SPILL CONTINGENCY PLAN

Devon Island Ice Cap Field Research Program

Arctic and Alpine Research Group

Department of Earth and Atmospheric Sciences

University of Alberta

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This Spill Contingency Plan was prepared in December 2010 in accordance with the Consolidation of Spill Contingency Planning and Reporting Regulations R-068-93, as set by the Nunavut Water Board, with regard to **NWB License No. 3BC-BGI0813.**

The Spill Contingency Plan is subject to review by a Nunavut Water Board Technical Review.
Review completed:

The Spill Contingency Plan will be effective until NWB License No. 3BC-BGI0813 expires on September 30, 2013.

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1. Introduction

This Spill Contingency Plan outlines a plan of action to be taken in the relatively unlikely event of a hazardous materials spill at the Devon Island Ice Cap research site operated by the University of Alberta and its research partners. The Plan outlines the procedures for responding to a spill that will minimize potential health and safety hazards, environmental damage and remediation activities.

The objectives of this document are to:

a. Identify the types of hazardous materials present at the site.
b. Identify specific individuals and their responsibilities with respect to responding to a spill.
c. Define procedures for the safe and effective containment and cleanup/disposal of a material spill.
d. Define the reporting procedures and communication network to be used in the management of a material spill.

The secondary objective of this Plan is to make all field personnel aware of the seriousness and the ramifications of a hazardous material spill, which should promote mindfulness whenever handling such materials. Prevention of any type of spill is the ultimate goal.

2. Site Description

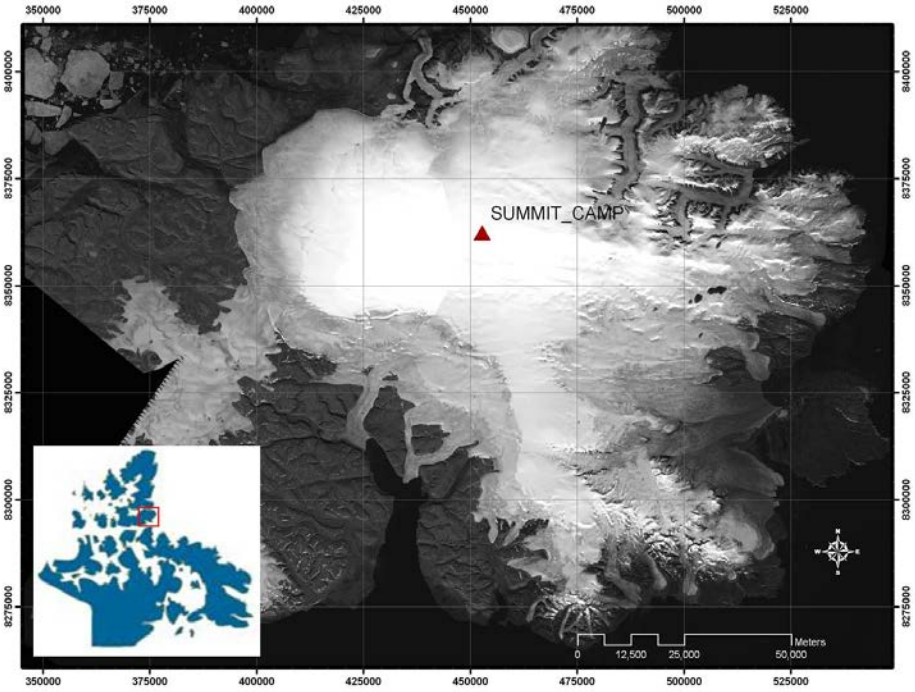
The area of operations for the University of Alberta Arctic and Alpine Research Group is the Devon Island Ice Cap (DIC), on Devon Island, Nunavut, Canada. The DIC is approximately 14,000 square kilometers of ice covering the Eastern portion of Devon Island. The Arctic and Alpine Research Group operates an ongoing multi-year research program on DIC, and to minimize transportation and mobilization costs a small temporary base camp is maintained at the Summit of the Ice Cap. This is a central location where personnel and material are based, and from which experiments at satellite locations can be conducted.

In the spring, when research operations are being conducted, the camp consists of 2-4 sleeping tents, a cooking/living tent, an equipment storage tent, snowmobiles, sleds, and a fuel supply. Upon completion of research activities each year, all scientific equipment, tools and camp supplies are flown off the ice cap when personnel leave the site. Remaining on-site is a small cache of equipment consisting of: large Weatherhaven tents, snowmobiles, sleds, and surplus fuel.

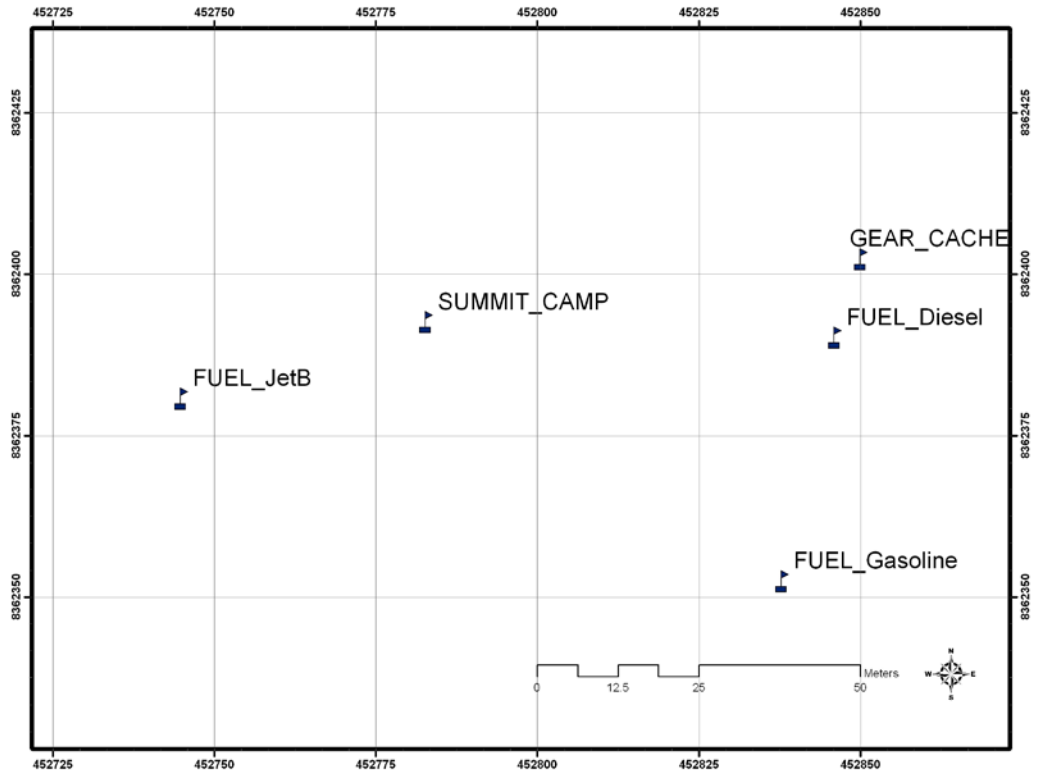
2.1 Site Maps

Map coordinates are UTM Zone 17X:

Devon Island Ice Cap: Landsat 2000 image



DIC Summit Camp Layout: Fuel Cache Positions 2010



2.2 Hazardous Materials Storage

Fuel caches are located at the Summit Camp of DIC at an elevation of around 1820m.a.s.l. At this location, snow accumulates year-round and melt is limited to a few days each year. There is never any running or ponded water on the surface. Our activities at the site take place in April and May of each year, when temperatures are always below freezing.

Fuel stored on site is separated by fuel type (as specified in Section 3) into individual caches. At the fuel caches, fuel is stored in 205 litre (45 gallon) drums which stand directly on the snow and their location is marked by stakes.

In summer, drums that are darker than the underlying snow will melt into it, developing a supporting ring of snow around them. Our experience over many years in such locations is that drums never tip over when stored in this way, and this keeps the risk of significant spills to a minimum. However, when drums are placed on plywood, the continuous surface cover suppresses melt of the underlying snow relative to adjacent uncovered snow. The result of this differential melting is that a snow/ice pedestal develops beneath the cover and drums can become elevated above the surrounding surface. Eventually there is a tendency for the platform to start to slip and for drums to tip over. Under these circumstances there may be a risk of spillage. When drums are placed on a plastic sheet/berm that might trap potentially spilled fuel, the result is usually uneven subsidence of the drums into the snow that can result in drums leaning or even tipping, again increasing the risk of spillage. For these reasons we stand drums directly on the snow. It makes them less likely to tip, and easier to handle (which also reduces the risk of spills).

At the close of field operations each year, the following must be done prior to leaving the site for the winter:

1. Empty barrels are removed from each fuel cache site, and are returned to PCSP Resolute.
2. Pumps should be removed from barrels.
3. All barrels that have been opened but not emptied must be checked to ensure that bungs and screw-caps are tightly sealed with an appropriately fitting bung-wrench.
4. Each fuel cache is organized: barrels are arranged in a group, gloves, funnels, wrenches, and all other fuel transfer supplies are removed and properly stored.
5. GPS locations of each fuel cache are recorded, and a tall wand or stake must be planted in the snow, such that it is visible 1 meter above the barrels. In winter, the drums are buried by blowing snow, and they must be easily re-located for excavation in the spring.

2.3 Spill Prevention Measures

Fuel transfer takes place in two ways:

1. Transfer from drum to jerry can using a barrel pump.
2. Pouring from jerry cans directly into the gas tank of skidoos, gas generators, or small gas powered drills.

During transfer, drip pans can be used to contain spills and the trapped fuel can be transferred directly back to the source drum or jerry can. When pouring fuel from a jerry can into small gas drills or generators, an appropriately sized funnel should be used to minimize risk of spillage.

When drums are in use, the barrel pump is left in the drum all the time and the open end of the transfer hose is stored facing upwards to prevent any release of fuel from the hose. There is a small risk of a spill when a barrel pump is removed, but this can be contained using a drip tray or absorbent pad. Once empty, drums are immediately re-sealed to ensure there is no risk of spillage of residual fuel. The same is true of empty jerry cans. Empty drums are removed from the field site on the first available aircraft and returned to PCSP at Resolute Bay. Empty jerry cans are returned at the end of each field season.

Leaky or damaged pumps, hoses, jerry can pour spouts or funnels must be repaired, if possible, or removed and no longer used.

3. Hazardous Material Inventory

The following is a list of the hazardous materials temporarily kept onsite at the Devon Ice Cap base camp. All materials fall under the class of Fuels and Lubricants, and are used as transport fuel or cooking and heating fuel.

Volumes stored on-site vary; fuel supplies are delivered by Twin Otter aircraft at the beginning of each research season. The amount delivered is intended to correspond to the amount that will be used during one season's research activities, with allowances made for an "emergency" supply. Surplus fuels are stored on-site over winter in properly sealed drums. Empty fuel containers are removed whenever aircraft are available to return them to PCSP Resolute Bay. There is no intention to keep permanent stockpiles of fuel at this site. All fuel supplies will be removed upon completion of the research program.

For each of the substances listed below, detailed information on specific health hazards or disposal procedures can be found in the MSDS sheets, in Appendix B of this document.

Diesel is used in heating stoves in large base-camp tents. It is stored in 205 litre (45 gallon) drums. Typical supply on-site is 1-2 drums.

Gasoline is used in snow machines, generators and ice coring drills. It is stored in 205-litre (45-gallon) drums or 20-litre (5-gallon) portable cans. Typical supply on-site is 10 drums.

Jet-B / JP-4 is used in helicopters or fixed-wing aircraft. It is stored in 205 litre (45 gallon) drums. Typical supply on-site is 5-10 drums.

Propane is used as primary cooking fuel. It is stored and transported in 11-kg (25-lb.) tanks. Typical supply on-site is 10-15 tanks.

Naphtha or white gas is used for emergency cooking/heating stoves. It is available in one-litre or 20-litre containers. Only small supplies, totaling 20-litres, are kept on-site. This is not stored in barrels, but on our Gear Cache.

2-cycle engine oil is used in snow machines. It is stored in 1-litre containers. Typical supply on-site is 20-30 litres. This is not stored in barrels, but on our Gear Cache.

4. Spill Resource Inventory

Spill kits are provided upon deployment to all field teams by the Polar Continental Shelf Project.
Spill kits are composed of: absorbent pads, heavy-duty Nitrile gloves, safety goggles, and disposable bags.
Minimum of 2 spill kits will be kept on-site.

In addition to spill kits, the camp is supplied with the following items that can be used to assist with a potential spill clean-up:

- 4 snow shovels
- 2 spades
- 100 heavy plastic garbage bags
- duct tape (4 x 100' rolls)
- plastic tarps
- Nitrile gloves
- 4 water-tight sealable plastic barrels (60L)

The above materials will be located in the base camp equipment storage tent.

5. Response Organization

5.1 Instructions and Training

Prior to deployment to the Devon Island Ice Cap field site, all personnel will be provided with a copy of the Spill Contingency Plan and will be instructed on its activation, should a spill occur in the field. Upon arrival at the field camp, personnel will be familiarized with the identification and location of all hazardous materials listed in the Inventory, and will be instructed on how to properly store, transport and handle these materials. The location of spill kits will also be provided.

5.2 Duties of the Spill Response Team

Due to the small number of personnel occupying the Devon Island Ice Cap field site at any time, the Spill Response Team necessarily includes all members of the field team. The only person with specific responsibilities is therefore the Field Supervisor (Project Manager or Camp Manager).

Spill Response Team Responsibilities

- Perform daily inspections at the Camp fuel storage areas.
- Report any spill to the Field Supervisor.
- Containment of the spill and site remediation.

Field Supervisor Responsibilities

- Assume complete authority over the spill scene and coordinate all personnel involved.
- Evaluate spill situation and develop overall plan of action.
- Activate the spill contingency plan
- Immediately report the spill to the NWT 24-Hour Spill Report Line and regulatory agencies. (For spill greater than 1 litre)
- Fill out the Spill Report Form (for spill greater than 1 litre)
- Report the spill to the Project Manager. (For spill greater than 1 litre)
- If required, obtain additional manpower, equipment, and material if not available on site for spill response by contacting the PCSP Base Manager.

6. Spill Response Plan

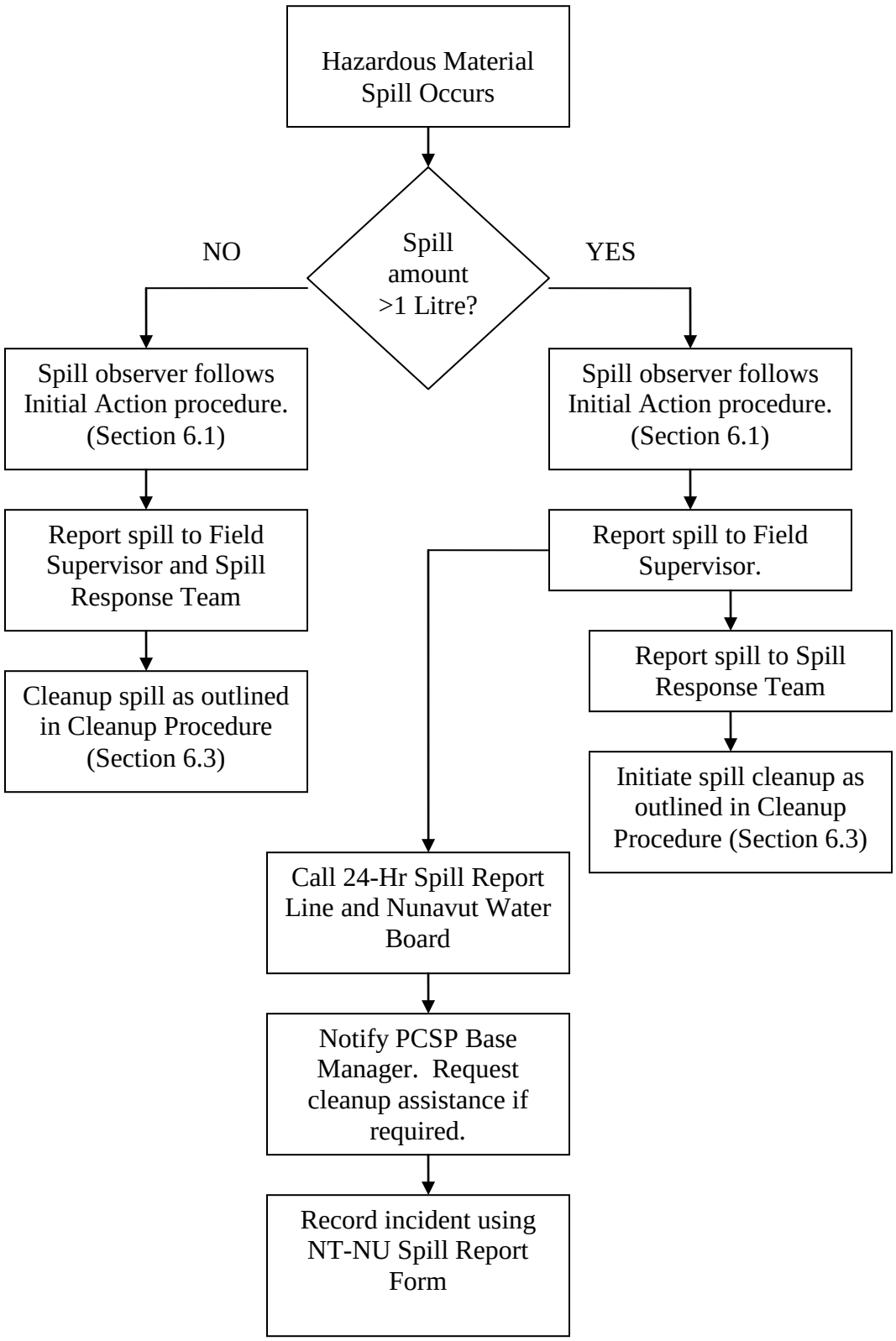
6.1 Initial Action

These instructions are to be followed by the first person on the spill scene.

1. Always be alert and consider your safety first.
2. Wear personal protective equipment.
3. Do not smoke and eliminate all source of ignition.
4. Assess the hazard to people in the vicinity of the spill. If possible control danger to human life.
5. Do not touch, smell, taste or get close to an unknown substance.
6. If substance has been identified and if possible and safe to do so, try to stop the flow of material.
    a. If filling is in progress, stop at once
    b. If seeping through a small hole, patch the hole if practical to do so.
    c. If necessary and practical, pump the fuel from the leaking container into a refuge container.
7. Immediately report the spill to the Field Supervisor and Spill Response Team by radio, satellite phone or in person.
8. Resume any effective action to contain, mitigate, or terminate the flow of the spilled material.
9. If in doubt about cleaning procedures or for a very large spill, consult material MSDS sheets for information or regulatory agencies for help.

6.2 Spill Response Plan

The following flow chart outlines the decisions to be made and the sequence of events to take in the event of a hazardous material spill at the Devon Ice Cap field site.



6.3 Cleanup Procedure

Spill Response Team members tasked with cleaning up a Hazardous Material Spill must address the following points before proceeding with a cleanup:

1. Always be alert and consider your safety first.
2. Wear personal protective equipment.
3. Do not smoke and eliminate all source of ignition.
4. Do not touch, smell, taste or get close to unknown substances.

For Spills <1 Litre

Any small spill (< 1L) will quickly soak into the surface snow. Snow is a very effective absorber of isothermal petroleum products; the petroleum will fill the void spaces between snow grains, and the snow will thus contain the spilled liquid until the petroleum begins to evaporate, or a temperature rise causes the snow to melt[1]. Therefore, absorbent powders, booms, or pads will not be effective at containing or extracting petroleum products already spilled on snow. The most effective way to remediate the spill site is to remove all contaminated snow to a facility equipped with a holding tank, where the snow/petroleum mixture can be melted and the petroleum burnt or evaporated off.

Contaminated snow will be slightly discolored – pale yellow in color. All contaminated snow, and snow in a 5cm buffer surrounding the contaminated area, shall be shoveled into a tub or bucket lined with a plastic garbage bag.

Once filled, bags should be securely tied shut, and the tub or bucket fitted with a lid. Containers of contaminated snow shall be stored out of direct sunlight until they can be removed to Resolute Bay at the earliest opportunity. Containers should be labeled to properly identify the contents to the cargo handlers at PCSP.

For Spills >1 Litre

Experience revealed from numerous case studies of accidental and field or laboratory experimental petroleum spills suggest that spills > 1L would simply percolate deeper into the snow pack until all liquid is absorbed by snow, or until it encounters a barrier[1,2,3]. At the site where fuel is stored on DIC, the surface snow pack is 2-3m deep. Below this is a hard icy layer 30-60cm thick, which is quite continuous over a wide area, and would act as a barrier to further downward migration into the snowpack of any spilled liquid. Since it is relatively easy to excavate the surface snow down to the depth of this ice barrier (2-3m), removal of all contaminated snow is still the best way to deal with a spill.

All contaminated snow, and snow in a 5cm buffer surrounding the contaminated area, shall be shoveled into a tub or bucket lined with a plastic garbage bag.

Once filled, bags should be securely tied shut, and the tub or bucket fitted with a lid. Containers of contaminated snow shall be stored out of direct sunlight until they can be

[1] Martel, C. James and Nadeau, Beth M.(1994) 'Snow as an expedient sorbent for hazardous materials', Journal of Environmental Science and Health, Part A, 29: 1, 237 — 247

[2] MacKay, D, P. J. Lweinovev, J. C. K. Overall and B. R. Wood; 1975. The behavior of crude oil spilled on snow. Arctic 28:9-10.

[3] Barber, F.g. 1970. Oil spills on ice: some clean-up options. *Arctic*, 23(4): 285-8.

removed to Resolute Bay at the earliest opportunity. Containers should be labeled to properly identify the contents to the cargo handlers at PCSP.

Since a larger spill may entail the excavation, storage and removal of a large volume of snow, additional supplies and assistance may need to be enlisted. In this case, contact the Base Manager at PCSP.

6.4 Material Specific Response Actions

Consult MSDS sheets (found in Appendix B) for specific information on hazards, handling precautions, or cleanup for each of the fuels or chemicals listed in Section 3.

7. Contacts

People and organizations to be contacted in the event of a hazardous material spill:

Title:	Name:	Contact:
Project Manager	Martin Sharp	780-492-5249 (work)
Camp Manager	Colleen Mortimer	780-492-3265
Department of Earth and Atmospheric Sciences, University of Alberta	Mary-Jane Turnell Assistant Chair (Admin)	1-26 Earth Sciences Building University of Alberta Edmonton, Alberta, Canada T6G 2E3 Office: (780) 492-3265 FX: (780) 492-2030
PCSP Base Manager	Michael Kristjanson	Resolute Bay Base (March-September) Phone: (867) 252-3872 Ottawa (October-February) Phone: (613) 947-1650
Nunavut Water Board	Phyllis Beaulieu	(867)-360-6338
Spill Report Line (24 hr)		PH: (867)-920-8130 FX: (867) 873 – 6924

Note: The Project Manager and/or the Camp Manager will, in most cases, be at the work site for the duration of all field research activities. The only way to contact personnel in the field is via satellite phone or HF radio communications. Satellite phone numbers are not known prior to their issue by PCSP to the field personnel. If field personnel must be contacted while conduction operations on DIC, contact the PCSP Base Manager, who will relay or coordinate communications.

Organizations whom can be contacted for additional information:

Agency:	Contact:
Department of Indian and Northern Affairs Canada, Manager of Field Operations	Peter Kusugak: PH: 867-975-4295, FX 867-975-6445
Environment Canada (Yellowknife)	(867) 669-4744
Department of Fisheries and Oceans	519-383-1813 or 1-866-290-3731
Government of Nunavut, Department of Environment, Environmental Assessment	Froeydis Reinhart: PH: (867) 975-7735, FX: (867) 975-7739
Kitikmeot Inuit Association	PH: (867)-982-3310

8. Reporting

If during the term of NWB License No. 3BC-BGI0813, a hazardous materials spill occurs, the Project Manager shall:

1. Employ the Spill Contingency Plan; and
2. For each spill occurrence, submit to the Nunavut Water Board Inspector, no later than thirty (30) days after initially reporting the event, a detailed report that will include the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site. The NT-NU Spill Report Form (available at http://env.gov.nu.ca/ and found in Appendix A of this document) shall be used for reporting.

Appendix A: Spill Report Form

The following is a copy of the NT-NU Spill Report Form. An electronic version (fillable .PDF form) is to be kept on all field laptops.

Appendix B: MSDS Sheets for Hazardous Materials Inventory

Copies of MSDS Sheets for all fuels and chemicals used or stored on-site at DIC (Listed in Section 3) shall be maintained with this document.