# Inuvik to Tuktoyaktuk Highway:
# Sedimentation and Erosion Control Plan

*Final Draft*

September 2013

*Prepared by:*
**KAVIK-STANTEC Inc.**
Inuvik, NT and Calgary, AB

Northwest Territories Transportation


Northwest
Territories Transportation

# Executive Summary

This Sedimentation and Erosion Control Plan (SECP) is one of three plans developed for the Inuvik to Tuktoyaktuk Highway (ITH) to protect fish and fish habitat. The SECP provides objectives and mitigation measures for erosion and sedimentation control during construction and operation of the ITH. Measures include mitigation for the highway right-of-way, installation of watercourse crossing structures, highway maintenance, camp operation and conducting borrow pit operations.

The SECP should be used in combination with two other fisheries related plans; the Fish and Fish Habitat Protection Plan (FFHPP) and the Fisheries Management Plan (FMP). The FFHPP provides mitigation against activities such as accidental fuel spills, water withdrawal, and overpressures in waterbodies or watercourses related to the use of explosives. The FMP provides management strategies and guidelines to prevent adverse effects on fish populations due to increased fishing pressure which may occur as a result of the ITH. These three fisheries related plans are a subset of a larger set of plans developed for the safe construction and operation of the ITH and will be used in conjunction with one or more of these other plans (e.g., Pit Management Plans). The SECP will be complementary to terms and conditions contained in all relevant permits and Authorizations.

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# Abbreviations

AANDC.....Aboriginal Affairs and Northern Development Canada
BMP.....best management practices
CCME.....Canadian Council of Ministers of the Environment
DFO..... Fisheries and Oceans Canada
EIRB.....Environmental Impact Review Board
FFHPP..... Fish and Fish Habitat Protection Plan
FMP..... Fisheries Management Plan
ILA.....Inuvialuit Land Administration
ITH..... Inuvik to Tuktoyaktuk Highway
NWT.....Northwest Territories
RECP .....Rolled Erosion Control Products
SECP.....Sedimentation and Erosion Control Plan
TSS ..... total suspended solids

# 1 INTRODUCTION

## 1.1 Purpose

The Sedimentation and Erosion Control Plan (SECP) was one of the conditions set forth by the Environmental Impact Review Board (EIRB) Panel and accepted by the Federal government. The SECP was also a commitment of the Developer. The plan describes the objectives and mitigation measures related to sedimentation and erosion control to be used in the construction and operation of the Inuvik to Tuktoyaktuk Highway (ITH) including; watercourse crossings, right-of way construction, camps and borrow pit operations. The SECP is one of several plans developed for the construction and operation of the ITH and will be used in conjunction with one or more of these plans (e.g., Pit Management Plans). The plan will be complementary to terms and conditions contained in all relevant permits and Authorizations.

The SECP is a living plan and will be updated as new information is brought forward. The plan will be reviewed annually during the construction phase of the ITH in order to capture "lessons learned" from previous year's construction and monitoring activities. Once the ITH is operational the SECP will be reviewed every 5 years or as required to provide the best guidance in preventing sedimentation and erosion of watercourses and waterbodies.

## 1.2 Relevant Guidance

The SECP was prepared in accordance with guidance provided in the following best management practices (BMP) publications:

- Northwest Territories Transportation. 2013. Government of the Northwest Territories, Department of Transportation - Erosion and Sediment Control Manual
- Alberta Transportation. 2011. Erosion and Sediment Control Best Management Practices
- Fisheries and Oceans Canada. 2007. Northwest Territories Operational Statement: Fish Timing Windows
- Fisheries and Oceans Canada. 2007. Operational Statement for Culvert Maintenance
- Fisheries and Oceans Canada. 2007. Operational Statement for Clear-span Bridges
- Fisheries and Oceans Canada. 2007. Operational Statement for Ice Bridges and Snow Fills
- Fisheries and Oceans Canada. 2007. Operational Statement for Bridge Maintenance
- Fisheries and Oceans Canada. 2007. Operational Statement for Maintenance of Riparian Vegetation in Existing Rights-of-way
- Fisheries and Oceans Canada. 2007. Operational Statement for Isolated or Dry Open-cut Stream Crossings

- Fisheries and Oceans Canada. 2007. Operational Statement for Temporary Stream Crossing
- Fisheries and Oceans Canada. 1993. Land Development Guidelines for the Protection of Aquatic Habitat
- Indian and Northern Affairs Canada. 2003a. Northern Land Use Guidelines Vol. 5: Access Roads and Trails
- Indian and Northern Affairs Canada. 2003b. Northern Land Use Guidelines Vol. 6: Camps and Support Facilities
- Inuvialuit Land Administration and Indian and Northern Affairs Canada. No Date. Inuvialuit Settlement Region Pits and Quarries Guidelines
- Ministry of Transportation Ontario. 2007. Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects

## 1.3 Regulatory Approvals

The ITH is located wholly within the Inuvialuit Settlement Region, with the route crossing Inuvialuit 7(1) (a), 7(1) (b) and federal crown lands. The ITH was reviewed by the Environmental Impact Review Board (EIRB) Panel and recommended approval by the federal government. The recommendation included a number of conditions of which the development and implementation of a SECP was one of these conditions. The federal government accepted the EIRB Panel recommendation and the requirement for a SECP. The SECP supports applications for permits, licences, and Authorizations from the Northwest Territories Water Board, Inuvialuit Land Administration (ILA), Aboriginal Affairs and Northern Development Canada (AANDC), and Fisheries and Oceans Canada (DFO).

## 1.4 Timing of Construction

To avoid rutting and erosion in permafrost terrain, overland travel is not permitted during summer months and new highway construction will only take place during late fall or winter when the active layer is frozen (Indian and Northern Affairs Canada 2003a). Therefore, construction of the highway and installation of the watercourse crossing structures and operation of the borrow sources will occur during winter. Additional construction (e.g., compaction and grading of previously constructed right-of-way) and installation (e.g., bridge decks) activities may be required at crossings structures during non-winter months; however, access will be on sections previously constructed along ITH right-of-way during late fall or winter. Although not expected one or more water crossings may have to be constructed during the non-winter months if flowing water was present during the winter period. This construction would be conducted in the period between July 15 and September 15 as per DFO Fish Timing Windows for the NWT (Appendix A). Mitigation for summer water crossings are provided in Section 2.11.

There are many areas where re-vegetation will be required. The planting of new vegetation in affected areas should be conducted as early in the growing season as possible to allow root growth and the vegetation to take hold during that first growing season.

## 1.5 Contractor Education

The SECP will be reviewed with the Contractor that will be completing the work. The purpose of this review is to ensure the Contractor understands the intent of the SECP, to gain buy-in for the plan, to obtain feedback on possible improvements, and to ensure the Contractor understands how to implement the plan. The contractor will be responsible for educating highway construction crews on the content of the plan and its importance to be implemented correctly.

## 1.6 Lessons Learned from Tuktoyaktuk 177 Access Road Design and Construction

Valuable lessons can be learned from previously constructed roads in similar locations and conditions. The construction of the access road to Borrow Source 177 provides such an example where lessons learned were gained and which will be used in the design and construction of the ITH. The complete document of lessons learned can be found in Appendix B, but lessons learned that are related to sedimentation and erosion control are provided below.

- Winter road construction is viable and winter access roads are not anticipated to be a concern.
- Refinement is required in culvert detailing, including end projection length, potential use of insulation, design elevations and design glaciation levels. These considerations have been incorporated into the culvert designs for the ITH.
- Geotextile between the embankment and the original ground is feasible with winter construction, and appears to achieve its intended purposes of maintaining roadbed stability and integrity.
- The use of a 'fill only' design section with no cuts in the traditional ditch areas adjacent to the embankment fully maintains the ground vegetation adjacent to the roadway. This intact vegetation cover provides excellent silt control for runoff from the roadway embankment, minimizing material transport into waterways.
- The culvert erosion control end treatment of the Tuktoyaktuk 177 access road appears to be working well, and will be used on the ITH.
- The use of erosion control matting, together with silt fences and rip rap, will be extended to the final highway project.

# 2 HIGHWAY RIGHT-OF-WAY AND WATERCOURSE CROSSINGS

## 2.1 Description

The two lane ITH alignment is approximately 130 km in length and made of granular material. The highway crosses 65 watercourses (Appendix C). The watercourses vary in size from ephemeral drainages, with only seasonal flow, to large permanent watercourses, which may flow year-round. Proposed crossing structures include culverts, open bottom culverts, short-span bridges, and pre-cast concrete girder bridges. Refer to the Final Drawings Package for engineering designs of all watercourse crossings.

## 2.2 Embankment Construction Mitigation

The embankment is a long ridge of material used to support the highway. Concerns regarding erosion and sedimentation control arise from water seepage or drainage from the embankment. Materials used in constructing the embankment may contain small amounts of ice, which when it melts can seep out of the embankment and into the surrounding area. Runoff from precipitation events off the embankment may carry sediment which may have the potential to enter aquatic environments. The following mitigation is designed to protect potential aquatic receiving bodies from the intake of sediment due to embankment construction or use.

Additional information can be obtained in Appendix D (Best Management Practices: Construction Practices, M1), Appendix E (Northern Land Use Guidelines: Roads and Trails).

- Sediment control measures along the highway will be in place prior to construction activities and the spring melt/freshet, were applicable.
- Machinery will be operated on land or on ice and in a manner that minimizes disturbance to the banks of the lake, river or stream.
- Removal of vegetation will be limited to the width of the right-of-way.
- Stockpiles of borrow material will be kept a minimum of 30 m from a watercourse or waterbody with the appropriate erosion control mitigation in place (e.g., snow berms, silt fences (Silt Fences BMP 1, Appendix F) etc.) to prevent sediment from entering a watercourse or waterbody.
- Drainage from the embankment will be into well-vegetated areas to avoid sediment deposition into adjacent waterbodies and watercourses.
- Parallel ditches are not expected to be required but if required will be constructed of coarse-grained material and will be reinforced with geotextiles or rip-rap in areas prone to erosion.
- Ditches will drain into well-vegetated areas to avoid sediment deposition into adjacent waterbodies and watercourses.

- Cross ditches (Off-take ditches BMP 21, Appendix G) if required, will extend beyond the right-of-way and into vegetated areas to avoid scouring and soil erosion.
- In areas of ice-rich permafrost, cross drains will be stacked on top of each other to maintain drainage in the event that the lower cross drain freezes.
- In areas of steeper highway gradient, ditch blocks or check dams (Rock check dams BMP 7, Appendix H) will be used if required to control water speed and trap sediment.

## 2.3 Watercourse Crossing General Mitigation

The following sections and mitigation applies to all watercourse crossings; irrespective of type or classification of the watercourse. Additional information can be obtained in Appendix D (Best Management Practices: Construction Practices, M1) and Appendix E (Northern Land Use Guidelines: Roads and Trails).

- Approaches and crossings will be constructed perpendicular to the watercourse wherever possible.
- Sediment control measures at watercourse crossing sites will be in place prior to construction activities and the spring melt/freshet were applicable.
- Machinery will be operated on land or on ice and in a manner that minimizes disturbance to the banks of the lake, river or stream.
- Construction activities will be planned to minimize in-stream work.
- In-stream work will be planned to occur as a single event at any one location.
- In-stream work will be restricted to low or no flow periods (winter construction).
- Removal of vegetation will be limited to the width of the right-of-way.
- Vegetation will not be cut < 10 cm from the ground.
- A vegetated buffer strip will be maintained between the work site and water course, except at the actual crossing location.

## 2.4 Riparian Areas

Vegetated areas immediately adjacent to a watercourse are referred to as riparian areas. These areas are valuable in maintaining fish habitat and stabilize stream banks, thereby reducing erosion and sedimentation into the watercourse. The following applies to all watercourse crossings; irrespective of type or classification of the watercourse. Additional information can be obtained in Appendix I (Riparian Zone Preservation BMP 6), and Appendix J (Rolled Erosion Control Products (RECP) BMP 11).

- Riparian areas will be maintained.
- When practical, riparian vegetation in the right-of-way will be altered by hand. If machinery must be used, the depth of the snow cover must be measured in order that machinery is operated in a manner that minimizes disturbance to the banks of the water body.
- Machinery will be operated on land.

- Banks will be restored to original condition if any disturbance occurs.
- Grading of the stream banks for the approaches will not occur.
- If the stream bed and banks are steep or highly erodible (e.g., dominated by organic materials and silts), erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice (e.g., snow fill) will be used to protect these areas.
- When altering a tree or shrub that is located on the bank of a watercourse it will not be cut < 10 cm from the ground to allow the root structure soil stability to be maintained.
- Waste materials created by construction will be stabilized and removed from the work site to prevent them from entering the watercourse.
- Prior to the spring melt/freshet, the site will be stabilized by covering exposed areas with erosion control blankets (e.g., cocoa matting) to keep soil in place and prevent erosion to allow re-vegetation the following spring (see Appendix J, Rolled Erosion Control Products (RECP) BMP 11). If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site will be stabilized using effective sediment and erosion control measures (e.g., riprap) to meet specific attributes of the watercourse. In areas with permafrost, care will be exercised to ensure these measures do not cause thawing or frost heave.
- Effective sediment and erosion control measures will be maintained until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

## 2.5 In-fills

A small number of watercourse crossings will require in-fills as part of the crossing structure. The in-fills will be located within the flood plain of these watercourses; however, no in-filling will occur within the channel. The in-fill material will be sloped to minimize erosion potential (i.e., 2:1) and will be reinforced with riprap or similar protective measures. In addition, one or more in-fills (e.g., Hans Creek) will include equalization culverts; the installation of these culverts will follow the procedures outlined in Section 2.8.

## 2.6 Bridge Crossings

Pre-cast concrete girder bridges will be used at watercourse crossings where flows are > 4.0 $m^3$/sec (Table 2-1). Bridges are used to minimize impacts at important fish bearing stream crossings. Bridges also minimize the potential for flow restrictions and disturbance to the stream bed. Locations for these watercourse crossings are provided in Appendix C.

- Disturbance of the natural banks will be kept to a minimum.
- No work will be carried out in the active stream channel.
- Design of the bridge will prevent runoff from the bridge deck and side slopes and approaches will be directed to a vegetated area to prevent sediment and other substances from entering the creek. Bridge maintenance mitigation is provided in Section 2.12.2.1.

- Temporary ice bridges or snow fills will be used to mobilize on the other side of the creek bank and will follow the DFO Operational Statement for Ice Bridges and Snow Fills (Appendix K).
- Temporary snow and/or sandbag berms will be used during construction of the bridge to prevent materials from entering the creek.
- Spoil and sediment-laden snow will be removed and disposed away from the site to prevent it from re-entering the watercourse.
- Footings for the bridge abutments and retaining walls will normally be installed outside the wetted perimeter (high-water-mark) of the watercourse and sufficiently stabilized to prevent erosion of the footing or undermining. Clear span bridges will follow DFO's Operational Statement for Clear Span Bridges (Appendix M).
- Where footings for the bridge abutments and retaining walls will be installed within the normal wetted perimeter, the area will be isolated using temporary snow and/or sandbag berms to prevent materials from entering the creek.
- If water pools in the excavated area (i.e., to construct bridge abutments), the water will be pumped away from the site to prevent suspended sediment in the water from re-entering the watercourse.
- Dried or wet concrete and other materials or sediment will be prevented from entering the creek during construction.
- Formworks will be removed from the site after their removal from the abutments and retaining walls to prevent debris from entering the watercourse.
- Appropriately sized riprap will be placed at the stream side of the abutment and retaining walls or any other area which cannot be re-vegetated and will be free of silt and other debris (see Appendix L, Riprap Armouring BMP 7).
- Disturbed areas will be stabilized and re-vegetated with natural vegetation. Cover such areas with mulch to prevent erosion and to help seeds germinate where possible will be re-established in the summer period where it has been removed or damaged.

### Table 2-1 Summary of Major Bridge Crossings

| Crossing | Bridge Span | Watercourse |
|---|---|---|
| 3 | 1-20m | Unnamed Watercourse |
| 8 | 1-20m | Unnamed Watercourse |
| 18 | 8-12-8m | Unnamed Watercourse |
| 23a | 12-14-10m | Unnamed Watercourse |
| 30a | 14-18-14m | Unnamed Watercourse |
| 31 | 14-18-14m | Hans Creek |
| 35a | 8-14-8m | Zed Creek |
| A3 | 8-14-8m | Unnamed Watercourse |

## 2.7 Open Bottom Culvert Crossings

One or more open bottom culverts may be used at watercourse crossings where flows are > 3.0 $m^3$/sec to < 4.0 $m^3$/sec (Table 2-3). Open bottom culverts are used to minimize impacts at important fish bearing stream crossings. Like bridges open bottom culverts minimize the potential for flow restrictions and disturbance to the stream bed.

- Disturbance of the natural banks will be kept to a minimum.
- Work will be carried out in the active stream channel when there is no water present, when possible. If water is present see Section 2.11.
- The open bottom culvert will be aligned parallel to the existing natural channel and located on a straight stream section.
- Design of the open bottom culvert deck and side slopes and approaches will be directed to a vegetated area to prevent sediment and other substances from entering the creek.
- Temporary ice bridges or snow fills will be used to mobilize on the other side of the creek bank and will follow the DFO Operational Statement for Ice Bridges and Snow Fills (Appendix K).
- Temporary snow and/or sandbag berms will be used during construction of the open bottom culvert to prevent materials from entering the creek.
- Spoil and sediment-laden snow will be removed and disposed away from the site to prevent it from re-entering the watercourse.
- Footings and retaining walls for the open bottom culvert will be installed outside the normal wetted perimeter (high-water-mark) of the watercourse if possible and sufficiently stabilized to prevent erosion of the footing or undermining.
- Where footings and retaining walls will be installed within the normal wetted perimeter, the area will be isolated using temporary snow and/or sandbag berms to prevent materials from entering the creek.
- Appropriate sized riprap will be placed at the stream side of culvert sides and will be free of silt and other debris (see Appendix L, Riprap Armouring BMP 7).
- Disturbed areas will be stabilized (e.g., cocoa matting) and re-vegetated with natural vegetation where possible. Cover such areas with mulch to prevent erosion and to help seeds germinate
- If re-vegetation is not possible stabilize area with rip-rap or other erosion control material.

### Table 2-2 Summary of Open Bottom Culvert Crossings

| Crossing | Watercourse |
|---|---|
| TBD | |

## 2.8 Bridge Sized Culvert Crossings

Bridge sized multi-plate culverts will be used at watercourse crossings where flows are < 4.0 $m^3$/sec to > 0.5 $m^3$/sec (Table 2-3). Locations for these watercourse crossings can be obtained in Appendix C.

- Disturbance of the natural banks and streambed will be kept to a minimum.
- Spoil will be disposed away from the site to prevent it from re-entering the stream bed.
- The culvert will be aligned parallel to the existing natural channel and located on a straight stream section.
- The culvert will be matched to meet normal flow velocities for all seasons.
- Each end of the culvert will be placed at least 0.15 m below the stream bed, and 'seated' there.
- Bedding gravel will be placed and compacted up to the design invert (level of the inside of the culvert) of the culvert.
- The culvert will be placed directly on the bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline.
- Additional clean gravel will be placed up and over the culvert.
- Appropriately sized riprap or similar erosion control material will be placed at the upstream and downstream ends of the culvert to protect the highway embankment and stream channel from erosion (see Appendix L, Riprap Armouring BMP 7).
- Riprap will be placed at a similar slope as the stream bank to maintain a uniform stream bank slope and natural stream alignment.
- Riprap will be free of silt and other debris.
- Disturbed areas not requiring rip-rap, will be stabilized using sandbags, rolled erosion control products or other similar erosion control methods, and natural vegetation will be re-established during the summer growing season where it has been removed or damaged. Cover such areas with mulch to prevent erosion and to help seeds germinate.

### Table 2-3 Summary of Bridge Sized Culvert Crossings

| Crossing | Diameter | Watercourse |
|---|---|---|
| 0 | 2.12m Dia SPCSP | Unnamed Watercourse |
| 1 | 1.66m Dia SPCSP | Unnamed Watercourse |
| 4 | 3.05m Dia SPCSP | Unnamed Watercourse |
| 5a | 2.12m Dia SPCSP | Unnamed Watercourse |
| 9 | 1.81m Dia SPCSP | Unnamed Watercourse |
| 11 | 1.81m Dia SPCSP | Unnamed Watercourse |
| 12 | 3.05m Dia SPCSP | Unnamed Watercourse |
| 13a | 3.36m Dia SPCSP | Unnamed Watercourse |

**Table 2-3 Summary of Bridge Sized Culvert Crossings (cont'd)**

| Crossing | Diameter | Watercourse |
|---|---|---|
| 15a | 1.81m Dia SPCSP | Unnamed Watercourse |
| 15b | 3.05m Dia SPCSP | Unnamed Watercourse |
| 15c | 1.81m Dia SPCSP | Unnamed Watercourse |
| 17a | 2.43m Dia SPCSP | Unnamed Watercourse |
| 20a | 1.66m Dia SPCSP | Unnamed Watercourse |
| 21 | 2.43m Dia SPCSP | Unnamed Watercourse |
| 22a | 2.12m Dia SPCSP | Unnamed Watercourse |
| 24a | 1.81m Dia SPCSP | Unnamed Watercourse |
| 29a | 2.12m Dia SPCSP | Unnamed Watercourse |
| 33a | 1.66m Dia SPCSP | Unnamed Watercourse |
| A12 | 2.43m Dia SPCSP | Unnamed Watercourse |

## 2.9 Large Culvert Crossings

Large culverts will be used at watercourse crossings where flows are < 0.5 $m^3$/sec (Table 2-4). These culverts range in size from 1.2 to1.4 m in diameter. Locations for these watercourse crossings are provided in Appendix C.

- Disturbance of the natural banks and streambed will be kept to a minimum.
- Spoil will be disposed away from the site to prevent it from re-entering the stream bed.
- The culvert will be aligned parallel to the existing natural channel and located on a straight stream section.
- The culvert will be matched to meet normal flow velocities for all seasons.
- Each end of the culvert will be placed at least 0.15 m below the stream bed, and 'seated' there.
- Bedding gravel will be placed and compacted up to the design invert of the culvert.
- The culvert will be placed directly on the bedding gravel shaped to properly support the bottom of the culvert on either side of the centerline.
- Additional clean gravel will be placed up and over the culvert.
- Appropriately sized riprap will be placed at the upstream and downstream ends of the culvert to protect the highway embankment and stream channel from erosion (see Appendix L, Riprap Armouring BMP 7).
- Riprap will be placed at a similar slope as the stream bank to maintain a uniform stream bank slope and natural stream alignment.
- Riprap will be free of silt and other debris.

- Disturbed areas not requiring riprap, will be stabilized using sandbags, rolled erosion control products or other similar erosion control methods, and natural vegetation will be re-established during the summer growing season where it has been removed or damaged. Cover such areas with mulch to prevent erosion and to help seeds germinate.

## Table 2-4 Summary of Large Culvert Crossings

| Crossing | Diameter | Watercourse |
|---|---|---|
| 2 | 1.2m Dia CSP | Unnamed Watercourse |
| 5 | 1.2m Dia CSP | Unnamed Watercourse |
| 6 | 1.2m Dia CSP | Unnamed Watercourse |
| 7 | 1.2m Dia CSP | Unnamed Watercourse |
| 10 | 1.2m Dia CSP | Unnamed Watercourse |
| 12a | 1.2m Dia CSP | Unnamed Watercourse |
| 12b | 1.2m Dia CSP | Unnamed Watercourse |
| 13 | 1.2m Dia CSP | Unnamed Watercourse |
| 14 | 1.4m Dia CSP | Unnamed Watercourse |
| 16 | 1.2m Dia CSP | Unnamed Watercourse |
| 17 | 1.4m Dia CSP | Unnamed Watercourse |
| 18a | 1.2m Dia CSP | Unnamed Watercourse |
| 19 | 1.2m Dia CSP | Unnamed Watercourse |
| 20 | 1.2m Dia CSP | Unnamed Watercourse |
| 21a | 1.2m Dia CSP | Unnamed Watercourse |
| 22b | 1.2m Dia CSP | Unnamed Watercourse |
| 24b | 1.2m Dia CSP | Unnamed Watercourse |
| 25 | 1.4m Dia CSP | Unnamed Watercourse |
| 26 | 1.2m Dia CSP | Unnamed Watercourse |
| 27a | 1.2m Dia CSP | Unnamed Watercourse |
| 27b | 1.2m Dia CSP | Unnamed Watercourse |
| 27b2 | 1.2m Dia CSP | Unnamed Watercourse |
| 27c | 1.2m Dia CSP | Unnamed Watercourse |
| 28a | 1.4m Dia CSP | Unnamed Watercourse |
| 33b | 1.2m Dia CSP | Unnamed Watercourse |
| 34a | 1.2m Dia CSP | Unnamed Watercourse |
| 34a2 | 1.2m Dia CSP | Unnamed Watercourse |
| 34b | 1.2m Dia CSP | Unnamed Watercourse |
| 34c | 1.2m Dia CSP | Unnamed Watercourse |
| 34e | 1.2m Dia CSP | Unnamed Watercourse |
| 39a | 1.2m Dia CSP | Unnamed Watercourse |
| 39b | 1.2m Dia CSP | Unnamed Watercourse |
| 39c | 1.2m Dia CSP | Unnamed Watercourse |

**Table 2-4 Summary of Large Culvert Crossings (cont'd)**

| Crossing | Diameter | Watercourse |
|---|---|---|
| 39d | 1.2m Dia CSP | Unnamed Watercourse |
| A2 | 1.2m Dia CSP | Unnamed Watercourse |
| A2a | 1.2m Dia CSP | Unnamed Watercourse |
| A8 | 1.2m Dia CSP | Unnamed Watercourse |
| A9 | 1.2m Dia CSP | Unnamed Watercourse |
| A10 | 1.2m Dia CSP | Unnamed Watercourse |
| A11 | 1.2m Dia CSP | Unnamed Watercourse |
| A13 | 1.2m Dia CSP | Unnamed Watercourse |

## 2.10 Summer Water Crossing Construction Mitigation

It is not anticipated that summer water crossing construction will be required however if flowing water is identified during winter construction, summer construction of the crossing may be favoured. No in-water construction will take place between September 15 and July 15 of any year, as per DFO Fish Timing Windows for the NWT (Appendix A). There are two options which may be used to conduct the water crossing while maintaining water flow. These options are the use of a flume, or dam and pump. Mitigation is provided for both methods below.

### 2.10.1 Flume (Open Bottom Culverts only)

- The flume will be sized to accommodate greater than anticipated flows as determined by hydraulic calculations.
- Stockpile all required materials before beginning instream work.
- Vehicles/equipment will use existing right-of-way.
- Install a pre-assembled flume or construct a sand bag dam/seal and flume.
- Isolation structures will be equipped with an impervious membrane to control seepage where necessary.
- Downstream dams/seal will only be used when necessary to maintain a dry work area.
- The open bottom culvert will be aligned parallel to the existing natural channel and located on a straight stream section.
- Install open bottom culvert as quickly as possible to minimize the time below the high water mark of the water course.
- Design of the open bottom culvert deck and side slopes and approaches will be directed to a vegetated area to prevent sediment and other substances from entering the water course.
- Temporary sandbag berms or similar mitigation (e.g., silt fences) will be used during construction of the open bottom culvert to prevent materials from entering the creek.

- Spoil will be removed and disposed away from the site to prevent it from re-entering the watercourse.
- Footings and retaining walls for the open bottom culvert will be installed outside the normal wetted perimeter (high-water-mark) of the watercourse if possible and sufficiently stabilized to prevent erosion of the footing or undermining.
- Where footings and retaining walls will be installed within the normal wetted perimeter, the area will be isolated using temporary sandbag berms or similar mitigation (e.g., silt fences) to prevent materials from entering the creek.
- Appropriate sized riprap will be placed at the stream side of culvert sides and will be free of silt and other debris (see Appendix L, Riprap Armouring BMP 7).
- Disturbed areas not requiring riprap, will be stabilized using sandbags, rolled erosion control products or other similar erosion control methods, and natural vegetation will be re-established during the summer growing season where it has been removed or damaged.
- Isolation structures will be kept in place until the open bottom culvert and erosion and sedimentation control mitigation is in place.
- Remove the downstream seal/dam materials if required followed by the upstream seal/dam materials. Remove the upstream seal/dam gradually to prevent erosion of the stream bed or banks.
- Remove the flume.

### 2.10.2 Dam and Pump

- Stockpile all required materials before beginning instream work.
- Vehicles/equipment will use existing right-of-way.
- Adequate electric power supply and adequately sized pumps will be available.
- Spare pumps and generators will be available and nearby.
- Pump capacity should exceed crossing flow rates with spare capacity to compensate for precipitation events.
- Minimize time and activity in the watercourse as much as practical while installing and removing dams and pumps and while installing the watercourse crossing.
- Remove debris in dam installation areas and prepare watercourse bed so as to provide an appropriate bed/dam-bottom fit.
- Install pumps and begin operation to equalize flow.
- Construct both the upstream and downstream dams. The dams should be constructed at or near the edge of the temporary workspace limit to allow for enough room to install the watercourse crossing. The dams may be constructed with sand bags, metal plate, aqua dam or other approved material or device, which ensures a tight seal to the bed and banks.
- Water flow dispersion (e.g., boulders, sandbags etc.) will be installed to prevent erosion at the discharge site prior to pump operations.

- Pump operations will begin during the installation of the dams. Conduct water crossing installation as rapidly as possible. Construct spoil containment sumps or berms, if necessary, to keep bank or stream bed spoil from flowing back into the non-isolated part of the stream channel.
- Pump any excess silt-laden water into a vegetated area at a distance that will preclude silt-laden water from re-entering the crossing.
- Isolation structures will be kept in place and the pumps operating until the water crossing has been installed and the wetted banks have been stabilized and reclaimed.
- Remove the downstream isolation structures followed by the upstream isolation structures and pumps. Upstream isolation structures should be removed gradually to prevent scouring and sedimentation of the stream bank and bed.
- Stabilize and reclaim remaining bank areas as soon as practical.
- Disturbed areas not requiring riprap, will be stabilized using sandbags, rolled erosion control products or other similar erosion control methods, and natural vegetation will be re-established during the summer growing season where it has been removed or damaged.

## 2.11 Embankment and Watercourse Crossing Maintenance (Construction and Operation)

During the construction phase of the ITH, grading and compaction of the embankment will be conducted during the summer period. Completion of some bridge work and re-vegetation activities along watercourse crossings may also be conducted.

Activities during the operational phase of the ITH include, embankment grading and repair, dust suppression, snow removal, maintenance of riparian vegetation, and culvert and bridge maintenance.

### 2.11.1 Construction Phase:

- Ensure mitigation measures along the right-of-way such as ditches, cross ditches and water energy dissipaters such as rock check dams or sand bags are operating efficiently and are in good condition.
- Dust suppression activities will be conducted as necessary to reduce dust and sediment from entering watercourses or waterbodies.
- Drainage from the application of dust suppressants (e.g., water) will be directed into vegetated areas.
- Use measures such as shrouding to trap and prevent; protective coatings, dirt, dried cement, and grease from entering the watercourse.
- Contain and store paint flakes, abrasives, and other waste materials in a manner that such materials cannot enter a waterbody or watercourse.
- When re-vegetating, stabilize any waste materials removed from the work site to prevent them from entering the water body. This could include covering spoil piles with biodegradable mats or tarps.

- In order to prevent erosion and to help seeds germinate, vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible the site should be stabilized using effective sediment and erosion control measures.
- Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

### 2.11.2 Operational Phase

- Ensure mitigation measures along the right-of-way such as ditches, cross ditches and water energy dissipaters such as rock check dams or sand bags are operating efficiently and are in good condition.
- Dust suppression activities will be conducted as necessary to reduce dust and sediment from entering watercourses or waterbodies.
- Drainage from the application of dust suppressants (e.g., water) will be directed into vegetated areas.
- Snow melt from winter snow-plowing should drain into vegetated areas to prevent sediment from entering a watercourse.
- Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

#### 2.11.2.1 Maintenance of Bridge Structures

Bridge Structures require occasional maintenance to ensure their longevity and that they are functioning in a manner which will not affect the environment. The following mitigation from the DFO (2007) *Operational Statement for Bridge Maintenance* (Appendix N) should prevent harm to fish and fish habitat due to sedimentation or erosion.

- Sweep decks, including curbs, sidewalks, medians and drainage devices to remove as much material as practical before washing.
- Adequately seal drains and open joints before washing to prevent sediment-laden wash-water from entering the watercourse.
- Direct wash-water past the ends of the bridge deck to a vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse. If this cannot be achieved, use silt fences or other sediment and erosion control measures to prevent wash-water from entering the watercourse.

- If replacement rock reinforcement/armouring is required to stabilize eroding areas around bridge structures (e.g., abutments and/or wing walls), the following measures should be incorporated:
  - Place appropriately-sized, clean rocks into the eroding area.
  - Avoid the use of rock that is acid-generating. Also avoid the use of rock that fractures and breaks down quickly when exposed to the elements.
  - Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.
  - Ensure rock does not interfere with fish passage or constrict the channel width.
  - If any in-water work is involved, adhere to DFO fish timing windows,
- If other bridge repairs are required which may cause sediment entering the watercourse or erosion use shrouding to trap and prevent concrete and other bridge materials from entering the watercourse.
- If working from land, install effective sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.
- Removal should be kept to a minimum and limited to the right-of-way of the bridge.
- Operate machinery on land (from outside of the water) in a manner that minimizes disturbance to the banks or bed of the watercourse.

### 2.11.2.2 Culvert Maintenance

Maintenance of culverts will follow DFO (2007) *Operational Statement for Culvert Maintenance* (Appendix O) as they pertain to sedimentation and control. Mitigation for the maintenance of culverts not related to sedimentation and erosion control are located in the FFHPP.

- Operate machinery on land (from outside of the water and in a manner that minimizes disturbance to the banks of the watercourse.
- Use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation.
- Install effective sediment and erosion control measures before starting work to prevent sediment from entering the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.
- If accumulated material in the culvert is affecting its function then remove accumulated material and debris slowly to allow clean water to pass, to prevent downstream flooding and reduce the amount of sediment-laden water going downstream.
- If replacement rock reinforcement/armouring is required to stabilize eroding inlets and outlets, place appropriately-sized, clean rocks into the eroding area.
- Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

- Re-vegetate any disturbed areas and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible the site will be stabilized using effective sediment and erosion control measures (e.g., sand bags, rip rap or other such material).

### 2.11.2.3 Maintenance of riparian vegetation along the ITH right of way

The maintenance of the riparian areas along the ITH will be consistent with the DFO (2007) Operational Statement for the Maintenance of Riparian Vegetation in Existing Right-of-Ways (Appendix P).

- Maintenance activities (e.g., mowing, brushing, topping, slashing, etc.) will affect no more than one third (1/3) of the total woody vegetation, such as trees and shrubs, in the right-of-way within 30 metres of the ordinary high water mark in any given year.
- When practicable, alter riparian vegetation in the right-of-way by hand. If machinery must be used, operate machinery on land and in a manner that minimizes disturbance to the banks of the water body.
- When altering a tree or shrub that is located on the bank of a waterbody, ensure that root structure and stability are maintained.
- Stabilize any waste materials removed from the work site to prevent them from entering the water body including covering spoil piles with biodegradable mats or tarps. All long-term storage of waste materials should be kept outside of the riparian area.
- Re-vegetate any disturbed areas and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible the site will be stabilized using effective sediment and erosion control measures (e.g., sand bags, rip rap or other such material).

# 3 BORROW SOURCES

## 3.1 Description

Borrow sources have been identified for the construction and maintenance of the ITH. Specific pit development and management plans have been developed for each borrow source to conduct borrow operations safely and to minimize effects to the environment. The plans also support applications for permits from ILA and AANDC. The pit development and management plan describes the aspects of managing the borrow sources from the start of operations to final reclamation.

This section of the SECP supports these plans and provides specific sediment and erosion control measures to mitigate for

- melt water and run-off during spring and summer;
- site remediation and closure; and
- temporary winter access roads.

## 3.2 General Mitigation

Additional information can be obtained in Appendix D (Best Management Practices: Construction Practices, M1) and Appendix Q (Inuvialuit Settlement Region Pits and Quarries Guidelines).

- Borrow sites will only be accessed during winter.
- Snowfills or ice bridges at winter road watercourse crossing sites to the borrow sites will be in place prior to construction activities and removed and notched prior to the spring melt/freshet, were applicable.

## 3.3 Vegetation and Riparian Area

Vegetated areas immediately adjacent to a watercourse are referred to as riparian areas. These areas are valuable in maintaining fish habitat and stabilize stream banks, thereby reducing erosion and sedimentation into the watercourse. Additional information can be obtained in Appendix I (Riparian Zone Preservation BMP 6).

- Removal of vegetation will be limited to the borrow source;
- Removal of vegetation, excavation, or terrain disturbance will not be within 50 m of water bodies or watercourses; and
- The site will be allowed to re-vegetate naturally. Assisted re-vegetation may be required in erosion-prone areas, such as steep slopes, where re-contouring and natural re-vegetation cannot control erosion in the short term.

## 3.4 Permafrost

- Permafrost disturbance will be reduced by restricting pit operations to the winter months.
- At least 2 m of overburden or other suitable material will be placed on exposed ice surfaces to provide insulation.
- Positive drainage will be established and maintained to prevent the formation of an end-pit lake.

## 3.5 Blasting

- Blast rock will not enter a waterbody or watercourse.
- Drainage from blast areas will be directed away from any waterbody or watercourse.

## 3.6 Stockpiling

- Stockpiling of organic, overburden, and borrow materials will occur in a manner that minimizes erosion.
- Stockpiling of organic, overburden, and borrow materials will not affect natural surface runoff, even after site re-contouring.
- Stockpiling of organic, overburden, and borrow materials will allow for drainage of residual melt water from any excess ice-rich material, which may remain on site.
- Drainage from the pit including residual water must be directed away from a watercourse or waterbody.

## 3.7 Re-contouring

- A minimum thickness of 2 m of borrow material will be re-contoured to cover the massive ice, prior to replacement of overburden and organic material.
- Re-contouring will be conducted in a manner to not impede natural drainage.
- Site re-contouring will be conducted in a manner to prevent melt water runoff to adjacent waterbodies.
- Slopes within the reclaimed borrow source area will not exceed a slope ratio of 2 to1.

## 3.8 Winter Access Road

Temporary winter access roads will be required to access the borrow sources during construction and maintenance of the ITH. These winter roads will only be operational when the ground is sufficiently frozen and there is an adequate layer of snow to prevent damage to the ground by vehicles. Additional information can be obtained in Appendix E (Northern Land Use Guidelines: Roads and Trails).

- If removal of vegetation is required, it will be limited to the width of the right-of-way and vegetation will not be cut < 10 cm from the ground.

- During preparation of the winter road, machinery (e.g., bulldozer) blades will be raised off the ground and will use mushroom shoes or smear blades to avoid cutting the tops of hummocks, tussocks or high spots, which can lead to ground thaw and subsidence during spring.
- Temporary ice bridges or snow fills will be used at watercourse crossings and will follow the DFO Operational Statement for Ice Bridges and Snow Fills (Appendix K).

# 4 CAMPS

Temporary camps will be established at borrow sites and occasionally off the right-of-way. Depending on the season of construction and borrow source some camps may remain on site for one or more years. In other cases camps may be located for only one winter season at a location and moved during same season. No permanent camp facilities will be constructed. Further mitigation for camp facilities can be found in Northern land Use Guidelines for Camps and Support Facilities (Appendix R)

## 4.1 Set-up and Operation

- Sediment control measures at camp locations will be in place prior to set-up activities and the spring melt/freshet, were applicable.
- Machinery will be operated on land or on ice and in a manner that minimizes disturbance to the banks of any watercourse or waterbody.
- Camps which will remain on location over a summer period will be constructed on a durable surface, such as gravel or sand that is consolidated and can withstand repeated, heavy use.
- Winter camp operations will be located on built-up snow pads and the site can be watered down to provide a durable base of ice.
- Camps will be located in existing clearings to minimize new land disturbance where possible.
- A gently sloping site is preferable for camp construction and operations to allow surface water to easily drain from the site.
- Clearing of vegetation will be reduced as much as possible
- Areas of high ice content will be avoided such as patterned ground due to permafrost, fine grained soils including clays, due to high near-surface ground-ice content and sedge wetlands and peat lands.
- All heated camp structures will be elevated above the ground surface to allow air circulation and preventing permafrost thaw.
- Camps will be located on high ground when possible to avoid accumulation of wind drifted snow.
- Leave a setback of a minimum of 30 m between the clearing and a water body;
- Camp operations will not be conducted within 30 m of the ordinary high water mark of any waterbody or watercourse
- Use sediment and erosion control measures during and after construction to prevent entry of sediment into water.
- Retain as much riparian vegetation as possible.
- Stabilize stockpiled materials to prevent erosion.

- Regular maintenance is required to ensure drainage control structures remain effective. For example, trapped sediment should be regularly removed and properly disposed of to ensure that the structure continues to effectively filter sediment.
- Construct the camp area on a gradient so that water runs away from the camp and into the surrounding terrain.
- Structures to slow surface runoff, such as sediment curtains or straw bales, can be used for areas with high surface runoff.

## 4.2 Reclamation:

- Re-contouring the site to restore natural drainage patterns. If re-contouring is not feasible, a stable drainage control system can be constructed to prevent surface water from eroding the site.
- Water collection and diversion structures, such as ditches, water bars and check dams, will be used where required to maintain stable drainage of the site.
- Natural re-vegetation of the site should be encouraged to control soil erosion. This can be accomplished by spreading organic topsoil, stored during site construction, over the surface.
- Assisted re-vegetation may be required in erosion-prone areas, such as steep slopes, where re-contouring and natural re-vegetation cannot control erosion in the short term.

# 5 MITIGATION MONITORING

All sediment and erosion control measures will be monitored daily during construction and operation to ensure the mitigation techniques employed are functioning and maintained properly. In part, monitoring will be identified and required through regulatory approvals such as the NWT Water Licence and DFO Authorization. Mitigation measures that may not be working will be repaired or revised immediately. Monitoring not related to sediment and erosion control is identified in the FFHPP.

Monitoring will be conducted by GNWT DOT inspectors and employees, construction operators, community environmental monitors and environmental contractors.

Trained environmental monitors with the assistance of environmental contractors will monitor the construction of watercourse crossings and other activities along the ITH. The environmental monitor will check to ensure the proper mitigation is being used and to conduct turbidity and total suspended solids (TSS) sampling. Regular monitoring of select water crossings will be conducted as per Section 5.1.

During operation of the ITH, GNWT DOT inspectors or employees will visually check all water crossings for any potential issues on an almost daily basis. This includes assessing culverts or other crossing structures for blockages or sedimentation or erosion. If sediment is entering a watercourse or erosion is occurring at the watercourse crossing, appropriate immediate action will be taken to correct the situation. Measurements for turbidity and TSS will be taken as described below.

## 5.1 Turbidity/TSS Monitoring

Construction will occur mainly over the winter period when watercourses are dry or frozen to the bottom and waterbodies are frozen over. During these periods daily monitoring for turbidity and total suspended solids (TSS) will not be conducted as there is no water to measure from. If or when construction occurs at a watercourse during the open water season then hourly monitoring of turbidity and TSS will be conducted during that construction period. Turbidity and TSS can naturally occur at levels above CCME Guidelines for Aquatic Health; the measurements of these parameters, above, at, and below a watercourse crossing allows for the determination of potential increases in these parameters related to a crossing structure regardless if these conditions are above or below CCME guidelines. Monitoring of these parameters during open water construction and post construction are described below in Section 5.1.1 and 5.1.2.

### 5.1.1 Watercourse Crossings

#### 5.1.1.1 Construction Phase

- When measurements of turbidity and TSS are taken they will be measured at 50 m upstream, the crossing and 100 m downstream at all bridge, open bottom culvert and select culvert crossings. In addition to turbidity and/or TSS the following measurements may also be taken pH, dissolved oxygen, conductivity, and temperature.
- During construction of a watercourse crossing turbidity and TSS measurements in addition to other measurements mentioned above will be conducted on an hourly basis if water is present or construction is completed during the period of July 15 to September 15.
- An environmental monitor will be present on a daily basis when construction at watercourses is occurring.
- Prior to leaving a watercourse crossing site, the monitor will check the snow and surrounding area for any sediment or other material which may enter the watercourse during freshet or later and ensure if any sediment or material is found to have it removed immediately.
- Measurements will be taken during or immediately, after freshet during the construction phase and for the first two years of operation.

#### 5.1.1.2 Operational Phase

- If at any other time during routine highway inspections, sedimentation or erosion by watercourse crossing is identified, water monitoring will be activated immediately to have measurements taken at 50 m upstream and at the water crossing and 100 m downstream. If increased sediment load is identified occurring beyond 100 m sampling will be conducted further downstream at 100 m intervals until sediment levels reach accepted CCME guideline levels.
- Hourly monitoring will occur when any remedial action is taken at the watercourse crossing during the open water season.
- After 2 years and less than 10% of the watercourses have shown significant increased levels of turbidity or TSS during operation of the ITH, then only those crossings which have shown increased levels of sediment will be sampled,
- If 10% or greater of the water crossings monitored indicate significant increases in turbidity or TSS then all the watercourses will be monitored for at least another two years.
- During highway operations all water crossings will be visually inspected as part of the daily highway inspection by DOT.

### 5.1.2 Borrow Locations

- Waterbodies or watercourses immediately adjacent to a borrow source will be sampled prior to activity at the borrow location and and monthly after spring break-up until freeze-up for TSS and turbidity.
- Waterbodies adjacent to borrow sources will have continuous monitoring of conductivity.
- A visual inspection will be conducted of the borrow site for potential sources of sedimentation or erosion which may affect a waterbody or watercourse.
- If sedimentation or erosion is occurring and sediment is entering a watercourse or waterbody, hourly turbidity and TSS monitoring will be conducted until the problem is rectified.
- Water quality criteria will be determined in discussion with regulators

## 5.2 Reporting

Quarterly and annual reports of all monitoring activities related to sedimentation and erosion control will be prepared for the period of construction and for two years of highway operation. If additional monitoring is required other than routine inspections after the first two years of operation, annual reports will be prepared for these additional years. Reports will provide results of monitoring activities, indicate if any problems were identified, and describe how these problems were corrected.

# APPENDIX A DFO Fish Timing windows

# TIMING WINDOWS



Version 3.0

## NORTHWEST TERRITORIES IN-WATER CONSTRUCTION TIMING WINDOWS FOR THE PROTECTION OF FISH AND FISH HABITAT

Restricted activity timing windows have been identified for Northwest Territories lakes, rivers and streams to protect fish during spawning and incubation periods when spawning fish, eggs and fry are vulnerable to disturbance or sediment. During these periods, no in-water or shoreline work is allowed except under site-or project-specific review and with the implementation of protective measures. Restricted activity periods are determined on a case by case basis according to the species of fish in the water body, whether those fish spawn in the spring, summer, fall or winter, and where the water body is located.

Timing windows are just one of many measures used to protect fish and fish habitat when carrying out a work or undertaking in or around water. Be sure to follow all of the measures outlined in the Operational Statements to avoid negative impacts to fish habitat.

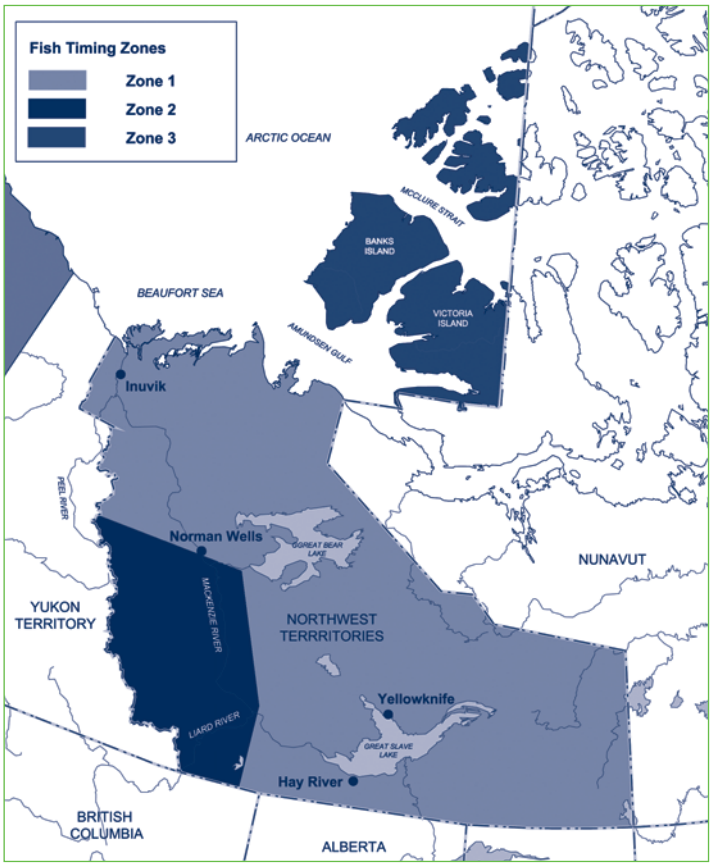



**Figure 1:**
**Fish Timing Zones for the Northwest Territories.**

### How To Determine Timing Windows

1. Determine the fish species living in the water body where you wish to do work. Consult with local organizations such as hunters and trappers committees, Renewable Resource Councils or your local Fisheries and Oceans Canada (DFO) office.

2. Determine if the fish living in the water body spawn in the spring, summer, fall or winter according to Table 1. There may be one or more spawning types in any given water body. For most water bodies in the NWT there are at least two spawning types. The spawning windows for multiple species should be observed.

3. Determine if the water body is in Zone 1, 2 or 3 according to Figure 1.

4. Using Tables 2 and 3, determine the in-water work timing restrictions according to the location of a water body (Zone 1, 2 or 3) and the type (spring/summer, fall or winter) of spawning fish. During these periods, in-water work (below the ordinary high water mark) is not permitted without site or project-specific review by DFO.

**Table 1:**
**General Range of Spawning Times in Northwest Territories.**

| FALL SPAWNERS | | |
|---|---|---|
| **Species** | **Range of Spawning Timing** | **Incubation/Hatch Time** |
| Lake Whitefish | Mid-September to mid-October | Late winter-early spring |
| Broad Whitefish | November | April-May |
| Round Whitefish | October-November | April-May (123-140 days) |
| Least Cisco | Late September to early October | May or June (break-up) |
| Arctic Cisco | Mid-September to early October | Spring under ice |
| Lake Cisco | September to November | Spring |
| Inconnu | Late September to early October | Spring |
| Lake Trout | Mid to late August | May-June |
| Bull Trout | Mid-August to October | Spring (around break-up) |
| Dolly Varden Char | September to early October<br>(Rat River - August 15 to late September) | 8 months (May or June) |
| Arctic Char | Late September to early October | April |
| Chum Salmon | September to October | 122-173 days |
| **SPRING/SUMMER SPAWNERS** | | |
| **Species** | **Range of Spawning Timing** | **Incubation/Hatch Time** |
| Arctic Grayling | Mid-May to early June | 8-32 days |
| Northern Pike | Early May to mid-June | Approximately 2 weeks |
| Walleye | April-June | 4-34 days |
| Yellow Perch | March-July | 8-20 days |
| Goldeye | Early May to early July | Approximately 2 weeks |
| Rainbow Smelt | April-May | About 29 days |
| Longnose Sucker | June | Approximately 2 weeks |
| White Sucker | June | Approximately 2 weeks |
| **WINTER SPAWNERS** | | |
| **Species** | **Range of Spawning Timing** | **Incubation/Hatch Time** |
| Burbot | December to mid-January | 30 days to 3 months |

**Table 2:**
**Timing Windows when In-water Activities are NOT Permitted, by Type of Spawning.**

| Zone | Spring/Summer | Fall | Winter |
|---|---|---|---|
| NWT Zone 1 | April 1 to July 15 | September 15[1, 2] to June 30 | December 1 to April 15 |
| NWT (SW corner) Zone 2 | April 1 to July 15 | August 15 to June 30 | December 1 to April 15 |
| NWT offshore islands Zone 3 | n/a | September 15[1] to June 30 | n/a |

NOTES: [1.] For lakes with spawning Lake Trout populations, the timing window begins earlier, starting August 15.
[2.] Dolly Varden in the Rat River begin spawning in mid-August and therefore the fall window for this system should be August 15 to June 30.

**Timing Windows for Water bodies Where All Spawning Types are Present or Fish Species NOT Known:**
If all spawning types are present, or if you don't know which species are in the water body, then Table 3 can be followed.

**Table 3:**
**Fish Timing Windows using All Spawning Types.**

| Zone | When In-water Activity Not Permitted | When In-water Activity May Occur |
|---|---|---|
| NWT Zone 1 | September 15 to July 15[1, 2] | July 16 to September 14[3] |
| NWT Zone 2 | August 15 to July 15 | July 16 to August 14 |
| NWT Zone 3 | September 15 to June 30[1] | July 1 to September 14 |

NOTES:
[1] For lakes with spawning Lake Trout populations, the timing window begins earlier, starting August 15.
[2] Dolly Varden in the Rat River begin spawning in mid-August and therefore the fall window for this system should be August 15 to June 30.
[3] For the Rat River and for lakes with spawning Lake Trout populations, the timing window when in-water activities may occur is July 16 to August 14.

**FISHERIES AND OCEANS CANADA OFFICES IN NORTHWEST TERRITORIES**

**Yellowknife Area Office**
Fisheries and Oceans Canada
Suite 101 – Diamond Plaza
5204 - 50th Ave
Yellowknife, NT X1A 1E2
Phone: (867) 669-4900
Fax: (867) 669-4940

**Inuvik District Office**
Fisheries and Oceans Canada
Box 1871
Inuvik, NT X0E 0T0.
Phone: (867) 777-7500
Fax: (867) 777-7501

*Aussi disponible en français*

**http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_f.asp**

DFO/2007-1329

# APPENDIX B Lessons Learned

# 1 LESSONS LEARNED FROM TUKOYAKTUK 177 ACCESS ROAD DESIGN AND CONSTRUCTION

## 1.1 Winter construction is viable.

While winter construction is difficult for both man and machinery, the experience of the Tuktoyaktuk 177 access road shows that material can be successfully sourced and placed in winter conditions.

Winter road access to borrow sites is not anticipated to be a concern.

The use of a side of embankment winter road to allow return traffic from the working face allows high truck delivery rates to be maintained without interference with returning trucks, while preventing damage to the original ground cover.

## 1.2 Drill / Blast works for Pit Development in Winter

Using drill / blast to excavate material from a source deposit in winter allows production rates sufficient to build the ITH project.

This production rate was a concern early in the Tuktoyaktuk 177 access road project, but has not proven to be an issue.

## 1.3 Placing Frozen Material in Embankment Works

Placing relatively dry frozen material in winter with minimal compaction does result in a reasonably stable embankment base. In particular, Tuktoyaktuk 177 access road, the embankments with larger fills show good stability in the near term years since completion of construction.

Early thaw in the surface layers with associated movements were dealt with adequately by grading and compacting the surface the summer following the winter placement of material.

## 1.4 Pit Selection is Important

Production from high moisture content sources in winter would be challenging, and is unlikely to be successful.

Material from the 177 pit with higher silt and moisture content came out as ‘nuggets’ which were pushed aside and allowed to thaw in the summer. Sources with higher moisture contents may require summer stockpiling to allow moisture to drain before winter placement.

## 1.5 Summer Shaping and Compacting of Winter Placed Material Works

Shaping side-slopes and grading and compacting the thawed surface layers of the embankment in the summer can produce a reasonable quality finished product.

## 1.6 Culvert detailing needs improvement for ITH project.

Issues such as end projection length, the possible use of insulation, design elevations with or without sub-cut, design glaciation levels, all need refinement.

It is anticipated that a design review incorporating senior design and geotechnical staff, together with senior DOT staff to review available methodology and construction technique be held prior to finalizing the design of the IT highway.

## 1.7 The use of a geotextile fabric Works

Geotextile between the embankment and the original ground is feasible with winter construction, and appears to achieve its intended purposes of maintaining roadbed stability and integrity.

## 1.8 Crossing polygonal terrain remains a challenge

Polygonal terrain may not be adequately addressed through strictly increasing roadway depth.

Prior to undertaking detailed design of the roadway embankment, a full thermal analysis of the embankment with different fill heights, side slopes, possible insulations, etc. needs to be completed.

The Tuktoyaktuk 177 access road design, as a lower speed access road, was constructed to a design 0.9 m minimum embankment depth, with the finishing gravel in place. The current as constructed roadway has a 0.7 m high minimum embankment depth and has no road surfacing gravels in place. This structural depth is much less than the 1.4 m minimum embankment depth proposed for the ITH.

The currently constructed roadway is, however, performing quite well in terms of stability in areas other than where there is polygonal terrain. The ITH design team may in fact be able to consider lowering the minimum embankment heights for ITH in light of how the Tuktoyaktuk 177 access roadway is currently performing.

## 1.9 Use of Fill Only Design Works

The use of a ‘fill only’ design section with no cuts in the traditional ditch areas adjacent to the embankment fully maintains the ground vegetation adjacent to the roadway. This intact vegetation cover provides excellent silt control for runoff from the roadway embankment, minimizing material transport into waterways.

## 1.10 Rip Rap Availability Remains a Concern

The lack of availability of rip rap for erosion control at crossings will be a challenge with construction of the ITH.

The Tuktoyaktuk 177 access road utilized rip rap from pits outside Inuvik, and from other sources outside of the project area. The cost of importing this material needs to be weighed

against the cost of providing other ‘manufactured’ types of erosion control for the project crossings.

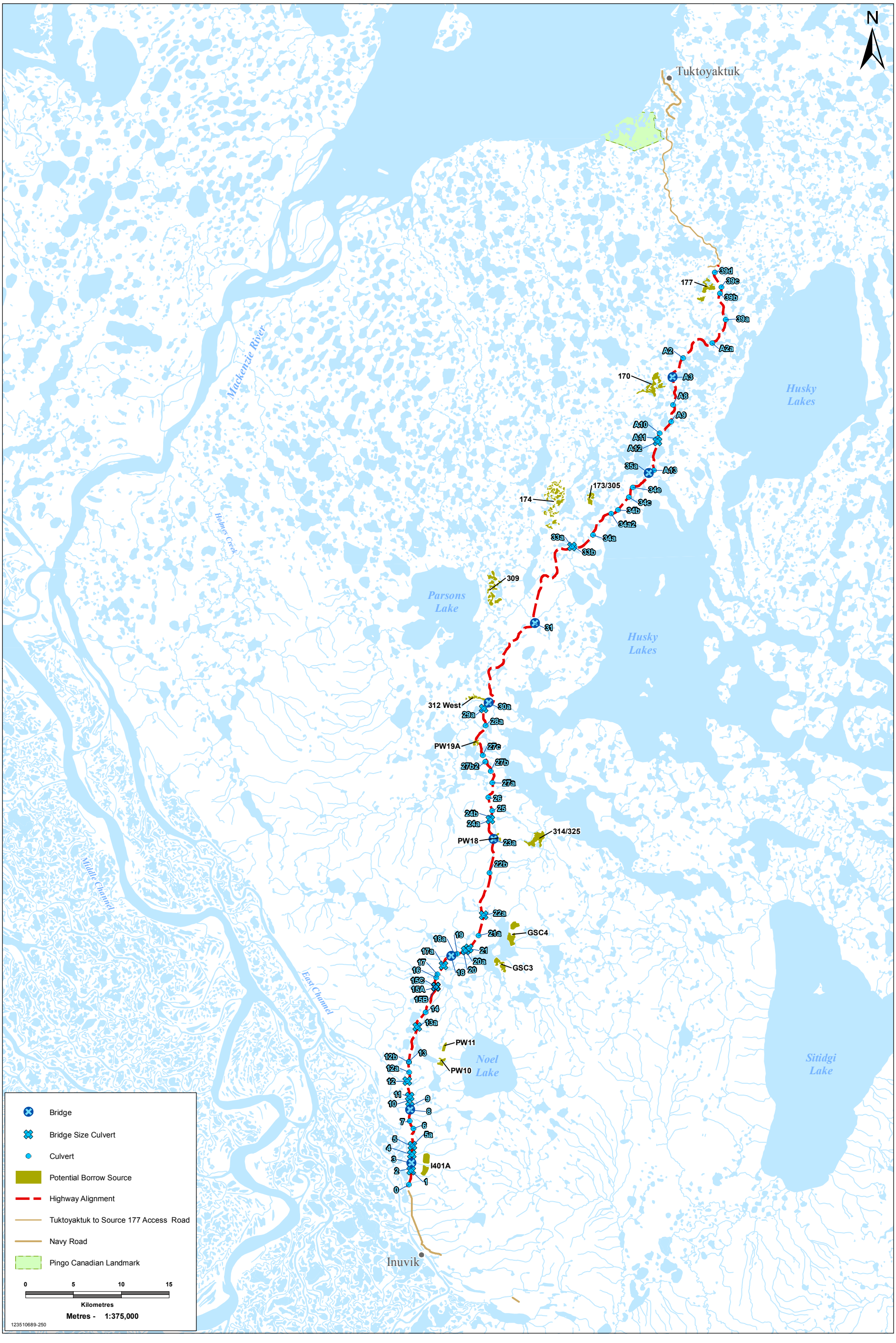
## 1.11 177 Culvert Erosion Control Works

The culvert erosion control end treatment of the Tuktoyaktuk 177 access road appears to be working well, and can be considered for use on the ITH.

The use of erosion control matting, together with silt fences and rip rap, will be recommended to be extended to the final highway project.

# APPENDIX C

## ITH Alignment Watercourse Crossing and Borrow Locations





INUVIK TO TUKTOYAKTUK HIGHWAY OVERVIEW

# ITH Alignment Watercrossings and Borrow Source Locations

*Base Data: Government of Canada; Watersheds: Government of Canada.*

PREPARED BY
Northwest Territories Transportation

PREPARED FOR
KAVIK-STANTEC

FIGURE NO.
**Appendix C**

Last Modified: September 4, 2013 By: jpetho

# APPENDIX D Construction BMP M1

# BEST MANAGEMENT PRACTICES

## *Construction Practices*

**M 1**

**FACTSHEET**



## DESCRIPTION AND PURPOSE

Work performed in and around water can potentially result in adverse effects on fish and fish habitat. These effects can be prevented by incorporating standard best management practices (BMP) into all work occurring in or near water. The BMP listed below should be used routinely for all watercourse crossing and maintenance projects.

## GENERIC BEST MANAGEMENT PRACTICES

### INSTREAM WORK

- Plan the project so that the amount of instream work is kept to a minimum
- Where possible, plan instream work to occur as a single event
- Restrict instream work to low flow periods where possible
- Limit machinery access to a single point on one bank
- Limit distance between machinery access point and work site
- Adhere to timing restrictions
- Minimize flow constriction
- Use instream pad built of washed gravel where instream equipment activity would generate excess sediment

### RIGHT-OF-WAY

- Keep right-of-way for watercourse crossings as narrow as possible within the constraints of safety and construction requirements
- Limit removal of vegetation to the width of the right-of-way
- Clear vegetation from unstable or erodible banks by hand, avoiding the use of heavy machinery
- Develop sediment control plans and install sediment control measures before starting work
- Inspect sediment control measures regularly and make necessary repairs immediately after damage has been discovered
- Stockpile top soil removed from the right-of-way outside of the active floodplain and use measures such as silt fences and holding ponds to prevent stockpile runoff from entering the watercourse
- Minimize the length of time that unstable erodible soils are exposed
- Direct runoff containing sediment away from the stream into a vegetated area
- Construct suitably sized settling ponds to precipitate suspended sediment before water is discharged into the watercourse
- Stabilize erodible soils as soon as practical by seeding, spreading mulch or installing erosion control blankets
- Allow at least 4 weeks of growing season when using seeding to stabilize erodible soils
- Maintain a vegetated buffer strip between the work site and watercourse except at the actual crossing location

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# BEST MANAGEMENT PRACTICES

## *Construction Practices*

**M 1**
**FACTSHEET**
2 of 3

## GENERIC BEST MANAGEMENT PRACTICES (CONT'D)

### MACHINERY

- Machinery should arrive on site in a clean, washed condition, free of fluid leaks
- Install stabilized entrances at vehicle and machinery access points
- Limit the amount and duration of instream work with heavy machinery. Work from the banks where possible
- Refuel machinery at locations well removed from the watercourse (maintain a minimum 100 m separation)
- Wash and service vehicles and machinery at locations well removed from the watercourse
- Work on instream pads composed of washed gravel to minimize sediment entrainment

### POTENTIALLY TOXIC MATERIALS

- Use bio-friendly hydraulic fluids in equipment operating in or adjacent to watercourse
- Store fuel, lubricants, hydraulic fluid and other potentially toxic materials at locations well removed from the watercourse
- Isolate storage areas so that spilled fluids cannot enter the watercourse
- Prepare a spill contingency plan
- Report all spills:

**AENV 24 Hour Spill Reporting Line: 1-800-222-6514**

- Ensure creosote treated and pressure treated lumber is completely dry (no evidence of seepage of treatment materials) before use in or near watercourse
- Lumber used in construction should be treated and painted at a site well removed from the watercourse
- Use bridge skirts or other appropriate measures to prevent material from entering watercourse when painting, cleaning or resurfacing bridge deck and superstructures
- Do not use ammonium nitrate-fuel oil (ANFO) based explosives

### COFFERDAMS AND BERMS

- Use cofferdams (earth fill, sheet pile or other proprietary designs) to separate instream work site from flowing water
- Use clean, washed material for construction and face berms with clean granular material
- Design cofferdams to accommodate the expected flows of the watercourse
- Limit cofferdams to one side of the watercourse at any one time and ensure that they block no more than one-third of the channel
- Restore the original channel bottom grade after removing cofferdams
- Treat all water pumped from behind the cofferdams to remove sediment before discharge

### TEMPORARY DIVERSION CHANNELS

- Construct temporary diversion channels in the dry, starting from the downstream end
- Design temporary diversion channels to accommodate expected watercourse flow from storm events (generally 1 in 5 year event, though the 1 in 2 year event may be used for non-critical situations)
- Use erosion control methods where appropriate

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Transportation

- Leave the existing channels untouched until the temporary diversions are constructed

## GENERIC BEST MANAGEMENT PRACTICES (CONT'D)

- Open diversion channels from the downstream end first
- Use clean, washed material to close existing channels and divert water to temporary diversion channels
- Use gradient controls to ensure that diversion channel slopes correspond to the existing channel gradients
- Protect unstable bends from erosion

### PUMPED DIVERSIONS

- Used where a channel must be completely blocked to allow work 'in the dry'
- Must not be used where there are fish passage concerns
- Intakes must be sized and screened to prevent debris blockage and fish mortality
- Pumping system should be sized to accommodate expected watercourse flow from storm events (generally 1 in 5 year event, though the 1 in 2 year event may be used for non-critical situations)
- Discharge point should be armored with clean rock to prevent erosion

### RECLAMATION AND SITE CLEANUP

- Begin reclamation and site cleanup as soon as construction has been completed
- Remove all waste material from the active floodplain
- Recontour, stabilize and revegetate disturbed areas to suit original conditions
- Remove all temporary facilities and structures
- Stabilize all slopes leading directly to the watercourse
- Seed exposed slopes immediately if there are at least 4 weeks remaining in the growing season. If this is not possible, slopes should be revegetated immediately in the next growing season

# APPENDIX E

## Northern Land Use Guidelines for Roads and Trails

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 05

# NORTHERN LAND USE GUIDELINES

## Access: Roads and Trails

Canada

# Table of Contents

# Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Vol. 01 Administrative Framework
- Vol. 02 Administrative Process
- Vol. 03 Applying Sustainable Development
- Vol. 04 Permafrost
- Vol. 05 Access: Roads and Trails
- Vol. 06 Camp and Support Facilities
- Vol. 07 Pits and Quarries
- Vol. 08 Mineral Exploration
- Vol. 09 Hydrocarbon Exploration
- Vol. 10 Other Land Uses
- Vol. 11 Abandonment and Reclamation

The series is available electronically at **www.publications.gc.ca**. Readers are encouraged to visit the site for updates and revisions to the series.

*For further information concerning the subject matter contained in this guideline series, please contact:*

## OTTAWA

Manager, Land Programs, Natural Resources and Environment Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudière
10 Wellington Street
Hull QC K1A 0H4
TEL: 819-994-7464 FAX: 819-997-9623
E-MAIL: NorthernLands@ainc-inac.gc.ca

## NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL: 867-669-2671 FAX: 867-669-2713
E-MAIL: NWTLands@ainc-inac.gc.ca

## NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL: 867-975-4275 FAX: 867-975-4286
E-MAIL: landsmining@ainc-inac.gc.ca

## YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below*:

Land Use—Lands Branch Department of Energy, Mines And Resources
Government of Yukon
Suite 320, Elijah Smith Building
300 Main Street
Whitehorse YT Y1A 2B5
TEL: 867-667-3173 FAX: 867-667-3214
E-MAIL: land.use@gov.yk.ca

# Acknowledgments

In the 1980s, Indian and Northern Affairs Canada published a series of six guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Regional Office staff and Northern Affairs Program staff in Ottawa. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

# Introduction

The purpose of this volume is to provide guidance on the construction and operation of roads and trails on Crown land in the Northwest Territories and Nunavut. If you are not operating on Crown land, it is your responsibility to contact the appropriate landowner for any land use guidelines that may be in place.

Due to the remote nature of the Northwest Territories and Nunavut, road construction is often required to conduct land use activities. This volume presents strategies for planning, constructing, operating and reclaiming roads in an efficient and environmentally responsible manner. Consultation with appropriate experts is recommended for specific engineering and geotechnical concerns.

CHAPTER
02

# Northern Roads and Trails



Roads and trails are often used to access land use activity sites in northern Canada due to the high cost and seasonal restrictions associated with travel by air or water. Existing road infrastructure is limited and access routes must often be planned and constructed before a primary land use activity like mining can begin. Development of a new access route in a remote, inaccessible area can have positive economic effects; however, it can also have negative impacts on land, water and cultural resources. Mitigation techniques should be outlined during the planning stage of road development to minimize potential environmental impacts.

Cold climatic conditions lead to the use of unique road-building techniques in the Northwest Territories and Nunavut. Winter roads that are constructed on frozen bodies of water and on frozen ground protected by layers of snow and ice are frequently used. The presence of permafrost in northern Canada requires different construction practices as surface disturbance can lead to permafrost melting and subsequent ground subsidence.

## 2.1 Classification

Roads are classified by season of use, size and purpose (Table 2-1). An all-season access road has a durable, all-weather surface that can be used by vehicles at any time of the year without damaging the land surface. A winter road is only operational when the ground is sufficiently frozen and there is an adequate layer of snow to prevent damage to the ground by vehicles.

## 2.2 Permitting

Most road or trail developments require a land use permit from the appropriate land use regulator. The application should include environmental background information and a description of the type of access, design specifications and development schedule. The application should also explain how identified environmental impacts will be avoided or minimized during construction and operation. If camps, quarries or pits are required during construction, the land use permit application should include details about these developments.

Proponents should discuss their proposed development with local Aboriginal groups and area land users. INAC and other regulatory authorities strongly encourage community engagement prior to and during the land use permitting process.

Other authorizations may be required depending on the nature of the development. The purpose of and the responsible authority for these authorizations is outlined in Table 2-2. Regulatory authorities should be contacted before applying for permits so that proponents understand the requirements and time frames necessary to obtain required permits. For more information on regulatory processes and applicable legislation, consult the *Administrative Process* volume of this series.

Table 2-1. All-season and winter road classifications

| ALL-SEASON ROAD | CHARACTERISTICS | EXAMPLE |
|---|---|---|
| Haul Road (logging road, forest road, local road) | • Connects developed resource areas to highways or communities<br>• Designed to carry heavy trucks at speeds of approximately 40 to 80 km/h |  |
| Access Road (pioneer road, fire road, spur road, shoo fly) | • Provides initial access to resource areas for exploration<br>• Requires minimal design work<br>• Designed to carry low traffic volumes at low speeds |  |
| Trail (push trail, cut line) | • Provides access for a limited duration<br>• Degree of clearing varies from merely pushing down vegetation to clearing a narrow right-of-way |  |
| **WINTER ROAD** | **CHARACTERISTICS** | **EXAMPLE** |
| Compacted Snow Road | • Winter use haul road<br>• Constructed of compacted snow and/or ice |  |
| Winter Access Road | • Constructed by dragging and levelling the surface to allow smoother travel<br>• Water may be used to build up ice for the roadbed |  |
| Winter Trail (push trail, cut line) | • Established for winter use by a single pass of a tracked vehicle using a blade, if necessary |  |

Table 2-2. Authorizations that may be required for road construction

| PERMIT | PURPOSE | RESPONSIBLE AUTHORITIES |
|---|---|---|
| Land Use Permit | Use and occupation of land associated with a road | • Indian and Northern Affairs Canada (Inuvialuit Settlement Region)<br>• Land and Water Boards (Mackenzie Valley – Northwest Territories)<br>• Indian and Northern Affairs Canada (Nunavut) |
| Water Licence | Use of water or deposition of waste into water, for example, water used to build a winter ice crossing or deposit sewage from a road camp | • Northwest Territories Water Board (Inuvialuit Settlement Region)<br>• Land and Water Boards (Mackenzie Valley – Northwest Territories)<br>• Nunavut Water Board (Nunavut) |
| Quarrying Permit* | Obtain granular materials | • Indian and Northern Affairs Canada |
| Quarry Lease* | Long-term access to granular materials | • Indian and Northern Affairs Canada (Nunavut only) |
| Fisheries Authorization | Work in fish-bearing waters, for example, installation of a culvert | • Fisheries and Oceans Canada |
| Timber Permit | Clearing timber prior to road construction | • Government of the Northwest Territories<br>• Government of Nunavut |
| Access Authorization | Access to and work on Aboriginal private lands | • Aboriginal private landowners |
| Access to a Public Highway Permit | Required prior to constructing a road that intersects a public highway | • Government of the Northwest Territories (NWT only) |

*In Nunavut, quarrying activities on Inuit-Owned Land must be authorized by the appropriate Regional Inuit Association.

FIGURE 1. Contact your local INAC resource management officer to discuss project options prior to applying for a land use permit.

CHAPTER 03

# Planning and Design

Proper planning will result in a road that uses the most suitable terrain, thereby reducing environmental impacts. A well-designed road will also result in efficient construction and operation.

Route selection is the first stage in the planning process and should be done before determining the type of access needed and associated road design. Existing and new environmental information must be gathered and used to determine what type of road is feasible and suitable given the environmental conditions. A systematic process should be followed for identifying alternative routes, evaluating these routes and choosing a preferred route based on consideration of all of the key planning issues.

The entire lifespan of the road should be considered during planning. For example, if a trail is likely to be upgraded to a haul road at a later date, the additional time spent finding a route with gentle grades, stable terrain and a minimum number of stream crossings will eliminate the need to construct an entirely new road in the future.

## 3.1 Site Conditions

### 3.1.1 Existing Information

Existing administrative and environmental information about the development area should be used to delineate the general area, the proposed location of the route and alternatives. Proponents are encouraged to identify and use existing roads where possible to reduce costs and the environmental footprint of the development.

Some examples of questions that can be answered using existing administrative and environmental information are listed below.

Administrative

- Who owns the land over which the proposed route will pass?
- Which land use regulators have authority over the land?
- Is the project within a region that has an approved land use plan?
- Who are other land users within the area (e.g. trappers, communities, tourism operators)?

Environmental

- What are the environmental and terrain conditions?
- Are there known environmental or terrain concerns within the area?
- Are land use, water quantity and water quality data available for the project area?
- Where is critical fish and wildlife habitat located within the area?

Some specific examples of information requirements and sources are outlined in Table 3-1.

Table 3 1. Information used for access route planning

| INFORMATION CATEGORY | INFORMATION SUB-CATEGORY | SOURCES |
|---|---|---|
| Environmental | • Topography and drainage<br>• Surface vegetation<br>• Sensitive landforms (e.g. pingos or eskers) | • Aerial photographs and maps<br>• Local INAC office<br>• Appropriate resource managers or regulatory boards<br>• Local operators and residents |
| | • Water management | • INAC Water Resources Division www.ainc-inac.gc.ca |
| | • Timber/forestry | • Government of the Northwest Territories, Environment and Natural Resources www.forestmanagement.enr.gov.nt.ca<br>• Government of Nunavut, Department of Environment |
| | • Fish and wildlife habitat | • Fisheries and Oceans Canada www.dfo-mpo.gc.ca<br>• Environment Canada www.ec.gc.ca<br>• Territorial environment departments |
| Engineering | • Road design<br>• Construction methods<br>• Water crosssings and bridges | • Engineers<br>• Examination of local roads<br>• Field investigations<br>• INAC resource management officer |
| Archaeological/cultural | • Location of archaeological sites and heritage resources<br>• Traditional use areas (e.g. berry-picking sites, traplines, cabins) | • Prince of Wales Northern Heritage Centre (Northwest Territories) http://pwnhc.learnnet.nt.ca<br>• Department of Culture, Language, Elders and Youth (Nunavut) www.gov.nu.ca/cley<br>• Inuit Heritage Trust (Nunavut) www.ihti.ca<br>• Field investigations |
| Reclamation | • Reclamation standards | • Local INAC office<br>• Appropriate resource managers or regulatory boards<br>• Territorial environment departments |

### 3.1.2 Field Investigations

Once a general area for the route has been identified, field investigations should be conducted to collect more detailed information on environmental conditions so that the final configuration of the route can be chosen. A combination of on-the-ground assessments and aerial reconnaissance should be conducted along the entire proposed route during both summer and winter to delineate the full range of environmental conditions. The ground and aerial assessments should provide information on topography, hydrology, soils, permafrost, geotechnical properties, wildlife habitat, and heritage resources. Field investigations will also identify areas that should be avoided or that will require special management. Pre-development field investigations also provide a baseline record of environmental data that will help in setting reclamation goals. All field data collected should be included in the land use permit application.

If a pit or quarry is needed to obtain construction materials for the road, specific field investigations should be carried out to determine if a suitable site is located within the area of the proposed route. Further information on pit or quarry development is available in the *Pits and Quarries* volume of this series.

### 3.1.3 Stable Terrain

High, dry and flat ground is an ideal location for most roads as these areas are blown clear of snow during winter, leading to frozen and stable ground. When thawed, these areas are typically well drained. It is not always possible to locate a road in ideal terrain, but ground that is particularly susceptible to erosion or subsidence should be avoided. Areas to avoid include:

- unstable slopes and slide areas;
- deep valleys because they retain snow that inhibits ground freezing; and,
- wet areas such as peatlands, wetlands, seeps and springs.

Except for stream crossings, water bodies should be avoided to prevent erosion and sediment deposition into the water. To prevent sedimentation and erosion, vegetated buffer strips of at least 30 m width are required to be left between roads and water bodies.

In tundra areas, roads are often situated on or near eskers because they are well drained and stable; however, eskers also provide critical habitat for wildlife. Known denning areas should be avoided when planning development on or near an esker.

FIGURE 2. Determine if existing roads can be used. Proper planning may have prevented the network of roads shown in this photograph.

FIGURE 3. Field investigations should be conducted in both the summer and the winter to ensure that the road is built with consideration for the full range of climatic and hydrological conditions.

FIGURE 4. In permafrost terrain, avoid road construction on patterned ground.

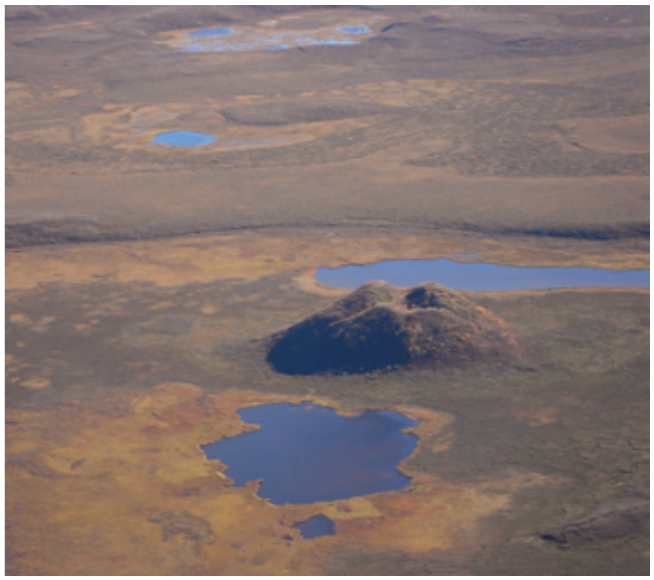

FIGURE 5. Pingos are ice cored hills that are unique to permafrost terrain. Vehicles and equipment are prohibited within 150 m of a pingo.



### 3.1.4 Permafrost

Some areas of perennially frozen ground contain significant amounts of ground ice. Disturbance of these areas should be avoided as they could melt and cause ground subsidence, potentially leading to soil erosion, instability of engineered structures and loss of habitat. Areas of ground ice are not always identifiable from surface features, so field investigations should be conducted to determine the extent and depth of permafrost and near-surface ground ice. In general, the following areas should be avoided in permafrost terrain due to high near-surface ground ice content:

- patterned ground;
- fine-grained soils, particularly clays; and
- sedge wetlands and peatlands.

Areas in permafrost terrain that have recently experienced a forest fire are prone to erosion, but a few years after the fire, once the ground ice has melted, these areas are more stable than older areas of unburned forest.

In discontinuous permafrost regions, it may be possible to avoid areas of permafrost altogether. Areas of black spruce trees or peatlands indicate the presence of ice-rich permafrost. Isolated patches of permafrost can also be cleared and allowed to melt prior to road construction. Further information on techniques to minimize permafrost disturbance is available in the *Permafrost* volume of this series.

## 3.2 Road Design

Once the location of the route has been determined, road design can be undertaken. Road design involves planning the road alignment, grades, embankments and surfaces, and requires an understanding of both local environmental conditions and transportation requirements, such as the purpose of the road, expected vehicle loads, frequency of use and duration of use.

The objective of road design is to construct a road that will be safe and minimize environmental disturbance. A well-designed road will be less prone to events that cause environmental disturbance and will require less maintenance to deal with issues such as wind-blown trees, blocked culverts, excessive rutting, washouts, ponding and bridge scouring.

For safety, road grades and curves must be suitable for all vehicles that will use the route. A wider right-of-way should be cleared on sharp curves to reduce the risk of accidents. Ideally, road grades should be less than six percent, which can often be accomplished by following the contours of the

FIGURE 6. Road grades and curves should be designed to be safe and minimize environmental disturbance. In this case, a wider curve and a lower grade would be safer and less prone to erosion.

land. Lower road grades will help reduce soil erosion and operating constraints as steeper grades often require large loads to be towed. In steep terrain, the use of lower road grades may increase the number of fills required and overall road length, so site-specific evaluations should be conducted to determine the best design.

The choice of proper road construction materials can also reduce operating and maintenance costs. Coarse-grained material should be used for road construction because it drains well and is less susceptible to frost heave. In wet areas, geotextiles can be used to distribute the bearing load and to prevent mixing of sub-grade materials with aggregates.

### 3.2.1 Drainage Control

Controlling drainage involves design aspects or structures that keep the road dry, including stream crossings. A detailed understanding of natural drainage patterns will assist in designing drainage control structures that will be appropriately sized for expected flows and will follow natural drainage courses. These measures will reduce erosion and ponding, resulting in lower long-term maintenance costs. The best time of the year to plan drainage control is during spring when all streams, seeps and springs are flowing. It is also important to understand high precipitation events during other seasons. If possible, a full year of observations is ideal. Important environmental factors to consider when determining expected flows and local drainage patterns include:

- total annual precipitation (rainfall and snowfall);
- high precipitation (storm) events;
- vegetation cover;
- topsoil and subsoil types; and,
- length of slopes.

Roads constructed in areas of soil with low infiltration rates, such as fine-textured silts and clays, will require more extensive drainage control measures as more water will be restricted to the surface. This is also the case in permafrost terrain where water is restricted to a thin active layer extending from the ground surface to the top of the permafrost. High precipitation events can lead to

erosive sheet flow. Rapid runoff from steep slopes is also a concern, especially on south- or west-facing slopes where snowmelt is more rapid. Non-forested areas may also be more susceptible to erosion.

Stream crossings are drainage control structures that should be particularly well planned as erosion and sedimentation into streams can affect water quality and fish habitat. A detailed watershed delineation should be completed for each stream crossing to determine the design requirements for a high flow, 100-year flood event. Once expected peak flows are understood, design considerations include:

- minimizing the number of stream crossings and using existing crossings where possible;
- selecting or constructing gently sloped approaches at right angles to the stream where the channel is straight, unobstructed and well defined, with a low bank height;
- locating stream crossings at sites with coarse-textured, well-drained material;
- locating stream crossings at least 500 m downstream of known fish habitat, such as spawning beds and rearing, feeding and overwintering sites; and,
- considering the high-water mark in the design of stream crossings.

Proponents should contact Fisheries and Oceans Canada and Transport Canada before conducting any stream crossing work to ensure compliance with regulations. More information on planning, constructing, operating and maintaining stream crossings can be found in the Canadian Association of Petroleum Producers' document *Pipeline Associated Watercourse Crossings* at www.capp.ca.

### 3.2.2 Visual Impacts

Where safety permits, the route should be designed to minimize its visual impact, especially in areas with high tourism or scenic value. The preferred mitigation technique is to avoid these areas; however, if avoidance is not possible, methods to reduce visual impacts include:

- minimizing long straight sections of road to reduce lines of sight; and,
- preserving a visual barrier between the route and public roads or streams by using buffer zones or doglegs.

## 3.3 Cultural, Subsistence and Recreational Values

Some areas of land are particularly valued for subsistence or recreational activities, such as traplines, hunting areas, canoe routes or tourism lodge sites. Aboriginal groups, territorial tourism departments, INAC resource management officers and local residents can identify sites of particular cultural, subsistence or recreational importance along a proposed route.

Representatives of existing interests, such as cabin owners or trappers, should be consulted during the planning phase so that their concerns can be addressed in the road design or alignment. The land use permit may also contain specific conditions to protect and minimize disruption to these existing interests.

FIGURE 7. Part of the planning process involves identifying and consulting with other land users near the proposed development.

## 3.4 Archaeological and Cultural Resources

Roads should be sited so that disturbance of archaeological and cultural sites is avoided. Archaeological and cultural sites should also be considered when constructing a winter road. The road corridor should be investigated during the summer prior to construction to identify potential archaeological or cultural sites. Territorial governments can provide information on documented sites through the Prince of Wales Northern Heritage Centre in the Northwest Territories and the Department of Culture, Language, Elders and Youth in Nunavut. Aboriginal

FIGURE 8. Verifying the route prior to construction can avoid unnecessary false starts such as this one

groups, communities and governments also have information on traditional-use areas.

If an archaeological or cultural site is discovered during construction, work in the area should be stopped immediately and the INAC resource management officer and territorial government notified. Signs of an archaeological site can include arrowheads, old encampments and evidence of buildings.

## 3.5 Verifying the Route

Once route planning has been completed and prior to applying for a land use permit, the entire route should be checked in the field and marked with flagging tape. Global Positioning System (GPS) coordinates should be recorded while in the field and provided to the INAC resource management officer. Verifying the route reduces the chance of building a road in an unsuitable area and the need to rebuild the road elsewhere, thereby reducing costs and minimizing the environmental footprint of the road. Marking the route with flagging tape before clearing begins also ensures that the clearing equipment operator can easily follow the intended route.

CHAPTER
04

# All-Weather Road Construction



This section outlines surface preparation activities and all-weather road construction methods. Clearing and construction should be scheduled when the ground surface is strong enough to support equipment without rutting or erosion. The proponent should contact the local INAC resource management officer prior to commencing construction. Construction should be suspended when conditions could result in serious erosion, such as heavy rainfall or when sub-grade soils are saturated. To avoid rutting and erosion in permafrost terrain, overland travel is not permitted during summer months and road construction should only take place during late fall or winter when the active layer is well frozen.

Field conditions encountered during road construction may require changes to the plan that was provided in the application for a land use permit. Prior to making these changes, the proponent should consult with the INAC resource management officer and the land use regulator to determine if the modifications require regulatory approval.

## 4.1 Surface Preparation

Surface preparation for a road includes removal of trees, shrubs and ground cover along the right-of-way prior to road construction. Clearing should be restricted to the approved right-of-way and to the minimum width necessary to conduct safe operations. Rights-of-way should be wide enough to allow road surfaces to dry quickly. If the right-of-way is too narrow, the road surface will be shaded and wet or icy, resulting in unsafe operating conditions.

Clearing vegetation is discouraged in some areas, such as permafrost terrain where the shade provided by vegetation may prevent ground thaw. Vegetation may also be left to provide a visual barrier between the road and a public highway or other land use. Buffers of uncleared land must be left beside water bodies to prevent erosion of riparian areas and the deposit of sediment into streams and lakes.

### 4.1.1 Trees

In forested areas, trees should be felled onto the right-of-way to minimize disturbance of the adjacent forest. Trees should be felled away from water bodies to avoid blocking streams and impacting water quality. Where it is safe and practical, standing live or dead trees along the route that provide wildlife habitat should be saved.

When clearing with a dozer blade, ensure that trees break off at the ground surface and avoid uprooting trees as this can tear the surface organic layer,

FIGURE 9. Proper scheduling of road construction will avoid rutting and erosion.

FIGURE 10. Clear only the minimum width necessary for road use.

exposing and thawing ice-rich mineral soil beneath. It may be preferable to hand cut trees instead. Remaining trees that lean over the right-of-way or into the adjacent forest should also be removed as they pose safety hazards and can tear the surface organic layer if they fall. The use of U-blades for clearing trees and other vegetation is discouraged as it usually results in a high number of pushouts on the sides of the route, which may cover brush below, causing a fire hazard.

Land use permits may include conditions for saving and stacking merchantable timber. In general, trees larger than 12 cm in diameter should be saved. For more information, contact the Department of Environment and Natural Resources, Government of the Northwest Territories or the Department of Environment, Government of Nunavut.

### 4.1.2 Shrubs

Once trees have been removed from the site, shrubs can be cleared. However, clearing of ground cover and the surface organic layer is strongly discouraged as it protects permafrost from disturbance and prevents erosion in non-permafrost terrain.

One of the least intrusive methods of clearing shrubs is to "walk down" the vegetation with a bulldozer blade at a fixed height. Small trees and shrubs are pushed down by the blade and the weight of the machine compresses the felled vegetation. This method of clearing is common for trails, such as seismic lines, where conventional wheeled vehicles will not be used. Some shrubs that have been walked down may not break and may recover during the following season, which will help prevent soil erosion and enhance vegetation recovery at the end of operations.

FIGURE 11. Brush can be walked down using a bulldozer.


FIGURE 12. A brush cutter can be used to cut and dispose of brush.

### 4.1.3 Brush Disposal

Once trees and shrubs have been cleared, the resulting brush should be cleared off the right-of-way. The brush disposal method used depends on the size of the right-of-way and the type of vegetation. The land use permit will often specify how brush is to be disposed of but, in general, brush should be disposed of progressively as clearing proceeds and disposal should be completed along the entire route prior to expiry of the land use permit. Brush should not be disposed of in or near water bodies. In some cases, brush can be salvaged and used to control erosion along the route. For instance, stacked brush on the downhill side of a slope can slow and trap sediment.

The lopping and scattering technique is used when vegetation that was pushed down during clearing does not lie flat on the ground. Branches are removed and stems are cut into lengths so that the vegetation lies flat on the ground, enhancing decomposition.

Windrowing and compaction involve piling cut brush in long rows on the side of the right-of-way and compacting the piles using heavy equipment to increase decomposition. Windrows should be placed at least five metres away from standing timber to reduce the hazard of a fire. Breaks of approximately ten-metre width should be left in the windrow at approximately 300-metre intervals to allow wildlife passage.

Brush can be disposed of by mulching with a wood chipper or a brush cutter. The resulting wood chips can be scattered on the ground and will decompose more rapidly than windrowed brush. This method reduces the risk of fire and the accumulation of snow on the right-of-way in comparison with windrowing.

Complete disposal of brush by burning is often required within the first 100 m adjacent to the intersection of a public road or water body. Brush piles should be placed in the middle of the right-of-way to minimize the risk of fire spreading to surrounding vegetation. Set fires must be monitored at all times. Burning should not be conducted in permafrost terrain with high ground ice content as it could cause ground subsidence.

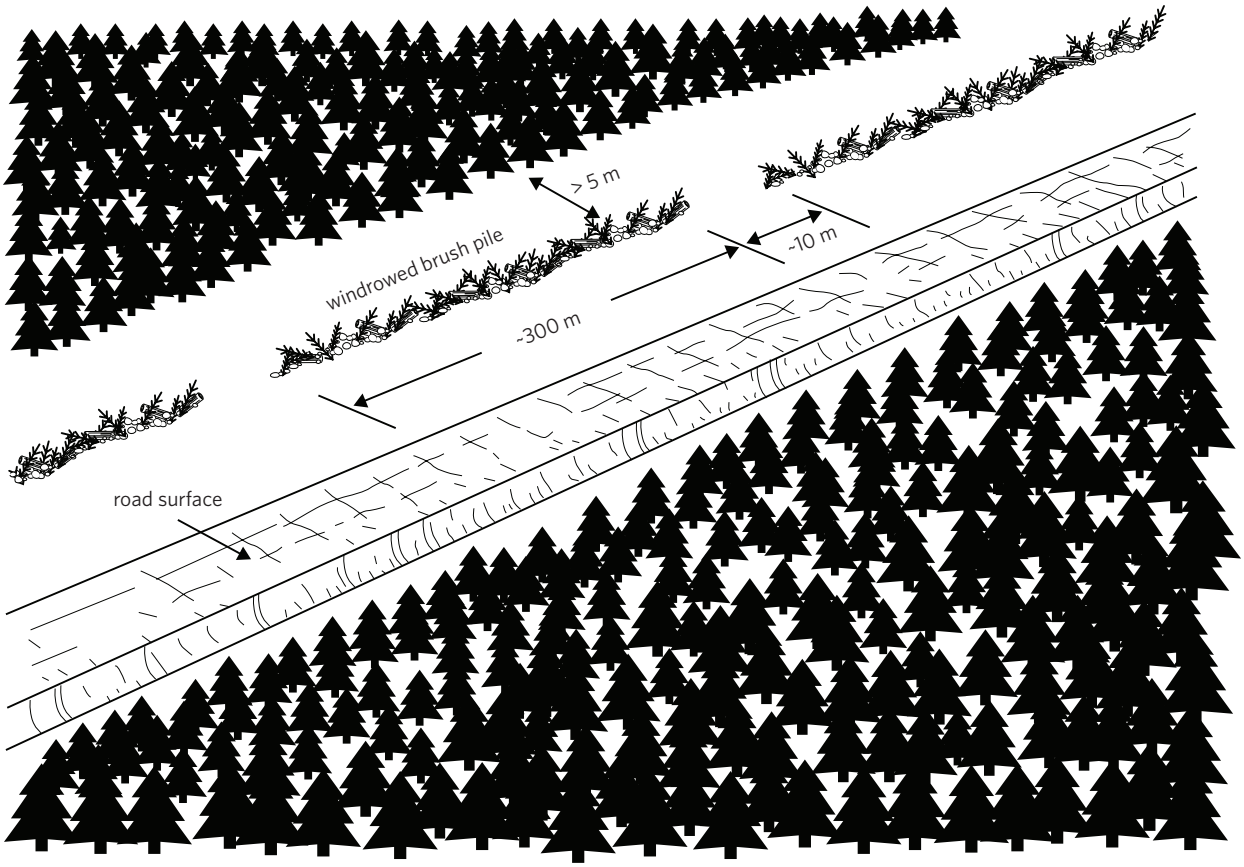


FIGURE 13. Openings of 10-m width left in windrows at 300-m intervals should ensure adequate passage for wildlife, and also reduce the fire hazard. Windrows placed at least 5 m away from standing timber reduce the risk of a fire. (1994 INAC Access Trails and Roads Guidelines)

### 4.1.4 Grubbing

Removal of stumps, roots and organic topsoil, known as grubbing, may be required to complete clearing for an all-weather road. Land use permits will often require the removal of tree stumps greater than 20 cm in diameter. To avoid erosion, grubbing should be minimized, particularly in areas of fine-grained soils or wet areas. If grubbing in fine-grained soils is unavoidable, it should be conducted during dry weather. Grubbing is not necessary for winter road construction or in areas where deeper fills will be used.

Disposal methods for grubbed material are the same as those for brush disposal, except for organic topsoil, which should be stockpiled separately from other materials for future reclamation use. Topsoil contains native plant seeds and organic matter that aid vegetation re-establishment. Stockpiles should be placed at a location that will not interfere with operations, will allow for the drainage of meltwater and will not be eroded by surface runoff.

FIGURE 14. Brush can be used as a sediment trap on steep slopes.

FIGURE 15. Improper disposal of brush in forest vegetation. Leaners should be cut down and brush windrowed.

## 4.2 Cuts and Fills

Cutting and filling is a road construction technique in which earth materials are excavated from one area and used to fill in an adjacent area to reduce the angle of a slope. Fills should use cut material from the upslope as cuts on the downhill side of a slope can lead to soil erosion. To ensure the stability of cuts and fills on slopes:

- Fill material should be compacted.
- The tops of cut slopes should be rounded.
- In unconsolidated material, the slope of the cut or fill should have a horizontal to vertical ratio of at least 2:1.
- Benches or breaks should be constructed on the slope to act as surfaces for revegetation.
- Rip-rap or cribbing should be used to slow surface runoff and erosion.
- Topsoil, seeds and mulch can be spread to enhance revegetation.

Cuts and fills should not be made on slopes in ice-rich permafrost terrain because they are prone to slumping. If a cut is unavoidable in permafrost terrain, the backslope should be nearly vertical to allow the ground to thaw and establish its own final position. A wide ditch at the base of the cut can contain the thawed material, which can be removed as required.

Fill from a borrow pit can also be used on level ground to protect areas prone to thawing and heaving, such as peatlands or other ice-rich permafrost terrain. To avoid disturbing the ground with road-building equipment, the fill should be end-dumped from an established roadbed.

## 4.3 Drainage and Erosion Controls

Drainage and erosion controls progress from relatively simple structures in flat terrain to more complex structures in steeper terrain. In flat areas, roads can be crowned so that runoff drains to either side of the right-of-way, leaving the surface dry. In areas with gentle slopes, roads should be outsloped so that the downslope side of the road is slightly lower than the upslope side to ensure effective drainage across the road. In steep or wet areas, water should be channelled into drainage control structures designed to carry greater volumes, such as ditches and cross drains.

FIGURE 16. The slope of this road has been reduced by fill excavated from the adjacent cut. Drainage and Erosion Controls



### 4.3.1 Drainage Control Structures

Parallel ditches are troughs that follow the road grade along the upslope side of the road to intercept water before it reaches the road. These are usually required for roads on steep slopes. To reduce erosion, parallel ditches should be constructed of coarse-grained material, and areas prone to erosion, such as ditch corners and discharge points, should be reinforced with geotextiles or rip-rap. To avoid sediment deposition into water bodies, ditches should drain into well-vegetated areas.

Cross ditches are shallow trenches that extend across the road in a downslope direction to drain ponded water from the uphill side or from the road surface. Cross ditches should extend beyond the right-of-way into vegetated areas to avoid scouring and soil erosion. The number of cross ditches required will depend on the length and slope of the particular road segment.

Berms are low mounds of earth fill that are constructed along the shoulder of a road in the path of flowing water to divert its direction and prevent erosion. Berms act as a dam and should be intercepted by cross ditches at regular intervals to allow water to flow away from the road.

Cross drains are pipes that extend through the roadbed to drain water from the uphill side of the road. These should be used on roads that are constructed of fill material with parallel ditches beside the road. To ensure that water will flow through them, cross drains should be located below the level of the parallel ditches. To prevent cross drain failure from frost heave, coarse-grained bedding materials should be used. The roadbed material should also be coarse grained and well packed to ensure that water does not erode around the cross drain. The cross drain should be properly sized and situated to accommodate the expected volume of water to prevent road washouts. The downstream end of a cross drain should not hang above the level of the ground as the resulting falling water will cause erosion below the outlet.

In areas of ice-rich permafrost, flowing water can lead to rapid thawing and erosion of the ground so water should be channelled under a road through cross drains rather than cross ditches on the surface. Cross drains can be stacked on top of each other to maintain drainage in the event that the lower cross drain freezes.

FIGURE 17. This cross drain is covered with coarse-grained granular material for frost protection.

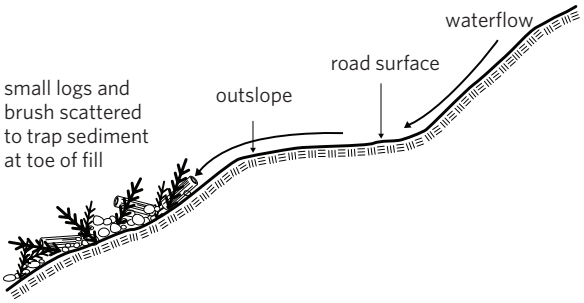


FIGURE 18. Sloping can be used to direct water off a road on a gentle slope. (modified from Hardy Associates (1978) Ltd., 1984)

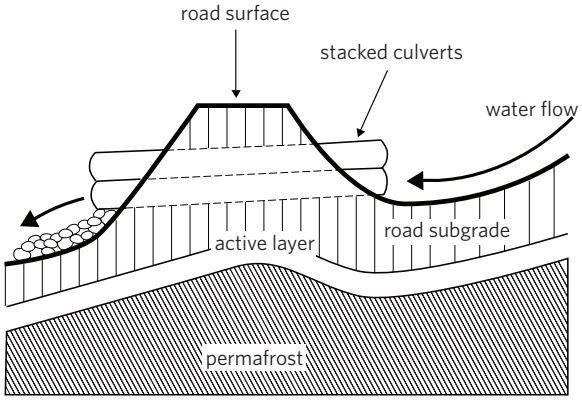


FIGURE 19. Stacked culverts can be used in permafrost terrain to ensure continuous drainage even if the bottom culvert becomes frozen. (modified from Hardy Associates (1978) Ltd., 1984)

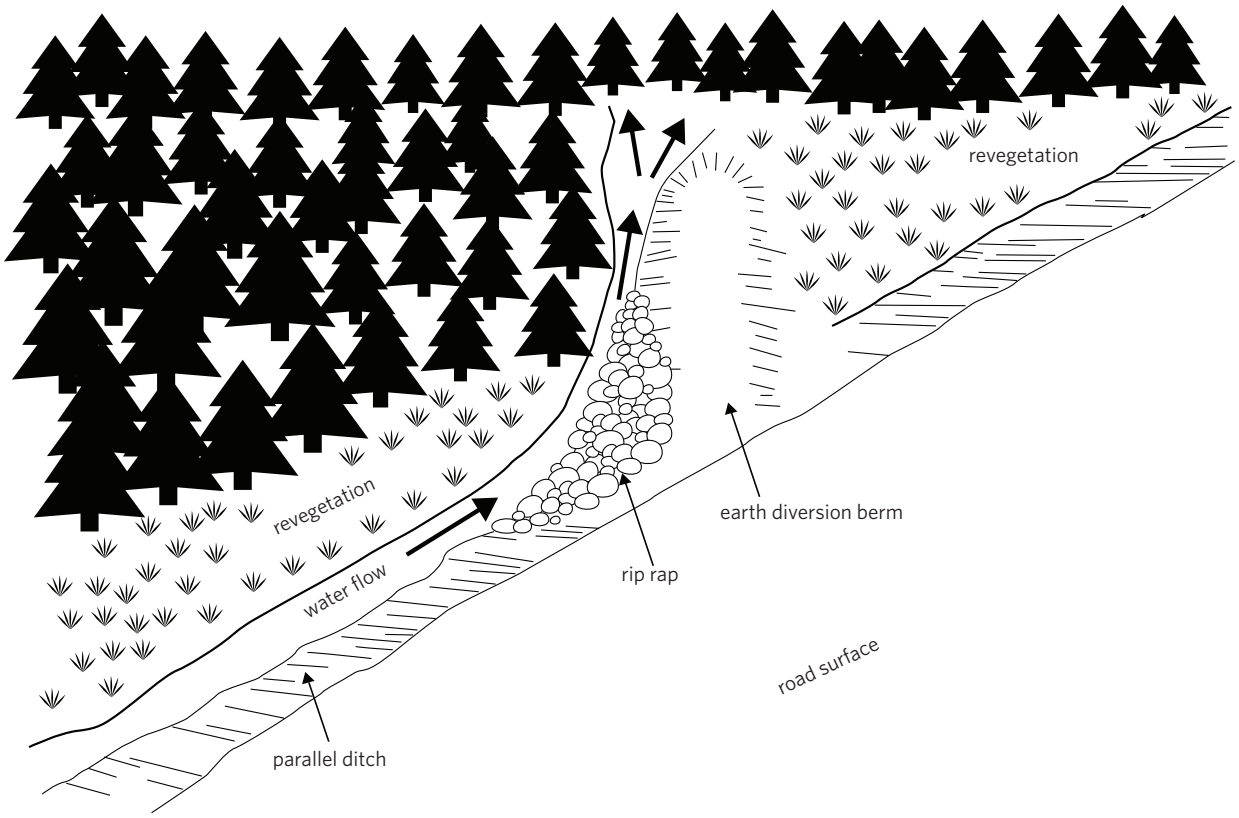


FIGURE 20. Diverting water away from the road and into a vegetated area at regular intervals will limit erosion and protect the roadbed. Directing runoff into a sedimentation pond is even more effective. (modified from Department of Transportation, Government of the Northwest Territories, 1993)

### 4.3.2 Erosion Control

Effective erosion controls, such as filter bags, silt fences or mats, can be used to slow runoff and reduce erosion where there is flowing water. In areas of higher velocity flow, such as ditches, ditch blocks can help control water speed and trap sediment. Ditch blocks are barriers to water flow that can be constructed of natural materials, including logs, cleared vegetation or rocks, or imported materials, such as sandbags. Spacing of ditch blocks should be determined by an engineer and will depend on the gradient and length of the ditch, soil texture and volume of runoff. Rip-rap should be used to armour the areas of highest velocity runoff, such as drainage channels and bridge abutments. Vegetation in ditches can also help control erosion and can be encouraged by seeding.

### 4.3.3 Drainage Icings

In cold weather, drainage control structures, particularly on slopes and at stream crossings, are prone to blockage by ice. Icings can also occur in flat terrain where areas of uneven snow removal or shading cause variable freezing of the active layer, forcing groundwater to the surface where it spreads and freezes. Pressure caused by icings can damage engineered structures and the build-up of ice on roads is a safety concern. If icings are observed, attempt to keep small channels thawed to promote continuous water movement.

Cross drains are particularly prone to icing. Methods to moderate this problem include:

- using open-ditch drainage;
- insulating cross drains;
- creating a frozen area above cross drains to block the winter flow of groundwater; and,
- installing a steam-circulating or electric-wire circuit in the cross drain to prevent freezing.

FIGURE 21. (Top) Ditch blocks and vegetation can be used to slow sediment movement in ditches parallel to the road.

FIGURE 22. (Middle) Silt curtains and matting can be used to control erosion near water bodies.

FIGURE 23. (Bottom) Icings can spread across a road and create a safety hazard.

## 4.4 Stream Crossings

Most roads will intersect several streams that will require various stream crossing methods. Stream crossings on all-weather roads can be temporary or permanent and include the use of fords, culverts or bridges. The use of logs for stream crossings is prohibited. The goal when building a stream crossing is to prevent erosion of riparian areas next to the stream and to avoid sedimentation into the stream as these situations could affect fisheries and wildlife habitat. There are several activities that should be avoided when constructing stream crossings:

- Minimize or eliminate in-stream activities as they tend to mobilize sediment, restrict stream flow or divert the natural stream course.
- Do not deposit soil or organic material into a stream.
- Avoid cutting stream banks to reduce the amount of sediment entering the stream.

Stream crossings should be located on stable ground at a narrow section of the stream with a gently sloped approach. Throughout construction, effective erosion controls, such as silt fences, should be used to prevent sediment from entering the stream. Engineered structures, such as culverts and bridges, should be installed progressively as construction of the road proceeds to eliminate the need for fording.

In-stream work may be required, for instance, to construct bridge abutments. While in-stream work is in progress, water-diversion channels or dams may be required to divert water from the stream bed. To allow fish passage, these structures should not block more than one third of the stream width and should be removed upon completion of construction. For more information on protecting fish and fish habitat while constructing stream crossings, refer to Fisheries and Oceans Canada at www.dfo-mpo.gc.ca.

### 4.4.1 Fording

Fording involves a vehicle travelling through a stream bed and may be acceptable under the following conditions:

- The crossing will not result in erosion and sedimentation into the stream or alteration (e.g. compaction or rutting) of the channel bed and banks.
- The stream bed is composed of non-erodible, coarse-grained material.
- Disturbance to riparian vegetation is minimized.

Fording should not be conducted in known fish-bearing streams, but if the crossing is unavoidable, fording should be restricted during spawning and migration periods. If sediment is inadvertently deposited into a stream, it must be removed immediately. The locations and proposed frequency of use of stream fords should be identified in the land use permit application.

FIGURE 24. Fording of this stream has resulted in rutting, sedimentation and erosion of the channel banks.

### 4.4.2 Culverts

Culverts are the most common stream crossing method for smaller streams. Professional engineering advice should be sought for installation of culverts to ensure that they are sized to accommodate the entire stream channel width and the highest annual flows. This will require a good understanding of local hydrology.

Culverts should be buried into the bed of the stream channel to a minimum of 20 percent of the culvert diameter at both the upstream and downstream



ends. This will promote the deposit of natural stream bed materials on the bottom of the culvert to maintain fish habitat and ensure that the water depth inside the culvert will be level with the water depth in the stream. Culvert alignment should approximate the existing stream channel alignment to mimic the natural stream flow, which will prevent bank erosion and channel scour. Culverts should extend a short distance beyond the toe of road fill material to prevent blockage at the end of the culvert by eroded soil. Granular material should be placed on top of the culvert to a minimum thickness of half the diameter of the culvert to prevent damage from vehicles travelling over.

In permafrost terrain, warm air circulating through culverts during summer may lead to thawing of permafrost in the roadbed and ground instability. To prevent thawing of permafrost, insulation can be placed around culverts during installation or flexible covers can be placed on the ends of large culverts to reduce the circulation of warm air. These covers should be removed in early winter to accommodate high water levels in the spring.

### 4.4.3 Bridges

Large, fast-flowing streams may require the construction of a bridge. Professional engineering advice should be sought for placement and construction of a bridge. Bridges should be high enough to permit the passage of water during periods of peak flow and ice during breakup. Sufficient clearance is also required in navigable waterways, and more information can be obtained from Transport Canada at www.tc.gc.ca. Bridge supports should be aligned to direct flow away from stream banks, but where this is not possible, banks should be armoured. Portable bridges are most appropriate for temporary roads because they can easily be removed, resulting in minimal disturbance to the stream.

FIGURE 25. (Top) A portable bridge is most appropriate for stream crossings on temporary access roads.

FIGURE 26. (Left) Incorrect sizing of culverts can lead to erosion and damage to the road.

FIGURE 27. (Right) Bridge abutments should be constructed out of the flood plain to avoid erosion and restricting stream flow.

CHAPTER 05

# Winter Access

Roads and trails that are only used during winter, when the ground is frozen, are common in the North. Frozen ground is much harder than unfrozen ground and can withstand greater vehicle loads as the formation of ground ice increases soil strength. A surface layer of snow also protects the ground surface from rutting and the potential for thermokarst erosion. In winter, the frozen surfaces of lakes and rivers should be accessed, where possible, to reduce impacts on the land.

All-terrain vehicles and tracked vehicles can be used on all types of winter access routes but, because of their higher ground pressure, conventional wheeled vehicles should only travel on compacted snow or ice roads.

## 5.1 Surface Preparation

In some cases, it may be necessary to clear trees or brush from the route. Brush can be used as fill in wet areas. Brush can also be used to insulate permafrost terrain, but this technique should not be used for all-weather roads as decomposing vegetation can destabilize the roadbed.

Before winter road construction can proceed, the ground should be frozen and there should be sufficient snow cover to protect the ground surface from the tires or tracks of vehicles. The land use permit will specify the minimum snow depths and the timing of vehicle access to ensure the ground is frozen.

Once vehicles are permitted on the road, some surface preparation, such as snow clearing and packing, is usually required to enhance ground freezing and protect the ground surface. The amount of surface preparation required depends on weather conditions, size of vehicles using the road and frequency of vehicle use. A small-scale winter trail may not require any surface preparation if it is to be used by low ground pressure vehicles for only a few passes.

When clearing or packing snow, bulldozer blades should be raised off the ground using mushroom shoes or smear blades (Figure 34) to avoid cutting the tops of hummocks, tussocks or high spots, which can lead to ground thaw and subsidence during spring. The road should be allowed to settle for a few days after the first compaction before allowing traffic as compacted snow gains strength

FIGURE 28. A smear blade raises the bulldozer blade off the ground surface.

FIGURE 29. A low ground pressure vehicle, such as a snowcat, can be used for a first pass to compact snow on a winter road.

with time. Snow windrows on either side of the road created by snow clearing should have breaks at regular intervals to allow wildlife passage and drainage of meltwater in the spring.

To build a more durable road that can accommodate heavy vehicles, water can be sprayed on the road to create ice layers that build up the road surface and protect the ground. Alternatively, the strength of the snow layer can be enhanced by disaggregating the surface layer and then repacking it and allowing it to harden. Disaggregating snow by tilling or running it through a snow blower will result in a stronger road surface.

In areas where there is not enough snow to protect the ground surface and vegetation, snow can be hauled from nearby water bodies, captured using snow fences or manufactured using snow-making machines, then spread along the road and compacted. When there is a lack of snow over a wider area, an aggregate ice road can also be constructed. Blocks of ice can be mined from adjacent lakes and end-dumped to form the road base. Water can then be sprayed on the blocks to bond them together.

FIGURE 30. The road surface can be built up with ice using a water truck with a sprayer.

## 5.2 Scheduling

### 5.2.1 Opening

Commencement of winter road construction depends on air temperatures and snow conditions. The opening date is usually designated in the land use permit (generally November 15), but can be changed at the discretion of the INAC resource management officer depending on weather conditions. After the opening date, the road can be opened to lightweight tracked vehicles that will compact snow on the road surface to enhance ground freezing. Pre-packing the snow will also minimize disturbance to the ground surface associated with using drags or blades. There should be at least 10 cm of compacted snow on the road before heavier wheeled vehicles are permitted to operate.

### 5.2.2 Closing

Winter roads should be closed before the ground thaws and vehicle travel causes rutting. The closing date is usually designated in the land use permit (generally April 15), but can be changed at the

discretion of the INAC resource management officer depending on the road and weather conditions.

Melting usually occurs first on south-facing slopes, stream approaches and road sections with dark surfaces, and these are good indicators that road closure is imminent. Sufficient time should be allowed for road closure, including the removal of all equipment and stream crossings. As air temperatures approach 0˚C, the frequency of road inspections should be increased to ensure that the road is shut down before rutting occurs. With approval from an INAC resource management officer, road use may sometimes be extended a few days past the closing date by allowing vehicle travel at night when temperatures are below 0˚C.

FIGURE 31. (Top) Winter roads are not ready for use by heavy wheeled vehicles until there is at least 10 cm of packed snow. Visible grass on this road indicates that there is less than 10 cm of snow.

FIGURE 32. Ponded water and a lack of snow indicate that the ground is thawing and this winter road should be closed immediately.

## 5.3 Water Use

Roads used by heavy vehicles during winter months can be strengthened by applying successive layers of water. Applying many thin layers of water to the roadbed and allowing them to freeze will result in a harder surface than building a road using several deep layers of water. An ice road surface can provide the following benefits:

- a smoother road surface requiring less maintenance;
- better protection of the ground surface; and
- a longer road life.

If water is required for winter road construction, a water licence may be required and water withdrawal protocols prescribed by Fisheries and Oceans Canada should be followed.

## 5.4 Ice Roads on Water Bodies

Ice road construction on bodies of water can be easier, more cost effective and have less environmental impact than winter road construction on land. The Government of the Northwest Territories' *A Field Guide to Ice Construction Safety* provides guidelines for appropriate ice thicknesses for winter roads on bodies of water.

## 5.5 Stream Crossings

Stream crossings for winter roads range from simple fills to engineered structures, including snow fills, ice bridges, culverts and bridges. All crossings should be located along gently sloped stream banks to minimize soil erosion. Ice and snow thickness should be sufficient to protect the stream banks from erosion (minimum 10 cm). Clean snow should be used to construct approaches to crossings and fills to ensure that debris does not enter the stream during spring.

Snow fills are the smallest scale winter stream crossing and involve compacting snow in the stream bed to create a road surface. They should only be used in streams that freeze to the bottom and should be removed, or notched, in the spring so that they do not impede stream drainage.

For streams that develop a solid ice cover, but do not freeze to the bottom, an ice bridge can be built to cross the stream. An ice bridge can be built by removing snow from the ice surface to increase the

FIGURE 33. A well-constructed snow fill located adjacent to a new bridge.

FIGURE 34. A poorly constructed snow fill consisting of mixed brush and snow.

FIGURE 35. An ice bridge built over a large stream channel.

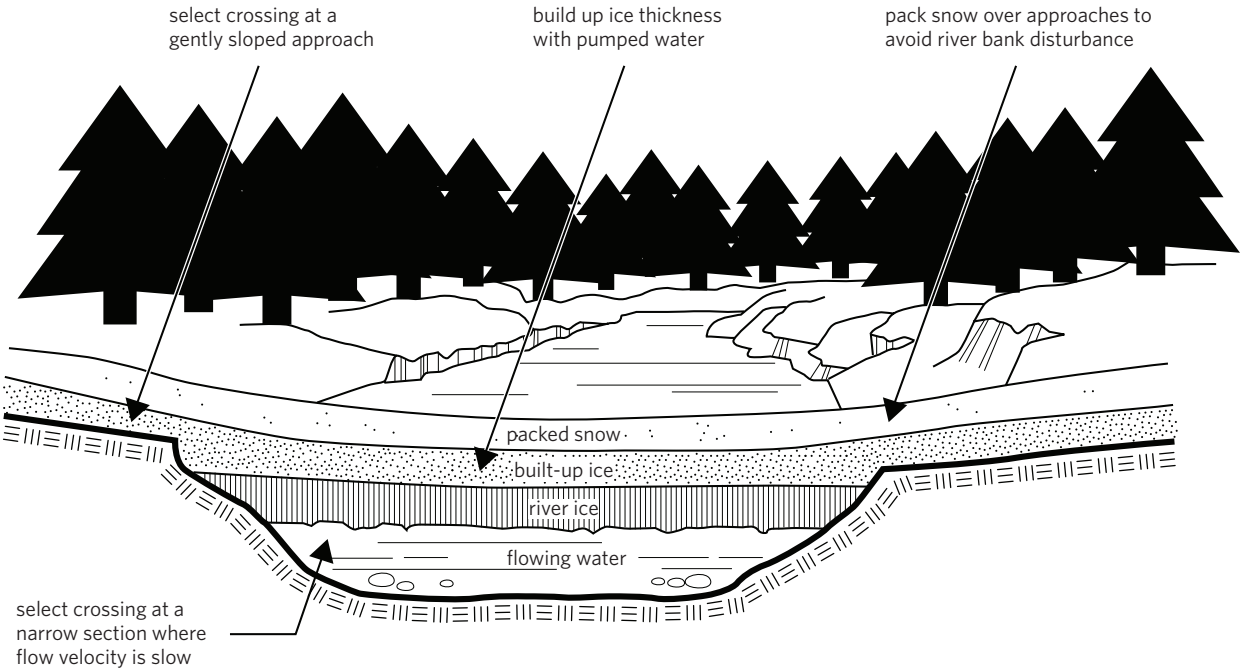


FIGURE 36. Typical ice bridge location and construction. (modified from Deparment of Transportation, Government of the Northwest Territories, 1993)

ice thickness. Water can then be used to increase the ice thickness in successive shallow layers. The Government of the Northwest Territories' *A Field Guide to Ice Construction Safety* recommends appropriate ice thicknesses for stream crossings.

Ice bridges must not obstruct the flow of water in a stream by causing it to freeze to the bottom. The resulting dam could create an icing that would spread beyond the stream banks, damaging both vegetation and the road. Overwintering fish and aquatic mammals would also be negatively affected. More information on protecting fish and fish habitat while constructing a snow fill or ice bridge is available from Fisheries and Oceans Canada at www.dfo-mpo.gc.ca.

As an alternative to ice bridges, pipe culverts can be placed in streams that do not develop a solid ice cover. Culvert installation must be preplanned and carried out during summer as described in Section 4.4.2. For fish-bearing streams, however, bridges or arch culverts, are preferable to the use of pipe culverts to maintain fish habitat. These bridges retain the natural stream bottom and slope.

All snow, ice and other construction materials associated with a stream crossing, including culverts, must be removed from the stream bed in the spring before freshet to allow free passage of water and fish. Removal of stream crossings should occur progressively along the right-of-way as the winter road is closed to minimize in-stream work. In some cases, a v-shaped notch cut into the middle of the stream crossing will allow for the passage of water and result in removal of the rest of the snow or ice during the spring freshet.

CHAPTER 06

# Operations



Operations include the establishment of operating conditions that protect the route, such as weight restrictions, and regular monitoring and maintenance that ensure the route continues to function with minimal impact on the environment.

## 6.1 Operating Conditions

Operating conditions for road use, such as appropriate vehicle loads and operating times, should be established to protect the integrity of the road and the safety of its users.

During wet periods, roads can become soft and rutting is more likely to occur. To preserve the roadbed, vehicles should keep off road shoulders and out of parallel ditches. In extremely wet conditions, the road should be closed to traffic.

Load limits can be implemented on roads to avoid rutting and should be based on road engineering specifications and local experience. On all-weather roads, limits are commonly used during spring when the road is saturated and its load-bearing capacity is at a minimum. Limits should account for vehicle speed, weight and frequency of vehicle loads. Load limits on winter roads may be based on the depth of the snow cover. For winter roads that cross over water bodies, limits can also be based on the ice thickness, how the ice formed and water pressure below the ice.

Dust suppressants are used to maintain visibility on roads during the summer months. Where possible, water should be used as a dust suppressant and the use of water may require a water licence.

Dust suppressants should only be used with the approval of the appropriate land use regulator, territorial environment department and INAC resource management officer. Proponents may be required to notify the public and property owners in the area. For more information on dust suppression techniques, review the Government of the Northwest Territories' *Guidelines for Use of Dust Suppressants on Commissioner's Land in the Northwest Territories* or the Government of Nunavut's *Environmental Guideline for Dust Suppression*.

## 6.2 Monitoring and Maintenance

Regular monitoring of a road will allow for continual assessment of its performance and quick identification of areas that need to be repaired. The frequency of monitoring depends on the size of the road, its use, and potential risks to users and the environment. Typical monitoring activities include observation of drainage and erosion control structures, and stream crossings. Observations should also include current weather conditions and their effect on the route.

Regular maintenance is required to protect the structural integrity of the road and the cleared right-of-way, maintain drainage control structures and minimize erosion. Regular maintenance activities include:

- cleaning or repairing drainage and erosion control structures;
- grading the road surface to minimize rutting, potholes or channelling of water;

FIGURE 37. Regular monitoring will identify areas prone to erosion that may need to be redesigned.

- removing vegetation that overhangs the road to enhance drying and visibility; and
- maintaining vegetation or revegetating slopes and ditches to minimize erosion.

Well-documented monitoring and maintenance logs can be used to identify long-term trends and problem areas along the road that may need to be redesigned.

#### 6.2.1 Drainage Control Structures

The performance of drainage control structures should be monitored after their installation, particularly during periods of high runoff, such as the spring freshet or heavy rainfall events. Scouring, flooding and displacement of rip-rap in ditches and berms are indicators that the structure is inadequate and should be upgraded as soon as possible. In some areas, natural drainage patterns may not be noticeable until after the road has been constructed and erosion or ponding occurs. In these areas, drainage structures will need to be added as problems are identified.

The structural integrity of bridges and culverts along the road should be assessed regularly. The morphology of the stream channel should also be monitored as any changes may affect bridge or culvert performance. Bridges and culverts should be inspected and cleaned regularly. During winter, culverts should be checked regularly for icing.

#### 6.2.2 Permafrost Terrain

Drainage patterns in flat permafrost terrain are difficult to delineate because of gentle slopes and low precipitation rates. During summer, groundwater is confined to a thin active layer above the permafrost and may drain laterally across a road surface. Due to these difficulties in planning for drainage, post-construction monitoring of drainage control structures is particularly important in permafrost terrain to determine if more drainage structures are required.

Filled areas built on ice-rich permafrost can be subject to uneven thawing of the foundation soil, especially if they are constructed of fine-grained soil. Differential settling can lead to significant lateral spreading, cracking or sloughing of the embankment side slopes. Regular monitoring and maintenance are required to identify, fill and level affected areas.

FIGURE 38. Culverts should be monitored and cleaned regularly to ensure that they continue to function properly.

FIGURE 39. Regular monitoring will identify areas where drainage controls are inadequate and need to be redesigned.



### 6.2.3 Snow

Clearing fallen or wind-blown snow is a routine maintenance activity required to allow the passage of vehicles. Best practices for clearing snow include:

- staking or flagging culverts and berms to avoid damaging them;
- creating breaks in snowbanks at regular intervals to allow wildlife passage; and
- removing snowbanks before freshet to allow the road to drain.

Normal traffic use of a road during winter will eventually cause washboarding, which can increase vehicle wear and damage. This can be prevented by grading and dragging the snow.

Throughout winter, and especially during spring, the entire road surface should be kept covered with white snow because soil on the road surface absorbs heat, accelerates ground thawing and reduces the length of time the road can be used during spring. Bare spots should be covered with snow as soon as possible. Soil should not be mixed with snow for use as fill.

## 6.3 Access Management

At times, it may be necessary to restrict or manage access to a road or trail, particularly if there are health, safety or wildlife concerns. Further information on access management strategies can be obtained from the local INAC resource management officer.

FIGURE 40. Differential settlement can occur in ice-rich permafrost terrain.

FIGURE 41. Clearing snow is part of routine winter road maintenance.

CHAPTER 07

# Spills

Spills can involve chemicals, hydrocarbons or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line at 867-920-8130. A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* at www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp

## 7.1 Spill Contingency Plan

A spill contingency plan must be in place during all phases of road construction and operation, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help operators respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how operators should respond to a spill, resources available on-site for spill response, and agencies and individuals that need to be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning*.

## 7.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when it is not in use to catch hydrocarbon drips.

## 7.3 Spill Response

Spill response includes stopping, containing and reporting a spill event. A well stocked spill response kit should be available on-site. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

FIGURE 42. Unexpected spill events do occur and a spill contingency plan will ensure that all operators are prepared to respond to them quickly and effectively.

CHAPTER 08

# Closure and Reclamation



## 8.1 Reclamation Goals

The key question that should be considered when defining the reclamation goals for a road is whether it will be used in the future for a different purpose or whether it will be permanently decommissioned. The route should be designed with the final end use in mind. Reclamation goals will require the approval of the appropriate regulators, and should be discussed with community members and Aboriginal groups.

Reclamation goals will form the core of the closure and reclamation plan that will be required by the applicable land use regulator for roads that are being decommissioned. These plans are not usually required for trails. Reclamation requirements will be specified in the land use permit.

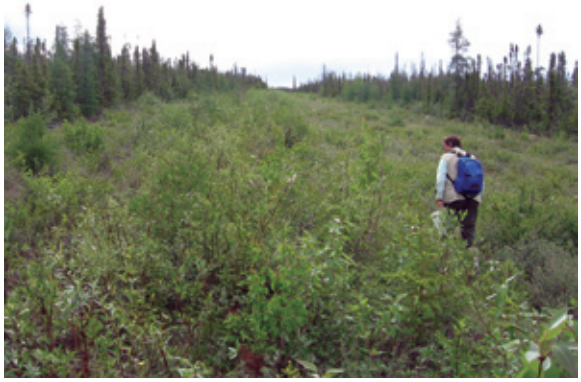

FIGURE 43. A reclamation goal could be to return the land to a stable condition by revegetating the site.

## 8.2 Reclamation Activities

Progressive reclamation should be conducted throughout construction and operation to reduce soil erosion and the length of time a site is disturbed. This can include activities such as revegetating ditches and reclaiming unused sections of roads, quarries and shoo flys. Reclamation of the cleared right-of-way adjacent to the road can be helped by leaving tree roots and shrubs in place during clearing and scattering brush to create micro-sites for native seeds.

Final site reclamation will occur when the road is no longer required. Monitoring after reclamation activities are complete will determine if reclamation has met the goals specified in the closure and reclamation plan. Monitoring the performance of progressive reclamation efforts during operations may shorten final reclamation monitoring requirements if they are found to be successful.

### 8.2.1 Remove Structures, Equipment and Garbage

During reclamation or extended shutdown of operations, all garbage, petroleum products and equipment should be removed from the road. For final reclamation, buildings should also be removed. If the road is being permanently decommissioned, culverts should be removed carefully to avoid sedimentation, and the stream bed and banks should be re-established. Where culverts are removed, cross ditches should be constructed across the road to maintain drainage.

FIGURE 44. This reclaimed site is well contoured and revegetated, but the culvert should be removed.

FIGURE 45. Erosion control can include the use of mats and planting willow cuttings.

### 8.2.2 Erosion Control

Areas that are not prone to erosion generally require minimal contouring and can be left to revegetate naturally. For instance, on flat sections of the route, stockpiled organic topsoil can be replaced evenly on the road surface and the surface can be scarified to provide sites for natural re-seeding.

On steep slopes, adequate cross drainage is required across the reclaimed road using cross ditches or berms. For slopes where soil erosion is a greater concern, active revegetation by seeding or planting should be conducted to achieve soil stability and restore the natural appearance of the site. The INAC resource management officer and territorial environment department should be contacted for information on approved seed mixes. Further erosion control measures include:

- planting shrub cuttings, such as willows;
- mulching and spreading;
- erosion control mats;
- soil binders;
- rock or gravel blankets; and
- creating terraces.

### 8.2.3 Restrict Access

Public use of reclaimed roads may disturb erosion control structures. To prevent public use of reclaimed roads, barriers can be constructed at their intersection with public roads. An effective method is to spread slash and debris on the right-of-way near the intersection.

## 8.3 Reclamation Monitoring

Monitoring will be required for several years after reclamation activities are completed to assess whether the closure objectives have been met. Monitoring requirements will usually be specified in the land use permit. Post-closure monitoring should attempt to answer the following questions:

- Are erosion control structures performing as designed?
- Are water management techniques effectively controlling water on and adjacent to the right-of-way?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the land use regulator is satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the road or trail.

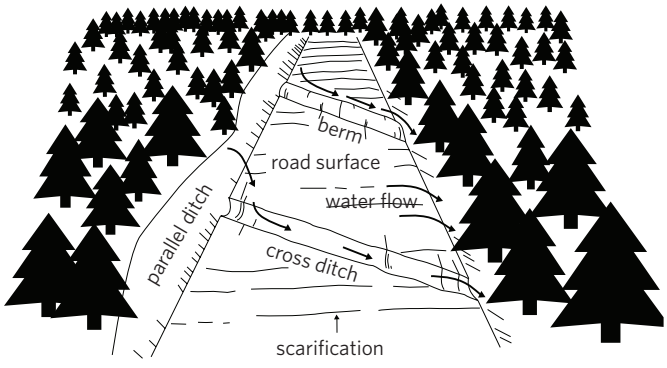


FIGURE 46. Berms and cross drains can be installed along the right-of-way to deflect water into surrounding vegetation and to control access. (1994 INAC Access Roads and Trails Guidelines)

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# Glossary

**Berm**

Low earth mound constructed in the path of flowing water to divert its direction.

**Binder**

Substance that encourages the adherence of soil particles, such as a chemical mat.

**Borrow pit**

Pit created to provide earth materials to be used as fill at another site.

**Buffer strip**

Area of land left untouched to provide a natural barrier between a development area and an adjacent area. Buffers can be used to protect important ecosystem components, such as wildlife habitat or water bodies, or they can be used to provide a visual barrier between a development area and an area of human use.

**Cross ditch**

Shallow trench excavated across a road to drain water in the downslope direction.

**Cross drain**

Pipe that extends through the roadbed to drain water from the uphill side of the road.

**Cut and fill**

Construction practice in which earth materials are excavated from part of an area and used as fill in adjacent areas.

**Cribbing**

Support structure usually built of timbers or logs, but can be of concrete or steel.

**Ditch block**

Barrier constructed within a ditch to control water speed and trap sediment, which could include logs, cleared vegetation or rocks.

**Dogleg**

Sharp change in the direction of a road. Designed to conceal the road from view for aesthetic purposes.

**Dragging**

Method of smoothing a road surface by pulling a heavy object behind a moving vehicle.

**End dumping**

A method of road building where material is dumped onto the ground surface, spread, and graded. Construction continues by driving to the end of the road and dumping another load.

**Esker**

Long, narrow ridge of coarse gravel and granular materials deposited by glacial meltwater.

**Fording**

Crossing a stream by driving a vehicle through it.

**Freshet**

Rapid rise in stream flow due to runoff from snowmelt during spring.

**Ground ice**

Ice present in ground materials. It dominates the geotechnical properties of the material and can cause terrain instability if it melts.

### Grubbing

Removal of stumps, roots, brush and excess organic matter from the route.

### Heritage resources

Historic, cultural or natural resource that has been identified by a community, territory or the federal government as being representative of the history or culture of an area.

### Hummock

Small mound of mineral soil, largely silt and clay, formed by differential frost heave that makes the ground irregular.

### Parallel ditch

Trough that runs beside the road.

### Peatland

Poorly drained organic terrain characterized by a high water table and the presence of permafrost.

### Permafrost

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

### Progressive reclamation

Action that can be taken during operations before permanent closure to take advantage of cost and operating efficiencies by using resources available from ongoing operations. Enhances environmental protection and shortens the time frame for achieving reclamation objectives.

### Pushouts

Trees that have been pushed down, off the right-of-way, as a result of clearing.

### Riparian

Area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

### Rip-rap

Layer of large stones or broken rock placed on an embankment for erosion control and protection.

### Rutting

Depressions in soil, soil erosion and ponding that are the result of repeatedly operating heavy equipment on wet, unfrozen soils.

### Shoo fly

Temporary access road built around a steep or difficult section of a right-of-way so that equipment can traverse the area without damaging the ground.

### Slash

Woody debris, such as branches, logs and brush, that remains on the ground after clearing has been completed.

### Subsidence

The gradual sinking or downward settling of the earth's surface in response to geologic or man-induced causes.

### Thermokarst

Terrain characterized by pits and depressions caused by permafrost degradation and melting of ground ice.

### Tussock

Thick clump of grass or sedge that can be up to 1 m in height formed by the accumulation of dead vegetation.

### Watershed

Area of land that drains water into a particular stream, river or lake.

### Windrow

Woody debris that has been piled into a long, continuous row.

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Published under the authority of the Minister of Indian Affairs and Northern Development and Federal Interlocutor for Métis and Non-Status Indians
Ottawa, 2010
www.ainc-inac.gc.ca 1-800-567-9604 TTY only: 1-866-553-0554

QS-8622-061-EE-A1
Catalogue: R2-226/6-2010E-PDF ISBN: 978-1-100-14743-7



Cette publication est aussi disponible en français sous le titre :
Lignes Directrices sur L'utilisation des Terres du Nord - Accès : routes et sentiers

# APPENDIX F

## Silt Fences BMP 1

| Silt Fence<br><br>Sediment Control | B.M.P. #1 |
|---|---|

**Description and Purpose**

- Permeable fabric barriers installed vertically on support posts along contours to collect sediment laden sheet flow runoff
- Causes water to pond allowing sediment to settle out as water filters through fabric
- Entraps and minimizes coarse sediment from sheet flow or overland flow from entering waterbodies
- Perimeter control for sediment transport and deposition

**Applications**

- Temporary measure
- Used at bottom of cut or fill slopes to collect sediment laden runoff
- Used along streams (or channels) banks
- Used around stockpiles
- Midslope grade-break (using "J-hook" or "smile" pattern to effect ponding, filtering and sedimentation)

**Advantages**

- Low permeability silt fences have high filtering capabilities for fine sand to coarse silt
- Filter fence more effective than straw bales at filtering out sediment

**Limitations**

- Applicable for sheet flow, cannot handle concentrated channel flow volumes
- May fail under high runoff events
- Limit to locations suitable for temporary ponding of sediment laden runoff
- Low permeability silt fences may not be strong enough to support weight of water retained behind it and may require reinforcement (i.e., wire mesh and stronger support)
- Sediment build up needs to be removed on a regular basis
- Damage to fence may occur during sediment removal
- Useable life of approximately one year dependent on regular maintenance

| Silt Fence<br><br>Sediment Control | B.M.P. #1 |
|---|---|

**Construction**

- Two methods of installation are commonly used
  - Trench method
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent)
- Trench Method
  - Select location of silt fence (usually along contours)
  - Drive support posts a minimum of 0.3 m into ground, spaced a maximum of 2 m apart
  - Excavate trench approximately 0.15 m deep by 0.15 m wide for entire length of fence along upstream side of posts
  - Attach the wire mesh or snow fencing, if used as reinforcement, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts
  - Backfill and compact soil in trench, being careful not to damage fence
- Mechanical Installation Method
  - Select location of silt fence (usually along contours)
  - Use mechanical installation machine to embed the fabric a minimum of 0.15 m into the ground. One mechanical installation method is by slicing (with special equipment) the geotextile fabric embeds into the ground without excavation and backfill. There is only minor disturbance of the ground. Tamping of ground is required for compaction.
  - Drive support posts a minimum of 0.3 m into ground, spaced a maximum of 2 m apart
  - Attach the wire mesh or snow fencing, if used as reinforcement to silt fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts

**Construction Considerations**

- Site Selection

  - Size of drainage area should be no greater than 0.1 ha per 30 m length of silt fence
  - Maximum flow path length above silt fence should be no greater than 30 m
  - Maximum slope gradient above the silt fence should be no greater than 2H:1V
- Fence should be placed on contour to produce proper ponding
- Fence should be placed far enough away from toe of slope to provide adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of fence should be angled upslope to collect runoff
- Fence should not extend more than 0.6 m above grade
- Posts can be wood or metal material dependent on design and ground conditions
- Posts should be placed on downstream side of fence
- Posts should not be spaced greater than 2 m apart
- Wire mesh or standard snow fencing may be placed between the posts and fabric barrier to provide additional strength and support reinforcement
- Geotextile should be cut from a continuous roll to avoid joints (if joints are necessary, the wrapping of fabric around the fence post and a minimum overlap of 0.2 m with staples should be used to attach the fabric to the post)
- Fence (and wire mesh or snow fence, if used) should be attached to posts with heavy duty staples, tie wires, or hog rings
- Fence (and wire mesh or snow fence, if used) should be dug into a trench at least 0.15 m deep to prevent undercutting of fence by runoff
- Trench backfill should be compacted
- Long runs of silt fence are more prone to failure than short runs
  - Maximum length of each section of silt fence should be 40 m
  - Silt fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours allowing an escape path for ponded water (minimizes overtopping of silt fence structure)

**Inspection and Maintenance**

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Repair undercut fences and repair or replace split, torn, slumping or weathered fabric immediately

| Silt Fence<br><br>Sediment Control | B.M.P. #1 |
|---|---|

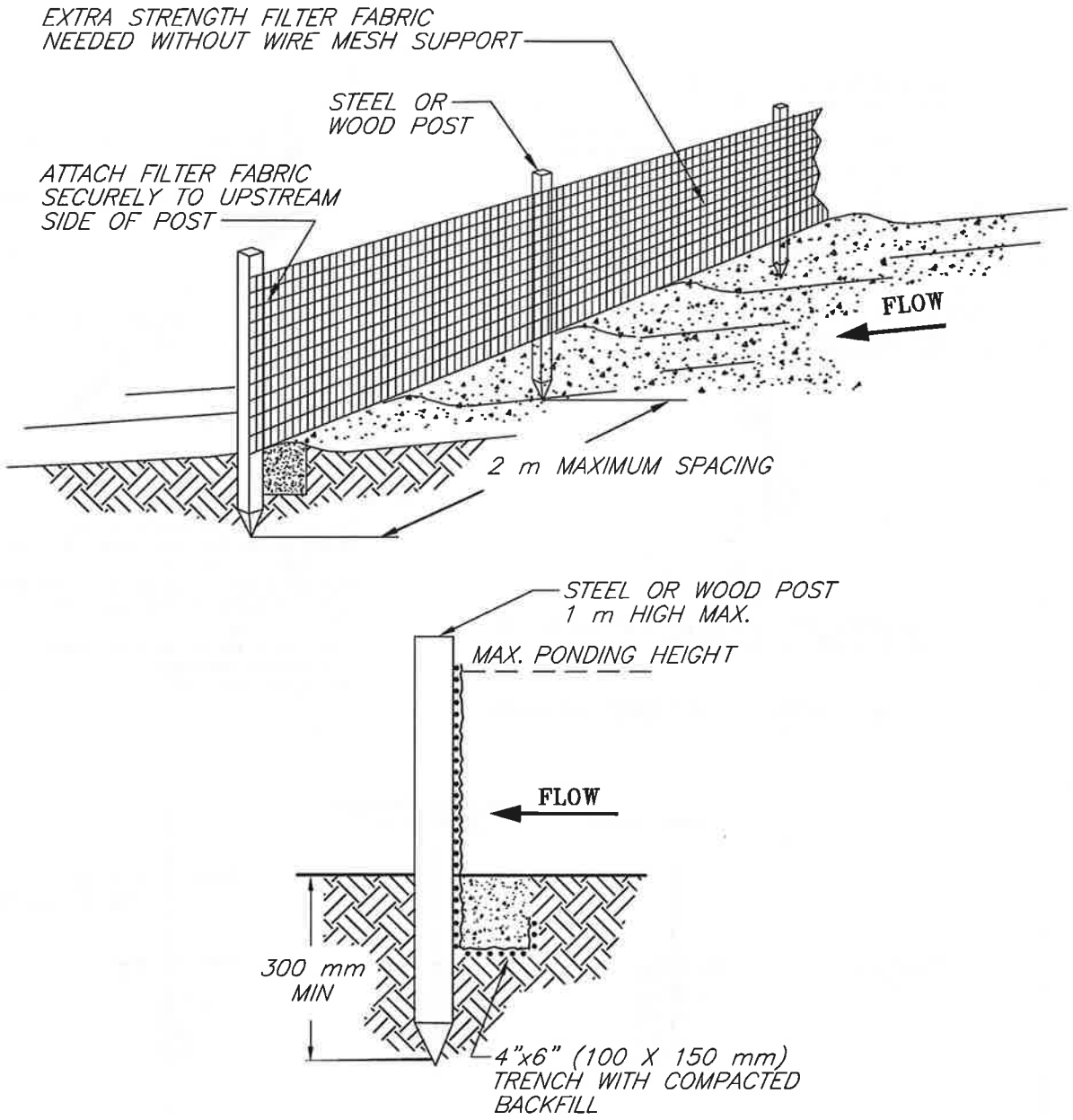
- Sediment build up should be removed once it accumulates to a depth of 0.2 m
- Remove fence after vegetation is established
- Deactivate fabric by cutting-off top portion of fabric above ground; bottom trenched-in portion of fence fabric can be left in-ground thus minimizing ground disturbance

**Similar Measures**

- Straw Bales
- Rock Barrier
- Permeable/Synthetic Barriers

**Design Considerations**

- For a silt fence system to work as a system, the following factors should be considered:
  a) quantity – adequate number and frequency of fence for efficient ponding and sedimentation
  b) installation – workmanship
  c) compaction – backfill and trenching of fabric
  d) support – posts adequately embedded, appropriate selection of post material and spacing
  e) attachment – secure fabric to post
- Install silt fences in a 'J' hook or 'smile' configuration




**TRENCH METHOD DETAIL**

NOTES:

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE DAILY AND AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN ACCUMULATED SILT REACHES 200 mm.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA WILL NOT CONTRIBUTE SEDIMENT OFF-SITE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

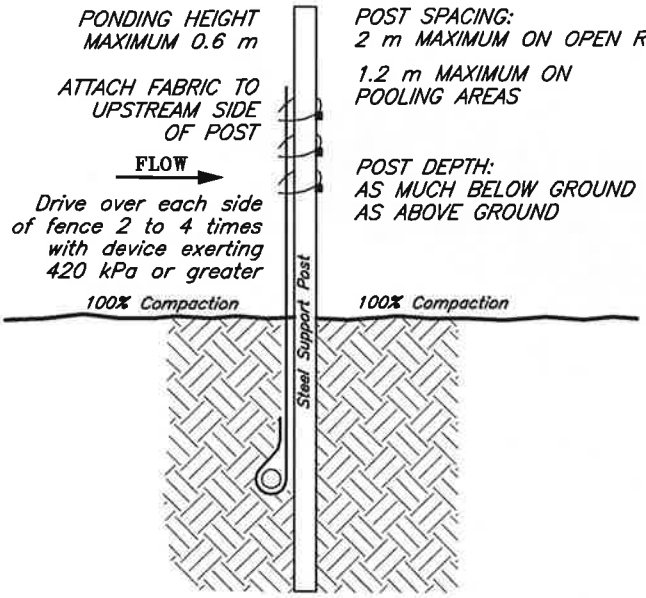
# SILT FENCE

## (TRENCH METHOD)

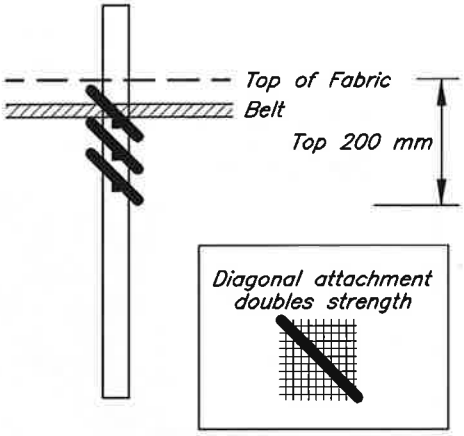


FILE: SILTFENC

**Government of Alberta ■**
**Transportation**



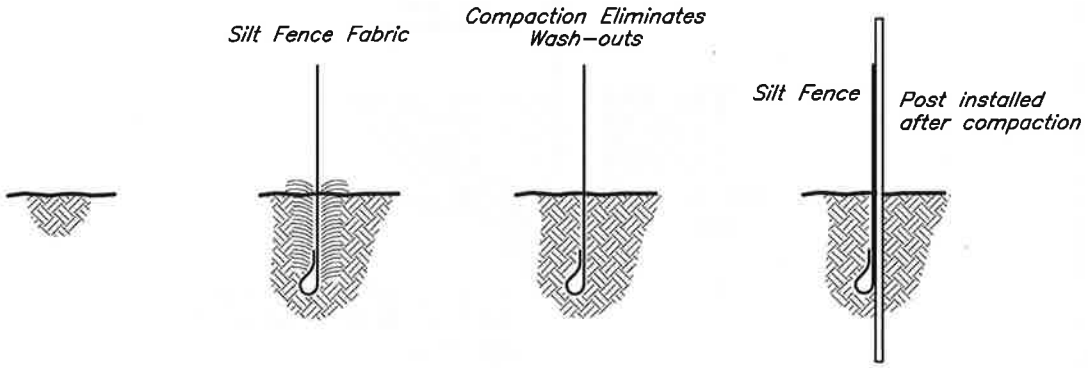

NO MORE THAN 0.6 m OF A 0.9 m FABRIC
IS ALLOWED ABOVE GROUND




ATTACHMENT DETAILS:

- Gather fabric at posts, if needed.
- Utilize three ties per post, all within top 200 mm of fabric.
- Position each tie diagonally, puncturing holes vertically a minimum of 25 mm apart.
- Hang each tie on a post nipple and tighten securely.
- Use cable ties (50 lbs) or soft wire.

## MECHANICAL (SLICING) METHOD




a) Before Installation

b) During fabric insertion. Disrupted soil.

c) After Compaction. Greater stability.

d) Completed Installation

## MECHANICAL (SLICING) METHOD INSTALLATION SEQUENCE

NOTES:

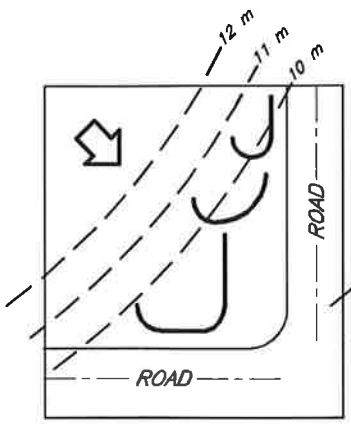
1. INSTALLATION MACHINE MUST ALLOW CONTINUOUS SLICING AND EMBEDMENT OF GEOTEXTILE INTO GROUND WITH MINOR GROUND DISTURBANCE.
2. INSTALLATION MACHINE TYPES WILL VARY WITH MANUFACTURER.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

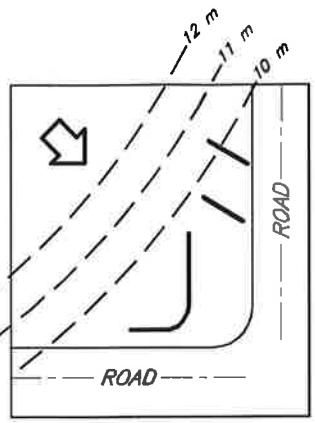
# SILT FENCE

## (MECHANICAL METHOD)

SOURCE: CARPENTER T. 2000

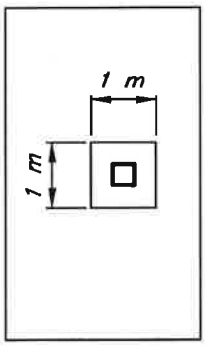


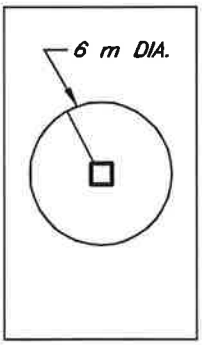

CORRECT



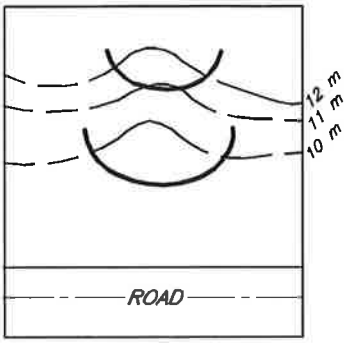

INCORRECT

"J" CONFIGURATION

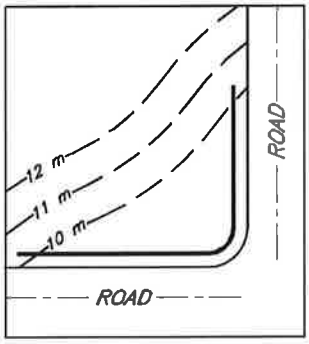


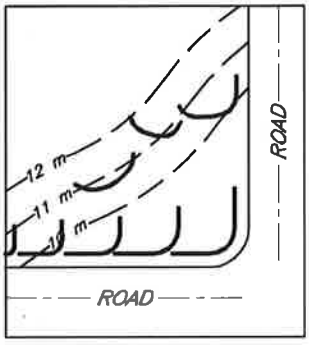

SILT FENCE BARRIER AT STORM INLET



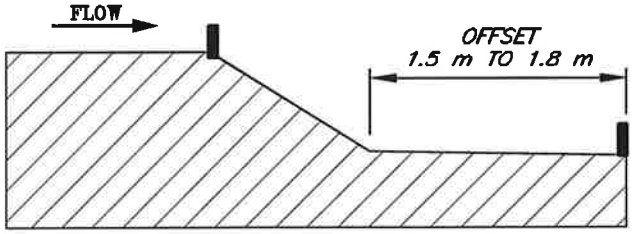

"SMILE" CONFIGURATION




AVOID LONG INSTALLATION




COMBINATION OF "SMILE" AND "J" CONFIGURATIONS




LOCATION AT TOP AND BOTTOM OF SLOPE

NOT TO SCALE

NOTE:

1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

SOURCE: CARPENTER T. 2000

# SILT FENCE
## (CONFIGURATION PLAN)

# APPENDIX G Offtake Ditches BMP 21

| Offtake Ditch (Intercept Ditch)<br><br>Erosion Control | B.M.P. #21 |
|---|---|

**Description and Purpose**

- Channels or swales commonly located along the crest of cuts slopes to intercept and convey runoff away from flowing down a newly excavated bare soil slope and to minimize erosion of slope from overlanding sheet flow
- Can be tied to outfall to slope drains (or downdrains) which carry water from higher slope elevations to lower elevation of a slope

**Applications**

- Permanent measure
- Effective method of intercepting runoff to avoid excessive sheet flow over slope and causing erosion, especially on cut slopes in highly erodible soils (sand and silt)
- Can be used in conjunction with slope drains which was installed down a large cut slope
- May be lined with vegetation, rip rap, erosion control blankets, or some other erosion protection measure, but this requirement may be appropriate only at highly sensitive and high risk environmental areas
- Can be used in conjunction with sediment control measures, such as check structures or permeable synthetic barriers as normal channel design, but this requirement may be appropriate only at highly sensitive and high risk environmental areas

**Limitations**

- Ditch may require lining to minimize soil erosion from concentrated flow
- Ditch may require design by qualified personnel if flow velocities and/or volumes are large
- Channel must be graded to maintain adequate depth, positive drainage to avoid ponding and breaching of channel flow, which may lead to overtopping of the channel to result flow to cause in downslope erosion
- Removal of sediment build up and ditch maintenance may be difficult due to limited access space as offtake ditches are commonly constructed at crest of slopes

**Construction**

- Use backhoe to form ditch a minimum offset distance of 2 m between crest of highway slope and top of offtake ditch sideslope, thus providing a dyke width of 1 m
  - Place and compact excavated soil to form a dyke between crest of highway slope and offtake ditch channel to provide adequate depth (1 m) of the offtake ditch

- The consequence of failure on this dyke will determine the level of compaction effort required

– Sideslopes of ditch should not be steeper than 2H:1V (depending upon material type)

– Depth of ditch (from base of ditch to top of embankment) should be a minimum of 1 m in depth; width of ditch should be 1 m minimum

– Ditch grade should be graded a minimum of 1% to promote positive drainage and outfall

**Construction Considerations**

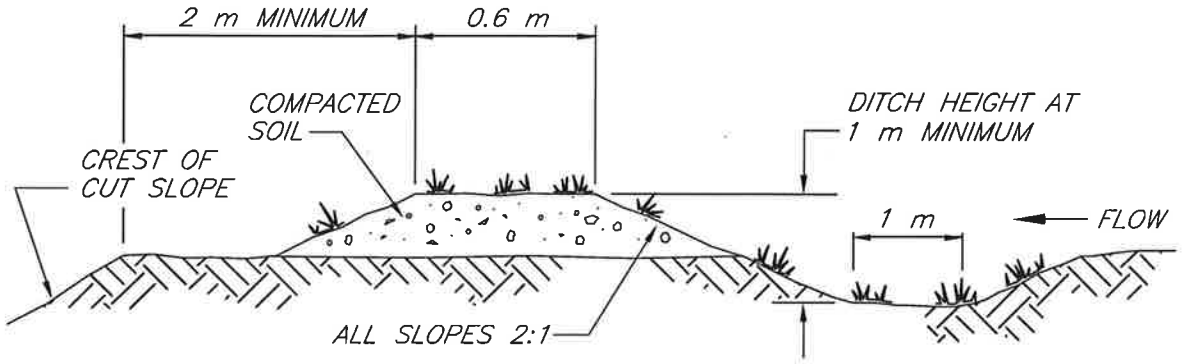
- Channel should be graded towards nearest outfall (draw) or drainage pipe

**Inspection and Maintenance**

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Repair any damage to channel immediately

**Similar Measures**

- Berms
- Barriers




# TYPICAL OFFTAKE DITCH

NOTES:

1. THE DITCH BEHIND THE DYKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
2. THE DYKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
3. FOR SENSITIVE HIGH RISK AREAS, THE DITCH SHALL BE STABILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

## OFFTAKE DITCH
## (INTERCEPT DITCH)



FILE: TEMPDIKE

**Government of Alberta ■**
**Transportation**

B.M.P. #21
Typical Section

# APPENDIX H

## Rock Check Dam BMP 7

| Rock Check Dam<br><br>Erosion Control and Sediment Control | B.M.P. #7 |
|---|---|

**Description and Purpose**

- Small dam constructed of rock placed across steep channel
- Decrease flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is detained allowing sediment to settle out

**Applications**

- Temporary or permanent measure
- Reduces long steep grade to intervals of gentle grades between successive structures
- Reduces flow velocities and kinetic energy to decrease erosion potential caused by runoff
- Sediment laden runoff is retained behind structure allowing sediment to settle out
- May be used in channels that drain 4 ha (10 ac) or less
- May be used in steep channels where storm water runoff velocity is less than 1.5 m/s (5 fps)

**Advantages**

- Cheaper than using riprap armouring or gabion structures in a ditch
- Easy to construct

**Limitations**

- Not appropriate for high flow velocity >1.5 m/sec; (use gabion structures for flow velocity >1.5 m/sec)
- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- Not to be placed in grass lined channels unless erosion is anticipated
- Susceptible to failure if water undermines or outflanks structure

**Construction**

- Excavate a trench key a minimum of 0.15 m in depth at the rock check structure location
- Place non-woven geotextile fabric over footprint area of rock check
- Construct structure by machine or hand
- Structure should extend from one side of the ditch or channel to the other

| Rock Check Dam<br><br>Erosion Control and Sediment Control | B.M.P. #7 |
|---|---|

- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of structures should be less than 0.8 m in height to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 5H:1V (minimum)
- Upstream slope of the check dam should be 4H:1V (minimum)

**Construction Considerations**

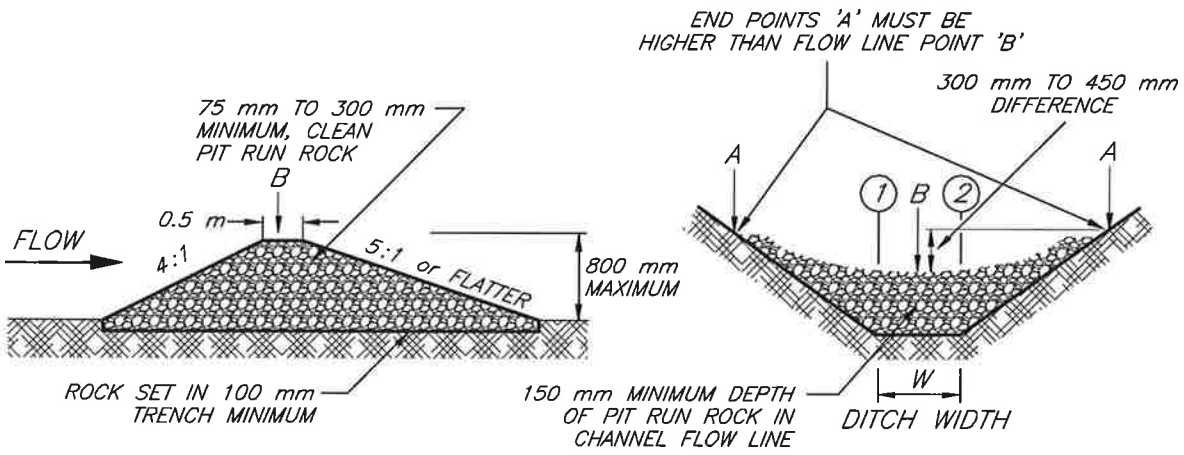
- Should be designed with roadside design clear zone requirements in mind.
- Height and spacing between structures should be designed to reduce steep channel slope to intervals of flatter gradient
- Rock check structures should be constructed of free draining aggregate
- Aggregate used should have a mean diameter ($D_{50}$) of between 75 mm and 150 mm and must be large enough to remain in place during high velocity flow situations. Maximum rock diameter should not exceed 150 mm if the structure is to be used as a sediment trap.
- If rock check structures are to be placed in channels with significant high flows, they must be properly designed for stone size and structure spacings

**Inspection and Maintenance**

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged aggregate immediately with heavier aggregate or gabion structures

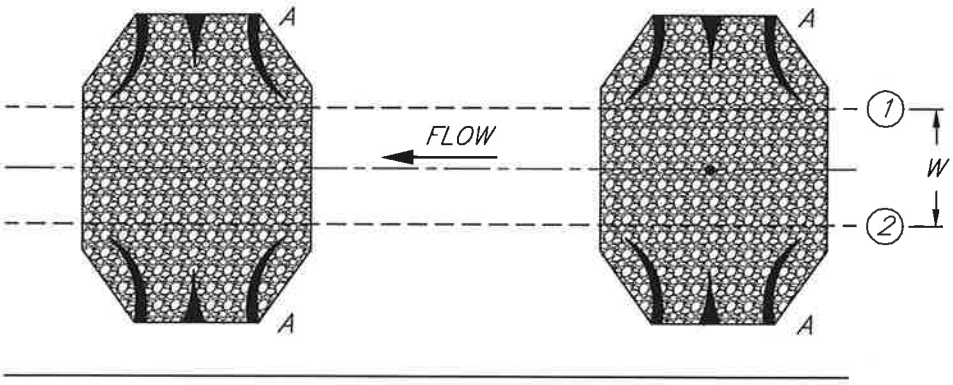
**Similar Measures**

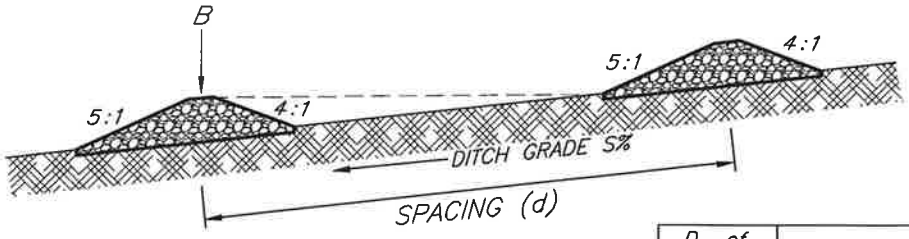
- Synthetic Permeable (Ditch) Barriers




SIDE VIEW

FRONT VIEW




| $D_{50}$ of ROCK ( mm ) | MAXIMUM FLOW DEPTH OVER ROCK ( mm ) |
|---|---|
| 75 | 50 |
| 150 | 100 |

SUGGESTED ROCK DIAMETER AND OVERFLOW DEPTHS

NOTES:

1. SUITABLE FOR FLOW VELOCITY ≤ 1.5 m/s.
2. SUITABLE FOR DRAINAGE AREA ≤ 4 ha.
3. SUITABLE FOR GRADES FROM 5% TO 8%.
4. SPACING (d) AND ROCK SIZE ($D_{50}$) TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

# ROCK CHECK DAM

**Government of Alberta ■**
**Transportation**

B.M.P. #7
Typical Section

# APPENDIX I

## Riparian Zone Preservation BMP

| Riparian Zone Preservation<br><br>Sediment Control and Erosion Control | B.M.P. #30 |
|---|---|

**Description and Purpose**

- Protection of existing plants and trees adjacent to all natural water bodies (riparian zones) adjacent to construction areas
- Existing vegetation acts as an effective vegetative buffer strip as a form of erosion and sediment control measure

**Applications**

- Permanent measure
- Existing established vegetation acts as an effective sediment control and erosion control buffer strip barrier to slow down flows and allow sedimentation filtration to occur
- May be used along property boundaries to minimize sediment transport off construction site despite non-presence of watercourse adjacent

**Advantages**

- Existing dense vegetation is more effective than any man-made structures or devices for sediment or erosion control, however, other forms of sediment and erosion control measures may be required on construction sites in addition to preserved riparian zones
- Any denuding of vegetation along steep valley slope with highly erodible soil will be detrimental and inducive to long-term sedimentation yield; it is important only to strip necessary areas along the footprint of construction. Preservation of riparian zone is mandatory along river valley slopes and along the edge corridor of waterbodies

**Limitations**

- Preservation of riparian zones may interfere with construction efficiency
- Careful planning is required to work around preserved riparian zones

**Construction**

- It is highly important to preserve an established vegetative buffer as freshly planted vegetation generally require substantial growth periods before they are as effective as established riparian zones
- Wherever possible, retain as much existing vegetation as possible between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize sediment transport off of the construction site into the sensitive zones

| Riparian Zone Preservation<br><br>Sediment Control and Erosion Control | B.M.P. #30 |
|---|---|

- Define and delineate riparian zones to be preserved in Environmental Construction Operations Plan (ECO Plan) prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field (with construction fencing, survey flagging, or other highly visible measure) so all personnel involved with construction operations can identify areas to be preserved

**Construction Considerations**

- Riparian zones must be fenced off immediately to minimize trespassing and to ensure effectiveness of riparian zone is maintained
- Do not allow equipment to enter areas not necessary to construction
- Based on site-specific situations established buffer zones of adequate width

**Inspection and Maintenance**

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Maintain fences protecting riparian zones from trespassing

# APPENDIX J

## Rolled Erosion Control Products BMP

| Rolled Erosion Control Products (RECP)<br>a) Channel Installation<br>b) Slope Installation<br>c) Straw Rolls<br>Erosion Control | B.M.P. #13 |
|---|---|

**Description and Purpose**

- Biodegradable or synthetic soil coverings used for temporary or permanent protection of disturbed soils at slopes and channels
- Categories of Rolled erosion control products (RECP) can be:
  - Erosion control blankets (ECB) (generally biodegradable and temporary)
  - Turf reinforcement mats (TRM)
  - Composite turf reinforcement mats (C-TRM)
- RECP may be manufactured of organic material, synthetic material, or as a composite of organic and synthetic materials
- Protect disturbed soils from raindrop impact and surface runoff erosion, increase water infiltration into soil, retains soil moisture and decreases evaporation loss
- Protect seeds from raindrop impact, runoff, and predators
- Stabilizes soil temperature to promote seed germination and enhance vegetation growth

**Applications**

- Temporary or permanent measure
- May be used to protect disturbed, exposed soils for cut or fill slopes at gradients of 2.5H:1V or steeper
- May be used on slopes where erosion potential is high
  - Silts and sands have higher erosion potential than high plastic clays
- May be used on slopes where vegetation is likely to be slow to develop
- May be used to protect disturbed exposed soils in ditches and channels (with high flow velocities) by providing additional tractive resistance cover in conjunction with a successful high density vegetative growth established

**Advantages**

- Degree of erosion protection is higher, more uniform, and longer lasting than for sprayed-on products (e.g., mulches)
- Wide range of commercially available temporary (biodegradable) or permanent products

| Rolled Erosion Control Products (RECP)<br>a) Channel Installation<br>b) Slope Installation<br>c) Straw Rolls<br>Erosion Control | B.M.P. #13 |
|---|---|

**Limitations**

- Non-performance of RECP may result from the following:
  - Low density vegetation growth (beneath RECP) due to non-favourable weather and growth conditions (i.e., soil type, moisture, storm events at critical times). It is noted that values of tractive resistance of RECP products for vegetative growth may be generally tested in laboratory after a growth period (e.g., 3 months) under greenhouse growth conditions. The effectiveness of RECP, especially along channels, is very dependent on success of vegetation growth on site. It is important that the designer should assess the effectiveness of RECP in accordance with site, soil, terrain and vegetation growth conditions
  - Hydraulic uplift of RECP and erosion of underlying soils can occur under rapid snow melt conditions when dammed up melt water generates a hydraulic head and high flow velocity generated in constricted snow melt channel. This situation can occur along steep channels interlaced with drop structures and with RECP lining installed in-between the drop structures. Ponding of melt water and non-anchored RECP joint areas allow flow entry beneath the RECP and generate hydraulic heads to uplift the RECP. This can occur along un-anchored edges of RECP at upper edges of ditch when snow melt occurs at tops of ditch and flow beneath the RECP. This is especially critical when underlying soil is easily erodible. (e.g., fine grained non-cohesive silty soils). It is important to trench-in and anchor the edges of the RECP installations and installed anchor pin (staples) at sufficient dense intervals
  - Ice build-up from groundwater seepage source can uplift and dislocate the RECP and causing flow beneath the RECP to erode the substrate soils. Winter ice accumulation may be related to groundwater regime and investigative design on subsurface drainage by a geotechnical engineer is required
- Can be labour intensive to install
- Must be installed on unfrozen ground
- Temporary blankets may require removal before implementation of permanent measures
- Rolled erosion control products (RECP) are not suitable for rocky sites
- Proper surface preparation is required to ensure intimate contact between blanket and soil
- Plastic sheeting can be used at sensitive slopes with precautions:
  - Plastic sheeting RECP product can be easily torn, ripped, non-biodegradable, and should be disposed of in a landfill

- Plastic sheeting product, if used, results in 100% runoff, thus increasing erosion potential in downslope areas receiving the increased flow volumes
- Plastic sheeting should be limited to temporary covering of sensitive soil stockpiles or temporary covering of small critical unstable slope areas

**Construction (Slopes)**

- RECP should be installed in accordance with manufacturer's directions

The following is a general installation method:

- Prepare surface and place topsoil and seed
- Surface should be smooth and free of large rocks, debris, or other deleterious materials
- Blanket should be anchored at top of slope in a minimum 0.15 m by 0.15 m trench for the entire width of the blanket
- The blanket should be rolled out downslope
  - (1) Where the blanket roll is not long enough to cover the entire length of the slope, a minimum 0.15 m by 0.15 m check slot should be excavated at the location of the lap, and the downslope segment of blanket anchored in the check slot, similar to the method used for the top of the slope, or (2) when blankets must be spliced down the slope, place blanket end over end (shingle style with approximately 0.10 m overlap. Staple through overlapped area at 0.3 m intervals.
  - The upslope portion of blanket should overlap the downslope portion of blanket, shingle style, at least 0.15 m with staple anchors placed a maximum 0.3 m apart
  - Adjacent rolls of blanket should overlap a minimum 0.1 m
  - Anchors should be placed along central portion of blanket spaced at $4/m^2$ minimum (0.5 m spacing) for slopes steeper than 2H:1V and $1/m^2$ (1 m spacing) for slopes flatter than 2H:1V
  - Anchors along splices between adjacent rolls should be placed 0.9 m apart

**Construction (Channels)**

- **A Blanket should be installed in accordance with manufacturers directions**

The following is a general installation method

- Prepare surface and place topsoil and seed

- Surface should be smooth and free of large rocks, debris, or other deleterious materials

– Begin by excavating a minimum 0.15 m deep and 0.15 m wide trench at the upstream end of channel and place end of RECP into trench

- Use a double row of staggered anchors approximately 0.1 m apart (i.e., 0.2 m linear spacing) to secure RECP to soil in base of trench
- Backfill and compact soil over RECP in trench

– Roll centre RECP in direction of water flow on base of channel

– Place RECP end over end (shingle style) with a minimum 0.15 m overlap downgrade

- Use a double row of staggered anchors approximately 0.1 m apart to secure RECP to soil

– Full length edge of RECP at top of sideslopes must be anchored in a minimum 0.15 m deep and 0.15 m wide trench

- Use a double row of staggered staple anchors a maximum of 0.1 m apart (i.e., 0.2 m linear spacing) to secure RECP to soil in base of trench
- Backfill and compact soil over RECP in trench

– Overlap RECP on sideslopes (shingle style down channel) a minimum of 0.1 m over the centre RECP and secure RECP to soil with anchors spaced a maximum of 0.2 m apart

– In high flow channels, a check slot across the width of the channel is recommended at a maximum spacing of 10 m to anchor the ends of the RECP to the underlying soil

- Use a double row of staggered staple anchors a maximum of 0.1 m apart (0.2 m linear spacing) to secure RECP to soil in base of check slot
- Backfill and compact soil over RECP in check slot

– Anchor terminal ends of RECP in a minimum 0.15 m deep and 0.15 m wide trench

- Use a double row of staggered anchors a maximum of 0.1 m apart (i.e., 0.2 m linear spacing) to secure RECP to soil in base of trench
- Backfill and compact soil over RECP in trench

| Rolled Erosion Control Products (RECP)<br>a) Channel Installation<br>b) Slope Installation<br>c) Straw Rolls<br>Erosion Control | B.M.P. #13 |
|---|---|

**Construction Considerations**

- Slopes should be topsoiled and seeded prior to placing RECP
- Ensure blanket is in intimate contact with the soil by properly grading soil, removing rocks or deleterious materials, prior to placing blanket
- In channels, blankets should extend to above the anticipated flow height, with a minimum 0.5 m of free board
- For turf reinforcement mat (TRM), blanket should be placed immediately after topsoiling
- Blanket should be anchored by using wire staples, metal geotextile stake pins, or triangular wooden stakes
  - All anchors should be a minimum of 0.15 to 0.2 m in length
  - For loose soils, use longer anchors
- Blankets should be placed longitudinal to direction of flow, with fabric not stretched but maintaining contact with underlying soil
- It is essential to understand product specifications and follow manufacturers instructions on installation methods

**Product Quality Assurance/Quality Control (QA/QC) Certification**

RECPs should be certified by the supplier/manufacturer to ensure product performance and compliance with specified property requirements. A certificate for QA/QC testing of manufactured products is required. The performance and QA/QC testing should be carried out by reputable laboratories (e.g., TxDoT – Hydraulic and Erosion Control Laboratory OR equivalent laboratory) to ensure a commonly acceptable QA/QC standard. Dependent on product type and intended performance, the product information certificate should be provided by the product supplier/manufacturer to include the following:

- Manufacturer's Certificate on
- Performance specification
  - Permissible Tractive Resistance (include testing methods and vegetative growth conditions)
  - Permissible Flow Velocity (if available)
  - Longevity (for biodegradable or non-biodegradable products)

- Minimum Average Roll Values (MARVs) along with specified testing methods for
  - Physical properties
    - Mass per unit area
    - Thickness
    - Tensile strength
    - UV Resistance
  - Other physical properties (for non-woven below Erosion Mat (if specified)
    - Grab tensile strength
    - Grab elongation
    - Puncture strength
    - Trapezoidal tear
    - UV Resistance

**Inspection and Maintenance**

- Areas covered with blankets should be inspected/remediated regularly or in accordance with the PESC and TESC Plans, especially after periods of severe rainfall or storm events, to check for blanket separation or breakage
- Any damaged or poorly performing areas should be repaired/remediated immediately. Regrading of the slope by hand methods may be required in the event of rill or gully erosion.
- Inspection and maintenance should continue until dense vegetation is established
- Areas with low vegetation density should be reseeded
- After approximately one year, a top dressing of fertilizer may be applied to improve vegetation cover and assist degradation of temporary blankets

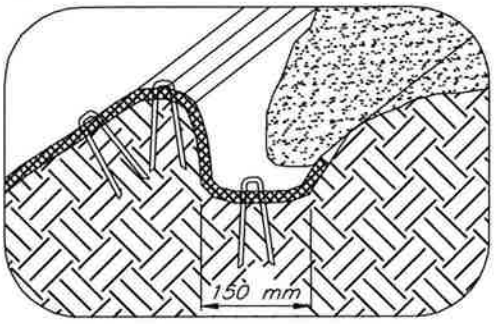
**Similar Measures**

- Mulching (for slopes only)
- Riprap (primarily in channels)
- Gabion mattresses (primarily in channels)

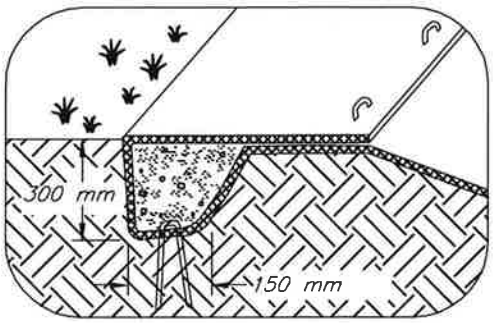
| Rolled Erosion Control Products (RECP)<br>a) Channel Installation<br>b) Slope Installation<br>c) Straw Rolls<br>Erosion Control | B.M.P. #13 |
|---|---|

**Design Considerations**

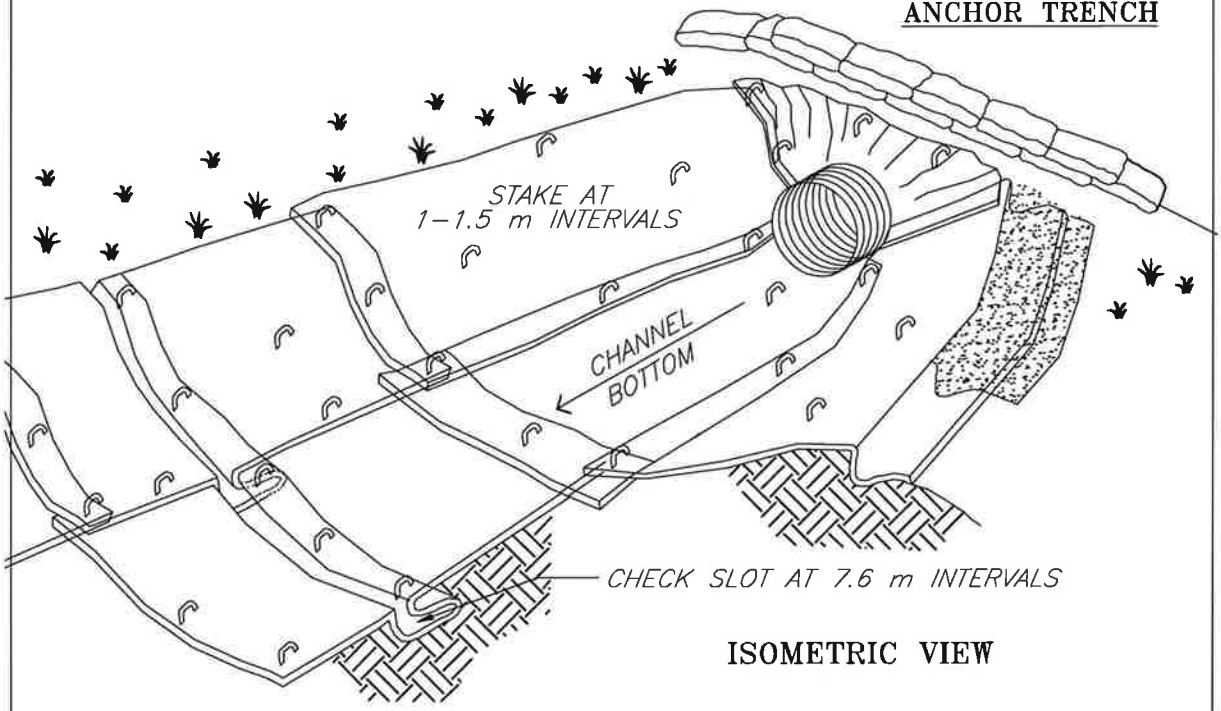
- Assess hydraulic flow conditions and tractive stress on channel
- Assess local soil, weather and growth conditions (favourable/non-favourable) for revegetation (within 3 to 12 months) to allow a determination on use or non-use of RECP as a protective measure. If the revegetation conditions are assessed favourable, the use of RECP can be considered
- Assess suitability of a RECP product using tractive resistance data tested for (i) bare soil, and (ii) vegetated (a specified duration of growth period) condition
- It is noted that tractive resistance data are adopted as selection criteria of RECP and permissible velocity data can be provided for reference.



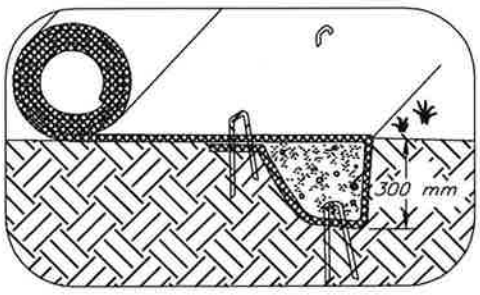

LONGITUDINAL ANCHOR TRENCH



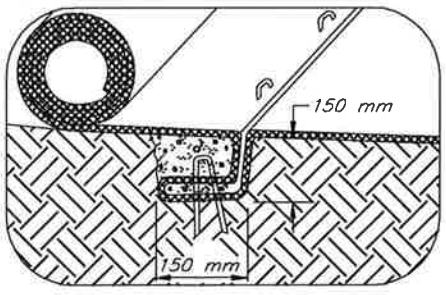

TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH




ISOMETRIC VIEW




INITIAL CHANNEL ANCHOR TRENCH




INTERMITTENT CHECK SLOT

NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

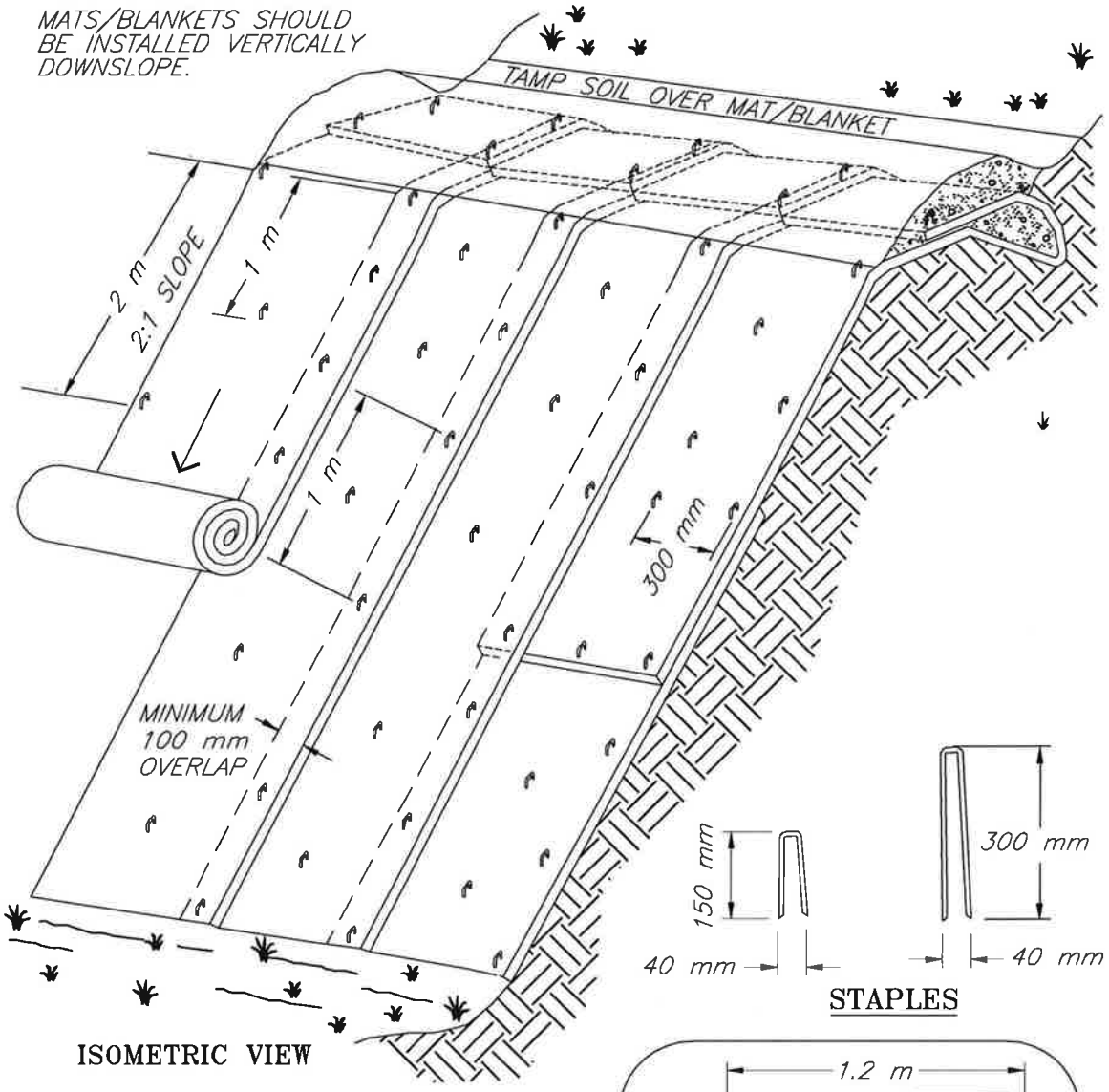
# ROLLED EROSION CONTROL PRODUCTS (RECP)

## CHANNEL INSTALLATION



**Government of Alberta ■**
Transportation

B.M.P. #13a
Typical Section




## TYPICAL SLOPE SOIL STABLIZATION

NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/ BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. CHECK SLOTS, STAKING, STAPLING AND OTHER CONSTRUCTION DETAILS PER MANUFACTURES SPECIFICATIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

## ROLLED EROSION CONTROL PRODUCTS (RECP) SLOPE INSTALLATION



**Government of Alberta ■**
Transportation

B.M.P. #13b
Typical Section

# APPENDIX K

## DFO Operational Statement for Ice Bridges and Snow Fills

# ICE BRIDGES AND SNOW FILLS

**Fisheries and Oceans Canada**
**Northwest Territories Operational Statement**

**Version 3.0**

Ice bridges and snow fills are two methods used for temporary winter access in remote areas. Ice bridges are constructed on larger watercourses that have sufficient stream flow and water depth to prevent the ice bridge from coming into contact with the stream bed or restricting water movement beneath the ice. Snow fills, however, are temporary stream crossings constructed by filling a stream channel with clean compacted snow.

Ice bridge and snow fill crossings provide cost-effective access to remote areas when lakes, rivers and streams are frozen. Since the ground is frozen, ice bridges and snow fills can be built with minimal disturbance to the bed and banks of the watercourse. However, these crossings can still have negative effects on fish and fish habitat. Clearing shoreline and bank vegetation increases the potential for erosion and instability of the banks and can lead to deposition of sediments into fish habitat. There is also potential for blockage of fish passage during spring break-up.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with the subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your ice bridge or snow fill project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- ice bridges are constructed of clean (ambient) water, ice and snow,
- snow fills are constructed of clean snow, which will not restrict water flow at any time,
- the work does not include realigning the watercourse, dredging, placing fill, or grading or excavating the bed or bank of the watercourse,
- materials such as gravel, rock and loose woody material are NOT used,
- where logs are required for use in stabilizing shoreline approaches, they are clean and securely bound together, and they are removed either before or immediately following the spring freshet,
- the withdrawal of any water will not exceed 10% of the instantaneous flow, in order to maintain existing fish habitat,
- water flow is maintained under the ice, where this naturally occurs,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Constructing an Ice Bridge or Snow Fill* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in the violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

**You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement.** The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

## Measures to Protect Fish and Fish Habitat when Constructing an Ice Bridge or Snow Fill

1. Use existing trails, winter roads or cut lines wherever possible as access routes to limit unnecessary clearing of additional vegetation and prevent soil compaction.

2. Construct approaches and crossings perpendicular to the watercourse wherever possible.

**3.** Construct ice bridge and snow fill approaches using clean, compacted snow and ice to a sufficient depth to protect the banks of the lake, river or stream. Clean logs may be used where necessary to stabilize approaches.

**4.** Where logs are used to stabilize the approaches of an ice bridge or snow fill:

**4.1.** The logs are clean and securely bound together so they can be easily removed.
**4.2.** No logs or woody debris are to be left within the water body or on the banks or shoreline where they can wash back into the water body.

**Note:** The use of material other than ice or snow to construct a temporary crossing over any ice-covered stream is prohibited under section 11 of the *Northwest Territories Fishery Regulations*, unless authorized by a Fishery Officer. Please contact the nearest NWT DFO office.

**5.** While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be necessary to accommodate the road. This removal should be kept to a minimum and within the road right-of-way.

**6.** Install sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and decommissioning activities and make all necessary repairs if any damage occurs.

**7.** Operate machinery on land or on ice and in a manner that minimizes disturbance to the banks of the lake, river or stream.

**7.1.** Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
**7.2.** Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water or spreading onto the ice surface.
**7.3.** Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
**7.4.** Restore banks to original condition if any disturbance occurs.

**8.** If water is being pumped from a lake or river to build up the bridge, follow DFO's *NWT Winter Water Withdrawal Protocol* (available from the DFO offices listed below), and ensure that the intakes are sized and adequately screened to prevent debris blockage and fish mortality (refer to DFO's *Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995) available at **www.dfo-mpo.gc.ca/Library/223669.pdf**).

**9.** Crossings do not impede water flow at any time of the year.

**10.** When the crossing season is over and where it is safe to do so, create a v-notch in the centre of the ice bridge to allow it to melt from the centre and also to prevent blocking fish passage, channel erosion and flooding. Compacted snow should be removed from snow fills prior to the spring freshet.

**11.** Stabilize any waste materials removed from the work site to prevent them from entering the lake, river, or stream. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

**12.** Vegetate and stabilize (e.g., cover exposed areas with erosion control blankets or tarps to keep the soil in place and prevent erosion) any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses. Cover such areas with mulch to prevent erosion and to help seeds germinate. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

**12.1.** Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

## FISHERIES AND OCEANS CANADA OFFICES IN NORTHWEST TERRITORIES

**Yellowknife Area Office**
Fisheries and Oceans Canada
Suite 101 – Diamond Plaza
5204 - 50th Ave.
Yellowknife, NT X1A 1E2
Phone: (867) 669-4900
Fax: (867) 669-4940

**Inuvik District Office**
Fisheries and Oceans Canada
Box 1871
Inuvik, NT X0E 0T0
Phone: (867) 777-7500
Fax: (867) 777-7501

*Aussi disponible en français*

**http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_f.asp**

DFO/2007-1329

# APPENDIX L

## Riprap Armouring BMP 14

| Riprap Armouring<br>a) Slope Protection<br>b) Channel Protection<br>Erosion Control | B.M.P. #14<br>(a & b) |
|---|---|

**Description and Purpose**

- Large, loosely placed cobbles or boulders placed along channel banks or slopes to protect underlying soil from erosion due to flowing water
- Can protect slopes and channel banks against erosion

**Applications**

- Permanent measure
- May be used on channel banks and slopes with flow velocities ranging from 2 m/s to 5 m/s (dependent on rock size and thickness); appropriate for slopes that do not exceed 2H:1V
- Riprap only needs to be placed at lower portion of channel section to the anticipated flow height (mean annual peak flow) plus freeboard
  - Other form of soft armouring (RECP blankets, seeding) can be used to promote vegetation to protect soil at upper portion of channel slopes, above riprap
- Must be used in conjunction with a non-woven geotextile underlay acting as a filtration separator with basal soil
- For fluctuating high flow channel, the riprap should be underlain by a layer of granular filter material for cyclic drawdown long-term performance with/without an extra layer of non-woven geotextile as underlay

**Advantages**

- Easy to install and easy to repair
- Very durable, long lasting, and virtually maintenance free
- Flexible

**Limitations**

- Expensive form of channel lining and stabilization
- Requires heavy equipment and transport of rock to site
- May not be feasible in areas where suitable rock is not available
- Riprap may have to be placed by hand
- Normally 2 to 3 times riprap thickness is required in comparison with gabion mattress thickness for equivalent protection performance under identical hydraulic conditions

| Riprap Armouring<br>a) Slope Protection<br>b) Channel Protection<br>Erosion Control | B.M.P. #14<br>(a & b) |
|---|---|

- Use of gabion is preferred at flow greater than 3 m/s due to larger nominal size of riprap and thickness required for erosion protection during flow velocities of this magnitude
- Can be classified as uniform or graded. Uniform riprap would contain stones which would contain a mixture of stones ranging from small to large. Graded riprap forms a flexible self healing cover

**Construction**

- Grade the slope or channel to final design grade
- Place filter (underlay) layer on prepared slope
  - Filter layer can consist of non-woven geotextile underlay and/or well graded granular material dependent on hydraulic conditions
- Place riprap layer
- Riprap should consist of a graded mixture of sound, durable stone with at least 50% of the riprap material being larger than 200 mm in diameter
- Riprap should be sized according to the following gradation and mass:

| | | Riprap Class | | | |
|---|---|---|---|---|---|
| | | **1M** | **1** | **2** | **3** |
| **Nominal Mass**<br>**Nominal Diameter** | **kg**<br>**mm** | **7**<br>**175** | **40**<br>**300** | **200**<br>**500** | **700**<br>**800** |
| None heavier than: | kg<br>or mm | 40<br>300 | 130<br>450 | 700<br>800 | 1800<br>1100 |
| No less than 20% or more than 50% heavier than: | kg<br>or mm | 10<br>200 | 70<br>350 | 300<br>600 | 1100<br>900 |
| No less than 50% or more than 80% heavier than: | kg<br>or mm | 7<br>175 | 40<br>300 | 200<br>500 | 700<br>800 |
| 100% heavier than: | kg<br>or mm | 3<br>125 | 10<br>200 | 40<br>300 | 200<br>500 |

Percentage quoted are by mass.
Sizes quoted are equivalent spherical diameters, and are for guidance only.

Source: AT Bridge Spec. 2010

- Non-woven geotextile fabric underlay below riprap should meet the following specifications and physical properties:

**Non-Woven Geotextile Filter Fabric**
**Specifications and Physical Properties**

| | Class 1M, 1 and 2 | Class 3 |
|---|---|---|
| Grab Strength | 650 N | 875 N |
| Elongation (Failure) | 50% | 50% |
| Puncture Strength | 275 N | 550 N |
| Burst Strength | 2.1 MPa | 2.7 MPa |
| Trapezoidal Tear | 250 N | 350 N |
| Minimum Fabric Overlap to be 300 mm | | |

Source: AT Bridge Spec. 2010

### Construction Considerations

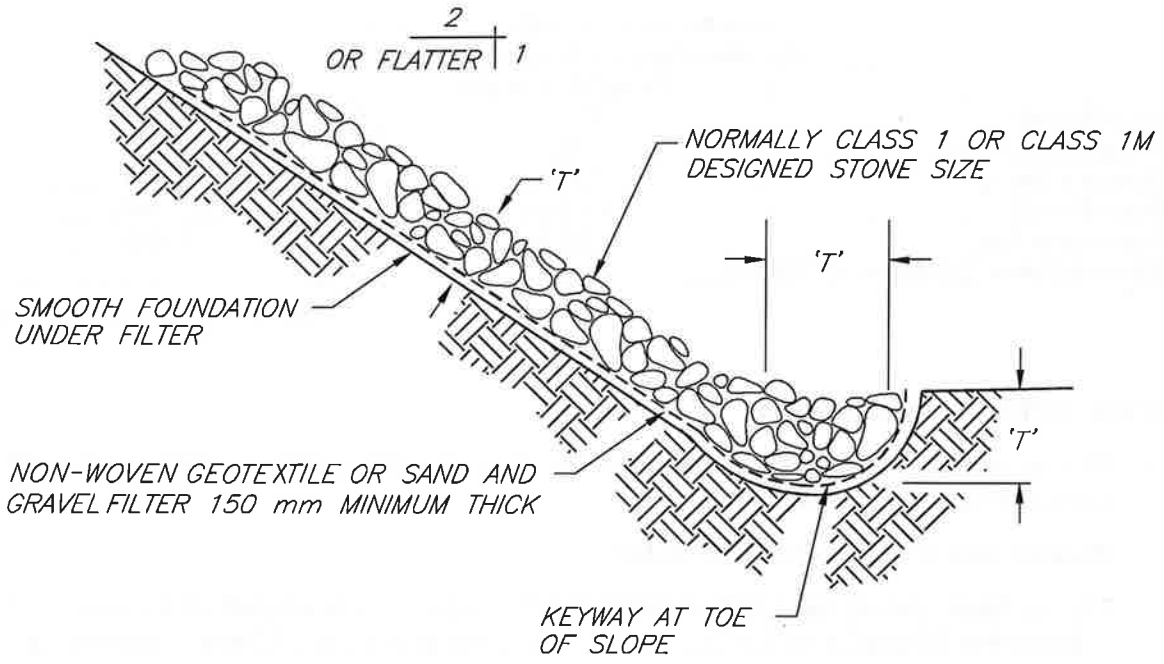
- Riprap should be placed in a uniform thickness across the channel so as not to constrict channel width
- Blasted rock is preferred (if available)
- Riprap layer should be 1.5 to 2 times the thickness of the largest rocks used, 1.5 to 3 times the thickness of the $D_{50}$ material, and not less than 300 mm in thickness

### Inspection and Maintenance

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Periodic inspections to check for erosion of protected material or movement of riprap

### Similar Measures

- Rolled erosion control products (RECP) well vegetated; not for use at severe flow and high velocity areas
- Gabion mattresses




## TYPICAL SECTION

NOTE:

1. 'T' = THICKNESS: THICKNESS SHALL BE DETERMINED BY THE ENGINEER.
   MINIMUM THICKNESS = 300 mm. (i.e. 1.5x $D_{50}$) FOR $D_{50}$ = 200 mm.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

# RIPRAP ARMOURING FOR SLOPE

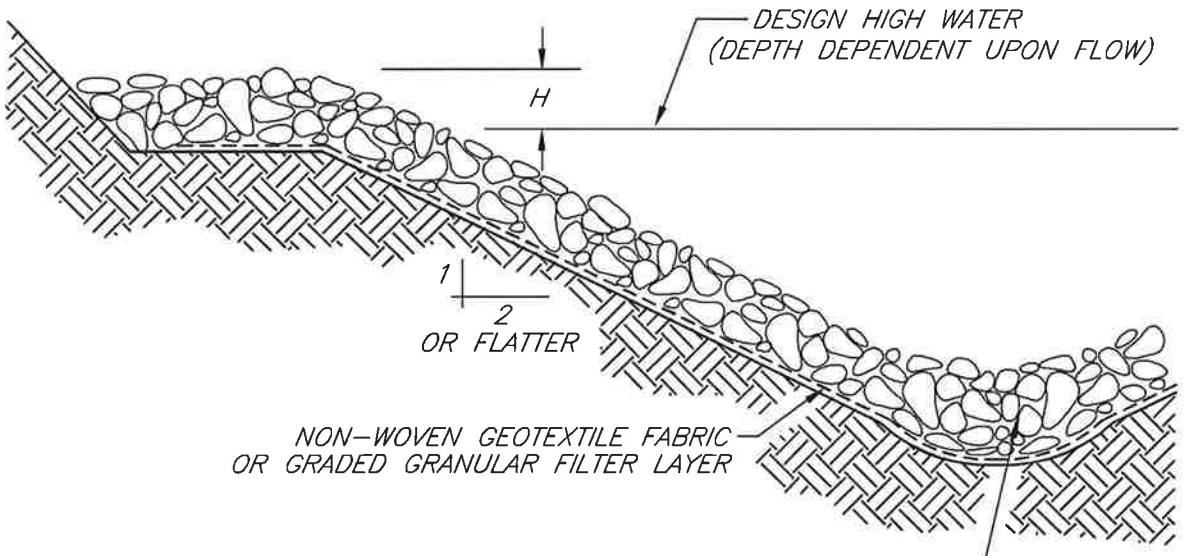


FILE: RIPRAP

**Government of Alberta ■**
**Transportation**

B.M.P. #14a
Typical Section

DESIGN HEIGHT (H), WIDTH AND STONE SIZE SHALL BE DETERMINED BY THE ENGINEER




## TYPICAL SECTION

NOTES:

1. RIPRAP GRADATION AND THICKNESS SHALL BE DETERMINED BY THE ENGINEER IN ACCORDANCE WITH HYDRAULIC CONDITIONS.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

# RIPRAP ARMOURING FOR CHANNEL



FILE: RCKCHNEL

**Government of Alberta ■**
**Transportation**

B.M.P. #14b
Typical Section

# APPENDIX M

## DFO Operational Statement for Clear Span Bridges

# CLEAR-SPAN BRIDGES

**Fisheries and Oceans Canada**
**Northwest Territories Operational Statement**

**Version 3.0**

This Operational Statement applies to the construction of small-scale bridge structures that completely span a watercourse without altering the stream bed or bank, and that are a maximum of two lanes wide. The bridge structure (including bridge approaches, abutments, footings, and armouring) is built entirely above the ordinary high water mark (HWM) (see definition below). A clear-span bridge is preferred to structures that are placed within the stream bed and therefore result in loss of fish habitat or alteration of natural channel processes.

Clear-span bridge construction has the potential to negatively affect riparian habitat. Riparian vegetation occurs adjacent to the watercourse and directly contributes to fish habitat by providing shade, cover and areas for spawning and food production. Only the vegetation required to accommodate operational and safety concerns for the crossing structure and approaches, within the right-of-way, should be removed. Stormwater run-off and the use of machinery can introduce deleterious substances to the water body and result in erosion and sedimentation.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat and maintain passage of fish. You may proceed with your clear-span bridge project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- the bridge is placed entirely above the HWM,
- the bridge is not located on meander bends, braided streams, alluvial fans, active flood plains, or any other area that is inherently unstable and may result in the alteration of natural steam functions or erosion and scouring of the bridge structure,
- the bridge is no greater than two lanes in width and does not encroach on the natural channel width by the placement of abutments, footings or rock armouring below the HWM,
- the work does not include realigning the watercourse,
- there is no alteration of the stream bed or banks or infilling of the channel,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Constructing Clear-Span Bridges* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

**You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement.** The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

## Measures to Protect Fish and Fish Habitat when Constructing Clear-Span Bridges

1. Use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation.

2. While this Operational Statement does not apply to the clearing of riparian vegetation, the removal of select plants within the road right-of-way (ROW) may be required to meet operational and/or safety concerns for the crossing

structure and the approaches. This removal should be kept to a minimum and within the road or utility right-of-way. When practicable, prune or top the vegetation instead of uprooting.

**3.** Design and construct approaches so that they are perpendicular to the watercourse to minimize loss or disturbance to riparian vegetation.

**4.** Design the bridge so that stormwater runoff from the bridge deck, side slopes and approaches is directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse.

**5.** Generally there are no restrictions on timing for the construction of clear-span structures as they do not involve in-water work. However, if there are any activities with the potential to disrupt sensitive fish life stages (e.g., crossing of watercourse by machinery), these should adhere to appropriate fisheries timing windows (see the *Northwest Territories In-Water Construction Timing Windows*) or alternatively, carry out the project when the waterbody is frozen to the bottom or is dry.

**6.** Machinery fording the watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and should occur only if an existing crossing at another location is not available or practical to use. A *Temporary Stream Crossing* Operational Statement is also available.

- **6.1.** If minor rutting is likely to occur, stream bank and bed protection methods (e.g., swamp mats, pads) should be used provided they do not constrict flows or block fish passage.
- **6.2.** Grading of the stream banks for the approaches should not occur.
- **6.3.** If the stream bed and banks are steep and highly erodible (e.g., dominated by organic materials and silts) and erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice should be used to protect these areas.
- **6.4.** The one-time fording should adhere to fisheries timing windows (see Measure 5).
- **6.5.** Fording should occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding.

**7.** Install effective sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.

**8.** Operate machinery on land (above the HWM) and in a manner that minimizes disturbance to the banks of the watercourse.

- **8.1.** Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
- **8.2.** Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water.
- **8.3.** Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
- **8.4.** Restore banks to original condition if any disturbance occurs.

**9.** Use measures to prevent deleterious substances such as new concrete (i.e., it is pre-cast, cured and dried before use near the watercourse), grout, paint, ditch sediment and preservatives from entering the watercourse.

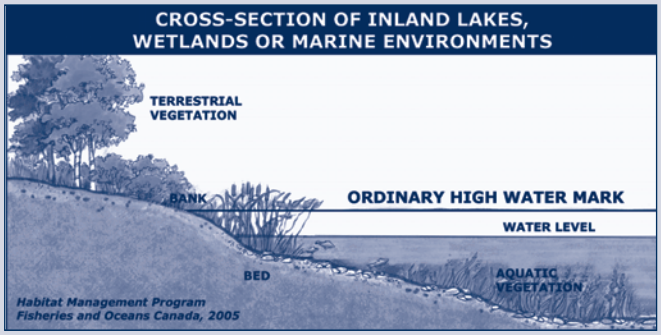
**10.** Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with preferably native grass or shrubs.

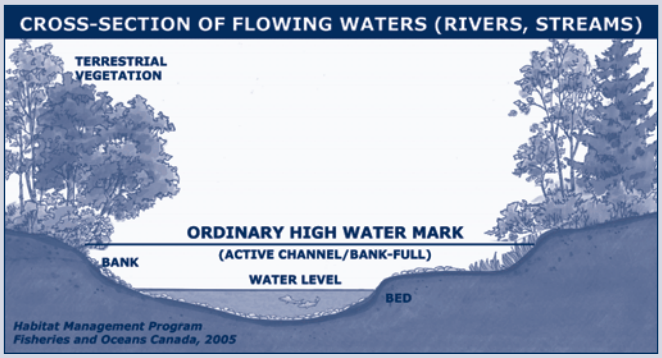
**11.** Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

- **11.1.** Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

**Definition:**

**Ordinary high water mark (HWM)** – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).




## FISHERIES AND OCEANS CANADA OFFICES IN NORTHWEST TERRITORIES

**Yellowknife Area Office**
Fisheries and Oceans Canada
Suite 101 – Diamond Plaza
5204 - 50th Ave.
Yellowknife, NT X1A 1E2
Phone: (867) 669-4900
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Box 1871
Inuvik, NT X0E 0T0
Phone: (867) 777-7500
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*Aussi disponible en français*

**http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_f.asp**

DFO/2007-1329

# APPENDIX N

## DFO Operational Statement for Bridge Maintenance

# BRIDGE MAINTENANCE

**Fisheries and Oceans Canada**
**Northwest Territories Operational Statement**

**Version 3.0**

Bridge maintenance is undertaken to extend the life of the structure and to ensure that it functions as designed, thus ensuring public safety. This Operational Statement applies only to: deck sweeping and washing to remove traction material (e.g., sand and salt residue), cleaning of all bridge components (substructure, superstructure and deck), the removal and application of protective coatings, deck wearing surface replacement, the removal of debris to protect piers and abutments, and structural repairs.

Bridge maintenance activities have the potential to negatively impact fish and fish habitat by introducing sand, sediments, deck surface materials such as concrete and asphalt, and other deleterious substances (e.g., salt, paint, solvents, oil and grease) into watercourses. Removal of woody debris and riparian vegetation may alter natural habitat features and flows that exist in the watercourse. Operation of machinery may impact habitat on the banks and bed, and result in erosion and sedimentation. Placement of rock to stabilize structures may alter natural habitat and flows, and block fish passage.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act.*

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your bridge maintenance project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- the work does not include realigning the watercourse or replacing the existing bridge,
- the work does not involve new dredging, placing fill (e.g., filling scour pools) or excavating the bed or bank of the watercourse below the ordinary high water mark (HWM) (see definition below),
- explosives are not used to remove debris, including ice build-up,
- the withdrawal of any water will not result in reduction in the wetted width of a stream, and will not exceed 10% of the instantaneous flow, in order to maintain existing fish habitat,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Maintaining a Bridge* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

**You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement.** The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

## Measures to Protect Fish and Fish Habitat when Maintaining a Bridge

**1. Deck Sweeping**

**1.1.** Adequately seal drains and open joints before sweeping to prevent material from falling into the watercourse.

**1.2.** Clean and remove debris and sediment from drainage devices and dispose of the material in a way that will prevent it from entering the watercourse.

**2. Deck Washing**

**2.1.** Sweep decks, including curbs, sidewalks, medians and drainage devices to remove as much material as practical before washing.

**2.2.** Adequately seal drains and open joints before washing to prevent sediment-laden wash-water from entering the watercourse.

**2.3.** Direct wash-water past the ends of the bridge deck to a vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse. If this cannot be achieved, use silt fences or other sediment and erosion control measures to prevent wash-water from entering the watercourse.

**2.4.** When extracting water from a watercourse, follow DFO's *NWT Winter Water Withdrawal Protocol* (available from the DFO offices listed below) and ensure the intakes of pumping hoses are equipped with an appropriate device to avoid entraining and impinging fish. Guidelines to determine the appropriate mesh size for intake screens may be obtained from DFO (*Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995), available at **www.dfo-mpo.gc.ca/Library/223669.pdf**).

**2.5.** Where possible, avoid using small streams as a source for water.

**3. Removal and Application of Protective Coatings**

**3.1.** Remove paint or protective coatings in a manner that prevents any paints, paint flakes, primers, blasting abrasives, rust, solvents, degreasers or other waste material from entering the watercourse.

**3.2.** Use measures such as barges or shrouding to trap and prevent blasting abrasives, protective coatings, rust and grease from entering the watercourse.

**3.3.** Contain paint flakes, abrasives, and other waste materials for safe disposal.

**3.4.** Store, mix and transfer paints and solvents on land and not on the bridge to prevent these materials from entering the watercourse in the event of a spill.

**3.5.** Do not clean equipment in the watercourse or where the wash-water can enter the watercourse.

**4. Removal of Debris (e.g., including woody debris, garbage and ice build-up)**

**4.1.** Unless the debris accumulation is an immediate threat to the integrity of the piers and abutments, time debris removal to avoid disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the *Northwest Territories In-Water Construction Timing Windows*), with the exception of ice build-up removal, which can be done at any time of year.

**4.2.** Limit the removal of material to that which is necessary to protect piers and abutments.

**4.3.** Remove debris by hand or with machinery operating from shore or a floating barge.

**4.4.** Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. **You should follow all other measures to the greatest extent possible.**

**5. Structural Repairs and Reinforcements**

**5.1.** Use barges or shrouding to trap and prevent concrete and other bridge materials from entering the watercourse.

**5.2.** If replacement rock reinforcement/armouring is required to stabilize eroding areas around bridge structures (e.g., abutments and/or wing walls), the following measures should be incorporated:

**5.2.1** Place appropriately-sized, clean rocks into the eroding area.

**5.2.2** Do not obtain rocks from below the HWM of any water body.

**5.2.3** Avoid the use of rock that is acid-generating. Also avoid the use of rock that fractures and breaks down quickly when exposed to the elements.

**5.2.4** Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.

**5.2.5** Ensure rock does not interfere with fish passage or constrict the channel width.

**5.2.6** If any in-water work is involved, adhere to fisheries timing windows, as outlined in Measure 4.1 above.

**6.** If working from land, install effective sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.

**7.** While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be required. This removal should be kept to a minimum and limited to the right-of-way of the bridge.

**8.** Operate machinery on land (from outside of the water) or on the water (i.e., from a barge or vessel) in a manner that minimizes disturbance to the banks or bed of the watercourse.

**8.1.** Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.

**8.2.** Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water.

**8.3.** Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.

**8.4.** Restore banks to original condition if any disturbance occurs.

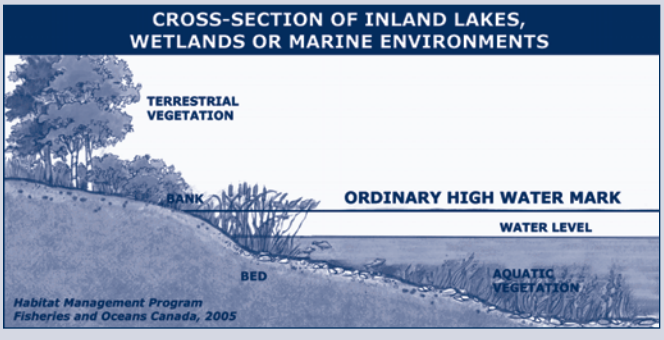
**9.** Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

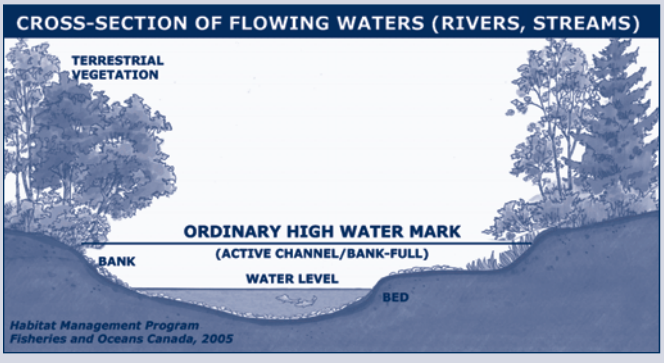
**10.** Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

**10.1.** Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

**Definition:**

**Ordinary high water mark (HWM)** – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).




## FISHERIES AND OCEANS CANADA OFFICES IN NORTHWEST TERRITORIES

**Yellowknife Area Office**
Fisheries and Oceans Canada
Suite 101 – Diamond Plaza
5204 - 50th Ave.
Yellowknife, NT X1A 1E2
Phone: (867) 669-4900
Fax: (867) 669-4940

**Inuvik District Office**
Fisheries and Oceans Canada
Box 1871
Inuvik, NT X0E 0T0
Phone: (867) 777-7500
Fax: (867) 777-7501

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**http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_f.asp**

DFO/2007-1329

# APPENDIX O

## DFO Operational Statement for Culvert Maintenance

# CULVERT MAINTENANCE

**Fisheries and Oceans Canada**
**Northwest Territories Operational Statement**

**Version 3.0**

Culvert maintenance is undertaken to extend the life of the structure and to ensure that it functions as designed, thus ensuring public safety and safe fish passage. Culvert maintenance includes the removal of accumulated debris (e.g., logs, boulders, garbage, ice build-up) that prevents the efficient passage of water and fish through the structure. Culvert maintenance may also include the reinforcement of eroding inlets and outlets, but does not include the replacement of damaged or destroyed bevel ends. Culverts requiring regular maintenance should be considered for future remediation via redesign or reinstallation.

Culvert maintenance activities can affect fish and fish habitat by the removal of woody debris that is important for cover and food production, by causing flooding and excessive stream scouring if blockages are removed too quickly, excessive erosion and sedimentation from the use of equipment along the stream bank, and disruption of critical fish life stages. Replacement of eroded rock armouring can alter flows and fish movement patterns if done excessively.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your culvert maintenance project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- the work does not include realigning the watercourse, installing a culvert liner or support struts, replacing damaged or destroyed bevels ends, or extending/replacing the existing culvert,
- explosives are not used to remove debris,
- the work does not include any dredging, infilling (e.g., filling scour pools) or excavation of the channel upstream or downstream of the culvert,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Maintaining Culverts* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

**You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement.** The activities undertaken in the Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

## Measures to Protect Fish and Fish Habitat when Maintaining Culverts

1. Use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation.

2. While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be required. This removal should be kept to a minimum.

3. Unless accumulated material (i.e., branches, stumps, other woody materials, garbage, ice build-up, etc) is preventing the passage of water and/or fish through the structure, time material and debris removal to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the Northwest Territories In-Water Construction Timing Windows). Any proposal to conduct such work under ice-covered conditions, with the exception of ice build-up removal, requires prior review by DFO.

4. Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. You should follow all other measures to the greatest extent possible.

5. Install effective sediment and erosion control measures before starting work to prevent sediment from entering the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.

6. Limit the removal of accumulated material (i.e., branches, stumps, other woody materials, garbage, etc) to the area within the culvert, immediately upstream of the culvert and to that which is necessary to maintain culvert function and fish passage.

7. Remove accumulated material and debris slowly to allow clean water to pass, to prevent downstream flooding and reduce the amount of sediment-laden water going downstream. Gradual dewatering will also reduce the potential for stranding fish in upstream areas.

8. Operate machinery on land (from outside of the water) and in a manner that minimizes disturbance to the banks of the watercourse.

    **8.1.** Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
    **8.2.** Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water.
    **8.3.** Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
    **8.4.** Restore banks to original condition if any disturbance occurs.

9. If replacement rock reinforcement/armouring is required to stabilize eroding inlets and outlets, the following measures should be incorporated:
    **9.1.** Place appropriately-sized, clean rocks into the eroding area.
    **9.2.** Do not obtain rocks from below the ordinary high water mark (see definition below) of any water body.
    **9.3.** Avoid the use of rock that is acid-generating. Also avoid the use of rock that fractures and breaks down quickly when exposed to the elements.
    **9.4.** Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.
    **9.5.** Ensure rock does not interfere with fish passage or constrict the channel width.
    **9.6.** If any in-water work is involved, adhere to fisheries timing windows, as outlined in Measure 3 above.

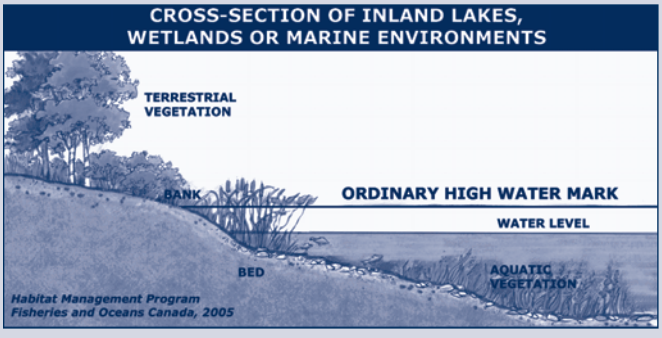
10. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

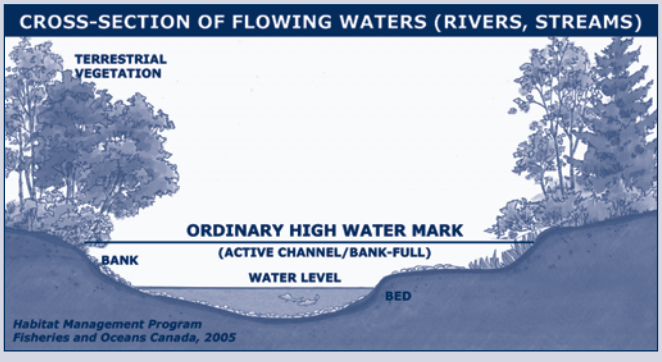
11. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

    **11.1.** Maintain effective sediment and erosion control measures until re-vegetation of the disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

**Definition:**

**Ordinary high water mark** – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).

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DFO/2007-1329

# APPENDIX P

## DFO Operational Statement for the Maintenance of Riparian Vegetation in Existing Right-of-Ways

# MAINTENANCE OF RIPARIAN VEGETATION IN EXISTING RIGHTS-OF-WAY

**Fisheries and Oceans Canada**
**Northwest Territories Operational Statement**

**Version 3.0**

Rights-of-way are areas of land devoted to providing transportation corridors (e.g., highways, railways) or utilities (e.g., pipelines, power lines, water lines) that often intersect waterways. Vegetation is closely managed in these areas to prevent disruption to transportation or utilities (e.g., circuit outages, fires) and to ensure personal safety. Maintenance activities include mowing, brushing, topping and slashing of terrestrial vegetation. This Operational Statement applies only to existing rights-of-way at the location where they intersect and cross a water body.

Riparian areas are the vegetated areas adjacent to a water body and directly contribute to fish habitat by providing shade, cover and food production areas. Riparian areas are also important because they stabilize stream banks and shorelines. In order to minimize disturbance to fish habitat and prevent bank erosion, it is important to retain as much riparian vegetation as possible, especially the vegetation directly adjacent to the watercourse, in the right-of-way corridor.

Activities carried out to maintain riparian vegetation in existing rights-of-way can negatively impact fish and fish habitat by causing excessive loss of riparian vegetation, erosion and sedimentation, disturbance to the banks and the bottom of the water body from use of heavy equipment, and introduction of deleterious substances as a result of inadequate containment of spoil piles and improper maintenance of equipment.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to be incorporated into your project in order to avoid negative impacts to fish habitat. You may proceed with your right-of-way maintenance project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan, or other applicable land use plan,
- the work involves the maintenance of vegetation in an **existing** right-of-way for a transportation or utility corridor and not construction of a new right-of-way,
- it is an existing right-of-way at the location where it intersects and crosses a water body,
- it involves the use of vegetative maintenance techniques that allow the root system to stay intact, to help bind the soil and encourage rapid colonization of low-growing plant species, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Maintaining Riparian Vegetation in Rights-of-way* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

**You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement.** The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form **(www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm)** to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

## Measures to Protect Fish and Fish Habitat when Maintaining Riparian Vegetation in Rights-of-way

**1.** While this Operational Statement does not cover the complete clearing of riparian vegetation, the alteration (e.g., topping and pruning) of select plants may be necessary to meet operational and safety needs.

**2.** Combined maintenance activities (e.g., mowing, brushing, topping, slashing, etc.) will affect no more than one third (1/3) of the total woody vegetation, such as trees and shrubs, in the right-of-way within 30 metres of the ordinary high water mark (see definition below) in any given year.

**3.** When practicable, alter riparian vegetation in the right-of-way by hand. If machinery must be used, operate machinery on land and in a manner that minimizes disturbance to the banks of the water body.

**3.1.** Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.

**3.2.** Wash, refuel and service machinery and store fuel and other materials for the machinery, which include hand tools, at locations away from the water to prevent any deleterious substance from entering the water body.

**3.3.** Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.

**3.4.** Restore banks to original condition if any disturbance occurs.

**4.** Machinery fording the watercourse to bring equipment required for maintenance to the opposite side is limited to a one-time event (over and back) and should occur only if an existing crossing at another location is not available or practical to use. A *Temporary Stream Crossing* Operational Statement is also available.

**4.1.** If minor rutting is likely to occur, stream bank and bed protection methods (e.g., swamp mats, pads) should be used provided they do not constrict flows or block fish passage.

**4.2.** Grading of the stream banks for the approaches should not occur.

**4.3.** If the stream bed and banks are steep and highly erodible (e.g., dominated by organic materials and silts) and erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice should be used to protect these areas.

**4.4.** The one-time fording should prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the Northwest Territories In-Water Construction Timing Windows).

**4.5.** Fording should occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding.

**5.** When altering a tree that is located on the bank of a water body, ensure that the root structure and stability are maintained.

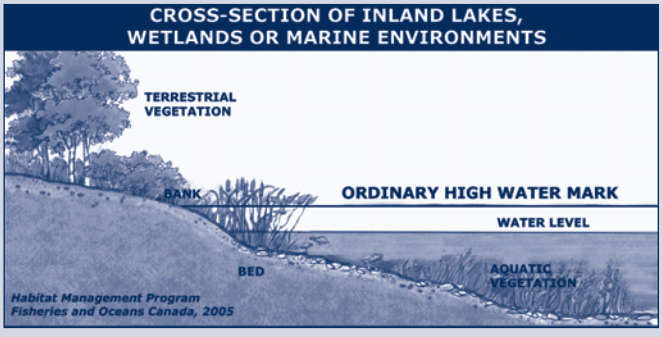
**6.** Stabilize any waste materials removed from the work site to prevent them from entering the water body. This could include covering spoil piles with biodegradable mats or tarps. All long-term storage of waste materials should be kept outside of the riparian area.

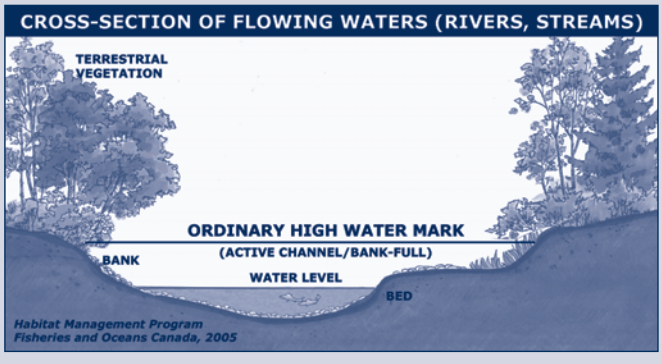
**7.** In order to prevent erosion and to help seeds germinate, vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

**7.1.** Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

**Definition:**

**Ordinary high water mark** – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).

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Suite 101 - Diamond Plaza
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DFO/2007-1329

# APPENDIX Q

## Inuvialuit Settlement Region Pits and Quarries Guidelines

## SECTION 3:

# INUVIALUIT SETTLEMENT REGION PITS AND QUARRIES GUIDELINES

Inuvialuit Land Administration
Leaders in Aborginial Land Management

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

# PREFACE

This document is an amended version of the INAC's pits and quarries guidelines, which is part of the land-use guidelines series. This set of guidelines serves as a supporting document to the Inuvialuit Settlement Region Granular Resources Management Plan which is a joint initiative by Indian and Northern Affairs Canada (INAC) and the Inuvialuit Land Administration (ILA).

The ISR Pits and Quarries Guidelines gives prospective users of granular resources information about the methods that should be used for obtaining gravel within the ISR, as well as about the permitting processes for Crown and Inuvialuit Private Land. These guidelines apply only to Inuvialuit Private land and Crown land within the Inuvialuit Settlement Region in the Northwest Territories. Resources on Commissioner's land require direction from the appropriate agency. The contact information for these agencies is found in Appendix A.

For further information concerning the subject matter contained in these guidelines please contact:

Inuvialuit Land Administration
P.O. Box 290
273 Inuvialuit Lane
Tuktoyaktuk, NT X0E 1C0
Tel.: (867) 977-7100
Fax: (867) 977-7101
Email: ilainfo@irc.inuvialuit.com

Indian and Northern Affairs Canada
North Mackenzie District Office
P.O. Box 2100
Inuvik, NT X0E 0T0
Tel.: (867) 777-8900
Fax: (867)777-2090

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# SECTION 1: ACKNOWLEDGEMENTS

In the 1980s, Indian and Northern Affairs Canada published a series of six land-use guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called “The Blue Books,” have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land-use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Affairs Program staff in Ottawa and Northern Regional Office staff.

Further edits were made by the Granular Resources Management Plan Working group within the Inuvialuit Settlement Region to create this document, which is specific to the ISR.

# SECTION 2: INTRODUCTION

The purpose of this volume is to provide guidance to pit and quarry operators when operating on Crown land or Inuvialuit Private land in the Inuvialuit Settlement Region. If you are not operating on Crown land or Inuvialuit Private land, it is your responsibility to contact the appropriate landowner for any land-use guidelines that may be in place. Resources on Commissioner's land require direction from the appropriate agency. The contact information for these agencies is found in Appendix A.

Granular resources are a strategic and valuable resource, and it is important that they are used in a sustainable way. This volume presents specific land-use techniques for quarrying within the Inuvialuit Settlement Region, and best practices that can be used by operators to minimize land disturbances and environmental impacts.

# SECTION 3: NORTHERN GRANULAR RESOURCES

Granular resources is a term that describes a wide range of materials from silts to sands, gravel and cobbles that are vital for the construction of a wide range of northern developments such as roads, pipelines, mines, and community infrastructure. Access to granular materials is often a challenge in the north because development activities are commonly located in remote areas with limited infrastructure. The availability of granular resources is often an important factor in determining how and if a proposed development can proceed. In order to minimize their environmental effects, and prevent any wastage of granular resources, proper land-use techniques and extraction methods should be used. The information presented in this volume reflects current industry best practices that apply to both pits and quarries. The guidelines are general in nature and should be supplemented, on a site specific basis, by engineering and other expertise.

## 3.1 Definitions

Pits and quarries are used to extract granular resources, as defined in Table 3-1. Granular materials are often used for construction, but some materials have other uses, such as carving.

| Type | Definition |
|---|---|
| Quarry | Extraction of rock materials by digging, cutting or blasting.<br><br>Quarries usually yield large stone that may then be crushed. Commonly quarried materials include limestone and granite. |
| Sand or Gravel Pit | Extraction of unconsolidated earth materials, such as sand or gravel by digging a pit. |
| Borrow Pit | Excavation of low-quality fill, such as silt, clay and topsoil.<br><br>Material is usually removed for use at a nearby site. |

***Table 3-1 Definitions for Pits and Quarries***

## 3.2 Granular Deposits

Different types of granular resources have specific uses. The proponent must evaluate the source material to ensure it has the characteristics required for the intended use. Each material and deposit has unique characteristics which will require a slightly different approach to development. Site investigations and testing should be conducted on the source material to verify:

- type, extent and geology of the granular deposit
- grade and quality of the deposit
- structural and chemical properties of rock
- extent of ground-ice in the material

If results from these investigations show that the granular material is suitable for its intended use, then the proposed development is ready to proceed through the four phases of land-use activity:

Phase 1 - Planning and Design
Phase 2 - Site Development
Phase 3 - Operations
Phase 4 - Reclamation

## 3.3 Quarry Permit and Lease Requirements

In the Inuvialuit Settlement Region, pit or quarry developments require a quarry permit, under the Territorial Quarrying Regulations on Crown land, or a quarry licence under the Inuvialuit Inuvialuit Final Agreement on Inuvialuit Private land. If activities include the use of equipment that exceeds the thresholds of the applicable land-use regulations, a land-use permit will be required. Quarry and land use permits will include terms and conditions specifying how operations must be conducted.

Applications for quarry permits/licences are assessed by INAC or ILA to determine:

- whether an existing pit can meet the demands or whether there is a requirement for the development of an undisturbed site
- if the proposed application is an appropriate use of the resource
- if potential reserves of the granular material are adequately identified
- if the development plan will maximize resource recovery
- if the proposed extraction and use of granular resources is consistent with the prioritization of materials outlined in the Inuvialuit Final Agreement (on Inuvialuit Private land only)

Aboriginal rights must be respected when planning and conducting land-use activities, including pits and quarries. Proponents should contact the local Community Corporation and Hunters and Trappers Committee to discuss their proposed development. INAC and ILA strongly encourage community engagement as part of the permitting process. Proponents should contact the applicable land-use regulator, depending on ownership of the land on which the granular resources lie, for more information on their requirements. Once permits are issued, INAC and ILA are responsible for ensuring compliance of their terms and conditions in the Inuvialuit Settlement Region. INAC resource management officers conduct regular inspections of quarry operations on Crown land, and the ILA requires the presence of an environmental monitor and

gravel checker at all times during quarry operations, and periodic inspections by the ILA Inspector.

Under Section 10 of the Territorial Quarrying Regulations, residents of the Northwest Territories are allowed to take up to 38.23 cubic metres (50 cubic yards) of sand, gravel or stone from Crown land per calendar year for their own personal use without having to obtain a quarry permit or pay any fees. A land use permit may be required, depending on the type of equipment required to extract and haul the resources. The personal allotment cannot be obtained from areas where any interest in the surface rights of lands has been licensed, leased or otherwise disposed of by the Crown. On Inuvialuit Private land, enrolled Inuvialuit beneficiaries are entitled to a personal gravel allotment of 38.23 cubic metres (50 cubic yards) per year. Any person wishing to obtain their personal gravel allotment must notify ILA prior to extraction, and a quarry license will be issued, if the proposed source is appropriate for the extraction of personal allotments.

Other permits may be required depending on the nature of work being conducted. Quarry operations that require blasting may require regulatory approval from the Workers' Safety and Compensation Commission. Removing granular resources from riverbeds, lakeshores or ocean shorelines may require a water license from the Northwest Territories Water Board, and approval from the Department of Fisheries and Oceans. Approvals for extraction from water bodies and shorelines are not normally granted unless there are no alternatives, and include more stringent conditions to minimize environmental impacts.

Fees for quarried material on Crown land vary depending on the type, and are set out in Schedule 2 of the Territorial Quarry Regulations. Royalty fees, based on an estimate of material required, must be submitted with a Quarry Permit application, and fees will be returned if the amount of material used is less than estimated. The amount of quarry returns must be reported monthly, and a final plan is required at the end of operations. In the case of a quarry lease, fees are required as per the schedule in the lease.

On Inuvialuit Private land (for uses other than personal allotment), at the time of application, the proponent will be required to pay a quarry license application fee, land use permit application fee, and land use permit fee. During quarry development and operation, ILA will require an environmental monitor to be on site at all times, as well as a gravel checker when resources are being extracted and hauled. Periodic inspections will also be required by the ILA Inspector. The proponent is responsible for paying the costs associated with site monitoring (environmental monitors, gravel checkers and inspectors). The proponent will also pay gravel royalty fees for the volume of gravel extracted, as per the Inuvialuit Final Agreement and ILA Fee Schedule. Surveying of the pit may also be required to verify gravel extraction quantities, at the cost of the proponent.

# SECTION 4: PLANNING AND DESIGN

Proper planning is crucial in conducting an efficient and environmentally responsible pit or quarry development. The planning process and collection of detailed site information should commence in the early stages of the proposed development to gain an understanding of the site, and submit to the regulatory authorities.

Pit management plans may be available for the most commonly used granular resource sites within the Inuvialuit Settlement Region from the respective land owner. These plans contain all relevant information for proponents wishing to develop and extract resources from the gravel source. Furthermore, the Inuvialuit Settlement Region Granular Resources Management Plan contains a generic pit development plan which sets out guidelines for what a proponent's pit development plan should look like if one doesn't already exist.

The following general suggestions should be considered:

- Contact regulatory authorities early to understand regulatory requirements and timeframes necessary to obtain the required permits.
- Initiate contact and discuss plans with local Community Corporations and Hunters and Trappers Committees well in advance of submitting permit applications.
- Estimate the quantity of material required and the duration of the operation.
- Review aerial photographs or satellite imagery to identify access routes to the site and locations to investigate site conditions.
- Conduct a field reconnaissance of the site (Section 4.1) to verify aerial photograph or satellite imagery interpretations, obtain surface and shallow-depth granular samples using test pits and boreholes, and conduct geophysical surveys.
- Finalize pit or quarry design before submitting permit applications.

There are a variety of information sources outlined in Table 4-1 that can be accessed when planning and designing a pit or quarry operation.

## *Table 4-1 Quarry and Pit Planning Information*

| Information Category | Examples of Required Information | Information Sources (Crown) | Information Sources (Inuvialuit) |
|---|---|---|---|
| Legal | Quarry Permit Fees and Royalties | INAC Resource Management Officer and District Offices | Inuvialuit Land Administration Office |
| | | Territorial Quarrying Regulations | Inuvialuit Final Agreement |
| | | Territorial Lands Act | |
| | Quarry Lease | Territorial Land Use Regulations | Inuvialuit Land Administration Rules and Procedures |
| | Land Use Permit | Environmental Impact Screening Committee | |
| | Blasting | Environmental Impact Review Board | |
| | | Northwest Territories Waterboard | |
| | | Department of Fisheries and Oceans Canada | |
| | | Workers Safety and Compensation Commission | |
| Geological | Type of deposit | INAC Granular Resources Inventory | ILA Granular Resources Inventory |
| | Extent of deposit | INAC Resource Management Officer and District Offices | Inuvialuit Land Administration Office |
| | Grade of deposit | NWT Geoscience Centre | |
| | | Geological Survey of Canada | |
| | | Site Investigation | |
| | | Local operators in project area | |
| | | Community Corporations and Hunters and Trappers Committees | |
| | | Municipal and Community Affairs (MACA)/Hamlets | |
| Engineering | Slope design | INAC Source-Specific Pit Management Plan | ILA Source-Specific Pit Management Plan |
| | Blasting | INAC Resource Management Officer | ILA Environmental Specialist |
| | | Engineers and Consultants | |
| | | Workers Safety and Compensation Commission | |
| | | Blasting Equipment Suppliers | |
| Operations | Staking Pit wall safety and operations | INAC Resource Management Officer | ILA Environmental Specialist |
| | | Territorial Quarrying Regulations | |
| | | Territorial Lands Act | |
| | | Territorial Land Use Regulations | ILA Rules and Procedures and Pit Management Plan |
| | | Workers Safety and Compensation Commission | |
| | Access roads | Equipment Suppliers | |
| | Equipment | | |
| Environmental | Fish and wildlife habitat | INAC Resource Management Officer | ILA Environmental Specialist |
| | | INAC Water Resource Division | |
| | Vegetation | Environmental Impact Screening Committee | |
| | Soil conservation Topography and drainage | Environmental Impact Review Board | |
| | | Northwest Territories Water Board | |
| | | Department of Fisheries and Oceans Canada | |
| | Permafrost | Aerial photographs and maps | |

| | | |
|---|---|---|
| | Water | Community Corporations and Hunters and Trappers Committees<br>Territorial Environmental Departments |
| Archaeological/Cultural | Location of archaeological sites | Territorial Land Use Regulations<br>Inuvialuit Cultural Resources Centre<br>Community Corporations and Hunters and Trappers Committees<br>Prince of Wales Northern Heritage Centre |
| Reclamation | Reclamation standards | INAC Resource Management Officer<br>ILA Environmental Specialist<br>INAC Source-Specific Pit Development Plan<br>ILA Source-Specific Pit Development Plan<br>Territorial Lands Act<br>Territorial Land Use Regulations<br>ILA Rules and Procedures<br>Territorial Environmental Departments<br>Environmental Impact Screening Committee<br>Environmental Impact Review Board<br>Northwest Territories Water Board<br>Department of Fisheries and Oceans Canada |

## 4.1 Site Conditions

Pit or quarry development should include an assessment of site conditions since these will often dictate how a development can be conducted most efficiently and with minimal environmental impacts. Factors that should be considered when assessing site conditions include:

- Topography and drainage
- Extent and depth of permafrost and ground-ice
- Soils, particularly organic layer composition and depth, and depth of overburden
- Proximity of water bodies
- Groundwater conditions (e.g. evidence of seepage or springs)
- Surface vegetation and the conservation status of the present plant species
- Sensitive landforms (Eg. pingos, sand dunes, wildlife areas, buffer zones near water bodies)
- Wildlife or fish habitat
- Type of access required
- Extent of reclamation required (Eg. minimum overburden)
- Existence of cultural/archaeological sites

Site selection for a quarry can be more complex than for a pit because blasting and processing equipment increase the impacts and potential risks to other land-users. Dust control, noise controls, warning signs and site security are mitigation measures that should be considered when planning site development.

### 4.1.1 Permafrost

The Inuvialuit Settlement Region is located in an area of continuous permafrost. Ice-rich permafrost is prone to subsidence and slumping when thawed and is more problematic for pit and quarry operations than permafrost with low ice content or areas without permafrost. Field investigations should determine the extent, depth and ice content of permafrost at a proposed pit or quarry site before proceeding with development. This will ensure that measures can be implemented to mitigate permafrost degradation, or an alternate location could be developed to avoid problems associated with permafrost disturbance.

Measures to mitigate degradation in areas of ice-rich permafrost include conducting work during the winter, and replacing the organic layer prior to spring thaw to provide an insulating layer between the permafrost and warm air temperatures. In the summer, ice-rich material should be stockpiled in windrows and allowed to melt and drain before use. More information is available in the INAC Blue Books.

## 4.2 Exploration

### 4.2.1 Pits and Quarries

Advanced exploration of the granular deposit will be necessary to further understand the geological properties and size of the granular deposit. Soil and rock types and their structure can be analyzed at a laboratory to determine if the granular material is suitable for the required use. Type and thickness of vegetation, overburden and interburden must be assessed to determine the preparatory work required to access the deposit, and to ensure the deposit has adequate volume to meet user needs. If advanced exploration activities such as drilling, test pits, or trial quarries, include the use of equipment that exceeds the thresholds of the applicable land-use regulations (Crown land) or ILA Rules and Procedures (Inuvialuit Private land), a land-use permit will be required.

### 4.2.2 Armour Stone Quarries

Quarries for large diameter armour stone require a more detailed field assessment to confirm that suitable material exists and that its extraction is feasible. The following factors should be considered:

- Stable, weather-resistant rock is required
- Deep quarries are likely to be good sources of armour stone, but the presence of groundwater will limit quarry depth
- If the deposit is within sedimentary rock, thick beds are required to yield large stone
- Secondary structures (Eg. jointing, faulting, and shearing) affect the feasibility of extracting large stone, and a drilling program may be required to delineate the deposit
- Pit layout will depend on the dominant structure
- A trial quarry to assess the feasibility of full-scale development may be necessary
- Transport of armour stone requires large, heavy equipment, which will affect access requirements, and may require that transportation be carried out during the winter

## 4.3 Pit/Quarry Development Plan

Following site exploration, a pit or quarry development plan should be created to outline the entire project life cycle, including site layout, preparation, operations, environmental concerns, and reclamation. The size and duration of the operation will determine the scope and level of detail required in the plan.

In pits or quarries with multiple users, an overall management plan may be developed by the owner. This plan will indicate where and how the proposed development can operate, and the proponent will be required to provide a development plan that shows how they will operate within the site constraints.

Generic pit management and development plans for granular sources within the ISR are available within the ISR Granular Resources Management Plan. There are a number environmental concerns related to the development of a pit or quarry. A description and proposed mitigation for each applicable concern should be addressed in the management plan. Table 4.2 provides an overview of potential environmental concerns and related mitigation options that may be encountered in the site layout or operations phase of development. These will be described in greater detail in the following sections.

***Table 4-2 Pit and quarry environmental concerns and mitigation techniques***

| Development Phase | Actitivities | Potential Environmental Effects | Mitigations Techniques |
|---|---|---|---|
| Site layout and preparation | Timber clearing<br>Vegetation removal<br>Soil and overburden removal | Soil erosion<br>Habitat loss | Retain vegetation to maintain slope stability<br>Maintain natural drainage patterns<br>Maintain vegetation buffer zones to protect water bodies<br>Construct ditches to direct runoff away from the site<br>Locate the development in a well drained area<br>Salvage and properly store organics, topsoil, and overburden for use in reclamation |
| Operations and monitoring | Blasting<br>Stockpilling<br>Crushing<br>Access road maintenance | Soil erosion and sediment deposition | Limit sediment movement using silt fences or straw bales<br>Use rip-rap to reinforce drainage channel corners and water discharge points<br>Revegetate where required to stabilize slopes |
| | | Water quality impacts | Limit sediment movement or use settling ponds before discharging<br>Use proper fuel containment and handling techniques, and have spill kits accessible<br>Use proper explosive handling techniques to minimize wastage |
| | | Water ponding and permafrost impacts | Minimize source of in-pit water by diverting surface water away from the development area<br>Place ice-rich material to thaw in a location where melt water will not re-enter pit<br>Limit pit or quarry depth |
| | | Dust generation | Spray water and use dust skirts on conveyors to minimize dust |

## 4.4 Water

The control of water into and out of a proposed pit or quarry site should be planned prior to development to enhance the efficiency of operations, limit effects on water quality, and prevent permafrost degradation. Water from within a pit or quarry should not be discharged to surface waters without an appropriate water license. Any use of water or deposit of waste into water above thresholds within the Northwest Territories Waters Regulations requires a water license that will specify discharge limits. Proponents should avoid conducting operations below the water table. The accumulation of groundwater will impede operations, must be pumped to the surface and may require treatment.

Ponded water that rests in low-lying areas of pits or quarries can also lead to permafrost degradation. Drainage ditches or channels should be installed to prevent ponding. Measures should be taken to prevent the migration of silt into water bodies. Settling ponds or impoundments may be constructed to control surface runoff where required. Construction methods and materials that prevent exfiltration and seepage to the surrounding environment should be used. Erosion control supplies (Eg. geotextile fabrics, straw blankets) should be kept on-hand to respond to scouring or slope destabilization caused by water erosion.

## 4.5 Fish and Wildlife

Project development and operations should aim to minimize wildlife disturbance and the loss of habitat. Caribou are a migratory species of particular concern in the north. Pit and quarry walls may attract certain bird species that prefer this type of habitat for nesting. Nesting birds should not be disturbed and the destruction of nests or bird mortalities should be immediately reported to a territorial wildlife officer and the local Hunters and Trappers Committee. Measures to minimize wildlife disturbance include:

- Reducing or stopping project operations during sensitive breeding times
- Ensuring working equipment is well maintained to minimize excessive noise
- Using proper waste disposal techniques to minimize wildlife attractants
    - o using covered containers for garbage and waste storage
    - o keeping the site clean at all times
    - o regularly removing waste from the site
- Using water management and erosion control techniques to prevent the deposition of sediment into fish-bearing water bodies (Table 5-2).

The *Species at Risk Act* protects wildlife species that may become endangered or threatened. Proponents should be aware of their special status and should minimize disturbance or contact with these species during operations. Species of special concern are listed under Schedule 1 of the *Species at Risk Act*, and more information is available from Environment Canada at www.ec.gc.ca.

## 4.6 Development Timing

Development timing is an important consideration in the north as many operations utilize the winter frozen-ground season to minimize land disturbance, and to maximize transportation efficiency. Proponents should consider scheduling specific components of their pit or quarry development at the most advantageous time of the year.
Development stages and suggestions for their timing in the Inuvialuit Settlement Region are listed below:

- Exploration:
    - o Access may favour winter, but field programs may favour summer
- Access and Transportation
    - o Will require winter roads, unless all-season road construction is planned
- Operations and Processing
    - o Generally favour summer; however, in areas of ice-rich permafrost, work should be scheduled during the winter
    - o Operations may need to stop during spring break-up
    - o Washing is a summer operation
    - o Critical life stages for birds, mammals and fish may limit operations during some seasons

# SECTION 5: SITE DESIGN

Careful consideration of site design prior to development will result in an efficient operation with minimal environmental disturbance. Site design should consider all potential uses for the site, allowing for enough room to conduct all phases of development, as well as considering the eventual reclamation of the site. Design may also be affected by land-use permit conditions. This section outlines specific factors that should be considered during the planning phase of the development.

## 5.1 Site Layout

The site layout should be designed with the following considerations:

- Adequate room for all activities, including stockpiling of resources and overburden
- A refuelling station with appropriate containment, if required (Section 8.2)
- Dust or noise, particularly if other land-uses are nearby

### 5.1.1 Quarries

Territorial mine safety legislation (Mine Safety Act) will dictate how a quarry must be developed and this will affect the layout of the quarry operation. Quarry-specific site layout considerations include:

- Orienting pit walls to take advantage of natural structure in bedrock
- Orienting walls to direct blasting and operating noises away from sensitive areas
- Using safety benches at regular intervals
- Using signage and/or fences to delineate potential safety issues
- Planning for a considerable volume of waste

## 5.2 Buffer Strips

Buffer strips are areas of land that are left untouched to provide a natural barrier between the development and an adjacent area. Buffers can be used to protect important ecosystem components such as wildlife habitat or water bodies, or they can be used to provide a visual barrier between the development and an area of human use. Buffer strips of existing vegetation at least 100 metres wide should be left around water bodies, and if trees are present, should be designed to resist damage from prevailing winds.
Direct sunshine in winter or spring can cause unsafe glare-ice conditions on access road surfaces. If possible, buffer strips should be designed to block road surfaces from direct sun exposure.

## 5.3 Visual Impacts

Minimization of visual impacts to areas of human use should be considered when designing a pit or quarry site. Land-use permits may have specific conditions regarding the appearance of a

development. The visual impacts of a pit or quarry can be reduced by using the following methods:

- Locating the development on the downhill side of a road
- Leaving a buffer strip at least 30 metres wide in place between the road and the pit
- Constructing a berm between the road and the development
- Ensuring that access roads have a 'dog-leg' to eliminate the line of sight

## 5.4 Noise and Dust

Dust and noise from pit or quarry operations can be a nuisance in areas where other land-uses, such as recreational areas, are nearby. Excessive dust can be an occupational hazard for those working on-site. Wildlife can also be deterred by noise.
The following considerations can minimize noise and dust issues:

- Erecting a berm to block noise
- Restricting operations during certain times
- Orienting quarry faces to direct noise away from other land-uses
- Considering prevailing winds when designing the site layout
- Applying dust suppression controls such as road watering, and using a dust skirt or minimizing the drop height when releasing material from a conveyor

# SECTION 6: SITE PREPARATION

Preparation of a pit or quarry site should proceed in an orderly sequence to ensure that materials overlying the granular resource are segregated and properly stored for future use in reclamation. The following section outlines measures that should be utilized in the preparation of a pit or quarry site, if a pit management plan is not already in place.

## 6.1 Clearing

Prior to clearing, the pit and quarry site boundaries should be flagged to delineate the project area and restrict the project footprint. Since the clearing of vegetation has both a visual and environmental impact, it is good practice to avoid clearing a larger area than is necessary for the development. A site survey should be conducted to confirm the planned site layout. Global Positioning System (GPS) units can be used to survey and delineate specific project components. The timing of clearing should be chosen carefully. In areas of ice-rich permafrost, vegetation clearing in the summer can expose the soil to direct sunlight, and lead to ground-ice melting and subsidence. Clearing activities should also be avoided during sensitive nesting periods for birds. Trees larger than 12 centimetres in diameter should be saved as merchantable timber. Land-use permits may indicate conditions for saving and stacking merchantable timber. Brush should be stockpiled for future use in site reclamation as specified in the land-use permit, or as directed by an INAC resource management officer.

## 6.2 Organic Topsoil Layer

As a result of site exploration, the proponent should have a good understanding of the local soils, including the depth of surface organic topsoil. This layer should be stripped and stockpiled separately from deeper mineral soil so as to minimize mixing. Topsoil will be replaced on the surface during reclamation, to function as a natural native seed bank and promote successful revegetation. Topsoil and organics can dry out quickly and can easily blow away or erode if not covered during storage. Tarpaulins can be used to protect stockpiles from wind and water erosion. Topsoil stockpiles should be stored at a secure location that will not interfere with pit operations, will not be affected by surface runoff, and will allow drainage of melt water from ground-ice.

## 6.3 Overburden

Overburden is rock or soil of low economic value that is located above the desired granular deposit, and below the topsoil layer. It must also be removed and stockpiled for reclamation prior to accessing the granular resource. Overburden should be removed in a manner that does not reduce the stability of adjacent ground. Stockpiles should be gradually sloped and rounded to minimize erosion from wind and water. As with topsoil, overburden stockpiles should be stored at a location that will not interfere with pit operations, will not be affected by surface runoff, and will allow drainage of melt water from ground-ice. Structures to collect and treat runoff from overburden stockpiles may be required if the water has a high silt content.

# SECTION 7: OPERATIONS

Operations must be conducted in accordance with approved management plans associated with the land-use permit. These plans include a Pit/Quarry Management Plan (Section 4.3) and a Spill Response Plan (Section 8.1). Major changes in operations may require amendments to existing permits or additional permits.

## 7.1 Resource Extraction

The method used to excavate the granular material will depend on the nature of the material, the equipment available, and in permafrost terrain, the extent and nature of the permafrost. Pits and quarries should not be excavated below the water table to avoid safety concerns, additional water handling, and permafrost degradation (Section 4.4).

If excavated material contains ground-ice, it should be stored at a location within the pit where it can thaw and drain. Small stockpiles will allow frozen material to thaw and drain in one summer season, as a large surface area will be exposed to heating. Melt water from thawing stockpiles may have high silt content, and require control and treatment before being discharged to surface water. Interburden is waste material that may be encountered within the granular resource and should be stockpiled in a depleted section of the pit. It can be handled in the same way as overburden (Section 6.3).

## 7.2 Resource Processing

Processing of granular material often requires an area of intensive heavy equipment activity, and can include crushers, screens, wash plants, generators and conveyors. Each processing step requires an accessible area within the pit to carry out the operation, stockpile the processed material, and allow trucks easy access to haul material out of the pit. The crusher should be located on hard and stable ground to support intensive use by heavy equipment. Oversized materials, such as boulders that are rejected for resource use should be stored and used for future reclamation activities.

For operations that require washing of granular materials, a water license may be required to use and dispose of wash water. Treatment of water from washing operations may also be required. Screening frozen material often leads to wastage caused by the presence of large frozen blocks. Wastage can be reduced by only screening dry, thawed material. Alternatively, frozen material should be crushed before being screened.

## 7.3 Monitoring

Operations should be monitored to ensure that they are proceeding according to the Pit/Quarry Management Plan and remain in compliance with local regulations and the land-use permit. For gravel sources on Crown land, there will be periodic inspections from the INAC Resources Officer and on Inuvialuit Private land, an Environmental Monitor will be present at all times. Monitoring results should answer the following questions:

- Are site preparation measures achieving goals?
- Are water management strategies effective?

- Are pit walls safe?
- Is the granular resource still suitable for end uses?
- How much ground-ice is present in the material?
- What is the behaviour and volume loss of the material as thawing occurs?
- Are wildlife sightings and interactions being recorded?

Regular monitoring can be used to assess the performance of designed structures (Eg. a water containment dyke) and specific environmental mitigation measures (Eg. spraying water to reduce dust). Monitoring will also promote the early detection of a problem which should trigger the appropriate response or contingency plan, and notification of the INAC resource management officer or the ILA Inspector.

## 7.4 Maintenance

The site and access roads should be regularly maintained to minimize erosion, sediment deposition, and dust emissions. Potholes, wash boarding, and frost heaving should be promptly repaired to minimize dust generation and equipment wear.
Hydrocarbon spills from equipment are a major source of environmental damage and are completely preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays should be placed under equipment when it is not in use to prevent hydrocarbon staining.

## 7.5 Site security

For safety and security purposes, uncontrolled access to the pit or quarry site should be limited. Contact an INAC resource management officer or ILA Inspector for more information on appropriate access control strategies.

## 7.6 Intermittent Operations

If a pit or quarry is to be closed seasonally, the operation is considered to be inactive. The proponent should inform and obtain consent from regulatory authorities to discontinue operations. Regulatory authorities may request financial assurance from the proponent to complete the reclamation. The pit or quarry must be stabilized before the operation is shut down. Areas where extraction is complete must be reclaimed by backfilling and/or contouring. Proper drainage must be in place to prevent flooding of the pit or quarry. If site conditions do not allow for positive drainage, intermittent operations may be impractical, and this should be identified at the planning stage.

# SECTION 8: SPILLS

A spill contingency plan must be in place during all phases of pit and quarry development. Spills can involve chemicals, hydrocarbons, or process water. Unexpected spill events do occur and a plan will help operators to respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. All spills must be reported immediately to the 24 hour spill line: 867-920-8130. On Inuvialuit Private land, all spills must also be reported to the ILA Environmental Monitor.

## 8.1 Spill Contingency Plan

A spill contingency plan outlines a logical order of how operators should respond to a spill, resources available on-site for spill response, and agencies and individuals who need to be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. The Government of the Northwest Territories has guidelines for developing a spill contingency plan that proponents should review, as a spill contingency plan is required to be submitted with the land-use permit applications on Crown and Inuvialuit Private land. The guidelines are available at:
www.enr.gov.nt.ca/eps/pdf/spill_contingency.pdf

## 8.2 Spill Prevention

Hydrocarbon spills are a major source of contamination at northern pit and quarry operations. Proper fuel storage and handling can help to prevent these spills. A dedicated refuelling area should be constructed using impermeable ground or a liner to contain drips and spills. A well stocked spill response kit should be available in the refuelling area. All vehicles should be equipped with spill response kits and drip trays. Used oil and fuel should not be stored at the site and should be disposed of immediately at an approved hydrocarbon waste disposal facility.

## 8.3 Spill Response

Spill response includes stopping, containing, and reporting the spill event. In permafrost areas, containment dikes should only be constructed of snow since excavating soil may expose underlying permafrost, causing thawing and subsidence. Photographs should be taken of the spill area and the extent of the spill should be delineated. During the winter, removal or compression of the snow may allow spreading liquid to be more clearly seen. At all times, ensure that there is no ignition source in the vicinity of spilled flammable products. Once the spill is contained and has been reported, a clean up strategy must be developed.

# SECTION 9: RECLAMATION

The final phase of pit and quarry development is reclamation. Reclamation objectives are influenced by site conditions and the future land-use, and must be satisfactory to regulatory authorities and key stakeholders. Proponents may suggest future uses for the site, but the landuse regulator will make the determination. A closure and reclamation plan is required by the land-use permit or land lease. In some cases, INAC or ILA may already have developed a pit reclamation plan that the proponent must follow. If a reclamation plan does not already exist, a plan should be developed with input from local stakeholders, regulatory authorities, and the INAC resource management officer or the ILA Environmental Specialist, and will require approval from the appropriate regulatory authority. Land-use permits may also contain specific conditions regarding reclamation. Once a closure and reclamation plan is approved, progressive reclamation may be conducted during operations at areas of the site that are no longer used. This will reduce the amount of reclamation required when operations are completed, and could reduce reclamation costs at the end of operations.
When operations are complete, the site must be reclaimed as per the reclamation objectives outlined in the plan, and to the satisfaction of the land-use regulator. Monitoring will last for several years after reclamation has been completed to ensure that reclamation objectives are being met. If they are not, proponents will be required to return to a site for further work. Once the regulator or land owner is satisfied that the site is stable, they will issue a letter of final clearance indicating that the permit holder is no longer responsible for the pit or quarry site.

## 9.1 Clean-up

Once operations are completed, all buildings, machinery, and fuel containers must be removed from the site. All garbage, blasting materials, and material stockpiles must also be removed.

## 9.2 Landscape Reconstruction

Coarse material, overburden, and topsoil stockpiled in the pit or quarry during operations should be used for reclamation of the site upon project completion. Use of frozen materials for reconstruction activities is not recommended as ground-ice may melt and cause subsidence. Coarse material should be buried at the bottom of the pit or used for slope reconstruction. Overburden should then be used for site grading and contouring. It should not be left piled in, or adjacent to the pit. Contour the site to blend with the surrounding topography but also consider the end land-use for the site. If sufficient overburden is available, gentle slopes and rounded shapes are visually preferable to straight lines. Once site contouring is completed and the ground surface has stabilized, stored topsoil should be placed evenly on areas from which the soil was stripped. Topsoil should be spread over as much of the surface of the disturbed area, and as close to the original depth as possible. The ground surface should be roughened to provide micro-sites suitable for revegetation. If cliffs are left in place, cliff faces may require scaling to remove loose material that could pose a safety hazard. Access to the site should be restricted and warning signs installed for public safety.

## 9.3 Drainage and Erosion Control

Successful reclamation involves proper surface drainage. Contouring should not block or divert natural drainage patterns on the site as reclaimed areas are susceptible to erosion while vegetation and soil stability become re-established. Drainage ditches should have adequate grade and capacity to divert runoff from the reclaimed site without eroding adjacent material. Riprap or boulders may be required to armour drainage ditch corners and discharge areas to prevent erosion from flows. Construction and repairs of drainage ditches should be performed during dry weather to avoid adding sediment to the water. Roughening the exposed soil surface using horizontal grooves also improves drainage and minimizes ponding.

## 9.4 Revegetation

Natural revegetation is preferred as it promotes the growth of native plants, and limits the introduction of invasive plant species that may be included in seed mixes. Salvaged topsoil often contains seeds from native plants and organic matter that aid in vegetation re-establishment. When slope soil erosion is a concern, seeding may be required. Native seed mixes should be used to avoid the establishment of invasive species.

The main objectives of revegetation are to prevent soil erosion, and improve the appearance of the reclaimed site. Revegetation objectives should be discussed with the land-use regulators, and will be specified in the Closure and Reclamation Plan. The selected option should be based on the end land-use, compatibility with the surrounding landscape, as well as limiting factors such as climate, the surface material and its moisture-holding capacity.

## 9.5 End-Pit Lake

Allowing surface water or groundwater to flood a pit and create a lake may be an acceptable reclamation goal. More careful planning may be required in areas of permafrost, since the presence of a large body of water in permafrost terrain will lead to warming and subsidence of the ground. In permafrost areas, information collected during the planning phase should be used to avoid ice-bearing permafrost during operations. Positive drainage should be used to divert water away from the pit area to prevent the formation of a lake. If permafrost is not a concern and an end-pit lake is planned, all economically viable gravel should be removed from the pit before flooding. Pit walls should be contoured to provide stability.

Proponents planning an end-pit lake should discuss their plans with the Department of Fisheries and Oceans. The following questions should be considered if planning an end-pit lake:

- Is presence of a lake compatible with the surrounding landscape?
- What will be the long-term health of the lake?
- Will the lake thaw adjacent land?
- Will the shore and slopes be stable?
- Is rip-rap or armour stone required to protect the shoreline?
- Will the water level in the lake rise over time?
- Will the pit lake be connected to other water bodies?
- Will shoreline or littoral habitat be enhanced for fish and wildlife?

## 9.6 Monitoring

Site monitoring will be required for several years to assess whether the reclamation objectives have been met. Monitoring requirements are usually specified in the land use permit. The following questions should be considered when monitoring reclamation:

- Has vegetation been re-established and has it reached predicted levels?
- Are erosion control structures performing as designed?
- Are water management techniques controlling water in and out of the pit and quarry?

Regulatory bodies and stakeholders may require additional monitoring as part of the licensing/permitting process.

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# GLOSSARY

| | |
|---|---|
| Armour stone | Stones or broken rock of larger size than rip rap that are placed on an embankment as erosion control and protection. |
| Borehole | A small diameter hole drilled from the soil surface to collect soil samples. |
| Buffer strip | An area of land that is left untouched to provide a natural barrier between a development and an adjacent area. Buffers can be used to protect important ecosystem components such as wildlife habitat or water bodies, or they can be used to provide a visual barrier between the development and an area of human use. |
| Dog leg | A sharp change in the direction of a road that is designed to conceal it from view for aesthetic purposes. |
| Dust skirt | A sheet that surrounds the outlet of a crusher to contain and minimize dust emissions. |
| Exfiltration | The removal of water from an area by percolation or absorption into the surrounding soil. Used to remove sediment from water. |
| Granular resources | Materials ranging from silts to sands, gravel and cobbles that can be used for a wide variety of construction purposes. |
| Granular Resource Management Plan | An overarching plan intended to serve the purposes of providing long term guidance for managing granular resources within a defined geographical area (ie: the ISR). This plan is the responsibility of the resource/land owner and is intended to be a document which identifies the granular resources which exist and the responsible utilization of such resources. |
| Ground-ice | A general term referring to all types of ice contained in freezing and *frozen ground.* Ground ice occurs in pores, cavities, voids or other openings in soil or rock and includes *massive ice*. It may occur as lenses, wedges, veins, sheets, seams, irregular masses, or as individual crystals or coatings on mineral or organic particles. |
| GPR | Ground Penetrating Radar is a technique used to delineate subsurface features by passing electromagnetic energy into the ground and back to a receiving antenna. |
| Interburden | Waste material encountered within the granular resource. |
| Littoral | The shoreline area of streams, rivers and lakes. |
| Major Projects Granular Resources Development | A proponent's plan for selection, investigation, development, closure and reclamation of several or many pits and quarries associated with a major project, whether entirely on Crown lands or partially on Crown lands. The plan should indicate what factors the proponent has considered in site selection, or rejection of sites, and plans for additional investigation to confirm that the sites contain the quantity and quality of material needed |

| | |
|---|---|
| Plan | to meet the requirements of the project, and how the proponent would implement and modify this plan to accommodate changes that might occur during the course of the project. It is intended that this broad project-wide plan would be supplemented by specific Pit/Quarry Development Plans for individual sites. This plan should also demonstrate how it complies with any overarching regional Granular Resource Management Plan as well as any specific Pit/Quarry Management Plans, established by the Crown or other affected land owners within the vicinity of the major project. |
| Overburden | Rock or soil of little or no value that is located above the desired granular deposit, and must be removed prior to quarrying. |
| Pit Operations Plan | An operational plan designed by a contractor operating in the quarry site which identifies specific periods of operation (timing). It is intended that this plan defines methods of extraction, related activities and on site infrastructure. Other users of the same source need to be considered and approval by the Regulatory Authority(ies) is necessary prior to operations start up. It is short term, or seasonal in nature. |
| Pit/Quarry Management Plan | A plan designed to define the best management of a specific quarry related to resource extraction, expansion and reclamation of the work area. The development of this plan must adhere to the concepts and statements committed to in the Granular Resource Management Plan, and is the responsibility of the resource owner. The plan is to provide assurance that as development of the quarry occurs that the extraction of the material is appropriately managed and controlled - Particularly if the site is a multi user site. Key attributes are that the plan is site specific, spans the life of the deposit and as a result, long term in nature. |
| Pit/Quarry Development Plan | A plan generally drafted by the developer or contractor intending to work a specific quarry site. It must adhere to the overarching Granular Resource Management Plan as well as the Pit/Quarry Management Plan. It is intended that this plan include specific methods of extraction and related activities (including reclamation) as well as address on site infrastructure. The Development plan fulfills the regulatory obligations by describing mitigation measures of pre-determined environmental conditions contained in the higher level Management Plans and upon submission must be approved by the Regulatory Authority(ies). This is a medium to short term plan designed to apply only for the life of a specific project. |
| Permafrost | Ground that is frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90% of the land area is underlain by permafrost, while in discontinuous permafrost, between 10 to 90% of the land is underlain by permafrost. |
| Progressive reclamation | Actions that can be taken during operations before permanent closure to take advantage of cost and operating efficiencies by using the resources available from ongoing operations. It enhances environmental protection and shortens the timeframe for achieving the reclamation objectives. |
| Riparian | An area of land adjacent to a stream, river, lake or wetland that contains vegetation that, |

| | |
|---|---|
| | due to the presence of water, is distinctly different from the vegetation of adjacent upland areas. |
| Windrow | Method of placing materials such that they are in long, continuous rows. |

# APPENDIX A- HAMLET CONTACT INFORMATION

**Aklavik**
Hamlet of Aklavik
Box 88
Aklavik, NT
X0E 0A0
Phone: 867-978-2351
Fax: 867 978-2434

**Sachs Harbour**
Hamlet of Sachs Harbour
General Delivery
Sachs Harbour, NT
X0E 0Z0
Phone: 867-690-4351
Fax: 867-690-4802

**Inuvik**
Town of Inuvik
Box 1160
Inuvik, NT
X0E 0T0
Phone: 867-777-8600
Fax: 867-777-8601

**Tuktoyaktuk**
Hamlet of Tuktoyaktuk
Box 120
Tuktoyaktuk, NT
X0E 1C0
Phone: 867-977-2286
Fax: 867-977-2110

**Paulatuk**
Hamlet of Paulatuk
Box 98
Paulatuk, NT
X0E 1N0
Phone: 867-580-3531
Fax: 867-580-3703

**Ulukhaktok**
Hamlet of Ulukhaktok
Box 157
Ulukhaktok, NT
X0E 0S0
Phone: 867-396-8000
Fax: 867-396-8001

# APPENDIX R

## Northern land Use Guidelines for Camp and Support Facilities

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 06

# NORTHERN LAND USE GUIDELINES

## Camp and Support Facilities

Canada

# Table of Contents

# Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Administrative Framework
- Administrative Process
- Applying Sustainable Development
- Permafrost
- Access: Roads and Trails
- Camp and Support Facilities
- Pits and Quarries
- Mineral Exploration
- Hydrocarbon Exploration
- Other Land Uses
- Closure and Reclamation

The series is available electronically from the INAC website: **www.ainc-inac.gc.ca.** Readers are encouraged to visit the site for updates and revisions to the series.

*For further information concerning the subject matter contained in this guideline series, please contact:*

## OTTAWA

Manager, Land Programs, Natural Resources and Environment Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudière
10 Wellington Street
Hull QC K1A 0H4
TEL.: 819-994-7464 FAX: 819-997-9623
EMAIL: NorthernLands@ainc-inac.gc.ca

## NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL.: 867-669-2671 FAX: 867-669-2713
EMAIL: NWTLands@ainc-inac.gc.ca

## NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL.: 867-975-4275 FAX: 867-975-4286
EMAIL: landsmining@ainc-inac.gc.ca

## YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below*:

Land Use—Lands Branch Department of Energy, Mines And Resources
Government of Yukon
Suite 320, Elijah Smith Building
300 Main Street
Whitehorse YT Y1A 2B5
TEL.: 867-667-3173 FAX: 867-667-3214
EMAIL: land.use@gov.yk.ca

# Acknowledgements

In the 1980s, Indian and Northern Affairs Canada published a series of six land use guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Affairs Organization and Northern Regional Office staff. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

# Introduction

This volume is written for proponents, operators and regulators of temporary camps in northern Canada. Temporary camps service land use projects of limited duration, such as mineral or hydrocarbon exploration. When the project is completed, the camp is generally dismantled. Camp support facilities include airstrips, roads, and fuel and waste storage areas.

This volume presents environmental issues and mitigation techniques associated with the life cycle of a camp from planning to reclamation. Use of proper mitigation techniques can protect the environment and lead to cost-efficiencies in construction, operation and maintenance of camp and support facilities.

Camp operators should note that these guidelines are subordinate to all relevant acts, regulations and permit requirements. When planning, proponents should also be aware of approved land use plans in their area. The guidelines are general in nature and site-specific conditions may require expert advice. Specifically, the guidelines should be supplemented by local research, traditional knowledge, engineering expertise, guidance from INAC land management staff and other appropriate authorities. It is the proponent's responsibility to be aware of and apply the most current and best available environmental mitigation practices.

FIGURE 1A & 1B. Temporary camps range in size and type of support facilities required.

CHAPTER
02

# Planning and Design



This volume describes the four phases of camp development, as outlined in Table 1, and best practices for development at each stage. The entire life cycle of a camp, from construction through operations and reclamation, should be considered before development begins. Proper planning saves time and money as a camp that is well planned prior to construction will minimize project delays and reduce the risk of adverse environmental impacts.

To minimize new land disturbance, proponents should assess the possibility of having a community-based operation or use an existing camp. Once a location is chosen, existing environmental, administrative, social and cultural information should be collected (Table 2). Information gaps can then be filled by conducting field investigations. A baseline environmental study will identify sensitive environmental conditions that may require special attention. Undisturbed site conditions can also be recorded for use during closure and reclamation. Baseline information can include soil, permafrost, vegetation, surface water and groundwater quality, and fish and wildlife habitat. All of this information will enable the proponent to provide a complete land use permit application to the appropriate land use regulator.

Table 1. Four phases of camp development.

| 1 PLANNING AND DESIGN → | 2 CAMP CONSTRUCTION → | 3 OPERATIONS AND MAINTENANCE → | 4 CLOSURE AND RECLAMATION |
|---|---|---|---|
| • Gather and analyze information<br>• Select a site<br>• Conduct a baseline study<br>• Plan operations<br>• Consider reclamation<br>• Apply for a land use permit | • Plan construction<br>• Carry out construction | • Implement maintenance programs<br>• Conduct regular inspections<br>• Identify and correct problems | • Prepare closure and reclamation plan<br>• Progressive reclamation<br>• Conduct closure and reclamation activities<br>• Closure monitoring |

## 2.1 Permitting

Most temporary camp developments on Crown land require a land use permit from the appropriate land use regulator before activity can proceed. Permitting thresholds applicable to temporary camps include the number of person-days, the amount of fuel storage, building construction and clearing of land. Thresholds are listed in the Mackenzie Valley Land Use Regulations *(www.laws.justice.gc.ca/eng/SOR-98-429/index.html)* for the Mackenzie Valley and Territorial Land Use Regulations *(www.laws.justice.gc.ca/eng/C.R.C.-c.1524/page-3.html)* for the Inuvialuit Settlement Region and Nunavut.

Each land use regulator has specific requirements for permit applications. Generally, an application should include environmental background information, a description of the planned camp and the development schedule. The application should also explain how identified environmental impacts will be avoided or minimized during construction and operation of the camp.

Authorization for water use may be required from the appropriate regulatory board. Permitting thresholds for camp water use and deposition of waste are listed in Northwest Territories Waters Regulations *(www.laws.justice.gc.ca/eng/SOR-*

Table 2. Information used for planning a temporary camp.

| INFORMATION CATEGORY | INFORMATION SUBCATEGORIES | SOURCES |
|---|---|---|
| Environmental | • Topography and drainage<br>• Surface vegetation<br>• Sensitive landforms (e.g. pingos or eskers) | • Maps, aerial photos, satellite imagery<br>• Territorial Geoscience Office (www.nwtgeoscience.ca and www.nunavutgeoscience.ca)<br>• Natural Resources Canada (www.nrcan-rncan.gc.ca)<br>• Local INAC office<br>• Appropriate resource managers or regulatory boards<br>• Local operators and residents |
| | • Water management | • Local INAC office<br>• INAC Water Resources Division (www.ainc-inac.gc.ca)<br>• Appropriate resource managers or regulatory boards |
| | • Timber/forestry | • Government of the Northwest Territories, Environment and Natural Resources (www.enr.gov.nt.ca) |
| | • Fish and wildlife habitat | • Fisheries and Oceans Canada (www.dfo-mpo.gc.ca)<br>• Environment Canada<br>• Territorial environment departments |
| Engineering | • Construction methods<br>• Camp access: roads or trails | • Engineers<br>• Field investigations<br>• INAC resource management officer |
| Archaeological/ cultural | • Location of archaeological sites and heritage resources<br>• Traditional-use areas (e.g. berry-picking sites, traplines, cabins) | • Prince of Wales Northern Heritage Centre - Northwest Territories www.pwnhc.learnnet.nt.ca)<br>• Department of Culture, Language, Elders and Youth, Nunavut (www.gov.nu.ca)<br>• Inuit Heritage Trust, Nunavut (www.ihti.ca)<br>• Field investigations and local residents |
| Reclamation | • Reclamation standards | • Local INAC office<br>• Appropriate resource managers or regulatory boards<br>• Territorial environment departments |

*93-303/index.html)*. Camp water supply is also addressed in the *Public Health Act* of the Northwest Territories and Nunavut. The local Environmental Health Officer should be contacted to discuss water supply prior to camp development (N.W.T.: *www.hlthss.gov.nt.ca;* Nun.: *www.gov.nu.ca/health*).

Other authorizations may be required depending on the scope and nature of camp development. The purpose of and responsible authority for authorizations that are commonly required for camp development are outlined in Table 3. For more information, consult the Administrative Process volume of this series.

Table 3 Authorizations that may be required for camp development.

| PERMIT | PURPOSE | RESPONSIBLE AUTHORITIES |
|---|---|---|
| Land Use Permit | Use and occupation of the camp site | • Indian and Northern Affairs Canada (Inuvialuit Settlement Region)<br>• Land and Water Boards (Mackenzie Valley – Northwest Territories)<br>• Indian and Northern Affairs Canada (Nunavut) |
| Water Licence | Use of water or deposition of waste, for example, treatment of camp sewage | • Northwest Territories Water Board (Inuvialuit Settlement Region)<br>• Land and Water Boards (Mackenzie Valley – Northwest Territories)<br>• Nunavut Water Board (Nunavut) |
| Fisheries Authorization | Work in fish-bearing waters, activities that may harm fish habitat | Fisheries and Oceans Canada |
| Quarrying Permit | Obtain granular materials | Indian and Northern Affairs Canada |
| Quarry Lease | Long-term access to granular materials | Indian and Northern Affairs Canada (Nunavut only) |
| Timber Permit | Clearing timber prior to camp construction | Government of the Northwest Territories (NWT only) |
| Quarry Authorization/ Access Authorization | Access and work on Aboriginal private lands | Aboriginal private landowners |
| Land Access Permit | Inuit-Owned Lands | Regional Inuit Associations (Nunavut) |

## 2.2 Environmental Conditions

The location of a camp should be selected with care to avoid terrain that could lead to future problems. All camp structures, including fuel caches and greywater sumps, must be located at least 31 m from the high water mark of a water body to reduce the risk of impacting water quality.

### 2.2.1 Area

Proponents should first consider sites in previously cleared areas and in natural clearings to minimize new land disturbance.

The size of a camp and the area required to support it will be determined by the following:

- purpose of the camp;
- number of occupants and length of their stay;
- seasons during which the camp will operate; and
- type of support facilities (e.g., fuel storage, airstrip, roads).

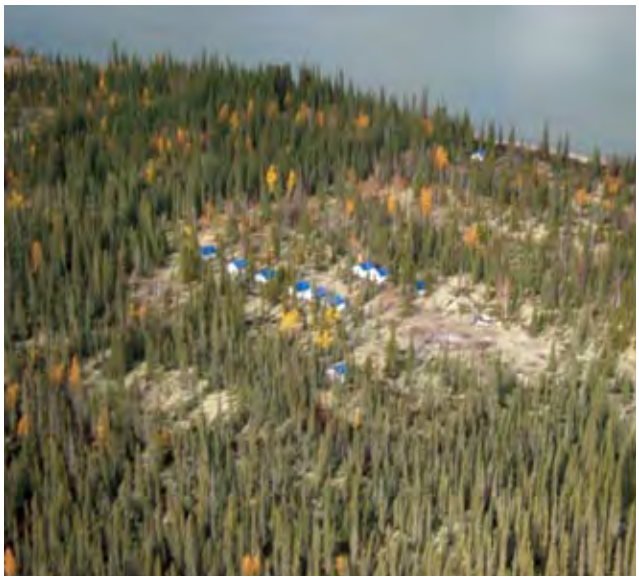
An increase in project activities may require camp expansion. To simplify future site changes, the chosen site should be large enough to accommodate expansion.

### 2.2.2 Durable Surface

Camps should be constructed on a durable surface, such as gravel or sand, that is consolidated and can withstand repeated, heavy use. This applies especially to camps operating during the summer, when a poorly located camp can erode and become very muddy. In more sensitive areas, elevated boardwalks can be built between camp facilities to reduce the impact of repeated use. Winter camp operations can be located on built-up snow pads and the site can be watered down to provide a durable base of ice.

### 2.2.3 Slope

A gently sloping site is preferable for camp construction and operations because surface water will easily drain from the site and vehicles will be able to access the site without rutting the surface. If a more steeply sloping site is chosen, slopes facing south or west may be preferable as they are usually warmer and drier.



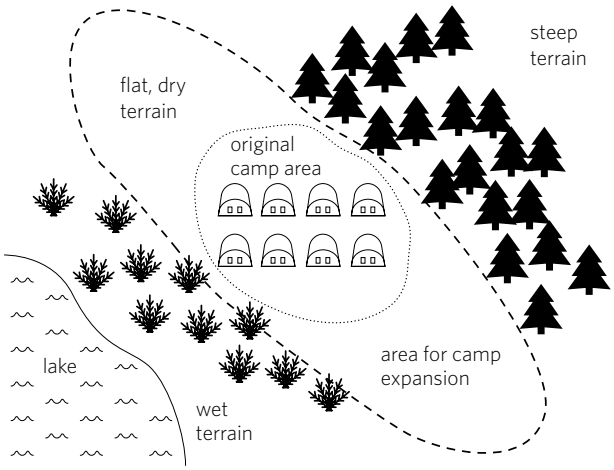



FIGURE 2. (top) Camps should be located in existing clearings to minimize new land disturbance.

FIGURE 3. (middle) Camps should be located where there is room for potential expansion.

FIGURE 4. (bottom) Camps should be constructed on durable surface material.

### 2.2.4 Vegetation

Vegetation stabilizes the soil with its roots and reduces surface runoff by evapotranspiration through leaves. Removal of vegetation can lead to soil erosion and increased surface water flow. In permafrost terrain, removal or disturbance of vegetation that shades the ground can lead to ground thaw and subsidence.

Boardwalks built between camp buildings can reduce damage to vegetation on high-traffic footpaths. Heavily used footpaths can also be marked using stakes and flagging tape to ensure that impacts to vegetation are confined to a small area.

In the High Arctic, plants grow slowly and are slow to recover from disturbance. In this dry environment, camps should be located in areas with minimal ground cover.

Land use permits may include conditions for saving and stacking merchantable timber in forested areas. For more information on timber management, contact the Department of Environment and Natural Resources, Government of the Northwest Territories.

### 2.2.5 Permafrost

Permafrost underlies the ground throughout many areas of the Northwest Territories and most of Nunavut. Many areas of perennially frozen ground contain significant amounts of ground ice in the near surface. Disturbance of these areas should be avoided as the ground ice could melt and cause the ground to subside, potentially leading to soil erosion and instability of camp infrastructure. Areas of ground ice are not always identifiable from surface features, so field investigations should be conducted at the campsite to determine the extent and depth of permafrost and near-surface ground ice.

In general, the following areas should be avoided in permafrost terrain due to high near-surface ground ice content:

- patterned ground;
- fine-grained soils, particularly clays; and
- sedge wetlands and peatlands.




FIGURE 5. (top left) Surface disturbance can be reduced by building boardwalks between camp structures.

FIGURE 6. (top right) The pathway is marked and streams are crossed by bridges to reduce impacts to vegetation and water.

FIGURE 7. (bottom left) Avoid locating a camp on patterned ground.

FIGURE 8. (bottom right) Probing for permafrost depths on a raised peatland.

Heat radiating from camp buildings may thaw permafrost, so all heated camp structures should be elevated above the ground surface to allow air circulation. Engineering advice should be obtained when establishing campsites in permafrost terrain. See the Permafrost volume of this series for additional information.

### 2.2.6 Wind Exposure

Campsites should be planned so that there are no long stretches of recently cleared, fine-grained soils exposed to the wind as these soils are easily eroded. Natural clearings are more resistant to wind because ground cover and root systems are already well developed. Sites that are cleared by hand can be more wind resistant as tree roots may still be intact.

North of the treeline, camps should be located on high ground to avoid accumulation of wind-drifted snow. In the absence of obstacles such as trees, snow is blown into low-lying areas, so a camp located on low ground would require frequent snow removal.

FIGURE 9. On the tundra, camps located on high ground require less snow removal.

### 2.2.7 Wildlife Habitat

Construction and operation of temporary camps and support facilities have the potential to alter or damage wildlife habitat. Proponents should identify species at risk that could be encountered or affected by the development and consider potential adverse effects of the project on those species and their habitat. If species at risk are encountered, the primary mitigation measure is to avoid disturbing them and their habitat. To discuss issues related to species at risk and for further information, proponents should contact the Canadian Wildlife Service *(www.ec.gc.ca/nature/default.asp?lang=En&n=FB5A4CA8-1)*. Information on species at risk is also available at the Species at Risk Public Registry *(www.sararegistry.gc.ca)* and in Species at Risk in the Northwest Territories *(www.enr.gov.nt.ca)*.

Proponents should also be aware of the presence of migratory birds in the development area. If migratory bird nests are present, the preferred mitigation measure is to clear the area during the nesting period. Information on migratory birds can be obtained from the Canadian Wildlife Service.

## 2.3 Social and Cultural Values

Social and cultural values should be considered when planning a camp. Local residents should be contacted to identify values, including the area's traditional and recreational usage and cultural significance.

### 2.3.1 Subsistence and Recreational Values

Community members, resource users and Aboriginal groups should be contacted early during the planning process to identify sites of particular cultural, subsistence or recreational importance in the area of interest. Existing uses can include traplines, cabins, hunting areas, canoe routes or tourism. Concerns can be addressed by the proponent in the choice of camp location and design. The land use permit may also contain specific conditions to protect and minimize disruption of existing interests.

The presence of a camp may detract from the scenic appeal of a landscape, especially in areas of high tourism or recreational value. Camps should be located and designed to minimize their visual impact. The preferred mitigation measure is to avoid highly valued areas; however, if avoidance is not possible, a visual barrier should be considered.

### 2.3.2 Archaeological Resources

Avoid archaeological and cultural sites when choosing a camp location. Information on documented sites can be obtained from the Prince of Wales Northern Heritage Centre in the Northwest Territories and the Department of Culture, Language, Elders and Youth in Nunavut. Aboriginal groups, communities and governments can also provide information on traditional-use areas. Field investigations should be conducted at the proposed location during the summer prior to camp construction to identify potential archaeological or cultural sites.

If an archaeological or cultural site is discovered at any stage of camp development, work in the area must be stopped immediately and the local INAC resource management officer, territorial government and regulatory board must be notified. Artifacts suggesting the presence of an archaeological site include arrowheads, old encampments or buildings.

FIGURE 10. Contact and engage stakeholders early during the planning process.

## 2.4 Access

Camp accessibility should be considered during the planning stage. Due to the remoteness of most northern camps, access is often by air. Chosen methods of access should be technically, environmentally and economically feasible.

### 2.4.1 Roads and Trails

Roads or trails can be used to access a camp. Environmental impacts should be minimized during road construction and operation. See the *Access: Roads and Trails* volume of this series for additional information.

### 2.4.2 Aircraft

Camps that are supported by fixed-wing aircraft can have airstrips located on land or use nearby water bodies. Where an airstrip is required on land, an existing airstrip or topographic feature capable of accommodating a plane should be utilized before constructing a new airstrip.

Camps that rely on helicopter support should be located in an open area that is large enough to build a helipad nearby.

### 2.4.3 Docks

For camps located near water bodies, a dock may be required for boat and float plane access. When determining the location and design of a dock, refer to the Department of Fisheries and Oceans' Dock and Boathouse Construction Operational Statement (*www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo08-eng.htm).*


FIGURE 11. (top) During winter, a nearby frozen lake provides air and road access to this camp.

FIGURE 12 (BOTTOM) A dock should be located in a sheltered area with a gentle shore and adequate water depth for float planes and boats.

CHAPTER 03

# Construction



Best construction practices can save time and money by minimizing future reclamation costs. Construction plans should address site-specific environmental, social and cultural conditions identified during the planning and design phase. Specific construction activities will vary according to the purpose, size and duration of the camp; terrain conditions; local weather conditions; and permit requirements. The proponent is responsible for adhering to all permit and regulatory requirements during and following the construction phase.

## 3.1 Development Timing

A key component of successful camp construction is the proper timing of activities. Winter projects should be scheduled between the average dates of fall freeze-up and spring breakup for the region, allowing adequate time for annual variability.

FIGURE 13. Deep rutting and soil erosion can occur if operations continue too late in the spring.

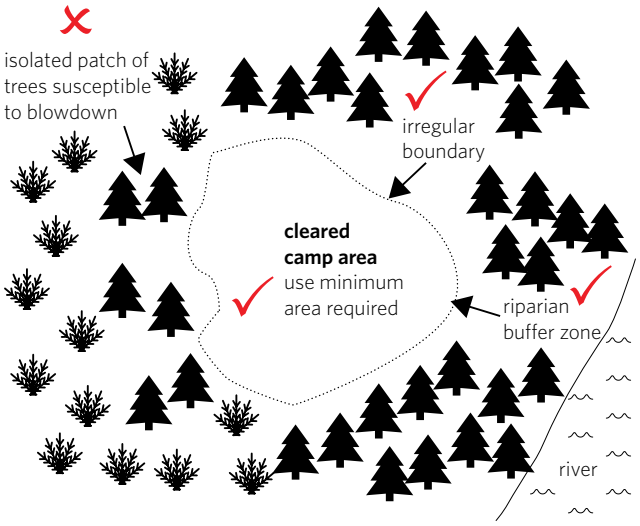
Sufficient time should be set aside for camp demobilization as serious environmental impacts can occur in late spring as the ground is thawing. Contact the local INAC resource management officer for typical freeze-up and breakup dates.

## 3.2 Clearing

The objective of clearing is to remove vegetation to allow for camp construction without disturbing the ground surface. For small areas, hand clearing is an effective, low-impact method. Clearing can also be undertaken with a machine, such as a dozer, but care should be taken to avoid uprooting vegetation so that roots are left in place to prevent soil erosion. Dozers can be equipped with mushroom shoes or a smear blade to prevent tearing the surface organic layer. Camp area boundaries should be irregular and follow natural edges to reduce the risk of high winds blowing down isolated patches of trees.

Cleared brush should be disposed of in a manner that minimizes fire hazards and allows for wildlife movement. Acceptable brush disposal methods depend on the amount and type of vegetation cleared, and will be specified in the land use permit. Brush should not be disposed of in or near water bodies, or left leaning against standing timber.

Lopping and scattering is used when vegetation that was pushed down during clearing does not lie flat on the ground. Branches are removed and stems are cut into lengths so that the vegetation lies flat on the ground, enhancing decomposition.



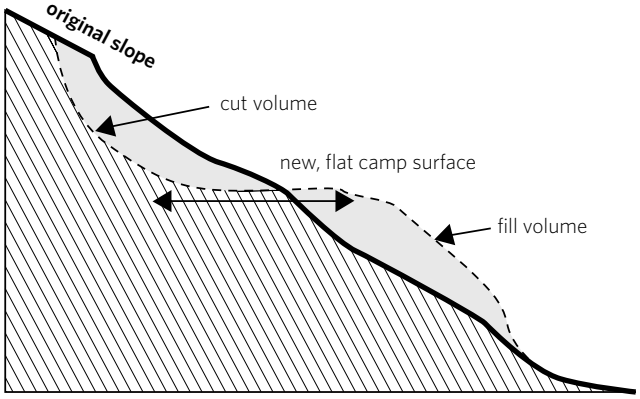




FIGURE 14. (top) Examples of clearing techniques.

FIGURE 15. (middle) Clearing brush with a skidder blade.

FIGURE 16. (bottom) Cut-and-fill technique for grading a sloped campsite.

Windrowing and compaction involves piling cut brush into long rows to the side of the clearing and compacting the piles using heavy equipment to increase decomposition. Windrows should be placed at least five metres away from standing timber to reduce the risk of fire. Breaks of approximately 10-metres width should be left in the windrow at approximately 300-metre intervals to allow wildlife passage.

Brush can also be disposed of by mulching with a wood chipper or a brush cutter. Resulting wood chips can be scattered on the ground, decomposing more rapidly than windrowed brush. This method reduces the risk of fire to a greater degree than windrowing.

Brush can also be completely disposed of by burning. Brush piles should be placed in the middle of the clearing to minimize the risk of fire spreading to surrounding vegetation. Set fires must be monitored at all times. Burning should not be conducted in permafrost terrain with high ground ice content as it could cause ground subsidence.

## 3.3 Site Grading

When there is no suitable flat terrain, the camp area may require site grading. However, site grading should be avoided in permafrost terrain to prevent ground melting and subsidence. In permafrost terrain, fill from another area may be required to create a flat building site.

Before any site excavation, organic topsoil should be stripped from the surface and stockpiled separately for later reclamation use. Material should be stored well away from water bodies to protect aquatic life. In addition:

- leave a setback of 31 m between the clearing and a water body;
- use sediment- and erosion-control measures during and after construction to prevent entry of sediment into water;
- retain as much riparian vegetation as possible; and
- stabilize stockpiled materials to prevent erosion.

On a slope, a cut-and-fill technique can be used to create a flat site. Materials are excavated from the top of a slope to be used as fill lower on the slope. However, since the excavated materials are highly susceptible to erosion, this technique should only be used if there are no other options, and should

never be used in permafrost terrain to avoid ground thaw and subsidence. Erosion-control measures should be placed on both the cut and fill areas immediately after excavation.

For winter-only camp operations, the preferred site-grading method is to level the camp surface with snow. The site can then be watered down to provide a durable base of ice.

## 3.4 Drainage Control

Controlling surface water drainage on the campsite will reduce soil erosion and sedimentation into streams. Drainage control is particularly important at campsites that have been graded because natural drainage patterns have been disturbed.

Drainage control options depend on the size of the site and the amount of surface runoff. The simplest method to control drainage is to construct the camp area on a gradient so that water runs away from the camp and into the surrounding terrain. Structures to slow surface runoff, such as sediment curtains or straw bales, can be used for areas with high surface runoff.

Regular maintenance is required to ensure drainage control structures remain effective. For example, trapped sediment should be regularly removed and properly disposed of to ensure that the structure continues to effectively filter sediment.



FIGURE 17. Sediment curtains used for drainage control at the edge of a clearing.

CHAPTER
04

# Operations and Maintenance

Operating maintenance and monitoring procedures should be developed during the planning phase. The proponent is responsible for ensuring that these procedures meet applicable regulatory requirements. Procedures should be reviewed and, if necessary, revised before the camp is commissioned to reflect changes that may have occurred during construction.

Maintenance should be performed on camp infrastructure on both a routine and an as-needed basis. For example, a weekly schedule to remove water from fuel containment areas can be established to maintain their storage capacity, but in the event of a large precipitation event these areas should be emptied immediately. Camp infrastructure should also be monitored on a regular basis to identify problems at an early stage before there is an environmental impact. For example, daily inspections of heating fuel drums and fittings can prevent a spill.

Problems identified while using, maintaining or inspecting the camp should be promptly addressed. An action plan for correcting problems and monitoring outcomes should be developed and implemented. For example, if solid food wastes that attract wildlife are often found in the greywater sump, filters can be installed on kitchen drains, and a monitoring schedule can be developed to determine the success of the filters in removing the solid wastes.

## 4.1 Fuel and Hazardous Materials

Fuel and hazardous materials have the potential to cause environmental damage at campsites if spilled. In addition to hydrocarbon-based fuels, common hazardous materials at a campsite include explosives, fertilizer, reagents for chemical analyses and glycol antifreeze. Proper storage and handling techniques reduce the risks associated with having these materials on-site.

### 4.1.1 Fuel and Hazardous Material Storage

On federal Crown land, storage of petroleum products in tanks with a capacity greater than 230 L and associated piping and equipment is regulated by Environment Canada's Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations *(www.laws.justice.gc.ca/eng/SOR-2008-197/index.html)*. The purpose of these regulations is to reduce the risk of contaminating soil and groundwater due to spills and leaks of petroleum products from storage tank systems. Land use permit and water licence conditions also address fuel storage location and handling.

#### *Location*

Fuel and hazardous materials must be stored on land at least 100 m above the high-water mark to reduce the risk of fuel spills into water unless expressly authorized in the land use permit or in writing by the INAC resource management officer. Fuel caches should be located on flat, stable terrain, or in a natural depression, away from slopes

FIGURE 18. Secondary containment structures can also be used for fuel drum storage.

leading to water bodies. During camp construction, temporary storage of mobile fuel facilities on frozen water bodies may be allowed by the appropriate land use regulator.

The location and content of all fuel caches must be reported in writing to the land use regulator as soon as they are established. This also includes small fuel caches of more than 410 L (two barrels of fuel) but less than 4000 L, which do not require a land use permit. The notification should include the cache location, a description of the fuel, when the fuel will be used and when the empty barrels will be removed.

Some materials are incompatible for storage with others. Operators should maintain a current inventory of the types and quantities of fuels and hazardous materials on-site, and understand how these materials may interact. Incompatible materials should be stored in separate areas (e.g., acids and bases, or flammable and oxidizing materials). Explosives should be stored separately from all other materials. To promote employee awareness of fuel and hazardous materials, a map should be posted within the camp depicting storage locations and their contents.

***Secondary Containment***

Secondary containment refers to any impermeable storage structure surrounding fuel containers that has the capacity to contain the fuel in the event of a spill. Secondary containment is required for stationary fuel containers with a capacity greater than 230 L. The capacity of the secondary containment structure should be 10 percent greater than the capacity of the largest fuel container within it. Double-walled fuel tanks provide secondary containment. Engineered bermed structures are another method of containment. Berms should be of sufficient height or depth to contain the wave resulting from a major breach of a large container. Large secondary containment areas may require an oil/water separator. If possible, tanks in fuel storage areas should be elevated so that leaks can easily be spotted.

To reduce the chance of spillage, tanks with fill and dispense pipes located on the top of the tank are preferable. Valves and fittings for fuel storage tanks are often sources of leaks and should also be located within a containment area. For small fuel containers, such as drums, secondary containment is a relatively low-cost option to reduce the risk of a spill. Fuel drums used for heating camp tents should be elevated on stands and drip trays should be placed under the fittings and valves.

### 4.1.2 Fuel and Hazardous Material Handling

All fuel and hazardous material containers, full or empty, should be handled with care to avoid spills.

Fuel transfer areas should be stocked with adequate spill-response supplies. An impermeable liner can be placed under the fuel transfer area to confine contamination in the event of a spill. A common cause of spills is a lack of attention during fuel transfer. The transfer of fuel should always be closely supervised by trained personnel. Larger

operations can designate an employee to conduct refuelling and oversee care of the fuel transfer area. When not in use, fuel nozzles should be placed in containers to prevent drips.

Fuel drums should be kept sealed to prevent fuel from leaking. Caches with multiple fuel drums should be spaced in rows to allow for leak inspections. Fuel drums should be stored on their side with bungs at the 9 and 3 o'clock positions to prevent leakage. Drums should be raised above the ground surface to prevent rust if they are to be stored for longer than six months. All drums must be clearly marked with the operator's name so that they are easy to identify.

Fuel and hazardous material storage areas and fuel lines should be clearly marked with signs or flagging to avoid accidental breaks and punctures. These areas should be kept clear of debris and snow to facilitate routine inspections for leaks. Valves should be clearly marked so that it is apparent which valve opens which fuel tank or fuel line.

Monitoring is a critical aspect of handling and storing fuel and hazardous materials. Camp personnel should be designated to monitor storage and use of hazardous materials and to routinely inspect storage containers, containment areas, drip trays, valves and conveyance lines for leaks and punctures. Inspection records should note the occurrence of and response to leaks or spills.

Snow and water should be regularly removed from secondary containment areas and drip trays to ensure that capacity is maintained. Accumulated snow or water should first be checked for fuel contamination and contaminated material should be appropriately disposed of.

#### 4.1.3 Storage of Empty Drums

All unused fuel and empty fuel and hazardous material containers must be removed from the campsite and properly disposed of when the operation is complete. Empty fuel drums can be collected on-site until there are enough to back-haul. Caps should be replaced on the empty drums in case there is remnant fuel within them. Costs for container removal can be reduced by progressively back-hauling drums on return trips of supply trucks or aircraft.

FIGURE 19. This fuel storage area is well marked with pylons, and drums are stored on their side and well spaced to allow for leak inspection, but snow should be cleared to facilitate leak inspection.

## 4.2 Waste Management

Appropriate waste storage and disposal can lower environmental risk, minimize wildlife attractants and reduce reclamation costs through progressive removal of wastes from the site. Failure to properly dispose of waste is a common reason why land use permits remain open after site demobilization, requiring a subsequent trip by the operator to clean up the site.

Waste management practices vary depending upon waste characteristics and available facilities. Proponents should develop a waste management plan based on the following hierarchy of preferred waste management methods:

1. Source reduction
2. Reuse or recycle
3. Disposal

Source reduction involves eliminating or reducing the volume of waste generated by a camp through the use of alternative products, methods or processes. Proponents should always consider source reduction first, when planning camp operations, to reduce the amount of waste generated at the site. The following sections outline waste disposal options.

### 4.2.1 Solid Waste

Solid waste disposal will be specified in the land use permit. Solid waste management options include:

- incineration;
- temporary storage and removal to an appropriate facility; and
- burial on-site (only if approved by the land use regulator, in an area that is not underlain by permafrost).

Solid waste management streams for combustible and non-combustible wastes are shown in Table 4. Combustible wastes primarily include kitchen wastes and packaging that are suitable for disposal by burning. To prevent wildlife attractants and health hazards, food wastes should be stored in odour-proof containers and incinerated on a daily basis. Non-combustible wastes include materials that can negatively affect air quality if burned, such as plastics, and materials that cannot be disposed of by burning, such as metals. These wastes should be separated, organized and stored on-site for eventual removal and disposal off-site.

Table 4. Solid waste management streams.

**SOLID WASTE MANAGEMENT STREAMS**

1. **Separate combustible and non-combustible solid wastes**
   Note that plastics, styrofoam, and rubber should not be burned to protect air quality

**COMBUSTIBLE WASTES**

2. **Store combustible solid wastes in odour proof secure containers**
   Wastes should be stored to avoid attracting wildlife
3. **Incinerate combustible wastes daily**
   Incinerator residue should be removed from site or disposed of at an approved area on-site

**NON COMBUSTIBLE WASTES**

2. **Separate non-combustible solid wastes and store on-site**
   Wastes should be organized in containers with secure lids
3. **Progressively remove non-combustible solid wastes from site throughout operations**
   Make use of empty trucks or aircraft to back-haul wastes

4. **All wastes should be removed from the site at closure**
   Collect and remove wastes from the entire camp area

FIGURE 20. A fuel-fired incinerator with a bin nearby to store non-combustible wastes.

FIGURE 21. Temporarily stored wastes sorted into secure, labelled containers.

***Incineration***

To promote complete combustion of wastes, a proper incinerator should be used following Environment Canada's Technical Document for Batch Waste Incineration *(www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=F53EDE13-1)*. This document guides owners and operators of batch waste incinerators regarding proper system selection, operation, maintenance and record keeping to assist them in meeting Canada-wide standards for dioxins, furans and mercury, and reducing releases of other toxic substances.

Incinerator residue, such as ash, remaining after burning is complete should be regularly removed and properly disposed of off-site.

Open-pit burning is prohibited, except in the Northwest Territories where it may be used to dispose of inert cardboard and wood waste.

***Temporary Storage and Removal***

All wastes that are not incinerated must be removed from the campsite. Wastes that are temporarily stored on-site should be kept in secure containers at least 31 m away from a water body. Some non-combustible materials can be crushed to reduce their volume.

Stored wastes should be back-hauled on the return leg of supply trips for reuse, recycling or disposal at an approved facility.

***Burial***

In special cases on-site burial of non-combustible material, such as scrap metal, may be approved by the land use regulator. Burial is not an option in permafrost terrain due to the difficulty of excavation, likelihood of subsidence if ground ice is present and probability of frost-jacking heaving wastes back to the surface. Expert advice should be obtained if an on-site waste disposal facility is planned.

**4.2.2 Sewage and Greywater**

Sewage refers to toilet wastes, and greywater refers to water from washing and kitchen facilities. Sewage is more likely to contain pathogens, but all waste water should be stored and treated well away from the water supply.

***Small Mobile Camps***

In the Northwest Territories, small mobile camps that remain at a site for no more than a few days may be permitted to disperse sewage and greywater over land. Overland dispersal is permitted in permafrost terrain because there is a greater environmental risk from excavating sumps than from spreading small volumes of waste water over land.

### *Small Stationary Camps*

Camps that stay in the same place for more than a few days require waste-water treatment or storage. Sewage may be treated and disposed of on-site, placed in a pit privy or stored in a holding tank for future removal from the site by pump truck. Greywater can be stored and treated in a sump, or stored in a tank for future removal from the site by truck.

In small camps, chemical, incinerating or composting toilets can be used for sewage treatment as they can render the sewage pathogen-free, and reduce the volume of waste. However, once treated, the remaining waste, such as ash, must be removed from camp.

Pit privies can be used to dispose of sewage and provide slow treatment. In permafrost terrain, excavation of pit privies may cause the surrounding ground to thaw and subside. To prevent health problems, privies should be located downslope and downwind from the camp in deep, stable, fine-grained soil. They should also be downstream of the water intake, and at least 31 m away from a water body. Privies should be large enough to hold all of the sewage from the camp and should be covered for health reasons. The shape of the privy depends on the camp layout. For example, in a trailer camp the pit could be long and narrow to service several trailers. To control sewage pathogens, pits can be periodically treated with lime. When full, pits should be covered with at least 30 cm of compacted soil.

Greywater should not be discharged directly next to or into a water body. Instead, greywater can be stored in an excavated sump that will allow for slow infiltration into the soil. The sump should be located at least 31 m away from a water body. Coarse gravel can be placed in the bottom of the sump to provide filtration, and supports can be built on the sides to prevent slumping. The sump should have adequate capacity to store expected greywater volumes, and should be located in mineral soil. Operators should inspect the greywater sump regularly and remove food particles that may attract wildlife. When full, greywater sumps should be covered with enough material to allow for future ground settlement.

### *Large Stationary Camps*

In larger camps with greater volumes of waste water, a portable sewage treatment system or an engineered sewage lagoon can be used to treat sewage and greywater. Proponents should seek expert engineering advice before siting or installing these systems, as an approval by the appropriate licensing board.



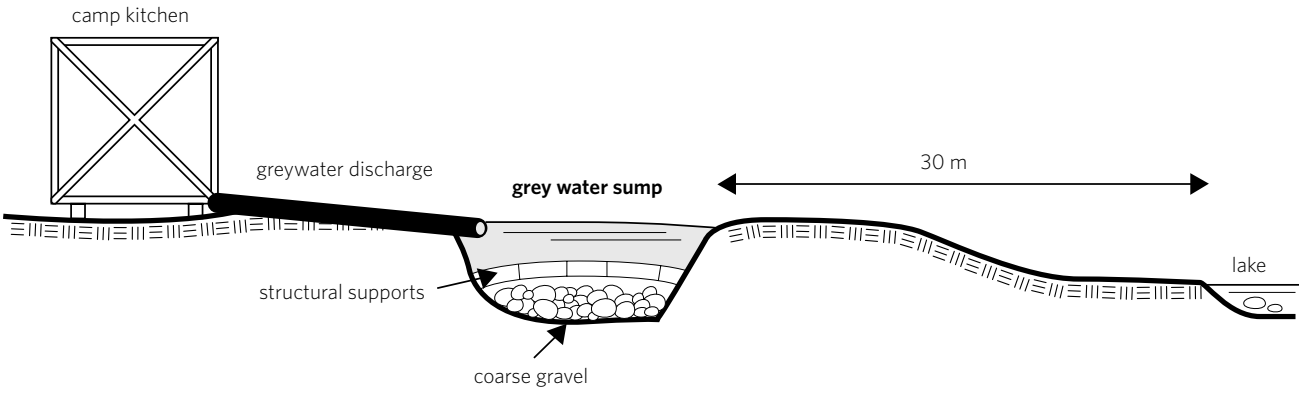



FIGURE 22. A properly excavated greywater sump.

## 4.3 Water Supply

Camps require a freshwater intake for domestic water use. The amount of water drawn should not be harmful to fish or fish habitat. Water intakes should be screened to prevent fish from being drawn in. For further information, consult the Department of Fisheries and Oceans' Freshwater Intake End-of-Pipe Fish Screen Guideline *(www.dfo-mpo.gc.ca/library/223669.pdf)*. To avoid excessive drawdown during the winter, consult the Department of Fisheries and Oceans Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut.

A water pump is often located next to the water source. Fuel should not be stored near water pumps to reduce the risk of a fuel spill into the water. Drip trays should be used underneath the pump to catch fuel drips.

## 4.4 Temporary Closure

Some camps are seasonal in nature. Equipment may be left on-site for the next season if properly stored and approved in the land use permit. Equipment should be protected from weather damage, vandalism and wildlife by storing it in a secure, inaccessible location. An on-site, weather-tight building, such as a grain bin, is recommended for storage at seasonal camps.

All wastes should be removed when the camp is temporarily closed. Tents and other structures should be taken down and stored, but tent frames can remain standing. Perishable food should be removed from the site and non-perishable items can be stored in a weather-tight, wildlife-proof building. Fuel drums should be resealed and stored in the fuel storage area. Fittings on heating fuel drums should be removed, the bungs resealed and drums angled so that water does not collect against the bungs.

## 4.5 Storage Authorization

In some cases, storage authorization may be obtained from the appropriate land use regulator to retain materials such as buildings, equipment and fuel drums at the campsite after the operating land use permit has expired. Such authorization is typically issued if the operator requires the equipment for a future land use operation in the area.

FIGURE 23. A large stationary camp with a sewage lagoon for waste-water treatment.

FIGURE 24. At this seasonal camp, tents will be removed and stored in the weather-tight grain bin.

CHAPTER 05

# Spills



Spills can involve fuel or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line (867-920-8130). A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* (www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp).

## 5.1 Spill Contingency Plan

A spill contingency plan should be in place during all phases of camp construction and operation, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help camp employees respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how personnel should respond to a spill, resources available on-site for spill response, and agencies and individuals that must be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning.*

## 5.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when it is not in use to contain hydrocarbon leaks.

## 5.3 Spill Response

Spill response includes stopping, containing and reporting a spill event. A spill-response kit should be available on-site and be well stocked with materials that can be used to contain a spill. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

FIGURE 25. A spill-response kit should include absorbent booms to contain spills on water.

CHAPTER 06

# Closure and Reclamation

When a camp is no longer required, it must be closed and reclaimed according to the closure and reclamation plan approved by the land use regulator or as directed in the land use permit. Operators should allocate sufficient time and resources to reclamation activities while equipment and personnel are still on-site during regular operations. Returning to the site to address problems after demobilization is complete can be costly and time consuming. Progressive cleanup during camp operation is the most efficient approach to reclamation.

Land use permits require a final land use plan within 60 days after completion of the land use operation or expiration of the land use permit. The final land use plan should describe the land used, any deviations from conditions specified in the initial land use permit application, details of any fuel or chemical spills and a description of the spill cleanup measures employed.

A closure and reclamation plan is also a common land use permit requirement and at a minimum should include:

- site conditions prior to development;
- environmentally sensitive areas;
- reclamation goal(s);
- equipment and methods to be used;
- reclamation waste management practices;
- monitoring activities to assess the success of reclamation measures; and
- contingencies if reclamation measures are unsuccessful.

## 6.1 Reclamation Goals

Reclamation goals provide direction for the closure and reclamation plan, and help in determining the methods and equipment needed to achieve final closure. Specific reclamation requirements may be outlined in the land use permit. Common reclamation goals include:

- Returning the site to a condition comparable to that which existed before camp development. Baseline information collected during the planning phase can be used to determine pre-development conditions.
- Reclaiming the site to a state suitable for some other land use (e.g., wildlife habitat, airstrip or equipment storage area).

Reclamation goals are a key component of the closure and reclamation plan and will require approval of the appropriate regulators. They should be discussed with all stakeholders, including community members and Aboriginal groups.

## 6.2 Reclamation Activities

### 6.2.1 Complete Removal

Camp closure requires removal of all material that was brought on-site, including structures and equipment. In addition, all garbage must be removed. Final cleanup should be conducted during the summer when surface debris is visible.

Areas contaminated by fuel or chemical spills must be completely cleaned up and contaminated soils properly disposed of.

### 6.2.2 Landscape Reconstruction

At sites where the topography has been changed to develop the camp area, it may be necessary to re-establish the original contours, especially if slopes have been excavated and drainage control structures have been used to control surface runoff. The goal of landscape reconstruction is to create a stable, maintenance-free site. This can be accomplished by recontouring the site to restore natural drainage patterns. If recontouring is not feasible, a stable drainage control system can be constructed to prevent surface water from eroding the site. Water collection and diversion structures, such as ditches, water bars and check dams, can be used.

Natural revegetation of the site should be encouraged to control soil erosion. This can be accomplished by spreading organic topsoil, stored during site construction, over the surface. The topsoil will provide a natural seed bank and a growth medium. A rough surface is preferable to a smooth surface to catch seeds and provide sites for growth. In non-permafrost areas, a simple way to create a rough surface is to run over the site with a tracked vehicle such as a dozer.

To assist erosion control as vegetation naturally re-establishes, mulched vegetation can be spread over the site, or a soil binder can be sprayed on the surface. Windrowed brush from the initial site clearing can also be spread over the site and compacted with a dozer to control erosion.


FIGURE 26. (top) A properly reclaimed campsite with all materials removed. Core sample boxes may remain in place.

FIGURE 27. (middle) Reclaimed sites should be stable and maintenance free. This site will require better drainage control structures to avoid further erosion.

FIGURE 28. (bottom) Water diversion ditches can be used to control surface runoff across a site.

FIGURE 29. Spreading and compacting brush over the site can control erosion and catch seeds.

FIGURE 30. Willow plugs can be planted to control erosion in sensitive areas such as riparian zones.

### 6.2.3 Revegetation

Assisted revegetation may be required in erosion-prone areas, such as steep slopes, where recontouring and natural revegetation cannot control erosion in the short term. Revegetation can include seeding of grass or legume species, planting trees or shrubs, and using fertilizer.

Where seeding is required, native seed mixes are preferred to reduce the risk of introducing invasive species. Prior to using any seed mixes or fertilizers, or for more information on appropriate seed mixes and fertilizers, contact the local INAC resource management officer and obtain advice from revegetation specialists.

If seeding is carried out during the winter and the site is located on level terrain, seeds and fertilizer can be distributed directly onto the snow cover and in most cases will successfully germinate. In other cases, it may be necessary to return to the area during the spring for seeding.

High Arctic and high altitude sites are very difficult to revegetate. Minimizing the extent of disturbance is the best mitigation approach.

### 6.2.4 Access

Airstrips should be reclaimed unless otherwise directed in the land use permit. All materials, including portable beacons and fuel barrels, must be removed.

Requirements for reclamation of roads are outlined in the land use permit. Primary reclamation activities include removing all materials, establishing erosion control and restricting access. See the Access: Roads and Trails volume of this series for more information.

Docks should be removed from the site at closure. Ease of removal should be considered when a dock is constructed as docks that are well anchored may be difficult to remove.

## 6.3 Reclamation Monitoring

Monitoring may be required for several years after reclamation activities have been completed to assess whether reclamation objectives have been met. Reclamation monitoring should answer the following questions:

- Have erosion-control measures been successful?
- Is water being successfully controlled on the site?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the INAC resource management officer is satisfied that the site is stable and reclamation objectives have been met, the land use permit will be recommended to the local land use regulator for closure.

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# Glossary

**Berm**

Low earth mound constructed in the path of flowing water to divert its direction.

**Binder**

Substance that encourages the adherence of soil particles, such as a chemical mat.

**Cut and fill**

Construction practice in which earth materials are excavated from part of an area and used as fill in adjacent areas.

**Drip tray**

A containment structure designed to catch fuel drips beneath fittings, valves or fuel transfer nozzles.

**Evapotranspiration**

Water lost from the soil by direct evaporation and transpiration from the surfaces of plants.

**Greywater**

Waste water originating from kitchen or washing facilities.

**Ground ice**

Ice present in ground materials. It dominates the geotechnical properties of the material and can cause terrain instability if it melts.

**High-water mark**

A mark or line indicating the highest level reached by a body of water.

**Peatland**

Poorly drained organic terrain characterized by a high water table and the presence of permafrost.

**Permafrost**

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

**Pit privy**

An excavated pit designed for storage and slow release of sewage.

**Riparian**

Area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

**Secondary containment**

A structure designed to contain hazardous materials if the primary containment, such as a fuel tank, fails.

**Sewage**

Toilet wastes.

**Sewage lagoon**

A body of water designed to contain and treat sewage.

**Source reduction**

Reduction or elimination of the volume of waste generated by using alternative methods or processes.

**Subsidence**

Ground surface settlement.

**Sump**

An excavated pit designed to contain waste.

**Treeline**

The zone above which trees do not grow. Occurs at high latitudes and high altitudes.

# Appendix A: INAC Local Resource Manager Contact Information

## NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL.: 867-669-2671 FAX: 867-669-2713
EMAIL: NWTLands@ainc-inac.gc.ca

## DISTRICT OFFICES

South Mackenzie District
*Yellowknife, Fort Smith, Hay River, Fort Simpson*
District Manager, South Mackenzie District
Indian and Northern Affairs Canada
16 Yellowknife Airport
Yellowknife NT X1A 3T2
TEL.: 867-669-2760 FAX: 867-669-2720

North Mackenzie District
*Inuvik, Norman Wells*
District Manager, North Mackenzie District
Indian and Northern Affairs Canada
P.O. Box 2100
Inuvik NT X0E 0T0
TEL.: 867-777-8901 FAX: 867-777-2090

## NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL.: 867-975-4275 FAX: 867-975-4286
EMAIL: landsmining@ainc-inac.gc.ca

## DISTRICT OFFICES

Kivalliq
P.O. Box 268
Rankin Inlet NU X0C 0G0
TEL.: 867-645-2831 FAX: 867-645-2592

Kitikmeot
P.O. Box 278
Kugluktuk NU X0E 0E0
TEL.: 867-982-4306 FAX: 867-982-4307

Qikiqtani
P.O. Box 100
Iqaluit NU X0E 0H0
TEL.: (867) 975-4500 FAX: (867) 975-4560

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada



www.ainc-inac.gc.ca
1-800-567-9604
TTY only 1-866-553-0554

QS-8622-082-EE-A1
Catalogue: R2-226/6-2011E-PDF
ISBN: 978-1-100-18250-6



Cette publication est aussi disponible en français sous le titre: *Lignes Directrices Sur L'utilisation des Terres du Nord: Campement et installations de soutien*