
- determine if there is a need to further research this potential contaminant pathway.

3.3 Remaining Tasks (After 2013)

- document and distribute re-vegetation procedure;
- document and distribute hydrocarbon contaminated soils procedure;
- if expected exposure concentrations of metals in water, soil, dust, plants or prey are identified as posing an unacceptable risk to wildlife or people, then specific research plans may need to be developed to address associated uncertainties; and
- if metals levels in post-closure vegetation remains a high risk contaminant pathway, determine appropriate post-closure monitoring methods as per Water License Part L, Item 3f.

4. Findings of Research Completed

4.1 Re-vegetation Methods

Data collection started in 2004. Field data collection is an ongoing activity, often with delayed analysis and interpretation. Preliminary interpretations of the available data include the following:

- Plan densities and cover continued to increase through increased 2009.
- Native grass cultivars and some native forbs successfully established but dwarf birch did not establish from seed.
- Treatments that performed well in the first few years are not necessarily the ones that had the highest densities and cover in 2009, and cover was influenced by treatment substrate and soil amendment.
- Processed Kimberlite (PK) continues to be a poor substrate for plant growth, regardless of soil amendment or species sown.
- The addition of salvaged top soil, North Inlet Water Treatment Plant sludge or sewage sludge is consistently a component of the top three performing treatments for any given substrate.
- Spring seeding resulted in greater plant cover than fall seeding across all soil treatments.
- Grass-dominated seed mixes consistently perform better than those dominated by forbs or shrubs.
- Shrub cuttings had poor survival. Best were crowberry followed by bear berry and cranberry.
- Of the seeded species sweet pea established in low densities. Fireweed was the most abundant species and established naturally.
- Water erosion of seed, cuttings and topsoil was an issue in some plots.

References that are directly or indirectly linked to DDMI's re-vegetation efforts are included in the References section. Annual progress summaries of the re-vegetation studies are included with the Annual Water License Reports submitted to the WLWB.

4.2 Closure Reference Concentrations

A similar program was conducted in 1998 (Mucklow and Swanson 1998) and will be used as a starting point for this work. Table 5 attached from Mucklow and Swanson (1998) is a relevant result from that work.

5. Remaining Scope to be Completed

5.1 Detailed Scopes of Work (2011 to 2013)

5.1.1 Re-vegetation

Monitoring of re-vegetation research plots will continue through 2011 when emphasis will shift from data collection to documentation and interpretation. Findings from this initial research will then be combined with information availability and applicability from Ekati research, and any other recent research to assess confidence in specifying a re-vegetation procedure for closure. It is possible that there will still be some uncertainties with aspects of the re-vegetation procedure that will need to be addressed with additional studies and/or trail applications. Specific outcomes, in addition to an initial re-vegetation procedure include recommendations for future research tasks and recommendations regarding continued monitoring of the existing research plots.

5.1.2 Contaminated Soils

Apply a risk-based approach to consider management and disposal options for contaminated materials. The assessment will be based on existing site information for typical hydrocarbon contaminant levels and include development of a risk assessment problem formulation and preliminary identification of risk management options for managing contaminated materials. Key findings from this work will be used to inform both operations and closure management approaches to hydrocarbon contaminated materials. It is also expected that the assessment will provide information to establish preliminary hydrocarbon closure criteria.

5.1.3 Closure Reference Concentrations

A literature and data review will be completed to nominate chemicals of potential concern, receptors, toxicity reference values and risk estimate equations generally following the approach used in Mucklow and Swanson (1998). This document will be circulated for review/revision. DDMI then suggests developing receptor-specific and area-specific receptor parameters such as time an animal/person might spend in an area, food/water ingestion rates or body weight jointly with communities and government. This could be an excellent opportunity to merge both science information and Traditional Knowledge (TK) to make a best representation of these parameters for northern populations. Listings of the types of information required would be distributed to so that all participants can contribute whatever information they might have. DDMI will then take the outcomes from these first steps and complete initial calculations of risk-based criteria. These criteria will be compared against possible water/dust/rock/prey/vegetation concentrations to identify parameters and media of greatest risk. Documentation of these results will be distributed for review. Derived reference concentrations will be considered for inclusion as site-wide closure criteria.

5.1.4 Post-Closure Vegetation Metals Level Risk

Communities and the Environmental Monitoring Advisory Board have identified a potential concern that post-closure vegetation that colonizes naturally or that has been established through a closure re-vegetation program may accumulate metals to a level that would pose an unacceptable risk to wildlife or people. The derived Closure Reference Concentrations (see Section 5.1.4) will be combined with a literature review of potential metals levels in vegetation to determine if post-closure vegetation is likely to pose an unacceptable risk to people or wildlife. If expected exposure concentrations in post-closure vegetation are identified as posing an unacceptable risk to wildlife or people, then specific research plans may need to be developed to address associated uncertainties and possibly monitoring methods.

5.2 Conceptual Scopes of Work (After 2013)

- Work scopes for tasks anticipated beyond 2013 include finalizing specific procedures for site-wide re-vegetation and for management/disposal of hydrocarbon contaminated material.

- The need for potential work scopes related to post-closure metals levels in vegetation will be determined pending outcomes of the 2011-2013 tasks.
- Other scopes of work may be identified based on the results of tasks completed before 2013.

6. Linkages to Other Research and LOM Plan

Specific linkages identified include:

- Thermally active zone depth in waste rock and PKC measured in research plans for these areas may be used as information for hydrocarbon risk assessment.
- Risk assessment frameworks applied in this research plan are the same as general framework that will be applied to other closure management areas.
- Information developed in support of closure criteria may be applicable to other closure management areas.
- Research on aspects of re-vegetation methods can potentially be coordinated with Ekati.
- Decision-making and planning relating to stockpiling of various wastes (e.g., vegetation, top soil, sewage sludge, north inlet sludge, fine PK).

7. Project Tracking and Schedule

Projects are tracked by task. The expected task schedule is shown in Table 1.

Table 1 Planned Project Activities

Year	Activities
2011	• Continued monitoring of re-vegetation research plots. • Conduct and document risk assessment for options for management and disposal of petroleum hydrocarbon contaminated materials.
2012	• Interpretation and documentation of field and laboratory monitoring results. • Assess information availability and applicability from Ekati. • Develop site-specific, risk-based closure reference concentrations.
2013	• Determine if post-closure vegetation is likely to pose an unacceptable risk to people or wildlife. • Assess confidence in developing re-vegetation procedure. • Identify any additional research that may be required and long-term monitoring scope for existing re-vegetation research plots.

8. Costs

Expected costs to complete the tasks described above are:

- Tasks completed (before 2011) - $350,000 plus in-kind costs;
- Task to be completed (2011-2013) - $150,000; and
- Tasks remaining (after 2013) – to be determined.

9. References

ABR, Inc. 2001. *Revegetation of mining disturbances in the north: Literature review and identification of research opportunities for the Diavik Diamond Mine, NWT, Canada*. Prepared for Diavik Diamond Mines, Inc. Fairbanks AK. 35 pp.

Bishop, S.C. and F.S. Chapin III. 1989. *Patterns of natural revegetation on abandoned gravel pads in arctic Alaska*. Journal of Applied Ecology 26(3):1073-1081.

Bishop, S.C., J.G. Kidd, T.C. Cater, L.R. Rossow and M.T. Jorgenson. 1999. *Land rehabilitation studies in the Kuparuk Oilfield, Alaska, 1998*. Thirteenth annual report prepared for ARCO Alaska, Inc. Anchorage, Alaska by ABR Inc. Fairbanks AK. Cited in: ABR, Inc. 2001.

Bishop, S.C., J.G. Kidd, T.C. Cater, K.N. Max and P.E. Seiser. 2000. *Land rehabilitation studies in the Kuparuk Oilfield, Alaska 1999*. Fourteenth annual report prepared for PHILLIPS Alaska, Inc. and Kuparuk River Unit, Anchorage AK by ABR Inc. Fairbanks AK. 38 pp. Cited in: ABR, Inc. 2001.

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Naeth, M.A. and Wilkinson, S.R. 2008. *Diamond Mine Reclamation in the NWT: Substrates, Soil Amendments and Native Plant Community Development, 2007 Annual Report*.

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Reid, N.B. and M.A. Naeth. 2005a. *Establishment of a vegetation cover on tundra kimberlite mine tailings: A greenhouse trial*. Restoration Ecology 13(4):593-600.

Reid, N.B. and M.A. Naeth. 2005b*. Establishment of a vegetation cover on tundra kimberlite mine tailings: a field trial*. Restoration Ecology 13(4):601-608.

The following Tables are from Mucklow and Swanson (1998).

TABLE 5 RISK-BASED REFERENCE CONCENTRATIONS (RBRC) FOR PLANTS, PREY, WATER, SOIL AND DUST FOR WILDLIFE RECEPTORS

Chemicals	Risk-Based Reference Concentration for Plants (mg/kg dry weight)	Risk-Based Reference Concentration for Prey (mg/kg dry weight)	Risk-Based Reference Concentration for Dust (ug/m^3)	Risk-Based Reference Concentration for Soil (mg/kg dry weight)	Risk-Based Reference Concentration for Water (mg/L)
Caribou					
Barium	170	n/a	2400	4000	130
Cadmium	8	n/a	370	200	20
Chromium (III)	28000	n/a	1000000	680000	68000
Cobalt	12	n/a	690	300	30
Copper	150	n/a	17000	3800	380
Lead	81	n/a	1300	2000	200
Molybdenum	1.6	n/a	180	40	4
Nickel	400	n/a	46000	10000	1000
Uranium	17	n/a	1900	410	41
Vanadium	2	n/a	230	50	5
Zinc	1600	n/a	180000	40000	4000
Northern Red-Backed Vole					
Barium	21	n/a	420	850	2.6
Cadmium	1.2	n/a	76	50	0.5
Chromium (III)	3400	n/a	180000	140000	1300
Cobalt	1.6	n/a	130	68	0.6
Copper	19	n/a	3000	780	7
Lead	10	n/a	220	410	4
Molybdenum	0.2	n/a	28	7	0.1
Nickel	50	n/a	7800	2000	19
Uranium	2	n/a	320	84	0.8
Vanadium	0.2	n/a	38	10	0.1
Zinc	200	n/a	31000	8200	77
Red Fox					
Arsenic	n/a	0.4	n/a	n/a	n/a
Barium	n/a	80	500	2800	6
Beryllium	n/a	3	n/a	n/a	n/a
Cadmium	n/a	5	90	160	1
Chromium (III)	n/a	13000	216750	460000	3250
Cobalt	n/a	6	158	225	2
Copper	n/a	72	3600	2600	18
Lead	n/a	38	270	1350	9
Manganese	n/a	420	n/a	n/a	n/a
Mercury	n/a	6	n/a	n/a	n/a
Molybdenum	n/a	0.6	32	23	0.2
Nickel	n/a	190	9450	6750	47

TABLE 5 RISK-BASED REFERENCE CONCENTRATIONS (RBRC) FOR PLANTS, PREY, WATER, SOIL AND DUST FOR WILDLIFE RECEPTORS

Chemicals	Risk-Based Reference Concentration for Plants (mg/kg dry weight)	Risk-Based Reference Concentration for Prey (mg/kg dry weight)	Risk-Based Reference Concentration for Dust (ug/m^3)	Risk-Based Reference Concentration for Soil (mg/kg dry weight)	Risk-Based Reference Concentration for Water (mg/L)
Selenium	n/a	0.9	n/a	n/a	n/a
Strontium	n/a	1250	n/a	n/a	n/a
Uranium	n/a	8	387	280	2
Vanadium	n/a	0.9	45	32	0.2
Zinc	n/a	760	38025	27000	190
Oldsquaw					
Barium	1100	480	4700	12500	140
Cadmium	78	11	320	280	9
Chromium III	54	7	190	190	6.5
Cobalt	38	5	200	130	4.5
Copper	2500	350	26000	9000	300
Lead	200	28	310	740	25
Molybdenum	190	26	2000	670	23
Nickel	4200	570	43000	15000	500
Uranium	870	120	9000	3100	100
Vanadium	620	84	6400	2200	74
Zinc	780	110	8100	2800	94
Ptarmigan					
Barium	120	n/a	2300	1300	100
Cadmium	2.7	n/a	160	29	7
Chromium III	1.8	n/a	91	20	5
Cobalt	1.3	n/a	96	14	3
Copper	87	n/a	13000	940	230
Lead	7	n/a	150	77	18
Molybdenum	6.5	n/a	950	70	17
Nickel	140	n/a	21000	1500	370
Uranium	30	n/a	4400	320	77
Vanadium	21	n/a	3100	230	55
Zinc	27	n/a	4000	290	70

APPENDIX IX

SUMMARY OF COMMUNITY ENGAGEMENT AND CONSULTATION

IX-1 Environmental Monitoring Advisory Board Closure Workshop

IX-1.1 DDMI Presentation – Closure Planning History

IX-1.2 DDMI Presentation – Closure Planning Future

IX-1.3 EMAB Closure Workshop Report

IX-2 DDMI Closure Site Visit – January 14, 2009

IX-3 Wek'èezhìi Land and Water Board Objectives Workshop – February 25 and 26, 2009

IX-4 DDMI Options and Criteria Workshop – May 12 and 13, 2009

IX-5 DDMI Site Workshop – Post-Closure Caribou Movement – August 17 to 21, 2009

IX-6 DDMI Presentation to Communities – September to December 2009

IX-7 DDMI Community Engagement

IX-8 DDMI Closure Planning

Appendix IX-1.1

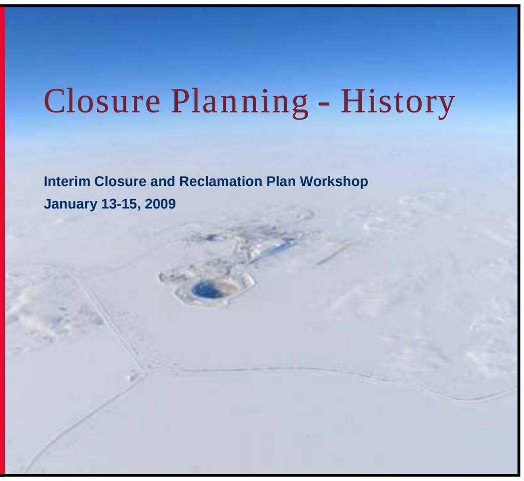
DDMI Presentation – Closure Planning History

EMAB Closure Workshop – January 13-15, 2009

RioTinto

Closure Planning - History

Interim Closure and Reclamation Plan Workshop
January 13-15, 2009



RioTinto

Presentation Outline

RioTinto

Vision Statement:

- We will close the Diavik Mine responsibly and progressively, leaving a positive community and environmental legacy.

Closure Objectives:

- Land and water that is safe for people, wildlife and aquatic life.
- Enhanced capacities for northerners and northern businesses.
- No long term care and maintenance.

RioTinto

Closure Planning - Schedule and Phases

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mine Design																							
Comprehensive Study Report																							
Engineering and Construction																							
Initial Closure and Reclamation Plan																							
Mining Operations																							
Interim Closure and Reclamation Plan																							
Final Closure and Reclamation Plan																							

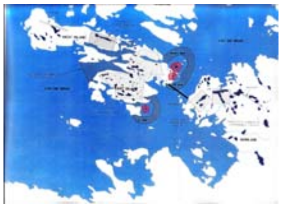
Closure Alternatives – Mine Design Phase

Human Resources Options

Mining Method Options

Siting Options
- PKC
- Wasterock

Design Options
- Water management
- Water treatment
- Processed kimberlite containment



Human Resources Alternatives

#1: southern head office – employing northerners opportunistically.
- Minimal northern socio-economic impacts at closure because of limited involvement

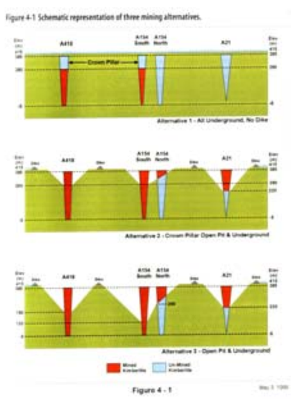
✓ **#2 – northern head office** – actively seeking northern involvement
- Greater socio-economic impact at closure but mitigated through progressive participation and capacity building

Mining Method Alternatives

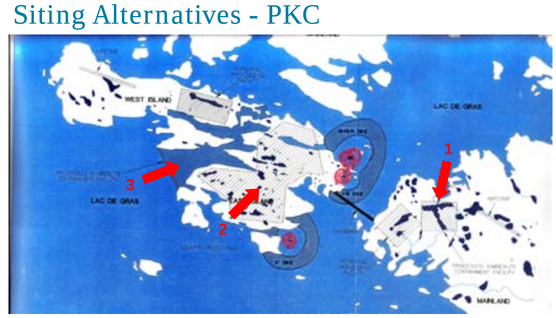
#1: All underground – not economical, technically risky and shorter mine life
- Easier closure option due to smallest environmental disturbance.

#2: Smaller open pits & underground – more underground mining, fewer northern opportunities, reduced economics
- Moderate closure – less wasterock than #3

✓ **#3: Larger open pits & underground** – best balance of economics and environment
- Moderate closure – more wasterock.



Siting Alternatives - PKC



#1: T-Lake on mainland – causeway and larger footprint
- Better closure option than #2 due to location.

✓ **#2: East Island valley** – closest to mine
- Most technically challenging closure

#3: Lac de Gras – preferred geochemical option – unacceptable from communities perspective.
- Technically most secure closure option.

RioTinto

Siting Alternatives - Wasterock

- ✓ **#1: Near open pits** – most practical
  - More difficult closure option.
- **#2: Backfill completed pits** – mining sequence issue, geochemical problems, double handling
  - Better closure option if placed directly into flooded pits.
- **#3: Lac de Gras** – widening of dikes – best geochemical control – fish habitat and communities concerns.
  - Technically most secure closure option.

RioTinto

Design Alternatives – Water Management

- **#1: treat and release PKC water** – use mine water for make-up
  - Better option for closure due to minimal water remaining in PKC
- ✓ **#2 – treat and release mine water** – use PKC as make-up water as it is the poorer quality water.
  - More difficult closure option

RioTinto

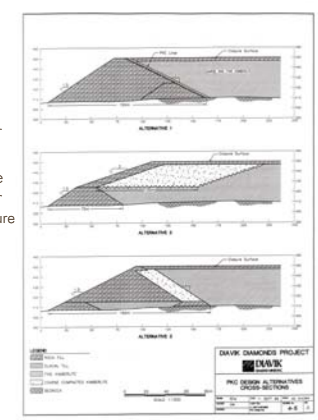
Design Alternatives – Water Treatment

- **#1: settling ponds** – variable performance
  - Minimal closure issues – settled solids
- ✓ **#2: clarification/filtration** – low chemical use/waste – good performance – limited parameters.
  - Minimal closure issues – settled solids and backwash
- **#3: hydroxide/sulphide precipitation** – adds metals treatment but uses chemicals and generates waste.
  - Increased closure issues – removed metals precipitates
- **#4: reverse osmosis** – excellent treatment performance but high waste generation
  - Significant closure issues – large waste volumes
- **#5: ion exchange** – good treatment performance but high waste generation
  - Significant closure issues – large waste volumes

RioTinto

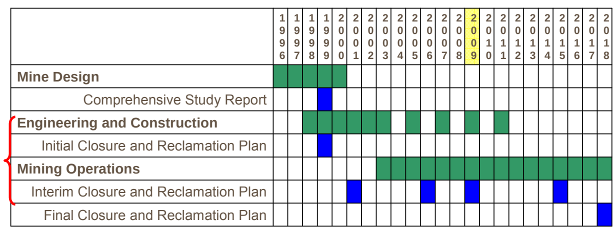
Design Alternatives - PKC

- ✓ **#1: rock dam with PVC liner** – most expensive – best operational seepage control
  - Possible long-term/closure seepage if liner degrades
- ✓ **#2: upstream construction with coarse PK liner** – no PVC liner, smaller footprint and capacity
  - Smaller closure area and better long-term/closure seepage management
- ✓ **#3: rock with PK liner** – seepage managed during operations with collection ponds
  - Best long term/closure seepage management



RioTinto

Closure Planning - Schedule and Phases



RioTinto

Socio-economic Aspects

Proposed Closure Objectives:

- Capacity building during operations to enable communities to best adapt to post closure socio-economic conditions.
- Sustainable capacities in communities

Existing Closure Plan:

- Implement participation agreements
- Implement socio-economic agreements
- Communicate

RioTinto

Underground, Open Pit and Dike

Proposed Closure Objectives:

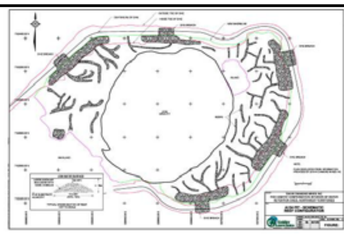
- Provide sustainable water quality in flooded pit areas for aquatic life.
- Develop physical habitat that enhances lake-wide characteristics.
- Enable safe small craft navigation.
- Ensure geotechnical stability.
- Eliminate public and wildlife access to underground.

RioTinto

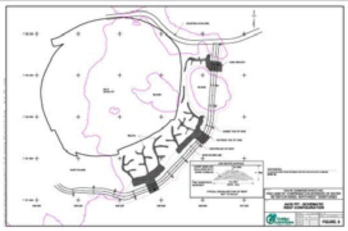
Underground, Open Pit and Dike

- Existing Closure Plan
  - Construct fish habitat reefs on pit crest.
  - Remove mobile mining equipment, seepage wells, unused AN, explosives, fuel, lubricants, thermosyphons, mounted instruments, and pit dewatering system.
  - Fixed UG equipment that cannot be salvaged will be cleaned an left in place – piping, wiring, ventilation.
  - Ventilation raises and decline access closed with cement plug.
  - Flood pit by controlled siphons to minimize erosion.
  - 7 cuts (30m wide x 2m deep) in dike once water quality is acceptable.

A154



A418



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Wasterock Area

Proposed Closure Objectives:

- Freeze Type III rock – no active zone.
- Keep drainage quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Ensure geotechnical stability.
- No water retaining structures.
- Provide safe passage for caribou but not attract caribou.
- Incorporate practical wildlife habitat features in final landscape.

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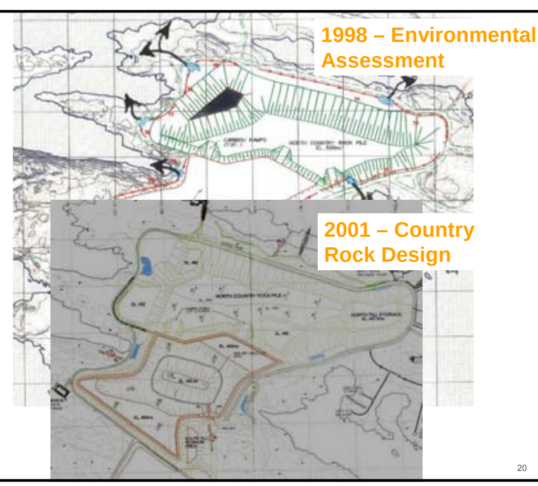
Wasterock Area

- Existing Closure Plan
  - A418/A154 wasterock segregation and storage into six drainage basins.
  - Grading of outer slopes to produce a stable final slope.
  - Type III covered with 1.5m till and 3m Type I rock.
  - Type II covered with 4m Type I rock.
  - Till contoured with erosion protection – flow breaks and rock lined ditches.
  - Ponds 1,2,3 converted to sediment settling ponds with spillways converted to discharge channels
  - South side and north side caribou ramps – 40-80m wide maximum 4:1 slope

19



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RioTinto

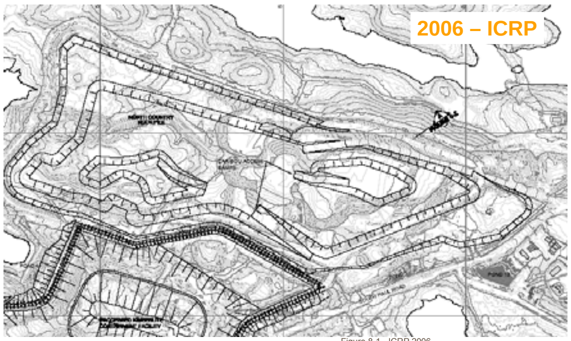

Figure 8-1 - ICRP 2006

RioTinto

Processed Kimberlite Containment

Proposed Closure Objectives:

- Maximize freezing of processed kimberlite.
- Keep drainage quality (runoff and seepage) safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Ensure geotechnical stability.

RioTinto

Processed Kimberlite Containment

- Existing Closure Plan
  - Minimize pond size towards end of operations then pump out
  - Pond area filled hydraulically with coarse PK and/or beach material
  - Pond area then pre-load with 5m thick rock spacer to cause consolidation over 2-years
  - Final pond cover of 1m till and 3 m rock over spacer dome
  - Processed kimberlite (coarse and fine) covered by 0.5 m thick till and 3m thick Type I rock cap graded to direct any surface runoff.
  - Surface runoff will exit the PKC area through a channel in the southern area via ponds 6,7 and/or 12 which will act as sedimentation ponds.
  - Ponds 4,5,6,7,12 transformed to sediment ponds with outlets to LDG.

RioTinto

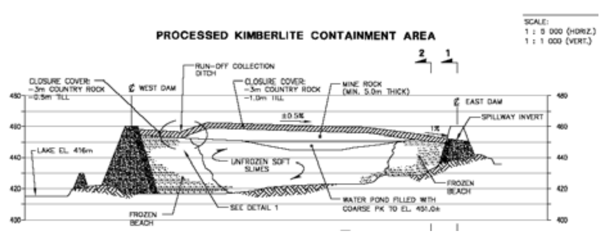

Figure 8-2 ICRP 2006

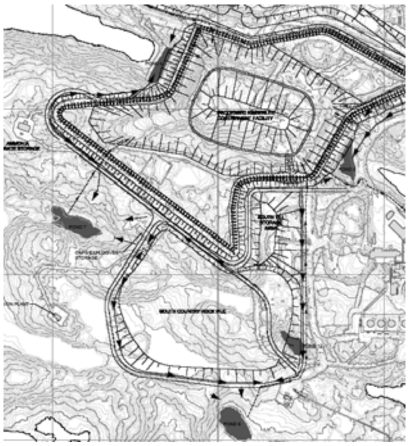

Figure 8-1 ICRP 2006

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Buildings and Roads

Proposed Closure Objectives:

- Maximize use of assets for regional benefits.
- Maximize use of on-site disposal.
- Provide a final landscape with restored drainage patterns and enhancements to encourage indigenous vegetation.
- Incorporate practical wildlife habitat features in final landscape

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Buildings and Roads

- Existing Closure Plan
  - Demobilization of major buildings to near ground level.
  - Concrete demolished to foundation level.
  - Demobilization/dismantling for off-site disposal or recycling.
  - Inert material for disposal either *in-situ* or in approved landfill area.
  - Sale of intact items to northern and southern-based enterprises, Donation of intact items for regional development, sale or donation to demolition and reclamation contractors
  - Contaminated soil placed within coarse PK and covered.
  - Hazardous material packaged and shipped off-site for disposal
  - Re-establishment of drainage – removal of culverts – scarify surfaces and targeted re-establishment of indigenous vegetation.

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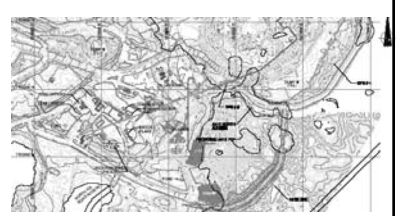

Figures 5-8 and 5-9 ICRP 2006

28

North Inlet

Proposed Closure Objectives:

- Water quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Hydrologic connectivity to keep levels equal to Lac de Gras.
- Evaluate opportunities to reconnect for fish habitat.

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North Inlet

- Existing Closure Plan
  - Evaluate suitability of sediment and water quality for sustainable aquatic life in north inlet.
  - Hydrologic connection (through permeable rock fill section in east dam) to Lac de Gras to manage water levels.
  - Option to breach east dam and have full connection for fish and water.

30

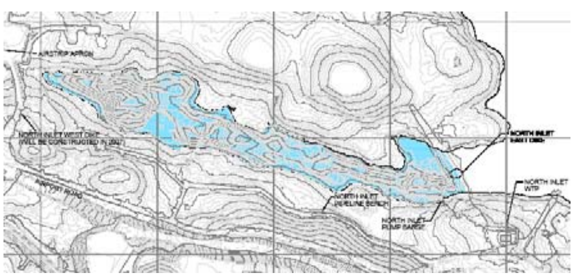


Figure 5-6 ICRP 2006

31

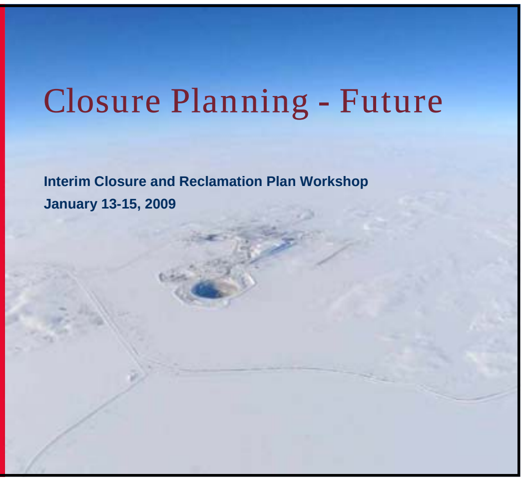
Questions?

32

Appendix IX-1.2

DDMI Presentation – Closure Planning Future

EMAB Closure Workshop – January 13-15, 2009



Closure Planning - Future

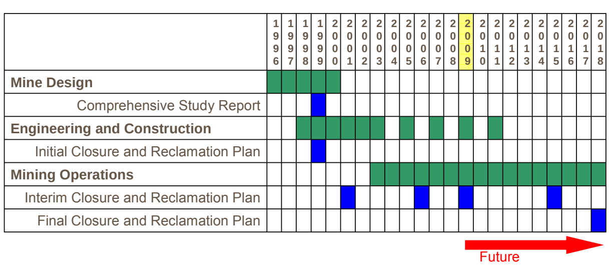
Interim Closure and Reclamation Plan Workshop
January 13-15, 2009

Presentation Outline

Discussion on future closure planning directions.

1. Closure Vision and Objectives
2. Socio-economic Aspects
3. Underground, Open Pits and Dikes
4. Wasterock Area
5. Processed Kimberlite Containment
6. Buildings and Roads
7. North Inlet

Closure Planning - Schedule and Phases



Vision Statement:

- We will close the Diavik Mine responsibly and progressively, leaving a positive community and environmental legacy.

Closure Objectives:

- Land and water that is safe for people, wildlife and aquatic life.
- Enhanced capacities for northerners and northern businesses.
- No long term care and maintenance.
- Other?

Socio-economic Aspects

Closure Objectives:

- Capacity building during operations to enable communities to best adapt to post closure socio-economic conditions.
- Sustainable capacities in communities.
- Other?

Future Closure Planning :

- Specifics in agreements are well defined
- Need to work on:
  - Timing and method of socio-economic aspects of closure communication
- Other?

5

Underground, Open Pit and Dike

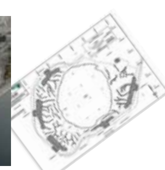
Closure Objectives:

- Provide sustainable water quality in flooded pit areas for aquatic life.
- Develop physical habitat that enhances lake-wide characteristics.
- Enable safe small craft navigation.
- Ensure geotechnical stability.
- Eliminate public and wildlife access to underground.
- Other?

6

Underground, Open Pit and Dike





- Future Closure Planning
  - Plans are generally well advanced for this area – there are no significant new alternatives currently being considered.
  - Need to work on:
    - Details of what makes sense to place in pit area/underground before flooding.
    - Design details of siphon system.
    - Update forecast of flooded water quality.
    - Details of closure specific monitoring programs.
    - Water quality criteria for breaching dike.
    - Caribou access/exclusion on dike.
  - Other?

7

Wasterock Area

Closure Objectives:

- Freeze Type III rock – no active zone.
- Keep drainage quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Ensure geotechnical stability.
- No water retaining structures.
- Provide safe passage for caribou but not attract caribou.
- Incorporate practical wildlife habitat features in final landscape.
- Other?

8

Wasterock Area

- Future Closure Planning
  - First area that will be available for significant progressive closure.
  - Closure design alternatives under review.
  - Need to work on:
    - Details for safe caribou travel – traditional knowledge input
    - Re-forecasting thermal conditions to guide cover design
    - Geotechnical analysis of final slope designs
    - Integration with final years of open-pit mining and use of wasterock for underground backfill.
    - Progressive reclamation opportunities
    - Seepage and runoff water quality criteria.
    - Options for other wildlife habitat.
    - Details of closure specific monitoring programs
  - Other?

9

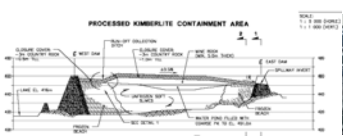
Processed Kimberlite Containment

Closure Objectives:

- Maximize freezing of processed kimberlite.
- Keep drainage quality (runoff and seepage) safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Ensure geotechnical stability.
- Other?

10

Processed Kimberlite Containment



- Future Closure Planning
  - Existing plan is conceptual – practical alternatives to be considered
  - Need to work on:
    - Possible operational changes to facilitate closure – deposition planning, water management, dam raise construction
    - Alternative closure designs
    - Caribou travel routes
    - Continue to investigate properties of deposited processed kimberlite and kimberlite water
    - Progressive reclamation opportunities and material availability
    - Seepage and runoff water quality criteria
    - Details of closure specific monitoring plans
  - Other?

11

Buildings and Roads

Closure Objectives:

- Maximize use of assets for regional benefits.
- Maximize use of on-site disposal.
- Provide a final landscape with restored drainage patterns and enhancements to encourage indigenous vegetation.
- Incorporate practical wildlife habitat features in final landscape
- Other?

12

Buildings and Roads

- Future Closure Planning
  - Existing plan is appropriately at concept level.
  - Need to work on:
    - Options for regional uses for assets
    - On-site disposal planning
    - Progressive closure using back-hauls
    - Final landscape designs – drainage, re-vegetation, scarified roads
    - Re-vegetation procedures
    - Wildlife habitat opportunities – process plant wall?
  - Other?

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North Inlet

Closure Objectives:

- Water quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
- Hydrologic connectivity to keep levels equal to Lac de Gras.
- Evaluate opportunities to reconnect for fish habitat.
- Other?

14

North Inlet

- Future Closure Planning
  - Existing plan is appropriately at concept level.
  - Need to work on:
    - Design options for both hydrologic and fish connectivity to Lac de Gras
    - Water and/or sediment criteria for determining connectivity
  - Other?

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Questions?

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Appendix IX-1.3

EMAB Closure Workshop Report

ARKTIS SOLUTIONS INCORPORATED
:: 117 Loutitt Street :: Yellowknife, NT:: X1A 3M2 ::
:: Phone: 867.446.0036 :: Fax 866.475.1147 ::

MEMORANDUM

File:	**Environmental Monitoring Advisory Board – Diavik Diamond Mine Closure and Reclamation Workshop**
To:	**Environmental Monitoring Advisory Board**
Attention:	**Mr. John McCullum (Executive Director)**
Subject:	**Workshop Final Report**
Author:	**Joe Murdock, Jamie VanGulck, Ph.D., P.Eng.**
Page Total:	**12 + Annexes**
Date:	**February 4th, 2009**

Preamble

Further to the Environmental Monitoring Advisory Board (EMAB) November 7th, 2008 issued *Terms of Reference*, Arktis Solutions Incorporated (ASI) was retained to provide approximately ten (10) person days of service to organize, develop, present and report on a *Closure and Reclamation Workshop* (hereafter referred to as the "*Workshop*"). The Workshop aimed and achieved in introducing Workshop participants to the first principles of mine closure and reclamation, the definitions of closure objective and closure criteria, and provided an outlet for community members to vocalize generalized concern. The Workshop also allowed for participant input on how communities believe they can best be involved in the review of Rio Tinto Limited's Diavik Diamond Mine Interim Closure and Reclamation Plan (ICRP).

This *Memorandum*, to be submitted within three (3) weeks following the Workshop closing, provides a summary of the Workshop, held January 13th, 2009 – January 15th, 2009 at the Explorer Hotel, Yellowknife and at the Diavik Diamond Mine. The Workshop was coordinated by Mr. John McCullum and was attended by EMAB board members and staff, community members, federal and territorial government employees, and representatives from Rio Tinto Limited.

1.0 - Introduction

EMAB was created pursuant to **Article IV** of the Environmental Agreement[1] ("*Agreement*") and mandated[2], in short, to implement an integrated and co-operative approach to achieve *Agreement* purposes and implement the *Agreement* guiding principles as per **Article I**. Signatories to the *Agreement* include the Government of Canada, Government of the Northwest Territories, Diavik Diamond Mines Inc., Tlicho Government, Lutsel K'e Dene First Nation, Yellowknives Dene First Nation, North Slave Métis Alliance and the Kitikmeot Inuit Association. To fulfill its responsibilities, EMAB serves as a public regulatory watchdog offering recommendations to the Minister of DIAND on matters including wildlife harvesting, the participation of Aboriginal Peoples through environmental training initiatives and monitoring programs and the need for and design of traditional knowledge and other studies. EMAB also acts as a vehicle to provide a meaningful role for each of the Aboriginal Peoples[3] in the review and implementation of Diavik Diamond Mine environmental monitoring plans. Finally, EMAB functions as an independent advisory body (apart from the *Agreement* Signatories), who provides an unbiased review of environmental documents. These reviews form interventions filed and considered by Institutes of Public Government (i.e., Wek'eézhíí Land and Water Board) as per federal legislation. An EMAB hosted Workshop also satisfies EMAB's mandate to facilitate programs and disseminate information to community members and the general public on matters relating the state of the environment.

This *Memorandum* serves to develop recommendations related to participant and the group development of closure objectives and closure criteria, ways in which communities can be involved in the development and review of the, yet to be submitted, third iteration of the ICRP. This *Memorandum* will also report on generalities from the workshop. As explicitly scoped, this project was to engage and inform participants on introductory mine closure and reclamation first principles and was not geared towards the specifics of the Diavik Diamond Mine. ASI exercises did include elements of the Diavik Diamond Mine, but as stated to EMAB and all participants, these elements were to be considered hypothetical in nature and viewed in similar light to any other mine development. Participants were to be exposed to the commonalities found in general mine closure and reclamation scenarios, with the concepts of closure objectives and criteria explained in detail and reinforced through instruction and applied exercises. The hypothetical exercises were to support delivered concepts and give participants experience in forming their own mine closure objectives and criteria.

ASI has not interpreted or evaluated Rio Tinto Limited's specific plans and strategies for the closure and reclamation of the Diavik Diamond Mine, nor has ASI reported or commented on participant opinions of how Diavik should be reclaimed. These aspects lie outside of the

[1] Created March 8th, 2000 and found at http://www.emab.ca/pdfs/diavik_enviro_agree.pdf.
[2] For a more thorough and accurate portrayal of EMAB's mandate, the Reader is referred to **Part 2** of **Article IV** in the *Agreement*.
[3] As defined under **Article III** of the *Agreement*.

scope of this Workshop and are to be completed through successive efforts by Rio Tinto Limited and the Wek'eézhíí Land and Water Board. Outlets under these groups may prove to be a more responsible forum to discuss and evaluate Diavik Diamond Mine closure and reclamation specifics. EMAB is also staging an independent review of the next iteration of the ICRP at a later date.

2.0 – Workshop Objectives

ASI's primary objective was to successfully engage participants into a discussion centered towards closure and reclamation principles. Workshop material and delivery format was developed to satisfy the following Workshop objectives set out in the ASI's *Proposal for Consulting Services*:

i. Discussions on the basic concepts of closure and reclamation and associated scientific first principles and Traditional Knowledge related to closure and reclamation engineering and strategy;
ii. A review of closure and reclamation elements through aerial photographs, schematics, other visual materials and resulting discussions. Regulatory elements and discussion can also be examined;
iii. Roundtable discussions on closure objectives and closure criteria with aim and intent to establish individual participant viewpoints and opinions on the subjects;
iv. Roundtable discussions identifying potential community and participant concern over closure and reclamation practices and future development. This discussion will aim to understand how communities may be involved in the development and review of a revised Diavik ICRP; and,
v. Presentations from Rio Tinto Limited, Department of Indian Affairs and Northern Development (DIAND), Wek'ézhíí Land and Water Board (WLWB) with accompanying question and answer periods.

As reported in **3.0 Workshop Summary**, a series of ASI and guest lectures, alongside interactive applied breakout sessions, formed the backbone of material delivery.

3.0 – Workshop Summary

On December 3rd, 2008 a project initiation meeting between ASI and Mr. John McCullum confirmed Workshop objections and direction. A draft Workshop agenda was then created and presented to EMAB on December 12th, 2008 for approval. Frameworks for breakout session exercises were then developed and provided to Mr. John McCullum for review on December 15th, 2008 – December 19th, 2008.

ASI contacted DIAND and WLWB on December 16th, 2008 to request their involvement in the Workshop and seek out their respective interest in presenting material. Both parties consented to providing a presentation to participants. Rio Tinto Limited was also contacted, on December 17th, 2008, to provide two Workshop presentations. Rio Tinto Limited agreed to present history of closure at the site and associated techniques employed to date and future Diavik reclamation plans such as those proposed in the third iteration of the ICRP.

On December 23rd, 2008, ASI met with Mr. Doug Ashbury, of Rio Tinto Limited, at his Yellowknife office to view photographs of Diavik made available for ASI breakout session exercises. Although initially considered, and offered by Rio Tinto Limited, ASI determined that the use of the Rio Tinto Limited large scale magnet model and/or conceptual physical model would not adequately complement Workshop material. These models were not used in the Workshop.

ASI met with EMAB on January 7th, 2009 to provide a general update on progress and solicit other visual materials for the Workshop. A final agenda, adopted for use, was provided to participants via email January 7th, 2009 and a pre-Workshop meeting was held on January 12th, 2009 between ASI and EMAB staff to outline ASI presentation materials and seek Client input.

The following ASI materials were provided for the Workshop and are annexed to this *Memorandum*:

i. Workshop Agenda (**Annex A**)
ii. Breakout Session *Briefing Notes* (**Annex B**)
iii. Breakout Session Instructions (**Annex C**)
iv. Breakout Session Participant Notes (**Annex D**)
v. Rio Tinto Limited, DIAND and WLWB PowerPoint Presentations (**Annex E**)
vi. Registered Participant List (**Annex F**)

The Workshop format included two *in-class* activity days that sandwiched a site visit to the Diavik Diamond Mine. A summary of each day of activities is provided below.

[Day One – January 13th, 2009]

Day One of the Workshop was held in Katimavik A of the Explorer Hotel in Yellowknife, NT. The Workshop began with general opening remarks from ASI facilitator Mr. Joe Murdock, EMAB Chairman Mr. Doug Crossley and an opening prayer led by Tlicho community member Mr. Michel-Louie Rabesca. Roundtable introductions followed where Workshop participants outlined expectations, desired outcomes and their personal conceptions on mine closure and reclamation.

The importance of terminology, definitions and translation was discussed and reiterated throughout the entire Workshop. Even though this was not a translation workshop, participants were given the opportunity to flag any topic that is not completely understood with respect to language translation. This was done to ensure that Workshop elements were not lost in translation. During the breakout session exercises, ASI provided additional attention to groups where technical translation was most needed.

Workshop participants were eased into the concept of mine closure through an ASI-led lecture module that introduced the mine life cycle, along with, mine operations and typical infrastructure found at mine sites. This included a ten (10) minute excerpt from the Natural Resources Canada-Ontario Ministry of Northern Development and Mines joint video production[4] which demonstrated mineral extraction and processing activities.

Participants were given an overview of the four (4) main phases of mining (exploration, development, operation and closure) and on the importance of incorporating the idea of closure throughout the entire mining cycle. Mine operations, through the stages of excavation, separation/milling and the production of end products, were discussed and participants acknowledged that mine by-products generally exist as waste that must be managed and considered at the mine end-of-life.

Participants were then lectured on, and provided examples of, various mine infrastructure that generally exist at site. Familiarizing participants with infrastructure generally found at mines serves a twofold reason. Firstly, an infrastructure review allowed for visualization of various mine components and activities that may be viewed during the Diavik Diamond Mine site visit and, secondly, introduced participants to the concept that the type of infrastructure at site, or to be installed in the future at site, plays a role in the development of closure objectives and criteria. The understanding and knowledge of infrastructure inventory and quantities and qualities of waste at site assists those in determining appropriate paths of action through closure criteria and closure objectives. Elements of a reclamation plan, reclamation stages, and the topic of mine financial assurance/security were also discussed.

Mr. Gord Macdonald and Ms. Colleen English (Rio Tinto Limited) provided participants with a general facilities overview and a history of closure and reclamation at the Diavik Diamond Mine Site. During the latter, Rio Tinto Limited outlined the decision path in evaluating and determining a selected alternative for such aspects as mining method, infrastructure siting and infrastructure design (water management and treatment, processed kimberlite containment area), and outlined past closure objectives stated in earlier iterations of the ICRP. PowerPoint slides for these presentations have been attached to this *Memorandum* via **Annex E**.

Throughout the Workshop, participants referred to the phrase "*the land and site should return to how it was before a mine*" when communicating closure objectives and criteria. The rationale behind Breakout Session One (1) allowed participants to examine and communicate their personal perspective on this commonly used phrase and offer a definition through illustration and/or a listing of spatially delineated characteristics/trends

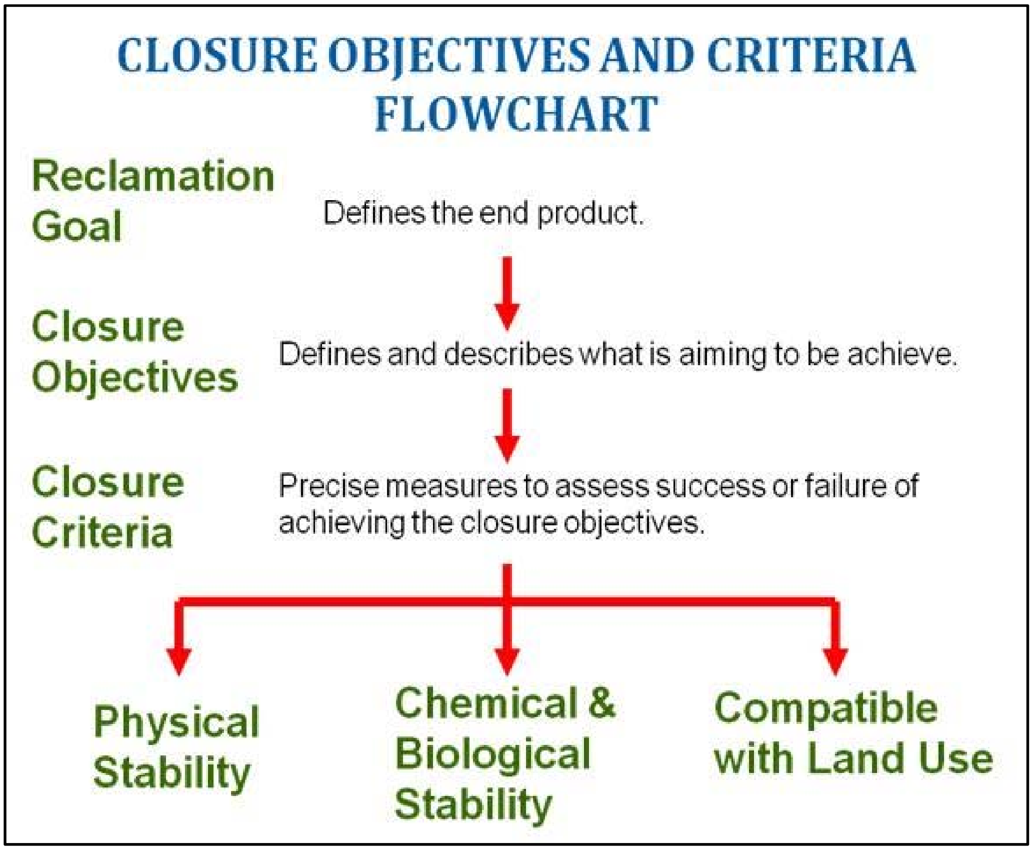
[4] NRCAN "Our Community... Our Future: Mining and Aboriginal Communities" (2005)

with respect to the Diavik Diamond Mine site and surrounding area. Participants were instructed to use personal experiences, Traditional Knowledge or Western Science through small group discussion. The framework for the breakout session is provided in **Annex B** and supplemental instructions provided to participants in **Annex C**. Example plots generated through Breakout Session One (1) are depicted in **Annex D**. Hardcopies of the participant plots have been provided to EMAB for future reference. Participants were then asked to share information they may have learned through the exercise. It was noted that participants observed a loose correlation between cabin location and traditional caribou migration in the area. Participants also expressed that there was a demonstrated knowledge of the land through their small group discussions and acknowledged that consideration, at a grand scale, should be given to other mining developments when considering the Diavik development.

Dr. Jamie VanGulck (ASI) provided an instructional session on environmental impacts through the definition of environment and compartmentalized environmental components of concern (ECC). ECC's include, but are not limited to, hydrology, water and air quality, noise, groundwater, fish and fish habitat, soils and landforms, vegetation and wildlife. These ECC subgroups assist an assessor to evaluate environmental impact. Participants were lectured on the definition of closure objective and closure criteria and their relationship within the closure process. As highlighted in **Figure 1**, participants were introduced to the concept of a reclamation goal. The reclamation goal, often referred to as reclamation vision, typically contains general *soft* statements that can not be quantifiably evaluated. Participants were shown that closure objectives provide a macroscopic definition on what is aimed to be achieved. Typically objectives include a definitive statement focussed towards specific infrastructure. Participants were asked to discretely consider each piece of infrastructure when defining closure objectives. Closure criteria were defined as the precise measures, or *goalposts*, used to assess the success or failure in achieving a closure objective. An effluent limit set out in a water licence would be an example of such criterion. Participants were also lectured on how environmental impact can be minimized by ensuring that mine components are physically, chemically and biologically stable, and compatible with end land use. In determining closure criteria participants were asked to establish goals that aim to achieve physical, chemical and biological stability, and the compatibility of end land use with respect to ECC's.

Unfortunately, due to time constraints imposed by active discussion throughout the day by workshop participants, Breakout Session Two (2) was not conducted on Day One (1) of the Workshop. This session was developed to engage participants in an applied exercise where participants in a small group arrangement, would review pre and post closure photographs of a mine component (from an unnamed mine). During this exercise, participants would develop possible closure objectives and criteria for various mine components and share findings through roundtable discussion. Instructions and a framework for this session can be found in **Annex C** and **B**.

Figure 1 – Flowchart Identifying the Process of Determining Closure Objectives and Criteria



[Day Two – January 14th, 2009]

Day Two involved a site visit to the Diavik Diamond Mine. The tour, led under the direction and plan of Mr. Gord Macdonald (Rio Tinto Limited), allowed participants the opportunity to visualize infrastructure and the Diavik site as a whole. Some participants had visited the site before, so the site visit allowed these participants to view how things have changed since their last visit. For other participants, the site visit acted as their first time viewing of the Diavik Diamond Mine. To feed into Day Three (3) events, Workshop participants were reminded to review site infrastructure in light of the concepts of closure objectives and criteria learned in Day One (1). Following in-house health and safety orientation, the mine site tour generally followed the route provided by Rio Tinto Limited, which is included in **Annex E** (Title: *Interim Closure and Reclamation Plan – Site Visit, January 14th, 2009*). This route provided an opportunity to view Diavik specific infrastructure. The tour bus made stops allowing participants to exit the vehicle and view infrastructure. Unfortunately visibility was limited in the tour bus due to frosted windows. Mr. Gord Macdonald and Ms. Colleen English (Rio Tinto Limited) addressed site specific questions posed by participants and Mr. Joe Murdock (ASI) was available to field participant general questions and concerns. ASI was also tasked, by EMAB, to create a photographic record of participant activity and engagement during the site visit.

[Day Three – January 15th, 2009]

The Workshop recommenced in Katimavik A of the Explorer Hotel with general opening remarks by Mr. Joe Murdock (ASI) and an opening prayer led by Tlicho community member Mr. Michel-Louie Rabesca. Participants provided general remarks on the Day Two (2) site visit through a roundtable discussion.

Day Three (3) provided a series of presentations including one from Mr. Nathen Richea of DIAND Water Resources Division. The DIAND presentation explained the Crown's role in mine closure and reclamation. This included defining the Minister's responsibilities, through appropriate legislation, in approving mines in the Northwest Territories and his role in providing expert advice on technical and regulatory matters related to mine closure before Administrative Tribunals such as the WLWB. Mr. Richea discussed the role of financial security and how the WLWB would set the monetary amount under a water licence through testimony and/or interventions provided by Interested Parties. He outlined that DIAND, under its responsibilities, would file a security estimate, through an intervention, that represents the *actual* cost to reclaim a mine site. Mr. Richea also explained that security amounts are held by, and furnished in a form deemed acceptable to, the Minister. He also explained that security held in trust by the Minister is legislatively available for the purpose of mine site reclamation only. Mr. Richea discussed DIAND's 2002 Mine Reclamation Policy and its main objectives and guiding principles and presented a series of guidance documents, including Mine Site Reclamation guidelines, prepared by DIAND to assist proponents in developing, operating and closing a mine site. PowerPoint slides for this presentation have been attached to this *Memorandum* in **Annex E**.

Mr. Ryan Fequet of the WLWB presented a background on the Board's mandate, and provided a comprehensive discussion on how community members could be involved and participate in the review of the Diavik Diamond Mine ICRP. This included reviewing material listed on the WLWB public registry, attending public hearings, and filing written interventions. The WLWB provided a WLWB definition of *closure objective* and *closure criteria* and provided examples for an open pit and waste rock pile. Mr. Fequet briefly outlined proposed closure and reclamation guidelines that are being developed under a working group formed by the Mackenzie Valley Land and Water Board. The WLWB has a seat on this working group and is contributing to the development of a guidance document. PowerPoint slides for this presentation have been attached to this *Memorandum* in **Annex E**. Mr. Fequet also circulated the inaugural version of The Wek'èzhìí News, a WLWB publication, and a Diavik ICRP work plan schedule to Workshop participants for their reference.

The definitions for closure objectives and criteria were re-examined as a group to prepare participants for the third breakout exercise. Breakout Session Three (3) was an interactive participant driven exercise where Workshop participants had a small group forum to vocalize viewpoints on closure objectives and criteria for specific infrastructure at the Diavik Diamond Mine. The exercise gave participants an opportunity to apply the definitions of closure objectives and criteria learned during the ASI lecture module to infrastructure they may encounter through the review of the Diavik ICRP. Although the infrastructure viewed was found at the Diavik Diamond Mine in the past, participants were instructed that the exercise was still hypothetical in nature and the objectives and criteria developed in small group discussion may or may not be considered by Rio Tinto Limited. The framework for the breakout session is provided in **Annex B** and supplemental instructions provided to participants in **Annex C**. Example plots generated through Breakout Session Three (3) are depicted in **Annex D**. Hardcopies of the participant plots have been provided to EMAB for future reference. In general, group discussions to develop objectives and criteria followed the framework of examining each piece of infrastructure and identifying the ECC. For each ECC, specific closure criteria were developed. A wide variety of discussions developed between various groups. Some focused on water quality impacts, others on caribou and fish impacts, or landform configuration. The diversity of the discussions and level of detail of the closure criteria developed is reflective of the various backgrounds of the workshop participants. Participants shared their results, generated through their small group discussions, to all Workshop participants.

Mr. Gord Macdonald of Rio Tinto Limited closed off the set of presentations with a concise presentation on future closure planning of the Diavik Diamond Mine. Here he briefly discussed an anticipated schedule for closure planning, Rio Tinto defined closure objectives, and outlined plans where additional closure planning work is required. PowerPoint slides for this presentation have been attached to this *Memorandum* via **Annex E**.

An ASI presentation on reclamation research planning was prepared but not presented due to time constraints imposed by active discussion throughout the day by workshop participants. This lecture aimed at providing participants with an understanding of the information typically found in a reclamation research plan, components of the research program and how the plan determines a scientific pathway needed to achieve set closure criteria.

Day Three (3) was closed off with concluding comments from Mr. Joe Murdock (ASI) and EMAB's Chair Mr. Doug Crossley. Mr. Francis Williah, a Tlicho community elder, provided the closing prayer to end the Workshop.

4.0 – Recommendations

The following recommendations and associated commentary reflect ASI's observations and opinions:

[Recommendation #1]

To avoid any confusion community members may have in future regulatory or industry sessions on closure and reclamation, EMAB should adopt a definition for closure objective and closure criteria and request that all parties (WLWB, Rio Tinto Limited etc.) accept and use these definitions in their future dealings. In some instances a reclamation goal/vision was viewed as a closure objective; however, a goal/vision lacks a definitive description on what is being achieved. At times reclamation goals that are misinterpreted as closure objectives are presented as *feel good* statements which are broadly based and can not be appropriately gauged and evaluated. For example ASI would classify a statement such as "*Ensuring that land and water is safe for people, wildlife and aquatic life*" as a closure goal/vision for it lacks a specific tag to mine infrastructure and is too broad based to develop clear focussed closure criteria. To avoid possible ambiguity and to allow for greater consistency in future discussions, EMAB, as a watchdog, should develop and endorse what they view as appropriate definitions for closure vision, closure objective and closure criteria and state complementary standards or guidance in how to develop these closure statements.

[Recommendation # 2]

Rio Tinto Limited should consider hosting another site visit during spring freshet and/or the summer season. Snow covering parts of the site made it difficult for participants to differentiate infrastructure components and other important features, such as water management (flows, spatial and temporal dimensioning), wildlife observation, and dust suppression/management. To concentrate efforts and allow for a more focussed discussion, these site visits should not include a wide range of participants, but rather specific smaller groups at a time. For example, a site visit accommodating only community members may allow for better scoped discussion on community concerns. This information may also pose useful to Rio Tinto Limited when integrating community input into future closure plans.

[Recommendation #3]

The Workshop participants, en masse, had a wide range of backgrounds, experiences and skill sets. Corralling together the views, concerns, knowledge and efforts of various internal stakeholder parties, with an aim to achieve outcomes that are beneficial to both Industry and the communities hosting the mine site, allows for a more effective mine closure plan. The following discussion provides some context to this statement.

As expressed by EMAB Chair Mr. Doug Crossley, through his general remarks, community involvement is imperative. As per participant testimony, there was an expressed sensitivity to mine closure and reclamation by community members. This mindset may be in large part due to legacy environmental practices carried through at Rae Rock, Colomac, Giant and Port Radium mines; these sites were discussed by workshop participants. Community members exhibited a desire to communicate their history and lessons learned from past mining experiences in the Workshop forum.

Workshop participants, particularly elder community members, expressed concern and the need for a precautionary approach in developing reclamation plans for mines and demonstrated an interest in working with Rio Tinto Limited through community engagement exercises. Rio Tinto Limited acknowledged community opinion and thanked participants for sharing their thoughts and feelings; however, numerous workshop participants repeatedly stated that information sessions, breakout exercises, and associated discussions should be held within affected communities so greater community input and participation can be sought out. This seemed to be the preferred community method in participating in the Diavik mine closure process. Additional effort could be made to integrate greater community input and opinion into Diavik specific closure options through a series of community meetings/presentations. These sessions could act as a resource base for Rio Tinto Limited, with the Crown[5], and/or EMAB. Additionally these sessions could allow community members to outlet their concerns, identify preferred closure options and environmental practice, and provide an update into the proposed changes set within the next iteration of the ICRP. Community meetings may have been completed in the past by various parties, but given the dynamic and ongoing nature of mine operation and closure, community concern and opinion should be of significant value. Understandably there are planned community sessions through the WLWB plan and mandate; however, consideration could be given to a separate set of community sessions where community members can be engaged and informed by Rio Tinto Limited and/or EMAB.

[Recommendation # 4]

From a community member perspective, there lacks a clear public understanding of what regulatory mechanisms exist with respect to mine reclamation and financial security. Terms and conditions related to reclamation water use, impacts to water through the deposition of waste in a reclamation effort, and the mine financial security amount, are dictated through the water licence instrument. Since the WLWB is a quasi-judicial administrative tribunal, it must adhere to the rules of procedural fairness and natural justice and thus it may only consider the evidence presented by Interested Persons before it during a public hearing or through written intervention. If community members, Aboriginal Governments/Organizations, First Nations and other Interested Persons do not participate in the WLWB process then their opinions, concerns, testimony and evidence will not be included and/or considered in the water licence. Even though this fact was presented during the DIAND and WLWB presentations and may be re-communicated by these organizations in the future, EMAB should reinforce this important fact through its community communications and meetings.

[Recommendation # 5]

EMAB, Aboriginal Governments/Organizations and First Nations, should consider conducting an evaluation of the Diavik ICRP and mine financial security assessment. This evaluation can form a WLWB intervention, with respect to closure and reclamation, which

[5] DIAND had stated that they may join Rio Tinto Limited on a community tour if the company undertakes this task.

combines Western Science technical opinions with Traditional Knowledge, community and personal experience and social will.

5.0 – Closing

ASI was pleasantly surprised with the conversation generated on the topic of mine closure and reclamation and believes the main focus of the Workshop, to generate participant discussion and lessons so participants can make more informed choices in the future, was satisfactorily accomplished. Although participant discussion did at times steer the group away from the planned agenda, it was considered appropriate and respectful to allow discussion on personal experiences and how previous mining developments have affected communities and individuals. The Workshop did not achieve a full consensus amongst participants on closure outcomes. This was not the intent nor was this an aim to be achieved. The Workshop did prepare, at an introductory level, the basic concepts of closure and stirred discussion and primed participants for future discussions through other regulatory and/or industry efforts.

ASI would like to thank EMAB for the opportunity to provide these services. Should you have any questions whatsoever about its contents please feel free to contact the undersigned at 867.446.0036 or murdock@arktissolutions.com.

Sincerely,

Joe Murdock,
Chief Executive Officer

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ANNEX A – Workshop Agenda

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BRIEFING NOTE

File:	**001-EMAB- Closure and Reclamation Workshop**
To:	**Environmental Monitoring Advisory Board**
Attention:	**Mr. John McCullum, Executive Director**
Subject:	**Final Agenda for Closure and Reclamation Workshop**
Authors:	**Joe Murdock, Jamie VanGulck**
Page Total:	**2**
Date:	**January 12th, 2009**

Final Agenda

Further to the to the draft agenda filed with EMAB through the December 9th, 2008 *Briefing Note*, ASI has prepared a final agenda for the January 13th-15th, 2009 workshop to be held in Katimavik A of the Explorer Hotel, Yellowknife, NT and at the Diavik Diamond Mine. The three day workshop will sandwich a site visit to the Diavik Diamond Mine on Day 2 between Day 1 and Day 3 presentation seminars at the Explorer Hotel.

DAY 1 – January 13th, 2009

Time (MT) (approximate)	Presentation/Event	Speaker
9:00-9:30	Introduction to EMAB's Closure and Reclamation Workshop and Introduction Exercise	Joe Murdock/Jamie VanGulck (ASI)
9:30-9:45	Welcoming Remarks from EMAB	Doug Crossley (EMAB)
9:45-10:15	Closure and Reclamation Community Perspective, Concerns, Observations and Expectations[1]	Workshop Participants
10:15-10:30	**Coffee Break**	
10:30-12:00	An Introduction to Closure and Reclamation	Joe Murdock/Jamie VanGulck (ASI)
12:00-13:00	**Lunch**	
13:00-14:00	An Overview of the Diavik Diamond Mine Operations and Site Layout and a Brief History on Closure and Reclamation Performed to Date	Gord MacDonald (DDMI)
14:00-15:00	**Breakout Session**: Examination of the Diavik Diamond Mine Area and Site History Prior to Development	Workshop Participants
15:00-15:45	The Establishment of Closure Objectives and Criteria	Joe Murdock/Jamie VanGulck (ASI)
15:45-16:00	**Coffee Break**	

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16:00-17:15	**Breakout Session**: Setting Closure Criteria and Objectives	Workshop Participants
17:15-17:30	Day 1 Closing Remarks	Joe Murdock/Jamie VanGulck (ASI)

DAY 2 – January 14th, 2009

DIAVIK DIAMOND MINE SITE VISIT

DAY 3 – January 15th, 2009

Time (MT) (approximate)	Presentation/Event	Speaker
9:00-9:20	Day 1 Recap, Highlights and Discussion with Q&A Session	Joe Murdock/Jamie VanGulck (ASI)
9:20-9:30	Outline for Day 3	Joe Murdock/Jamie VanGulck (ASI)
9:30-10:15	Department of Indian Affairs and Northern Development's Role in Closure and Reclamation of the Diavik Diamond Mine	Nathen Richea (DIAND)
10:15-10:30	**Coffee Break**	
10:30-11:15	Wek'eezhii Land and Water Board's Role in Closure and Reclamation of the Diavik Diamond Mine[1]	Ryan Fequet (WLWB)
11:15-12:00	The Closure and Reclamation Research Plan	Joe Murdock/Jamie VanGulck (ASI)
12:00-13:00	**Lunch**	
13:00-14:30	The Interim Closure and Reclamation Plan (ICRP) for the Diavik Diamond Mine[1]	Gord MacDonald (DDMI)
14:30-14:45	**Coffee Break**	
14:45-16:00	**Breakout Session**: The Closure and Reclamation of Diavik Diamond Mine Site Components	Workshop Participants
16:00-16:15	Final Workshop Comments and Roundtable Discussion on Workshop	Joe Murdock/Jamie VanGulck (ASI) and Workshop Participants
16:15-16:30	Closing Remarks from EMAB	Doug Crossley (EMAB)

[1] Workshop Participants will have an opportunity to provide input to DDMI and WLWB about how communities feel it would be best to involve them in the ICRP review process.

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Annex B – Breakout Session *Briefing Notes*

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BRIEFING NOTE

File:	**001-EMAB- Closure and Reclamation Workshop**
To:	**Environmental Monitoring Advisory Board**
Attention:	**Mr. John McCullum, Executive Director**
Subject:	**Breakout Session I – An Overview of the Diavik Diamond Mine Operations and Site Layout**
Author:	**Joe Murdock**
Page Total:	**3**
Date:	**December 17th, 2008**

BREAKOUT SESSION I

Preamble

Further to the Arktis Solutions Inc. (ASI) *Briefing Note* dated December 9th, 2008, ASI was to produce and present additional *Briefing Notes* on the individual Breakout Sessions planned for the Environmental Monitoring Advisory Board (EMAB) Closure and Reclamation (C+R) Workshop. The function of this *Briefing Note* is to dually serve as an instructional framework for the exercise and provide EMAB the exercise rationale.

Further to **Section 2(d)(ii)** and **Section 2(d)(iv)** of the EMAB accepted *Proposal for Consulting Services (PCS)*, ASI proposed to develop an exercise which examines C+R elements through aerial photographs, site plans and other visual materials and roundtable discussions identifying potential community and participant concern and opinion.

Breakout Session I aims to satisfy the provisions of the *PCS* through an interactive participant driven exercise where workshop participants have an opportunity to review the Diavik Diamond Mine site and associated operations through visual aid and provide comment on personal experience.

Objective

Building on the Diavik Diamond Mine Inc. (DDMI) introductory presentation on the Diavik Diamond Mine site and operation, this exercise (completed in small groups) will familiarize workshop participants with the mine site and surroundings (Lac de Gras area) and also allow participants to vocalize their understanding of the current and past state of the site and surrounding area. **Breakout Session I**, through a desktop examination of the site and engaged discussion, will prepare participants for the Day 2 Site Visit and provide

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EMAB and ASI with participant perspectives on the mine site area prior to, during, and after closure.

Participants

This exercise will involve all workshop participants. Work groups can be created once a final list of workshop participants is developed and made available by EMAB.

Outline

Duration: One hour (1:00h).
Group Organization: Ideally groups of three (3) or four (4) individuals will be formed.

Pre-chosen, before workshop start, groups will break away and assemble at separate tables where they will be provided with a short instruction sheet outlining directions for the exercise. This will be reinforced with verbal instructions communicated by ASI facilitators. ASI will illustrate, through a demonstration for all groups, how the exercise can be completed.

Workshop participants will be asked to observe site plans and aerials of the Diavik Diamond Mine and the surrounding areas (appropriately scaled to allow for discussion of areas proximal to the mine site) and offer discussion on their experiences and knowledge of the site prior to and during the operation of the Diavik Diamond Mine. Workshop participants will also be asked to highlight land, water, air, wildlife, fish, vegetation, topography aspects that may be impacted as a result of mine construction and operations and where they feel appropriate attention could be focused during closure and reclamation. Each group will be provided with an individual set of site visuals (aerial photographs, site plans) and will be advised that illustrations (such as denoting migration routes or identifiable areas of concern) on site plans and aerials are welcomed.

Mr. Joe Murdock and Dr. Jamie VanGulck will circulate around the room fielding questions and interacting with groups. If groups are having difficulty in getting started one of the Facilitators will join the group to initiate group discussion. Groups will have forty (40) minutes to engage in the exercise and five (5) to ten (10) minutes to present point form notes on individual group discussion to all workshop participants.

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Required Materials

To best carry out this exercise the following materials are required:

i. Table-top versions (large sized) of mine site plans and aerial figures.
ii. Writing instruments (markers) and large chart paper for group presentation.

Closing

Should you have any questions whatsoever about the contents of this *Briefing Note* or if revisions are needed please feel free to contact the undersigned at 867.446.0036 or murdock@arktissolutions.com. ASI will continue to move forward with the development of this breakout session and other exercises as committed to in the *PCS*.

Sincerely,

Joe Murdock,
Chief Executive Officer

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BRIEFING NOTE

File:	**001-EMAB- Closure and Reclamation Workshop**
To:	**Environmental Monitoring Advisory Board**
Attention:	**Mr. John McCullum, Executive Director**
Subject:	**Breakout Session II – The Establishment of Closure Objectives and Criteria**
Author:	**Joe Murdock**
Page Total:	**3**
Date:	**December 18th, 2008**

BREAKOUT SESSION II

Preamble

Further to the Arktis Solutions Inc. (ASI) *Briefing Note* dated December 9th, 2008, ASI was to produce and present additional *Briefing Notes* on the individual Breakout Sessions planned for the Environmental Monitoring Advisory Board (EMAB) Closure and Reclamation (C+R) Workshop. The function of this *Briefing Note* is to dually serve as an instructional framework for the exercise and provide EMAB the exercise rationale.

Further to **Section 2(d)(i)** and **Section 2(d)(iii)** of the EMAB accepted *Proposal for Consulting Services (PCS)*, ASI is to build awareness on the basic concepts of C+R, scientific first principles and Traditional Knowledge related to C+R engineering and strategy and hold roundtable discussions on closure objectives and criteria.

Breakout Session II aims to introduce workshop participants, in a small group setting, to closure objectives and criteria through observation and discussion of mining closure scenarios at anonymous mining sites.

Objective

Following ASI's presentation on setting mining closure objectives and criteria, workshop participants will be tasked to review photographs of a mine site or mine infrastructure (not including Diavik), such as waste rock piles, open pits, etc., that illustrate the site activities pre- and post-closure. Participants will be given the opportunity to discuss and collectively establish closure objectives for the presented case and detail how these objectives could be achieved (closure criteria). This exercise will aid in developing capacity by exposing participants to past C+R situations and having them understand terminology and define objectives and criteria.

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Breakout Session II, through a review of real life closure scenarios and engaged discussion, will ease participants into **Breakout Session III**, where they will examine Diavik specific infrastructure and establish hypothetical closure criteria and objectives.

Participants

This exercise will involve all workshop participants. Work groups can be created once a final list of workshop participants is developed and made available by EMAB.

Outline

Duration: One hour (1:15h).
Group Organization: Ideally groups of three (3) or four (4) individuals will be formed.

Groups will break away and assemble at separate tables where they will be provided with a short instruction sheet outlining directions for the exercise. This will be reinforced with verbal instructions communicated by ASI facilitators. ASI will illustrate, through a demonstration for all groups, how the exercise can be completed.

Workshop participants will be asked to review photographs from C+R programs conducted at mine sites (not including Diavik). At minimum, the photographs will include a pre- and post-closure depiction of a site or infrastructure at site (e.g., waste rock pile). The participants will be asked to detail differences in the photographs that relate to reclamation (e.g., differences in land topography, vegetation cover, etc.), as well as, hypothesize how the post-closure case would impact the environment (e.g., wildlife, fish, water quality) compared to the pre-closure case. From the discussion results, the participants will be asked to summarize the objective of the closure scenario and detail what criteria may have be used to attain the closure condition. Each group will be assigned three to six pre- and post-closure photographs. All groups will be assigned the same set of figures.

Mr. Joe Murdock and Dr. Jamie VanGulck will circulate around the room fielding questions and interacting with groups. If groups are having difficulty in getting started one of the Facilitators will join the group to initiate group discussion. Groups will have forty (40) minutes to engage in the exercise and five (5) to ten (10) minutes to present point form notes on individual group discussion to all workshop participants.

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Required Materials

To best carry out this exercise the following materials are required:

i. Large coloured photographs of mining C+R examples (chosen by ASI).
ii. Writing instruments (markers) and large chart paper for group presentation.

Closing

Should you have any questions whatsoever about the contents of this *Briefing Note* or if revisions are needed please feel free to contact the undersigned at 867.446.0036 or murdock@arktissolutions.com. ASI will continue to move forward with the development of this breakout session and other exercises as committed to in the *PCS*.

Sincerely,

Joe Murdock,
Chief Executive Officer

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BRIEFING NOTE

File:	**001-EMAB- Closure and Reclamation Workshop**
To:	**Environmental Monitoring Advisory Board**
Attention:	**Mr. John McCullum, Executive Director**
Subject:	**Breakout Session III - The Closure and Reclamation of Diavik Diamond Mine Site Components**
Author:	**Joe Murdock**
Page Total:	**3**
Date:	**December 15th, 2008**

BREAKOUT SESSION III

Preamble

Further to the Arktis Solutions Inc. (ASI) *Briefing Note* dated December 9th, 2008, ASI was to produce and present additional *Briefing Notes* on the individual Breakout Sessions planned for the Environmental Monitoring Advisory Board (EMAB) Closure and Reclamation (C+R) Workshop. The function of this *Briefing Note* is to dually serve as an instructional framework for the exercise and provide EMAB the exercise rationale.

As explicitly stated in **Section 2(d)(iii)** of the EMAB accepted *Proposal for Consulting Services (PCS)*, ASI proposed to develop an exercise which includes:

"*Roundtable discussions on closure objectives and closure criteria with aim and intent to establish individual participant viewpoints and opinions on the subjects.*"

Breakout Session III, the final breakout session on Day 2, aims to satisfy this commitment through an interactive participant driven exercise where workshop participants have a forum to vocalize viewpoints on closure objectives and criteria for specific infrastructure at the Diavik Diamond Mine.

Objective

The main focus of this exercise is to have participants act in the role of "*Decision Maker*" and institute the lessons learned through **Breakout Session I** and **II** where participants examine the Diavik Diamond Mine area and operation and set closure objectives and criteria. In this breakout session, participants will be provided two infrastructure components (e.g., waste rock pile, processed kimberlite containment, road networks) to restore into a form they deem acceptable for closure. This will be completed through small group discussion and

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presentation. This exercise allows participants to apply the concepts developed during the workshop and mine site visit, and will act as an appropriate closing exercise to the workshop session.

Participants

It is preferable if all Workshop Participants, DDMI Representatives and Government Officials partake in this session. To encompass differing viewpoints, each group should have one DDMI Representative or Government Official. Work groups can be created once a final list of Workshop participants is developed and made available by EMAB.

Outline

Duration: One hour and fifteen minutes (1:15h).
Group Organization: Ideally groups of three (3) or four (4) individuals will be formed.

Groups will break away and assemble at separate tables where they will be provided with a short instruction sheet outlining directions for the exercise. This will be reinforced with verbal instructions communicated by ASI facilitators. ASI will provide a sample run through of a piece of infrastructure to give participants and example on how they may complete the exercise.

Each group will assigned two pieces of infrastructure and will be tasked to answer the following question:

"*If you were the C+R Specialist at the Diavik Diamond Mine how would you restore the* ***(insert piece of infrastructure)*** *for closure?*"

Mr. Joe Murdock and Dr. Jamie VanGulck will circulate around the room fielding questions and interacting with groups. If some groups are having difficulty in getting started, one of the Facilitators will join the group to initiate group discussion. The groups will have forty (40) minutes to develop closure objectives and criteria specific to the infrastructure assigned. They will be asked to take point form notes and list: what their closure objectives are and their reasoning; when this objective should be achieved; and, why and how this objective will be completed (what criteria). Finally, each group will have the opportunity to present their points to all others in the workshop.

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Required Materials

To best carry out this exercise the following materials are required:

i. Table-top versions (large scaled) of mine site plans and photographic figures of specific mine infrastructure[1].
ii. Writing instruments (markers) and large chart paper for group presentation.

Closing

Should you have any questions whatsoever about the contents of this *Briefing Note* or if revisions are needed please feel free to contact the undersigned at 867.446.0036 or murdock@arktissolutions.com. ASI will continue to move forward with the development of this breakout session and other exercises as committed to in the *PCS*.

Sincerely,

Joe Murdock,
Chief Executive Officer

[1] A list of Diavik specific infrastructure will be provided to EMAB and DDMI following a more comprehensive review of the ICRP. ASI will contact EMAB and DDMI in the intermediate future.

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Annex C – Breakout Session Instructions

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BREAKOUT SESSION INSTRUCTIONS

File:	001-EMAB- Closure and Reclamation Workshop

BREAKOUT SESSION I

- Examine the large sized maps and satellite image of the area in and around the Diavik Diamond Mine.
- Ask yourself "*What do I know about the area on the map and mine site*?". This can include personal experiences at the mine site, on the land, through technical and other readings and other discussions you have had with people.
- Label areas on the figures (in marker) where you have personal knowledge of the site. On the chart paper write (in marker) your knowledge of these areas. Think of the following:
  - Where have you or friends and family personally visited? Are there any items of significance?
  - Is there any history that others may not know about on the areas on these maps? Are there protected or heritage areas? If so let others know.
  - How have things changed over time?
- Label areas on the figures (in marker) where you have an understanding of specifics of the site and region. On the chart paper provided write (in marker) your understanding of the area. Think of the following:
  - location and access;
  - climate and permafrost;
  - geology and the terrestrial environment (i.e. land types, topography, vegetation);
  - water quality and physical features (i.e. water depth, flow);
  - wildlife (i.e. migration and habitat types);
  - aquatic environment;
  - surface waters; and
  - anything else that comes to mind.
- Have you been to the Mine site before? Have you read about features of the mine site in reports? Label key features of the mine site (waste rock piles, dykes, lakes) on the satellite image of the mine with the markers provided.

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BREAKOUT SESSION II

- Examine the package of figures provided in envelope.
- Match up "before" and "after" reclamation photo sets. There is one "before" and one "after" photo in each set. There are 4 sets total.
- Examine the photo sets and develop the closure objectives and criteria. Discuss in your group and write down on the chart paper. This is a hypothetical exercise.

As previously defined in the workshop presentation,

OBJECTIVE: Defines and describes what is aimed to be achieved. This can be general in nature and include big general statements.

CRITERIA: Precise measures to assess success or failure of achieving the closure objectives. This could be a test that is performed.

BREAKOUT SESSION III

- Examine the large site figures and 11" x 17" figures of specific infrastructure. There is a large schematic listing the location of the infrastructure on the site.
- This is a hypothetical exercise. Develop closure objectives and criteria for the following pieces of infrastructure:
  - North Country Rock Pile
  - Processed Kimberlite Containment (PKC) Area and the PKC West Dam
  - Open Pit
- Discuss in your group and write down objectives and criteria. Feel free to add illustrations on the diagrams if you would like.

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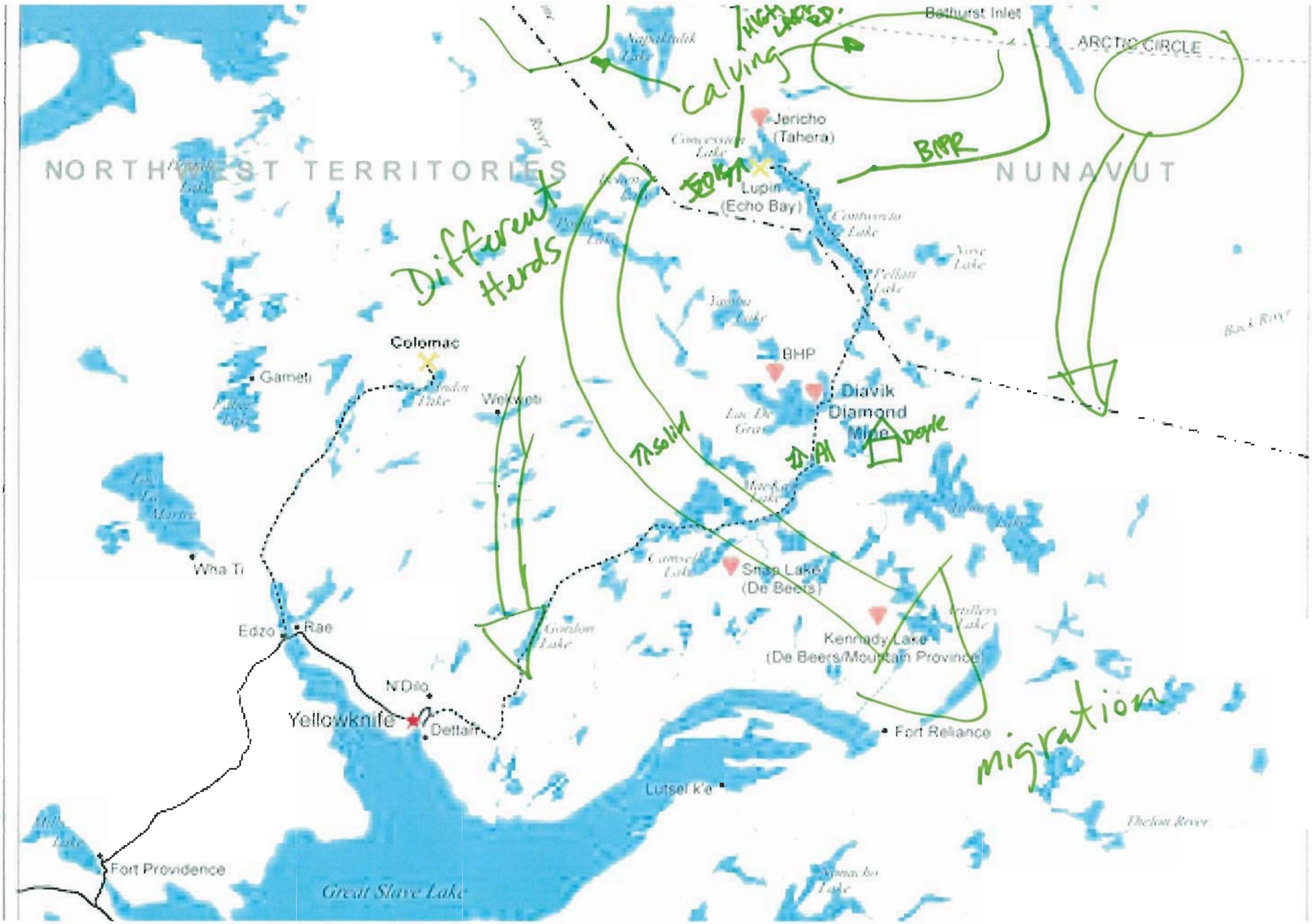
Annex D – Breakout Session Participant Notes

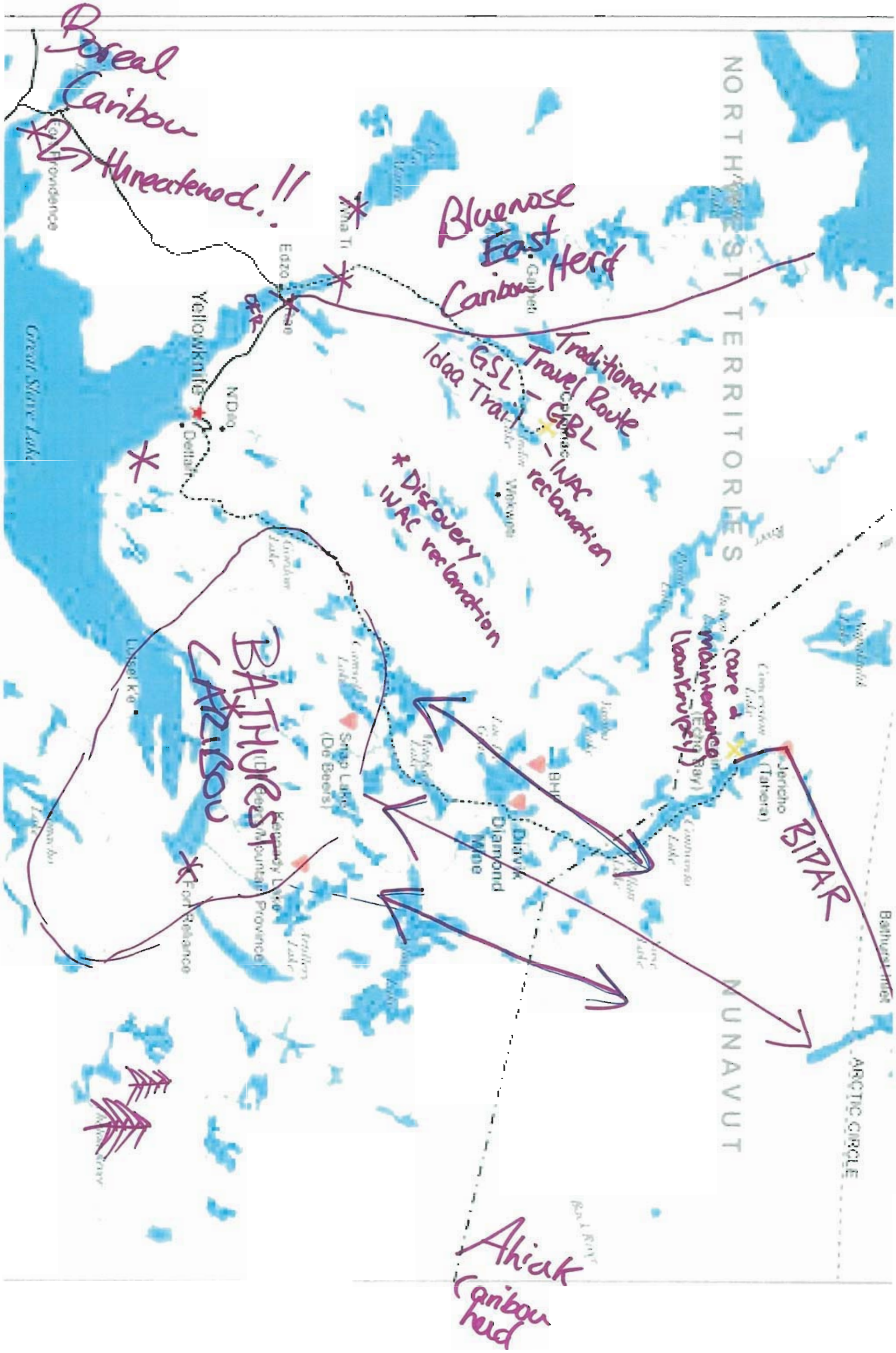

pot. Fish Habitat
Pot. Fish Habitat
Waste Rock
Revegetation Plots
Dust Suppressant
A21 Wasterock
Emulsion
Tank

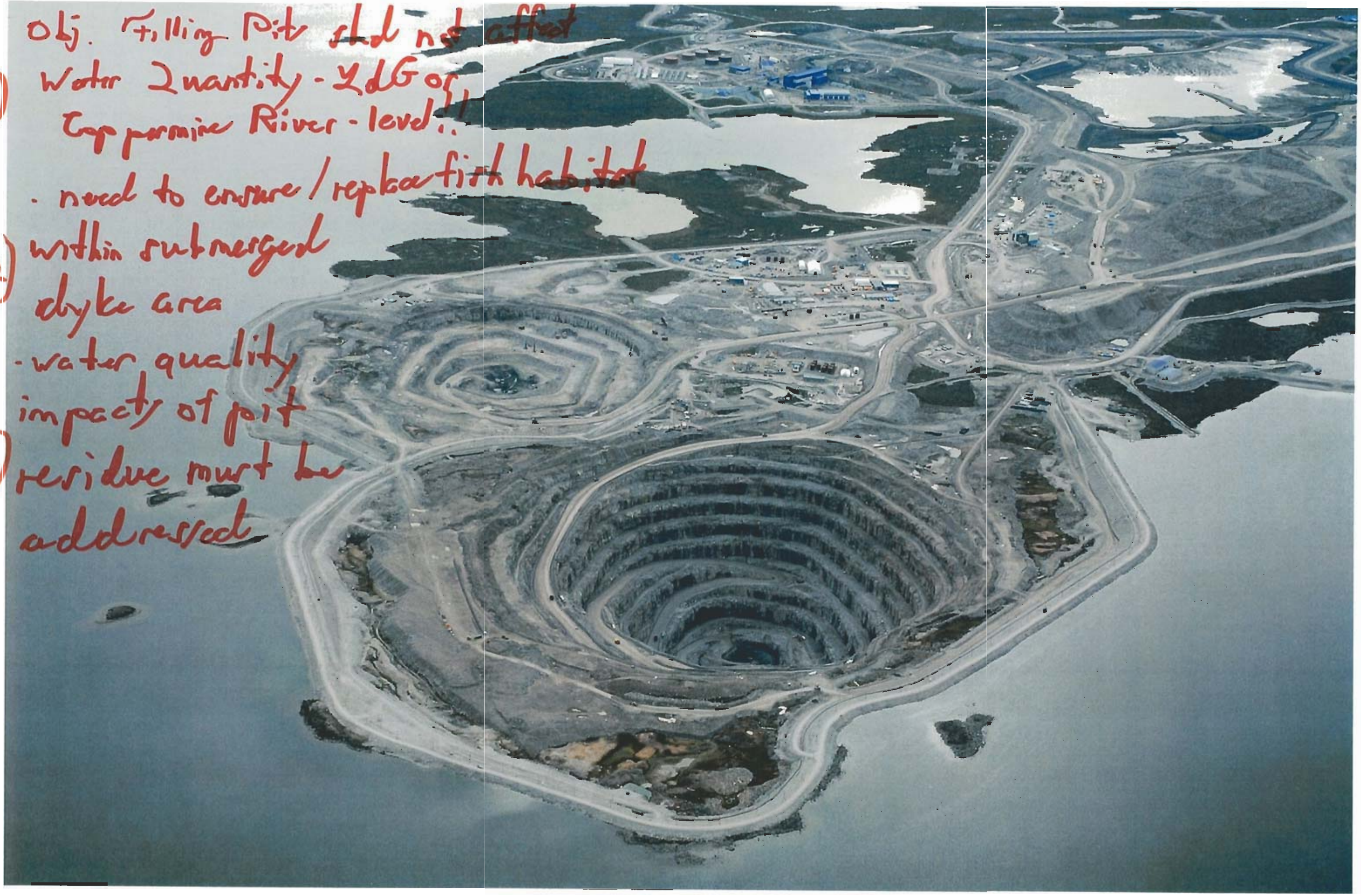
Diavik Diamond Mine Site

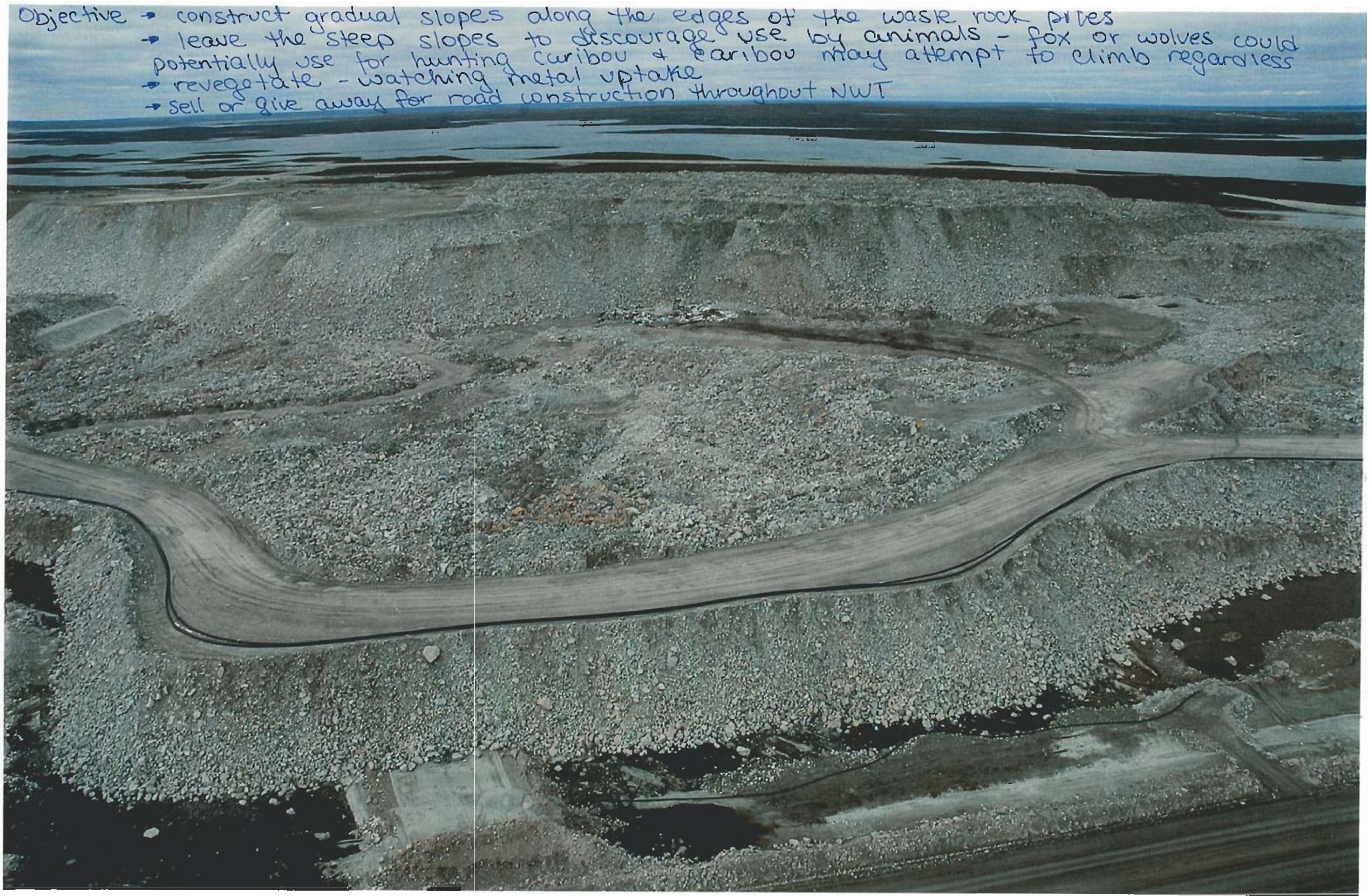


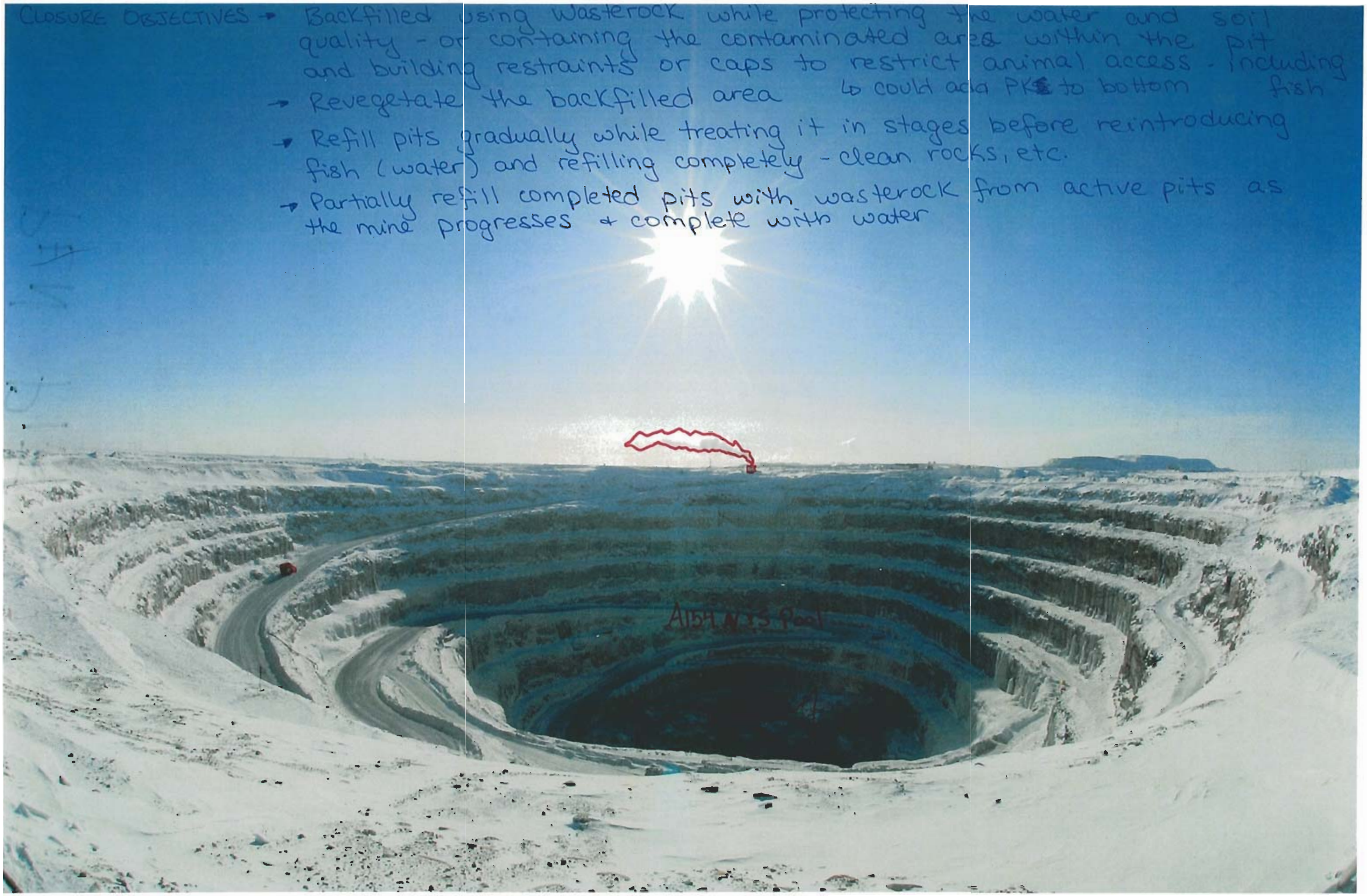
NORTHWEST TERRITORIES
NUNAVUT
Bathurst Inlet
ARCTIC CIRCLE
Jericho
(Tahera)
Lupin
(Echo Bay)
Colomac
Gameti
Wekweti
BHP
Diavik
Diamond
Mine
Snap Lake
(De Beers)
Kennady Lake
(De Beers/Mountain Province)
Wha Ti
Edzo
Rae
N'Dilo
Yellowknife
Dettah
Fort Reliance
Lutsel k'e
Fort Providence
Great Slave Lake
Calving
Different
Herds
BPR
migration

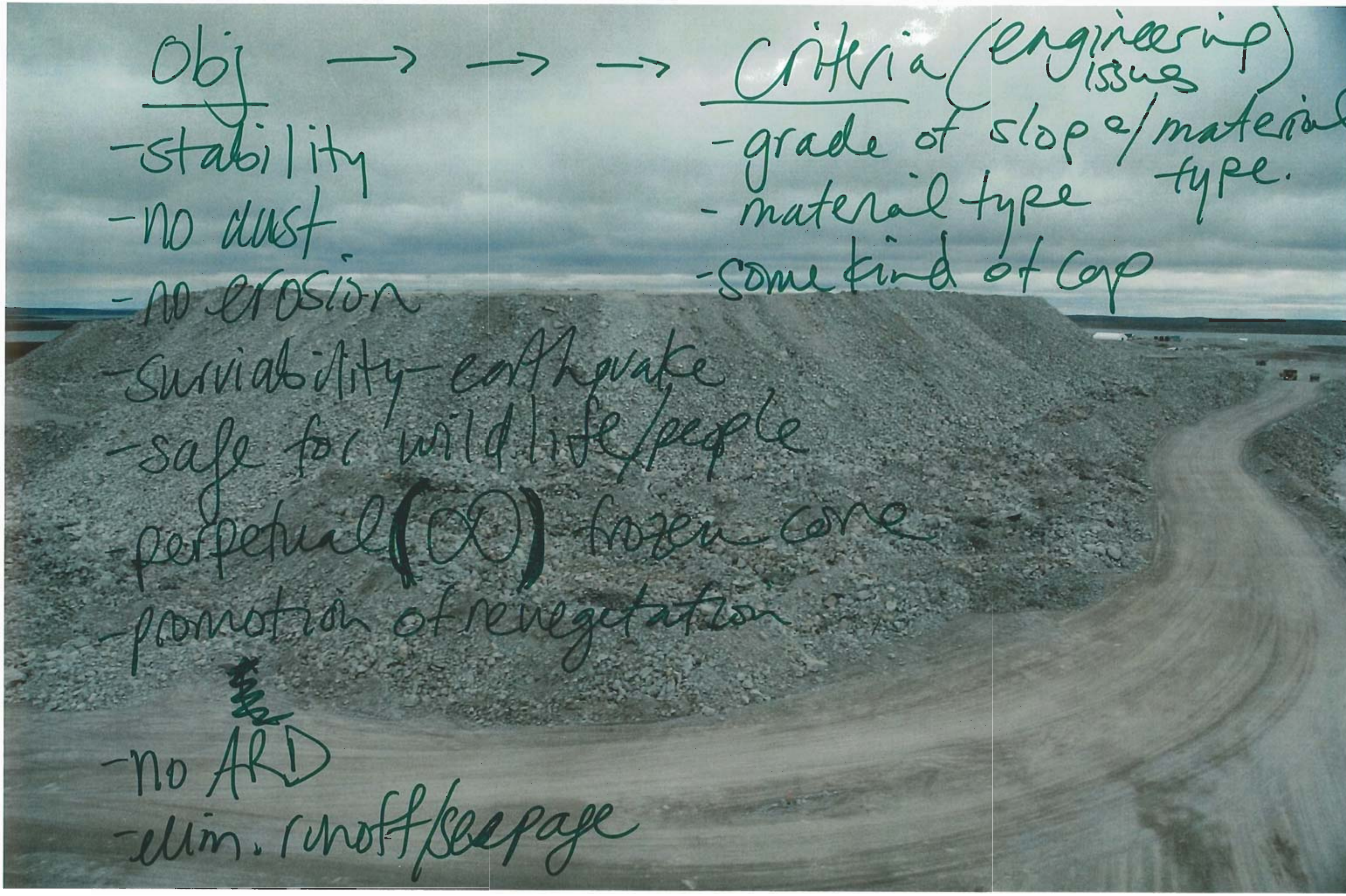
NORTHWEST TERRITORIES
NUNAVUT
Bathurst Inlet
ARCTIC CIRCLE
Jericho (Tahera)
Contwoyto Lake
Lupin (Echo Bay)
BHP
Diavik Diamond Mine
Colomac
Gameti
Wekweeti
Wha Ti
Edzo
Rae
N'Dilo
Yellowknife
Dettah
Snap Lake (De Beers)
Kennady Lake (De Beers/Mountain Province)
Fort Reliance
Lutsel k'e
Fort Providence
Great Slave Lake
Thelon River
1996 wolverine no caribou grizzly dens
1950's hunting area.
2008
2001 – 2006
caribou since 2005
2006
2003

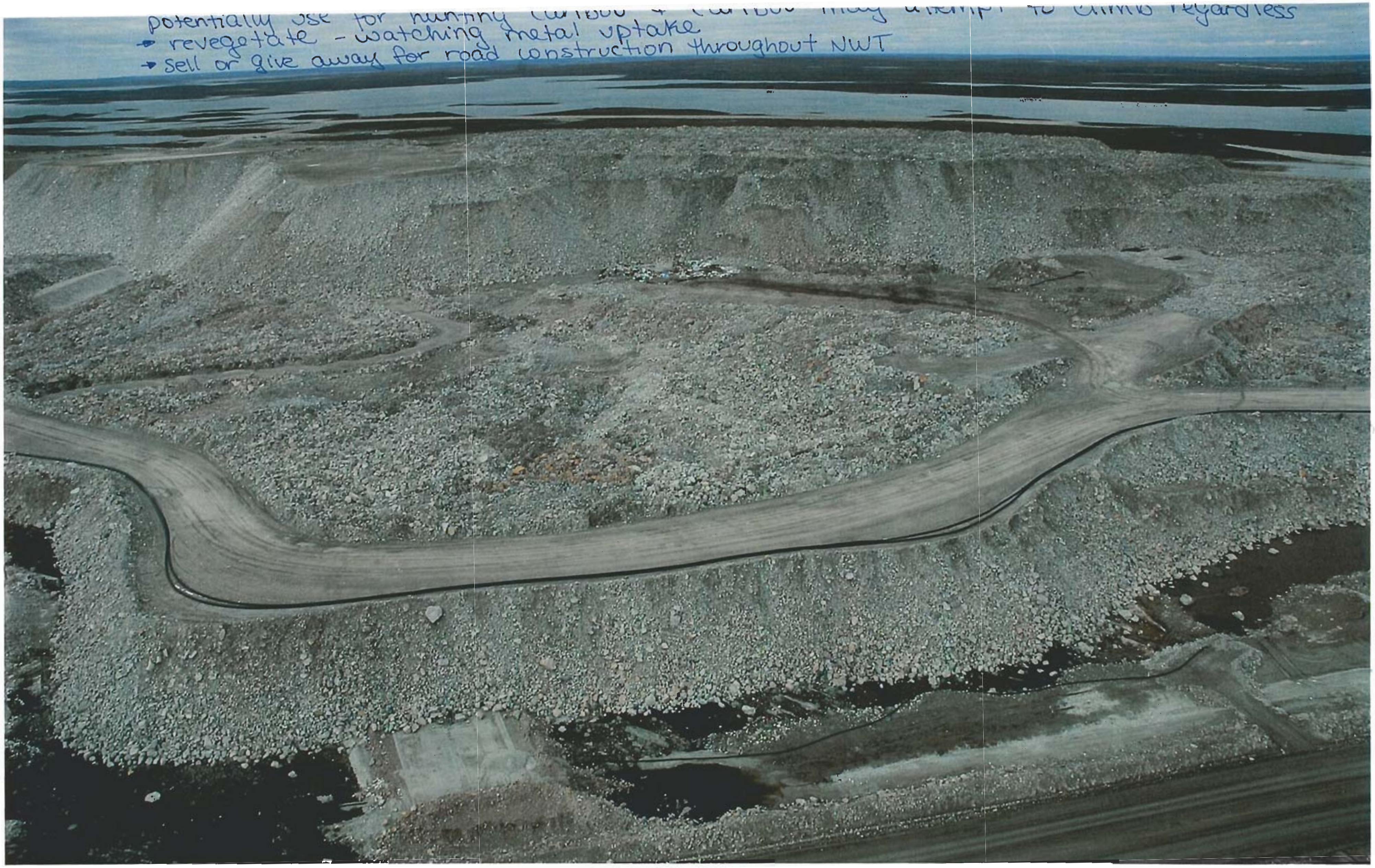

Boreal Caribou
threatened!!
Bluenose East Caribou Herd
Traditional Travel Route
GSL - GBL
Idaa Trail
- INAC reclamation
* Discovery INAC reclamation
BATHURST CARIBOU
care & maintenance (bankrupt)
BIPAR
Ahiak caribou herd
NORTHWEST TERRITORIES
NUNAVUT
ARCTIC CIRCLE
Great Slave Lake
Yellowknife
Dettah
N'Dilo
Edzo
Gameti
Wekweeti
Lutsel K'e
Fort Reliance
Fort Providence
Snap Lake (De Beers)
Kennady Lake (De Beers/Mountain Province)
BHP
Diavik Diamond Mine
(Echo Bay)
Jericho (Tahera)
Bathurst Inlet


Obj. Filling Pit shd not affect
1) Water Quantity - LdG or
Coppermine River - level!!
. need to ensure / replace fish habitat
2) within submerged
dyke area
- water quality
impacts of pit
3) residue must be
addressed


Objective → construct gradual slopes along the edges of the waste rock piles
→ leave the steep slopes to discourage use by animals - fox or wolves could potentially use for hunting caribou & caribou may attempt to climb regardless
→ revegetate - watching metal uptake
→ sell or give away for road construction throughout NWT


CLOSURE OBJECTIVES → Backfilled using wasterock while protecting the water and soil quality - or containing the contaminated area within the pit and building restraints or caps to restrict animal access - including fish
→ Revegetate the backfilled area ↳ could add PK to bottom
→ Refill pits gradually while treating it in stages before reintroducing fish (water) and refilling completely - clean rocks, etc.
→ Partially refill completed pits with wasterock from active pits as the mine progresses + complete with water
A154N + S Pool


Obj → → → criteria (engineering issues)
- stability
- no dust
- no erosion
- surviability - earthquake
- safe for wildlife/people
- perpetual (∞) frozen core
- promotion of revegetation
- no ARD
- elim. runoff/seepage
- grade of slope w/material type.
- material type
- some kind of cap


potentially use for hunting caribou + caribou may attempt to climb regardless
→ revegetate - watching metal uptake
→ sell or give away for road construction throughout NWT

Annex E – Rio Tinto Limited, DIAND and WLWB PowerPoint Presentations

Presentation Material Excluded by DDMI

Appendix IX-2

DDMI Closure Site Visit – January 14, 2009

RioTinto

Interim Closure and Reclamation Plan – Site Visit

January 14, 2009

RioTinto

Visitors

1	Francis Williah - Tlicho
2	Peter Huskey - Tlicho
3	Michel Louie Rabesca - Tlicho
4	Florence Catholique – LKDFN Representative – EMAB
5	Charlie Catholique _ LKDFN
6	James Marlowe - LKDFN
7	Lena Adjun - KIA
8	Stanley Anablak - KIA
9	Doug Crossley – KIA Representative – EMAB Member
10	Lawrence Goulet – YDFN Representative - EMAB
11	Floyd Adlem – EMAB Member - Cancelled
12	Bertha Drygeese - YDFN
13	Grant Beck – NSMA Representative – EMAB Member
14	Shannon Hayden - NSMA
15	George Mandeville - NSMA
16	Joe Murdock - EMAB Consultant
17	Nathan Richea - INAC
18	Erica Nyyssonen - GNWT
19	Ryan Fequet - WLWB
20	Gord Macdonald – Colleen English DDMI

2

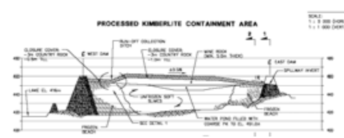
RioTinto

Tour Route

3

RioTinto

1. Processed Kimberlite Containment



- Closure Objectives:
  - Maximize freezing of processed kimberlite.
  - Keep drainage quality (runoff and seepage) safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
  - Ensure geotechnical stability.
  - Other?

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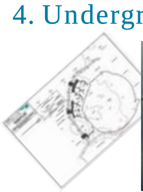
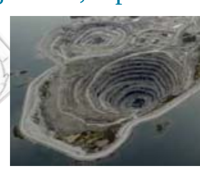
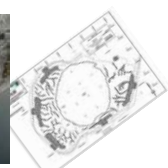
2. Wasterock Area

- Closure Objectives:
  - Freeze Type III rock – no active zone.
  - Keep drainage quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
  - Ensure geotechnical stability.
  - No water retaining structures.
  - Provide safe passage for caribou but not attract caribou.
  - Incorporate practical wildlife habitat features in final landscape.
  - Other?

3. North Inlet

- Closure Objectives:
  - Water quality safe for human/wildlife and no significant adverse effects on water uses in Lac de Gras.
  - Hydrologic connectivity to keep levels equal to Lac de Gras.
  - Evaluate opportunities to reconnect for fish habitat.
  - Other?

4. Underground, Open Pit and Dike

- Closure Objectives:
  - Provide sustainable water quality in flooded pit areas for aquatic life.
  - Develop physical habitat that enhances lake-wide characteristics.
  - Enable safe small craft navigation.
  - Ensure geotechnical stability.
  - Eliminate public and wildlife access to underground.
  - Other?

5. Buildings and Roads


- Closure Objectives:
  - Maximize use of assets for regional benefits.
  - Maximize use of on-site disposal.
  - Provide a final landscape with restored drainage patterns and enhancements to encourage indigenous vegetation.
  - Incorporate practical wildlife habitat features in final landscape
  - Other?

RioTinto

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