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Table 3-8: Intermediate Gas Pipeline Block Valve Sites

Valve Type	Site Name	Kilometre Post (KP)	Land Ownership[a]	Land Use Designation (SPDLUP)
Block valve located within Little Chicago facility site	Little Chicago facility site	223.0	Private (K'ahsho Got'ine)	General Use
Block valve location includes cathodic protection ground bed	**Loon River**	**309.7**	**Crown (K'ahsho Got'ine)**	**General Use**
Block valve loction includes cathodic protection groundbed	Chick Lake	390.6	Private (K'ahsho Got'ine)	Lac a Jacques, Turton Lake, Sam Macrae Lake, Yamoga Rock SMA
Block valve located within Norman Wells compressor station site	Norman Wells compressor station	475.5	Norman Wells Municipality	Mackenzie River SMA
Block valve location includes cathodic protection groundbed	**Great Bear River**	**551.4**	**Crown (Tulita)**	**Great Bear River Conservation Zone**
Block valve location includes cathodic protection ground bed	**Little Smith Creek**	**622.6**	**Crown (Tulita)**	**Mackenzie River SMA**

NOTE:
[a]Valve sites on Crown land are highlighted in bold lettering.

Table 3-9: Intermediate Valve Sites on the NGL Pipeline

Valve Type	Site Name	Kilometre Post (KP)	Land Ownership[a]	Land Use Designation (Sahtu Preliminary Draft Land Use Plan)
Manual block valve and check valve	**Unnamed creek – downstream**	**235.3**	**Crown (K'ahsho Got'ine)**	**General Use**
Main line block valve	Tieda River – upstream	273.5	Private (K'ahsho Got'ine)	Yeltea Lake and Manuel Lake SMA
Manual block valve and check valve	**Tieda River – downstream**	**276.9**	**Crown (K'ahsho Got'ine)**	**Yeltea Lake and Manuel Lake SMA**

Table 3-9: Intermediate Valve Sites on the NGL Pipeline (cont'd)

Valve Type	Site Name	Kilometre Post (KP)	Land Ownership[a]	Land Use Designation (Sahtu Preliminary Draft Land Use Plan)
Main line block valve	Loon River pump station – upstream	305.1	Private (K'ahsho Got'ine)	General Use
Isolation valve upstream of station	**Loon River pump station – upstream**	**309.5**	**Crown (K'ahsho Got'ine)**	**General Use**
Isolation valve downstream of station	**Loon River – downstream**	**309.6**	**Crown (K'ahsho Got'ine)**	**General Use**
Main line block valve	**Hare Indian (Rabbitskin) River – upstream**	**324.2**	**Crown (K'ahsho Got'ine)**	**Mackenzie River SMA**
Manual block valve and check valve	**Hare Indian (Rabbitskin) River – downstream**	**330.8**	**Crown (K'ahsho Got'ine)**	**Mackenzie River SMA**
Manual block valve and check valve	**Jackfish Creek – downstream**	**338.9**	**Crown (K'ahsho Got'ine)**	**General Use**
Main line block valve	**Tsintu River – upstream**	**347.5**	**Crown (K'ahsho Got'ine)**	**General Use**
Manual block valve and check valve	**Tsintu River – downstream**	**352.2**	**Crown (K'ahsho Got'ine)**	**General Use**
Main line block valve	**Unnamed stream – upstream**	**365.2**	**Crown (K'ahsho Got'ine)**	**Lac a Jacques, Turton Lake, Sam Macrae Lake, Yamoga Rock SMA**
Manual block valve and check valve	**Unnamed stream – downstream**	**368.9**	**Crown (K'ahsho Got'ine)**	**Lac a Jacques, Turton Lake, Sam Macrae Lake, Yamoga Rock SMA**
Main line block valve	Donnelly River – upstream	380.1	Private (K'ahsho Got'ine)	Lac a Jacques, Turton Lake, Sam Macrae Lake, Yamoga Rock SMA
Manual block and check valve	Donnelly River – downstream	383.7	Private (K'ahsho Got'ine)	Lac a Jacques, Turton Lake, Sam Macrae Lake, Yamoga Rock SMA
Main line block valve	**Hanna River – upstream**	**404.6**	**Crown (K'ahsho Got'ine)**	**General Use**
Manual block valve and check valve	**Hanna River – downstream**	**416.0**	**Crown (K'ahsho Got'ine)**	**General Use**

Table 3-9: Intermediate Valve Sites on the NGL Pipeline (cont'd)

Valve Type	Site Name	Kilometre Post (KP)	Land Ownership[a]	Land Use Designation (Sahtu Preliminary Draft Land Use Plan)
Main line block valve	Elliot Creek – upstream	431.2	Private (Tulita)	Mackenzie River SMA
Manual block valve and check valve	Oscar Creek – downstream	446.6	Private (Tulita)	Mackenzie River SMA
Norman Wells block valve and pig receiver	Norman Wells Enbridge Interconnect	476.4	MACA	Mackenzie River SMA

NOTE:
[a]Valve sites on Crown land are highlighted in bold lettering.

Pigging Facilities

Pigs are devices placed into pipelines to clean the inside of the pipeline or to monitor its condition and position. Pig launchers and receivers are facilities that enable pigs to be inserted into, or removed from, the pipeline (see the photograph provided in Figure 3-20).

Cleaning pigs are usually made of hard rubber or foam and may be ball or bullet-type. Monitoring or smart pigs, equipped with inertial-guidance technologies, will be used to monitor changes in pipeline centreline coordinates and assess ground movements that could lead to pipeline deformations and strains. Other types of smart pigs, such as magnetic flux or ultrasonic pigs, will be used to determine if areas of the pipelines have experienced potentially problematic metal loss.

On the gas pipeline, pig receivers and launchers will be installed at both the Little Chicago facility site and Norman Wells compressor station. On the NGL pipeline, a pig receiver will also be located adjacent to the existing Enbridge pump station in Norman Wells. There are no other pigging facilities proposed for the SSA.

Figure 3-20: Example of a Pig Launcher or Receiver

Cathodic Protection

The pipelines will be protected against external corrosion by a combination of an external coating and a cathodic protection system. This system will consist mainly of deep impressed current anode groundbeds that will be appropriately spaced to provide the pipeline with the requisite level of cathodic protection (see Figure 3-21 and Figure 3-22). Shallow groundbeds might also be considered in areas of discontinuous permafrost. Where required, a galvanic system might be used to complement the impressed current system.

The cathodic protection system will be shared between the gas and NGL pipelines and will be spaced, as required, to provide the pipelines with the requisite level of cathodic protection. Deep anode groundbeds will be installed inside the Little Chicago and Norman Wells compressor station footprints and along the pipeline right-of-way at:

- Loon River (KP-309.7)
- Chick Lake (KP-390.6)
- Great Bear River (KP-551.4)
- Little Smith Creek (KP-622.6)

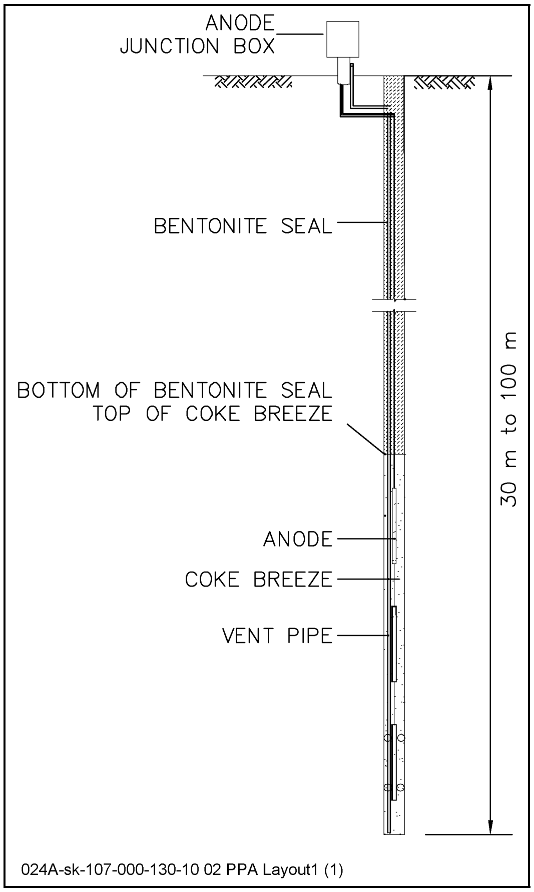

Figure 3-21: Typical Deep Anode Groundbed

Three of the anode groundbeds are situated in a general use zone, as identified in the SPDLUP. Three are in special management areas – one at Chick Lake, one at Great Bear River and one at Little Smith Creek.

A rock drill will typically be used to drill deep anode groundbeds in frozen and rocky terrain.

The anodes will be powered by rectifiers or TEGs. Rectifiers will be used where alternating current (AC) power is available at the facility sites. TEGs will be used at locations without a continuous supply of AC power.

Test stations, consisting of test leads connected to the pipeline and terminating in junction boxes mounted on posts, will be installed at about 3.0 km intervals along the pipeline right-of-way. The effectiveness of the cathodic protection system will be evaluated by taking measurements at the test stations of electrical potential of the pipeline with respect to the ground.

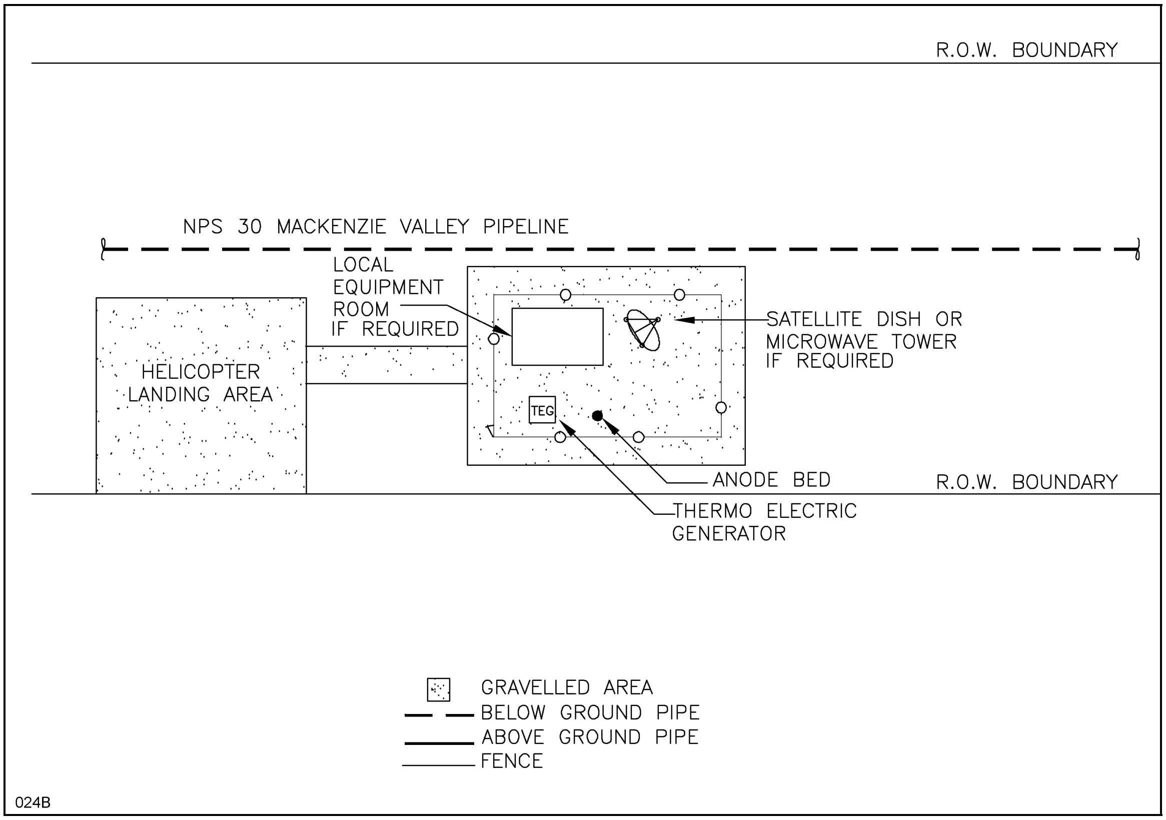

Figure 3-22: Typical Remote Cathodic Protection Deep Anode Bed Site

Signs and Markers

Appropriate signs will be specified and designed to warn the public, GNWT Department of Transportation and any third-party utility companies of the presence of the pipelines. These bilingual warning signs, in English and the regional Aboriginal language, will consist of the following:

- road crossing warning signs, which will be installed where the crossing pipeline enters and exits the road right-of-way and will be visible from the travelled surface of the road
- pipeline crossing warning signs, which will be installed adjacent to the intersection of crossing pipelines
- watercourse crossing signs, which, except for vegetated crossings, will be installed just back from the top of the bank on either side of the watercourse crossing, and if practical, will be visible from the centre of the channel
- signs which will be posted directly above the pipeline on any fence lines that are crossed, and placed on the support post of the aerial markers

- signs which will be placed on all posts installed to support cathodic protection test lead junction boxes

Aerial markers will be installed at about 5.0 km intervals along the pipeline, and will provide reference locations along the pipeline that will be visible from the air.

PIPELINE CONSTRUCTION

Construction Plan

In developing this plan, the following were considered:

- safety and emergency response
- concerns of local residents
- environmental protection
- regulatory requirements
- permafrost conditions
- seasonal constraints
- reduced daylight during the winter
- severe weather conditions
- coordination between the gas and NGL pipeline construction
- construction logistics
- infrastructure requirements
- specialized construction equipment
- select fill requirements

Public concerns considered in the construction planning process are described in Section 10.

Construction Spreads

The preliminary construction plan assumes that pipeline construction will be segmented into five construction spreads (see Appendix C) for each year of construction. These spreads will vary in length from about 120 to 160 km, with the shorter spreads for constructing both the gas and NGL pipelines.

The first year involves preparatory activities starting in the summer of 2006, such as building the infrastructure needed for construction and clearing the right-of-way and facility sites. The second and third years involve completing the preparatory activities and constructing the pipelines and associated facilities.

Most pipeline installation activities will be completed during the winter. Some activities, such as watercourse crossings, might be completed during the summer, where access to the work site is practical.

Construction Methods

Conventional winter pipeline and industrial facility construction methods and equipment will generally be used to build the proposed pipelines and associated facilities. Conventional winter construction techniques include:

- winterizing construction equipment and fuel tanks
- welding, followed by trenching
- lowering and backfill of the pipelines
- providing protection and housing for the workforce, including camp facilities, lighting and weather protection

Right-of-Way and Temporary Workspace

Right-of-Way Configuration

The pipeline right-of-way will provide work areas and travel areas to support safe and efficient construction. Figure 3-23, Figure 3-24 and Figure 3-25 show typical pipeline configurations for single and dual pipe alignments for right-of-way widths of 30 m, 40 m, and 50 m, respectively.

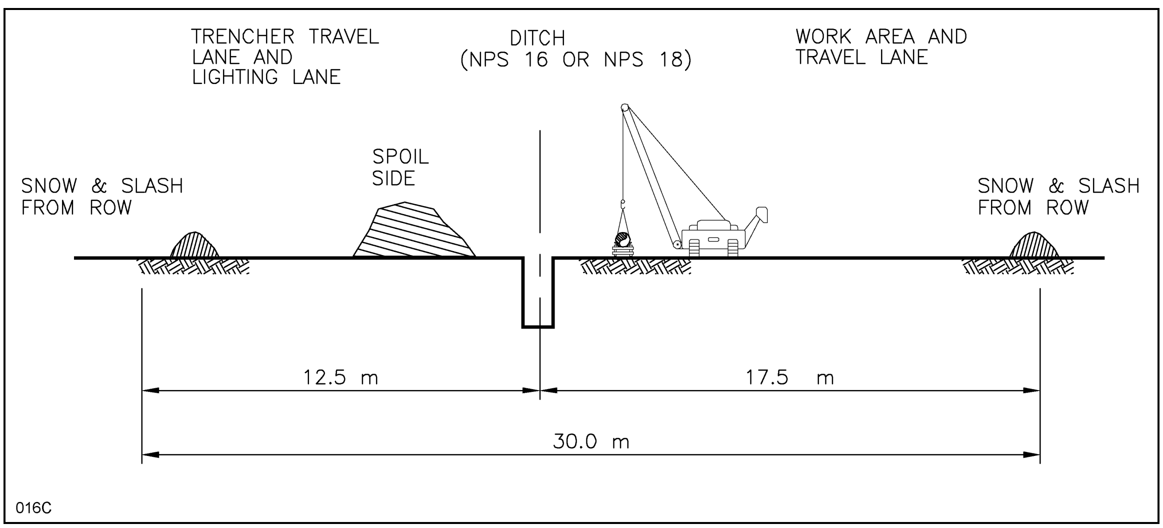

Figure 3-23: Typical Right-of-Way Configuration for Single Pipe (30 m)

A trencher travel lane will be located between the ditch spoil pile and the edge of the right-of-way. The lane will be between 3.5 and 5.0 m wide and will be used to move lighting plants and ditching equipment.

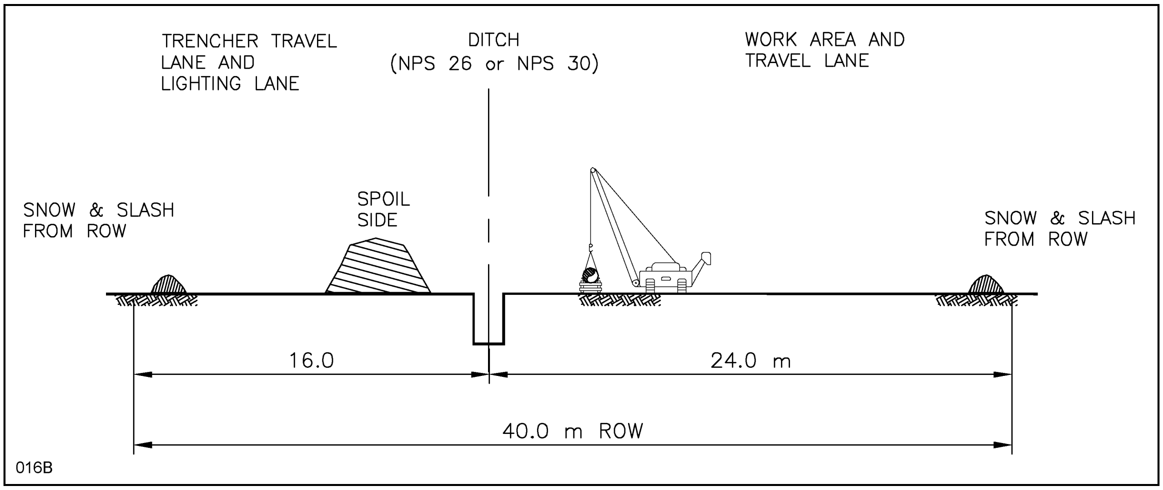

Figure 3-24: Typical Right-of-Way Configuration for Single Pipe (40 m)

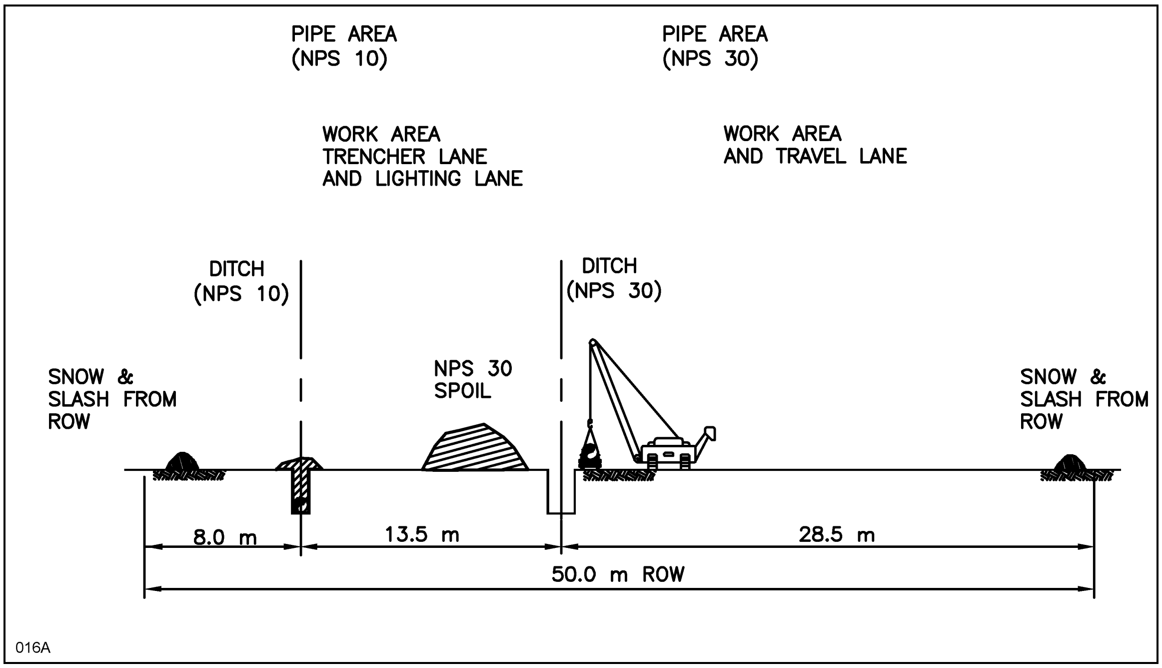

Figure 3-25: Typical Right-of-Way Configuration for Dual Pipelines (50 m)

A travel lane and work area will also be located within the right-of-way. Its surface will be prepared to safely accommodate the movement of construction equipment, including buses and pipe-stringing trucks. Over sensitive terrain and where practical, snow and ice pads will be constructed on the travel lane to facilitate the movement of construction equipment. An example of an active right-of-way during construction is provided in Figure 3-26.

Right-of-way preparation techniques suitable for several combinations of slope and soil conditions have been developed. These techniques include options to protect sensitive permafrost terrain to reduce potential thaw-induced erosion or instability resulting from disturbance of surface organic cover.

Steep longitudinal and sidehill slopes will be graded during construction to provide safe working conditions and for performance of the work (see Figure 3-27). Grading will depend on various factors such as slope angles, soil types and ice content. Unstable ice-rich slopes will typically be protected using snow, ice, or snow and ice work pads where practical, or will be remediated if grading is required.

Mitigation measures will be implemented both during and after construction to limit potential thaw settlement in permafrost areas. These measures might include, but are not limited to, revegetation, drainage control structures, surface insulation methods such as wood chips where available, and reclamation of graded slopes.

Temporary Workspace

Temporary workspace during construction will be required at a number of locations for the following uses:

- shooflies on the pipeline right-of-way
- watercourse crossings with defined banks
- turnaround areas or pushouts
- road, highway and pipeline crossings
- equipment storage areas
- deep grade or large slope sites
- sidebends
- sharp direction change areas
- valve sites
- pig launcher and receiver sites
- timber storage sites

The temporary workspace requirements for the pipelines through the SSA are estimated at 180.1 ha. This space is necessary for construction activities and is incremental to the right-of-way itself. Areas required for timber storage and bypasses on the pipeline right-of-way are excluded from this estimate and will be identified as construction planning and engineering progresses. The need for and size of additional temporary workspaces will be identified. The exact locations will be determined in the field during surveying, clearing and construction.

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Typical workspace requirements are depicted in Figure 3-28, Figure 3-29, and Figure 3-30 for a watercourse crossing, pushout area and sidebends.

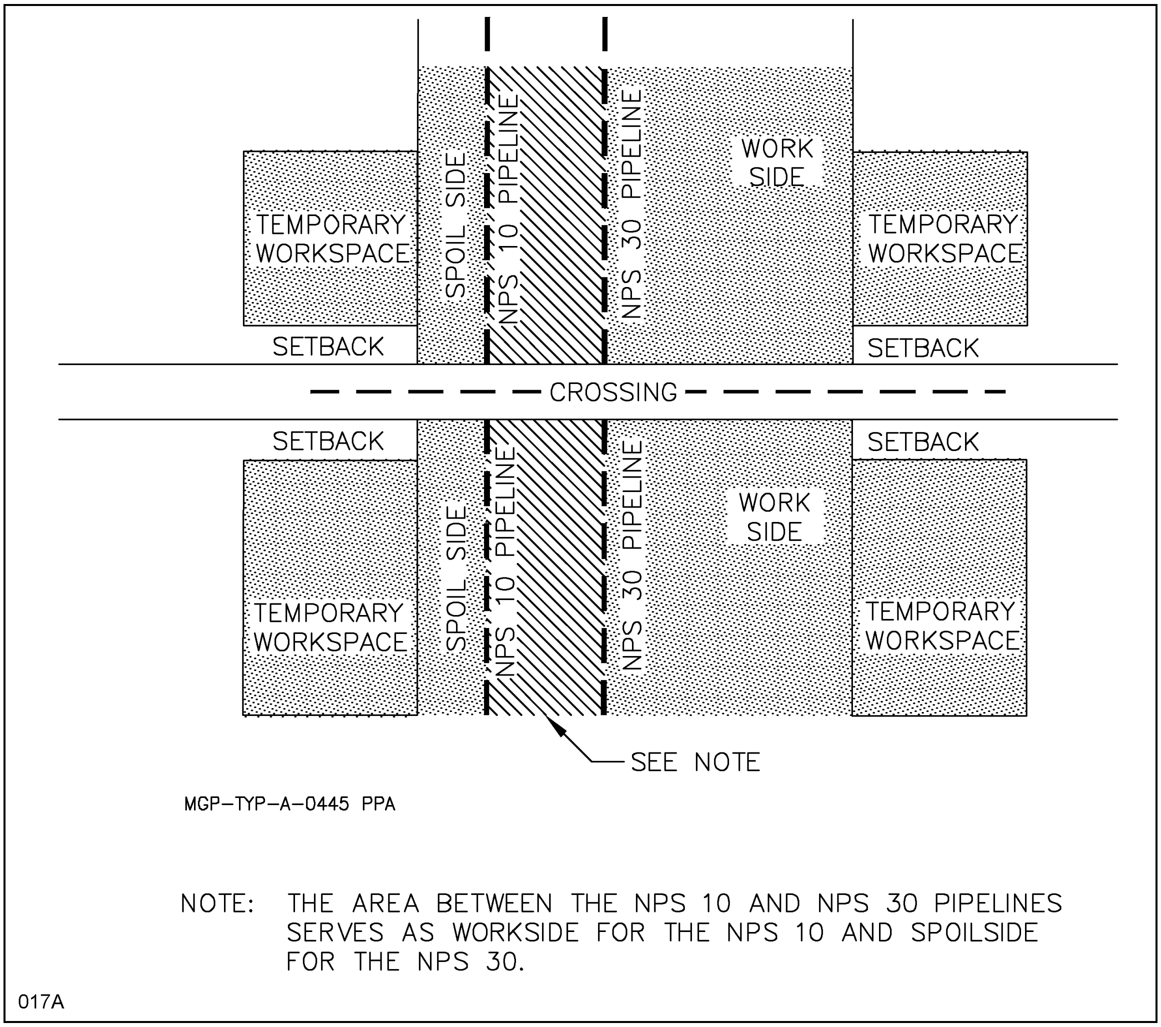

Figure 3-28: Typical Temporary Workspace at Watercourse Crossing – Dual Pipe Alignment

Clearing and Subsurface Investigations

The right-of-way and temporary workspace will be cleared for pipeline construction when ground conditions allow. The full width of the right-of-way might not be cleared in some areas, such as at the approaches to watercourse crossings with steep south-facing slopes. In the SSA, pipeline right-of-way clearing is expected to start in 2006 and end in 2009.

Before the start of right-of-way construction activities, the pipeline centreline will be located and staked within the identified route corridor. This will require clearing a line-of-sight for surveying, using hand tools where necessary, in forested or bush areas.

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Clearing and subsurface investigation activities include:

- surveying and marking the right-of-way and temporary workspace
- fencing or flagging areas to be avoided, such as environmentally sensitive sites
- clearing trees and shrubs from the right-of-way
- investigating subsurface conditions within the right-of-way

Trees and brush will be cut off at ground level. Non-merchantable timber and brush will be burned or windrowed on the edge of the right-of-way. Timber will be stockpiled for project use in storage areas adjacent to the right-of-way. Timber might be used as a source for wood chips or riprap to insulate slopes along the right-of-way, for log corduroy, or to aid in bridge construction (see Figure 3-31). If requested, timber will also be stockpiled for community use, where practical.

Figure 3-31: Example of Laying Log Corduroy on Travel Lane

Surface Preparation

The right-of-way surface will be levelled or graded to facilitate moving vehicles and equipment. Larger diameter pipe, such as the NPS 30 gas pipeline, requires larger construction equipment. This generally increases the extent of levelling that is required. Certain design locations such as side slopes, river crossings and steep gullies, typically require grading.

Before grading, loose surface material, including tree stumps and roots, will be windrowed to the edge of the right-of-way. Windrowed material might be distributed over the right-of-way during cleanup and reclamation.

The snow, brush and vegetative material that remain on the work side of the right-of-way will be compacted with light tracked equipment and then with rubber-tired equipment. More snow and water will be added and then the travel surface will be compacted, using progressively heavier equipment. Excess snow accumulations and loose surface material will be ploughed or blown to the side of the travel lane.

In sensitive terrain, disturbance of the surface organic layer will be limited by using protective blades or equivalent on ground engaging equipment, where practical.

The travel lane might be built up by adding water and snow for sensitive terrain, where practical. Snow will form the bulk of the constructed work side and travel lanes. Additional water might be used on steeper sidehills in sensitive terrain to provide a safe travel lane and workspace areas.

Dragging and surface-grading the travel lanes will achieve a smooth driving surface. Maintenance will be done on an ongoing basis, using conventional construction equipment, water and snow. The combined work area and trencher lane on the spoil side of the right-of-way might also be built up, but it will only be maintained while it is required to support the movement of equipment in the area.

Pipe Stringing and Bending

Once the right-of-way is cleared and levelled, pipe joints up to 24 m long will be transported by truck from the pipe stockpile sites and set up on the right-of-way on temporary supports or skids.

The pipeline must accommodate both horizontal and vertical changes in the right-of-way alignment. Where changes in the natural ground contours are greater than the ability of the pipe to bend naturally, joints of pipe will be bent on site to the desired degree of curvature, using a pipe-bending machine (see Figure 3-32), or the land will be graded as necessary, or a combination of both. If a large bend is required, pre-bent segments will be delivered to the right-of-way for installation.

Figure 3-32: Example of a Pipe Bending Machine on Pipeline Right-of-Way

Welding and Inspection

After welding is complete, each weld will be inspected to detect defects. Figure 3-33 is a photograph of a pipeline welding operation in winter.

Any defect will be repaired, or cut out and replaced. The welds will then be re-inspected and externally coated for protection from corrosion.

Figure 3-33: Example of Welding Shelters on Pipeline Right-of-Way

Trenching, Lowering In and Backfilling

As the welding operation is completed, a pipeline trench will be excavated using equipment, such as chain and bucket wheel trenching machines and backhoes (see Figure 3-34 and Figure 3-35). In frozen ground and rock, the ditch line might be ripped before excavation. Explosives, if needed, will be stored and transported in an approved manner.

Materials excavated from the trench, known as spoil, will be placed temporarily beside the excavated trench (see the left-most photograph in Figure 3-36).

Bedding materials, such as sand and gravel or urethane pillows, might be placed in the trench before the pipe is lowered, if the trench bottom is rocky or otherwise unsuitable. Free water that has collected in the trench might need to be pumped out. Sideboom tractors and backhoes will be used to lower pipe into the trench.

If the spoil material is suitable, it will be used as backfill over the pipe, after the pipe has been lowered in. If the spoil material is unsuitable, imported select material will be used as backfill. Spoil material might be considered unsuitable if it contains large rocks, boulders or large clumps of ice-rich material. Select material might be placed around the pipeline so as not to damage the coating. The trench is then filled with the remaining spoil.

Figure 3-34: Example of a Chain Ditcher

At sites that have subsurface water flow or steep slopes with high water erosion hazards, mitigation alternatives that will be considered for installation before the trench is backfilled include ditch plugs, surface diversion berms, trench breakers and subdrains. Flowing surface water and water forced to the surface by ditch plugs will be diverted off the right-of-way by diversion berms. Excess trench spoil material will be bermed over the pipeline or spread over the right-of-way as part of cleanup and reclamation.

Photographs of trenching, pipe lowering and backfilling cleanup are shown from left to right in Figure 3-36.

The pipeline cover will be a minimum of 0.9 m, with some sections, such as at watercourse crossings, requiring deeper burial. The minimum depth of cover under watercourses with defined beds and banks will be 1.2 m.

Settlement of backfill materials placed in the trench after the pipeline is installed depends on, among other things, the ice content of the soil placed in the trench. Ditch settlement in areas with high ice content soils might be offset with varying amounts of ice-free imported fill.

Slope Stability

Criteria to determine where site-specific slope designs are required have been developed for the project. These criteria include predicted thaw depth and slope stability, soil loading on the pipe, and right-of-way erosion potential.

Figure 3-35: Example of a Bucketwheel Ditcher

Figure 3-36: Examples of Trenching, Lowering in Pipe and Backfilling Cleanup

Slopes requiring site-specific design will be identified as the design progresses. Designs might include:

- installing thermally insulated pipelines, together with right-of-way wide insulation, such as wood chips, foam insulation, borrow material or other suitable material
- installing heat pipes or thermosiphons to reduce the depth of thaw bulbs
- narrowing the right-of-way clearing

Pressure Testing

Segments of welded pipe will be pressure tested at predetermined test pressures for pre-established periods. If a leak is detected, the affected segment of pipe will be exposed and repaired or replaced. A freeze point depressant-water mixture will be added to water to lower the freezing point of the test medium for pressure testing of the NGL and gas pipelines in the SSA. Freeze depressants are materials, usually liquids, such as methanol or glycol, which are added to a fluid to lower its freezing point.

Cleanup, Reclamation and Post-Construction Monitoring

Construction waste will be removed for treatment, if required, and disposed of at approved locations, according to the waste management plan for the project (see Section 11).

The right-of-way will be re-contoured and, in areas of high erosion potential, specialized mitigation measures might be implemented. Examples include ditch plugs, berms and subdrains. Disturbed portions of the right-of-way might be re-vegetated with native seed, transplanted with local shrubs, or both, based on the project reclamation criteria.

Reclamation and mitigation measures implemented during construction will be monitored during the operations phase. Long-term monitoring programs will be established for areas with environmental, geotechnical and pipeline integrity concerns.

Pipeline Commissioning

Commissioning and start-up activities are expected to begin in early 2009 and be completed by year-end. A commissioning and start-up plan will be developed for pipelines and facilities before commissioning starts. The plan will:

- include an overview outlining the purpose, objectives and management-of-change process to be followed
- define roles and responsibilities, including coordination processes and interfaces with the gathering system commissioning and start-up plan
- outline procedures for mechanical completion, pre-commissioning, commissioning, start-up, performance testing and turnover for continuous operation

Commissioning activities verify that equipment and systems are functioning according to the design and that the system is ready for operation. This includes energizing selected equipment and systems.

After mechanical completion, each system component will be inspected and tested, and documentation will be completed to ensure that the systems are safe before proceeding with commissioning activities. Testing includes pressure testing facilities for strength and leaks. Testing media being considered include:

- heated water
- water and freeze depressant mixture
- air
- nitrogen

Start-up activities begin with the introduction of hydrocarbons into the process system. Equipment and processes will be started up for initial operation and monitored. All remaining emergency shutdown tests will be completed, and system performance data will be collected.

At the end of the start-up period, and after regulatory authorizations have been received, the pipeline will be turned over to operations staff for continuous operation and commercial service. This includes providing design data, construction records and performance test records.

PIPELINE OPERATIONS

Operation of the pipeline system includes activities required to transport gas and NGLs in a safe, efficient, and reliable manner. All activities, including safety, health and environmental performance, will meet applicable laws, regulations, permit conditions and corporate standards. The development will be operated according to the applicable regulatory requirements, and permit and licence conditions. Operational policies, practices and activities will demonstrate care for the safety of people and stewardship of the natural environment.

Operations Activities

The pipelines and facilities will be designed for safe operations. Emergency shutdown systems will be designed for remote or manual operation.

Operation of the gas and NGL pipelines will be continuously monitored and controlled from the main control centre (MCC) in Calgary. The gas compressors will be started and shut down remotely from this location. Emergency shutdown of the pipelines or compressor stations will be initiated from the MCC, if required, or locally when personnel are on site.

Pipeline operations work will require that crews travel to various locations along the pipeline. Scheduled operations and maintenance visits outside the Norman Wells facility will be done primarily by helicopter. Crew sizes are estimated to range from two to five people. Most routine travel will be to compressor stations and appurtenance sites, such as valve sites, for a short period (e.g., one to two days). Travel to most locations is expected to be infrequent, likely two or three times a year.

Maintenance Activities

Pipeline and right-of-way inspection and repair programs will be planned and executed to ensure a safe and reliable operation and to reduce any adverse environmental effects. Air, water and ground transportation will be used, depending on the location, need and season.

An aerial surveillance program will include scheduled inspections and be incorporated with routine operation and maintenance flights. Aerial surveillance will be conducted weekly during initial operations. This frequency is expected to be reduced, depending on right-of-way performance and industry activity along the pipeline corridor. Ground surveillance will also be implemented, at intervals that are yet to be determined. Vegetation, such as trees and shrubs will be controlled along the right-of-way and near facilities to maintain visibility during patrols and to facilitate access during maintenance.

Over the project life, non-routine maintenance activities will be undertaken, where required, along the pipeline and at facility sites. Mitigation might be required to address the effects of thaw settlement, frost heave, slope movements and erosion. Site-specific plans will be developed using data from operating conditions, trend analyses, and engineering assessments.

When practical, major work activities will be planned to occur in winter to facilitate access to the site. Crews of up to 20, and several pieces of equipment, might be mobilized to the site.

CROSSINGS

This subject describes the land use activities and construction techniques that will be used to install the pipelines across different types and sizes of watercourses in the SSA, including those that require approval under Section 6 (b) and (c) of the MVLUR. Watercourse crossings that meet the threshold criteria for a Type B water licence under the *Northwest Territories Water Act* will be addressed in a related application.

In addition to pipeline watercourse crossings, this subject describes the land use activities and construction techniques that will be used to cross watercourses, ravines, and other depressions encountered during the construction of access roads and the pipeline travel lane. Crossings of third-party pipelines, highways and roads are also described.

WATERCOURSE CROSSINGS FOR PIPELINES

The proposed pipelines through the SSA cross 262 watercourses. The construction techniques that might be used at watercourse crossings include HDD, open cut and isolated (i.e., open cut with either fluming or dam and pump techniques).

No aboveground crossings are planned.

Crossing Criteria

The criteria that will be considered in designing the watercourse crossings include stream type and scour potential, streambed soil conditions, subsoil type, water flow during construction, bank stability, potential geothermal effects and environmental constraints, and community input.

The feasibility of the technique that will be used at each watercourse crossing will be verified in the field by confirming that the subsoil conditions are appropriate. Alternate construction techniques will be developed for HDD and isolated crossings. If there is no flow at an isolated crossing, or if there are no issues concerning fish or fish habitat, open cut crossings will be used at these sites.

The watercourses that will be crossed by the pipeline have been grouped into five main types, as described next.

Large Watercourse Crossings

These are water channels that appear with a name on 1:50,000 Government of Canada topographic maps and have a perennial flow and drainage area greater than 1,000 km^2. Six large watercourse crossings have been identified for the SSA, four in the K'ahsho Got'ine District and two in the Tulita District.

Active I Watercourse Crossings

These are water channels with a perennial flow or that are partially frozen to the channel bed during winter. They typically provide feeding and holding areas for large-bodied fish species. Twenty-five Active I watercourse crossings have been identified in the SSA, eight in the K'ahsho Got'ine District and 17 in the Tulita District.

Active II Watercourse Crossings

These are water channels that are frozen to the bed or have no flow during the winter. However, for Active II streams in discontinuous permafrost, the effects of frost bulbs will be considered and, if required, mitigated. Twenty-five Active II watercourse crossings have been identified in the SSA, 11 in the K'ahsho Got'ine District and 14 in the Tulita District.

Vegetated Channels

Vegetated Channels are ephemeral watercourses that might be depressions or swales and are used by fish only for short periods during high water levels, if at all. This type of watercourse experiences flow primarily during spring runoff and has no discernible banks or evidence of annual sediment transport. Two hundred and two Vegetated Channels have been identified along the right-of-way in the SSA, 109 in the K'ahsho Got'ine District and 93 in the Tulita District.

Lakes

There are four lake crossings in the SSA.

The primary watercourse crossing techniques planned for the SSA are shown, by type and district, on Table 3-10.

Table 3-10: Primary Watercourse Crossings in the SSA

District	Trenchless	Isolated	Open Cut
K'ahsho Got'ine	1	7	128
Tulita	2	12	112
Totals:	3[a]	19	240

NOTE:
[a]An HDD Crossing (RPR-249) is located partly on Sahtu private land and land within the Fort Good Hope municipal boundary. This crossing is discussed in both land use permit applications, but will be classified as a single crossing.

Construction Techniques

Open Cut Crossing

An open cut technique is appropriate for crossing Vegetated Channels and Active II watercourses, and for Active I and Large watercourses that cannot be crossed in a practical way by an isolated or trenchless method, or that have no issues identified relating to fish or fish habitat.

Open cut crossing involves excavating a trench in the watercourse bed using a backhoe, dragline, dredge, clam or other similar machinery. Depending on the size and depth of the watercourse, the equipment might operate from a barge.

Due to the winter construction period, many of the watercourses will be dry or frozen to the bottom. For vegetated crossings, the open cut technique is simply an extension of the regular trenching activities across the frozen watercourse. Therefore, ditch plugs, drag sections, separate pre-welded sections of pipe, stockpiles, buffers and spoil containment berms might not be necessary.

Work Area

The construction crew will ensure that there is sufficient temporary workspace for spoil, material and equipment stockpiles, pipe preparation activities and access to both sides of the crossing. The right-of-way grade crew will install a vehicle crossing of the watercourse on the work side of the right-of-way as close as practical to the crossing location, allowing for the movement of personnel and equipment around the watercourse crossing site. Typical bridging descriptions are discussed in the topic entitled "Access Road and Travel Lane Crossings."

Pipeline Installation

The pipeline crossing trench will be excavated. The spoil material will be placed on the banks of Active I and Active II channels, or for large rivers, in the stream channel. If there is water flow present in the large crossings, breaks will be left in the pile to maintain continuous flow of the water and areas of highest water velocity will be avoided to the extent practical. The pre-welded section of pipe will be lowered into the ditch for backfilling. Backfill of native or imported materials will be completed as soon as practical.

Completion

Due to the winter construction period, Vegetated Channels will be dry or frozen to the bottom and will therefore be crossed by regular trenching techniques.

The watercourse bed will be stabilized. When the vehicle crossing is no longer required, it will be removed.

No spoil will be left on the ice after construction. In some cases, the stream might be diverted within the wetted perimeter by damming or sheet piling to allow excavation "in the dry" for half the crossing at a time. A typical open cut crossing schematic for Large, Active I and Active II Channel crossings is shown in Figure 3-37.

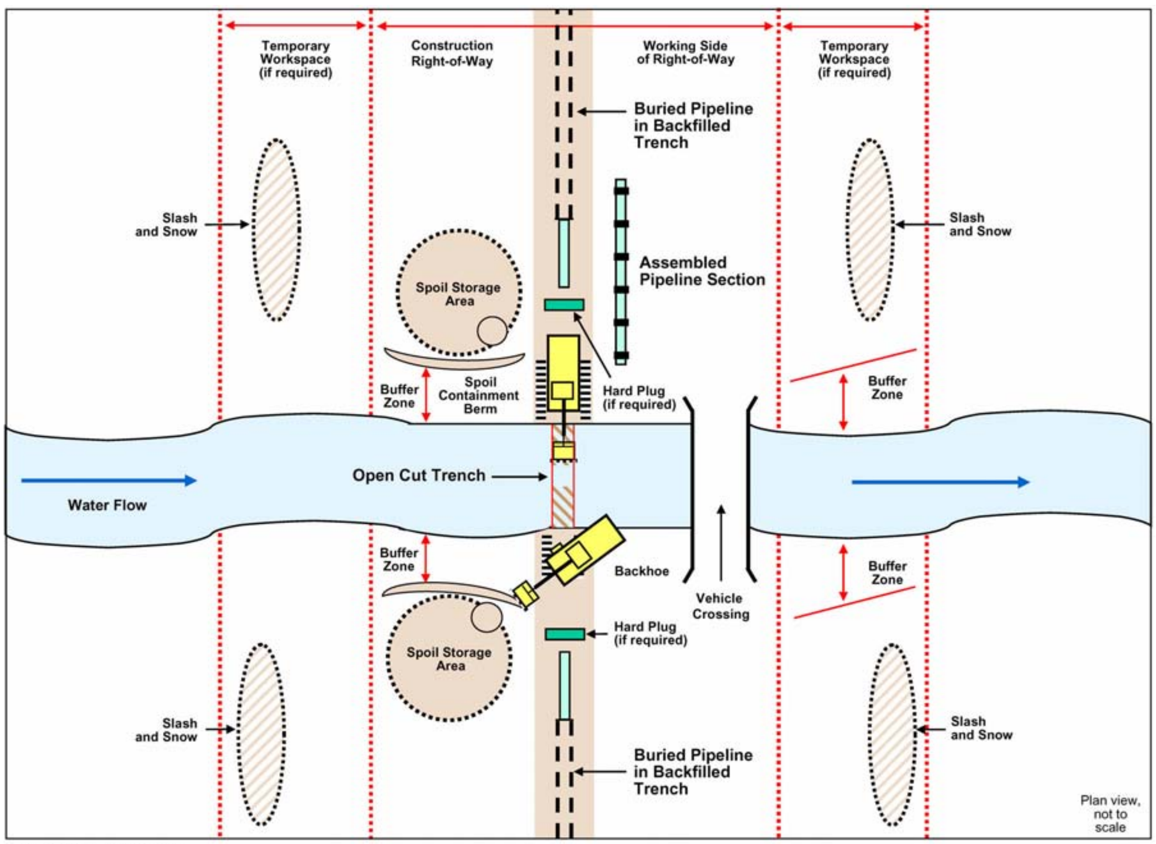

Figure 3-37: Typical Open Cut Watercourse Crossing

Isolated Crossing

An isolated crossing technique will be used rather than an open cut method when water flow through a location is anticipated at the time of construction, in combination with potential issues concerning fish and fish habitat. It involves damming the watercourse to permit excavation while maintaining clean water flow around the crossing location using pumps or flumes. This reduces turbidity and sedimentation downstream of the crossing.

Work Area

The construction crew will ensure that there is sufficient temporary workspace for spoil, material and equipment stockpiles, pipe preparation activities and access to both sides of the crossing. The right-of-way grade crew will install a vehicle crossing of the watercourse on the work side of the right-of-way as close as practical to the crossing location. This will allow for the movement of personnel and equipment around the watercourse crossing site.

Pump Installation

The pumps will be installed and checked for sufficient flow to match natural stream volumes. Clean water will be pumped around the excavation site and released back into the watercourse below the crossing location.

Dam Construction

Ice and snow at the crossing location will be removed to prepare the bed and banks of the watercourse for the installation of the dams. The upstream dam will be constructed first, using sand bags, metal plates, and aqua dams to channel the water toward the pumps. The downstream dam will then be constructed in the same manner to isolate the crossing.

Pipeline Installation

The crossing trench will be excavated with the spoil being placed away from the stream channel. The pre-welded section of pipe will be lowered into the ditch for backfilling. Backfill of native or imported materials will be done from the centre of the crossing back toward the banks.

Completion

The watercourse bed will be stabilized and reclaimed. The downstream dam will be removed first, followed by the removal of the upstream dam. Bypass machinery will then be shut down and removed to restore natural watercourse flow.

A typical isolated crossing, showing a dam and pump technique, is illustrated in Figure 3-38. A photograph of an example is shown Figure 3-39.

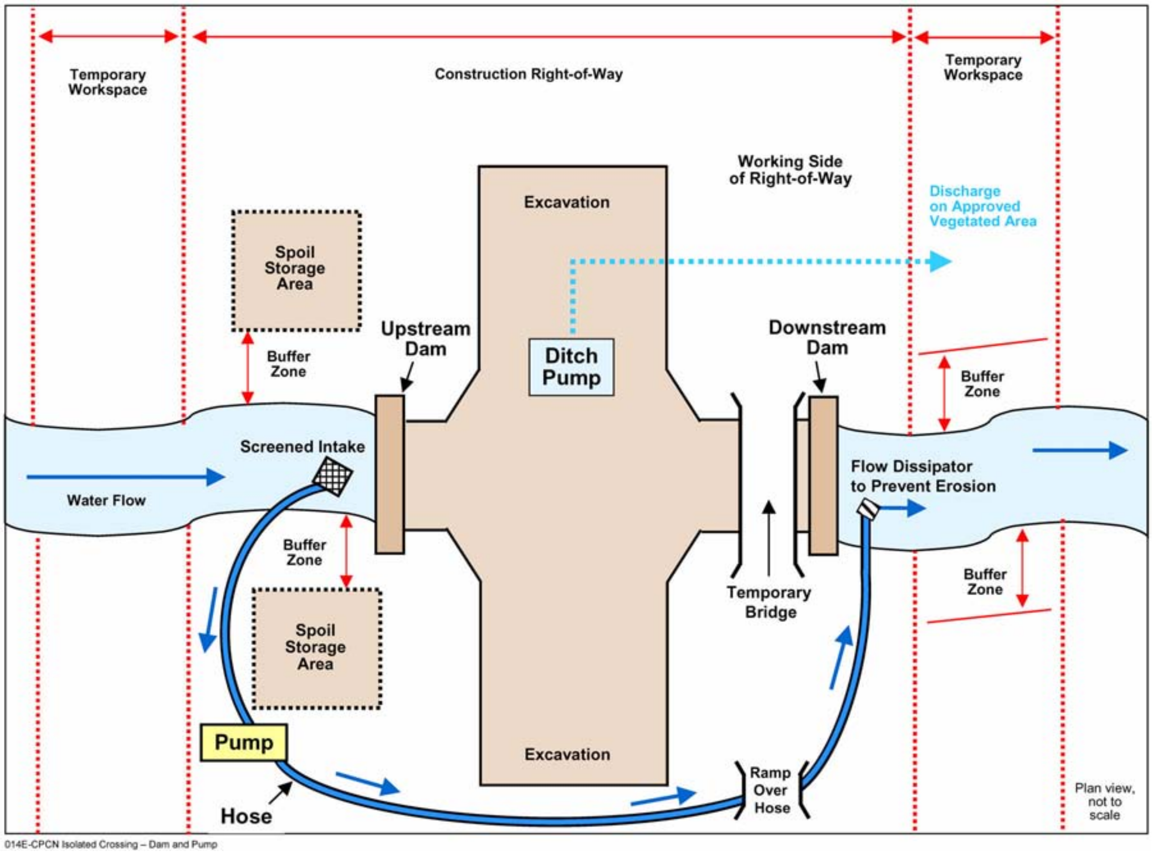

Figure 3-38: Typical Isolated Crossing – Dam and Pump

Figure 3-39: Example of Isolated Dam and Pump Crossing

A dam and flume procedure is similar to the dam and pump procedure except that a flume between the upstream and downstream dams is used for the water bypass instead of pumps. Flumes are used if the water flow is too great for pumps to handle or due to potential issues concerning fish and fish habitat, as this method allows fish passage during construction.

A typical isolated crossing, showing a dam and flume technique, is illustrated in Figure 3-40. A photograph of a dam and flume crossing is shown in Figure 3-41.

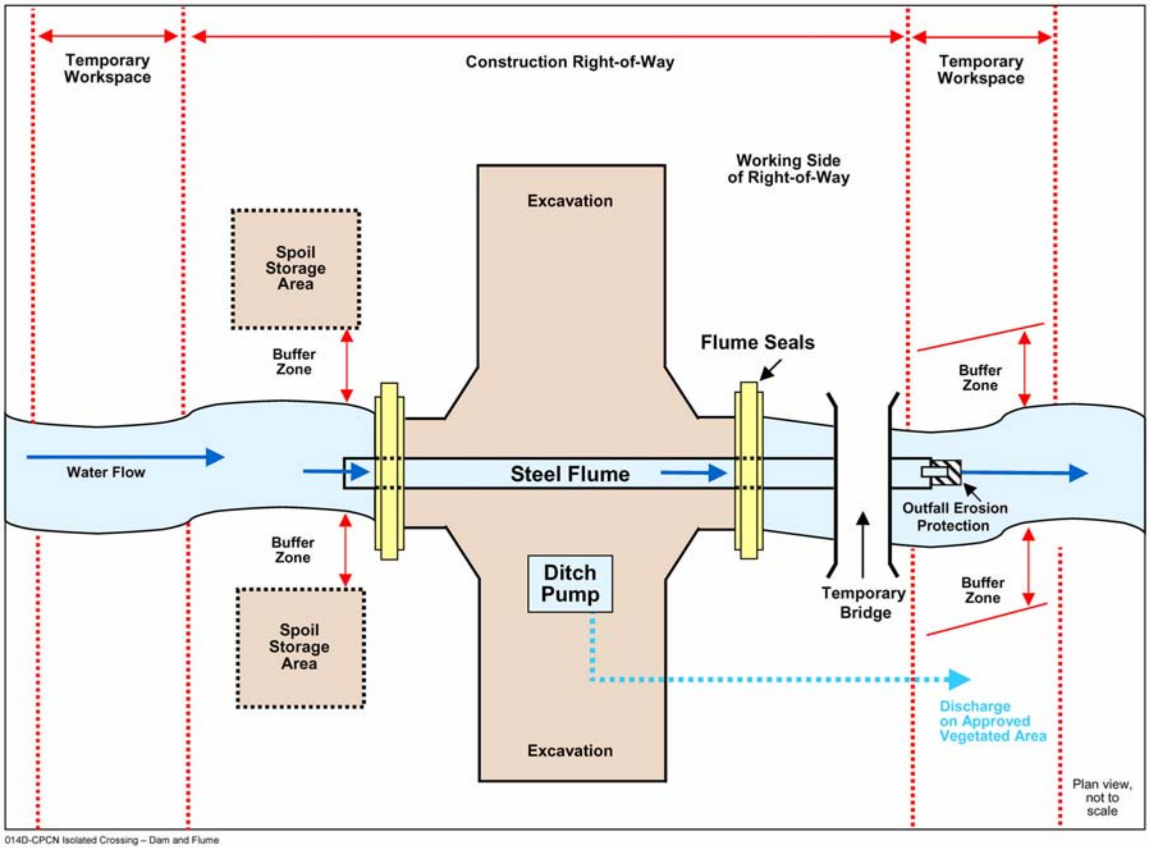

Figure 3-40: Typical Isolated Crossing – Dam and Flume

Figure 3-41: Examples of an Isolated Dam and Flume Crossing

Horizontal Directionally Drilled Crossings

Three HDD crossings are planned for the SSA, those being across:

- Hare Indian (Rabbitskin) River near KP-330.2
- Great Bear River near KP-556.0
- Saline River near KP-653.4

An HDD requires two work areas, one on each side of the watercourse, with access for vehicles and equipment across the watercourse on or near the right-of-way between the work areas.

Entry Side Work Areas

The entry side is where the drilling equipment is set up. Generally the width of the right-of-way is not adequate to accommodate the drilling operation so additional temporary workspace is required. The amount of additional temporary workspace is dependent upon the pipe diameter, length of crossing and soil conditions. An additional right-of-way width of about 50 m extended along the right-of-way for about 50 m might be required to accommodate the drilling rig and support equipment. The area will be graded to a reasonably level and flat condition to provide a safe work surface, as shown on the entry side photograph in Figure 3-42. The only incremental excavation, beyond the pipe trench, is the rig anchor block.

Figure 3-42: Horizontal Directional Drill Photograph – Entry Side

Exit Side Work Area

The exit side is where the pipe is assembled into a continuous string that runs along the length of the crossing. An additional 15 m of width running the length of the crossing of temporary right-of-way is usually required for this work. Grading of the exit side work area will be completed as if it were a normal right-of-way. If the right -of-way has a horizontal bend within the length of the crossing from the exit point, temporary workspace that deviates from the actual right-of-way will be required for a distance that will allow the entire pipe string to be laid out in a direct line with the crossing. A mud tank is also required at the drill-head exit point.

Access

Winter road or temporary bridge access is required across the watercourses between each of the work areas. These accesses will likely be the same crossings that are required by the pipeline construction crew. The construction and use of these bridging mechanisms was described previously.

Drilling

The drilling will typically be a 24 hour a day operation. First, a pilot hole is drilled under the river to the exit side. The course of the pilot hole is guided along a predetermined path by an electronic guidance system and the actual path is plotted against the planned path, which is designed to be deep enough to safeguard the integrity of the pipeline. This path minimizes the possibility of drilling mud reaching the surface through fractures in the soil. With successive passes, the hole is reamed larger to the specified size that will accommodate the pipeline. While drilling, drilling mud is circulated under pressure to carry the drill cuttings out of the hole into the mud tank. Mud with entrained cuttings is circulated through shaker screens, which remove the cuttings and return the mud to a tank for reuse. This method is a continuous process and the mud supply must be supplemented as the size of the hole is increased. Drilling fluid and solids from HDD activities requiring disposal might include water, bentonite-based mud, and cuttings. The need for chemical additives is currently under review by the project. Disposal options currently being considered for the fluids and solids from HDD watercourse crossings include distribution along the pipeline right-of-way and disposal to borrow sites. Disposal procedures and locations will be selected to reduce any potential impacts from the HDD materials on local water supply and quality, or future use of borrow sites. Reclamation measures for the disposed drilling fluids and solids are being developed and will be included in the project's reclamation plans.

When the design hole size is attained (a few centimetres larger than the pipe), the drill pipe is attached to the crossing pipe with a pulling head and a swivel and then pulled into the hole.

An HDD schematic is shown in Figure 3-43.

If the pipe is severely damaged during pull back, the damaged segment of pipe will be cut out and replaced. The entire crossing section might be removed and the hole reamed again.

If the damaged pipe cannot be removed, a decision will be made to attempt another HDD crossing at an adjacent location, or to switch to an alternative pipe installation method. The likely alternative is an open cut crossing, which might require another crossing location.

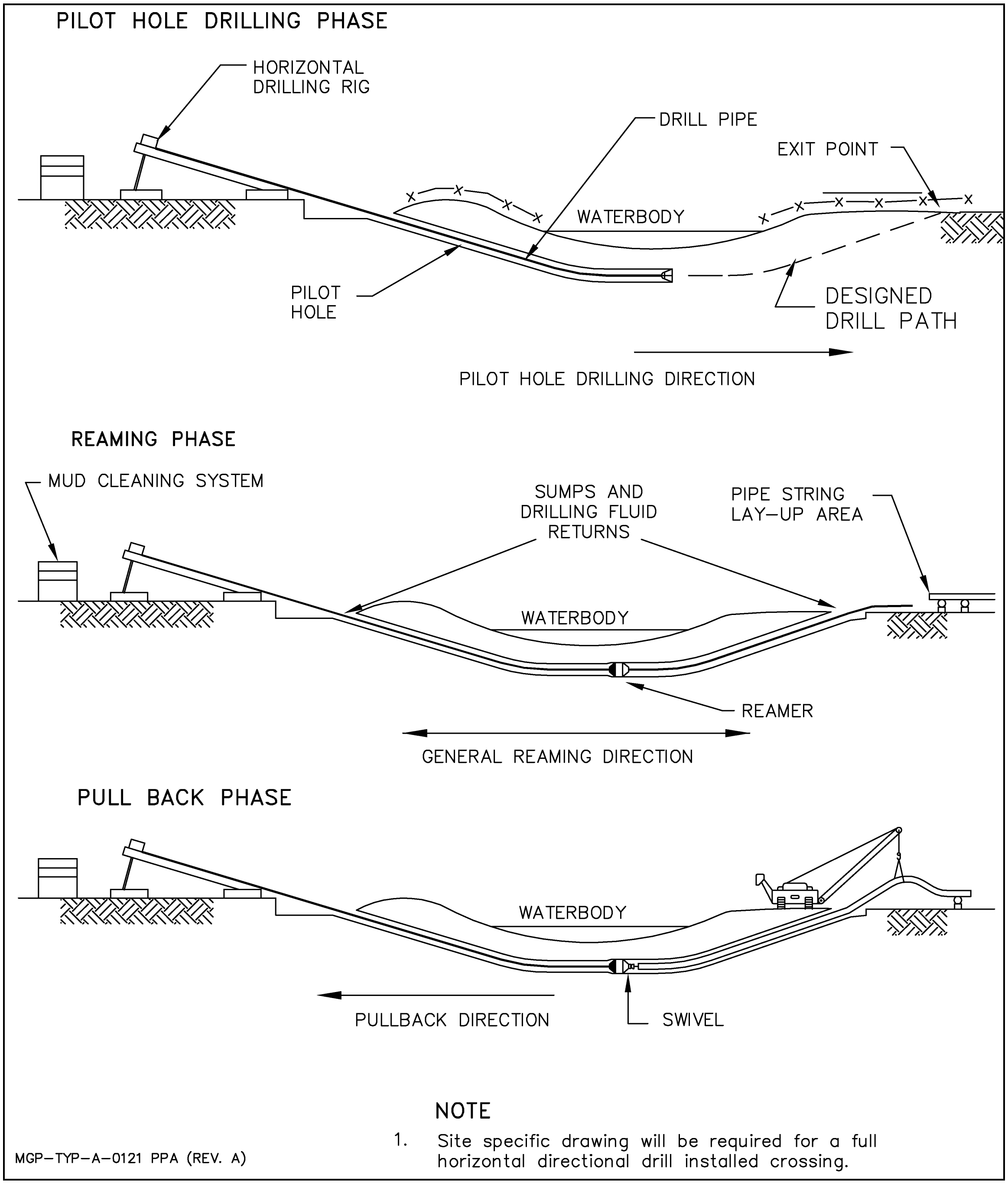

Figure 3-43: Schematic of a Typical Horizontal Directional Drill

Weighting at Watercourse Crossings

Pipe sections installed using conventional open cut techniques in open water conditions might be weighted with concrete-coated pipe or bolt-on concrete weights to provide negative buoyancy (see Figure 3-44).

Dry or fully frozen crossings with sufficient mineral soil cover might not require weighting. Insulation might be applied to the pipeline at the crossings to reduce potential frost bulb formation, or thaw settlement or both.

Figure 3-44: Examples of Concrete Weights to Counter Buoyancy

Signs and Markers

Pipeline markers will be installed at the banks of all non-vegetated crossings during the construction phase and for operations purposes, after construction.

ACCESS ROAD AND TRAVEL LANE CROSSINGS

Construction vehicles will use existing bridges, where feasible. In the absence of such bridges, one of six main techniques might be used to cross watercourses encountered during construction of access roads – permanent bridges, temporary bridges, culvert crossings, timber fill crossings, ice bridges or snow fill crossings. Typical drawings for each of these techniques (excepting permanent bridges) are shown in Figure 3-45 through Figure 3-49.

Permanent Bridges

Permanent bridges are often used on all-weather roads that cross flowing streams and on winter roads where the travel season needs to be extended in the fall and spring. Supports will be installed on each bank and a span will be built across them. A site-specific design will be required at each of these sites.

Temporary Bridges

Temporary structures might be used on winter roads and in conjunction with the pipeline right-of-way to cross streams with unstable beds and banks or ones that are too deep, too wide, or too fast flowing for other crossing methods. Common structures include flat bed rail car frames or longer Bailey bridges.

Timber mat supports are sometimes built at each end before the temporary bridges are installed. Ramps will be built from snow, ice or granular material. Curbs might be required to prevent mud or debris from entering the watercourse.

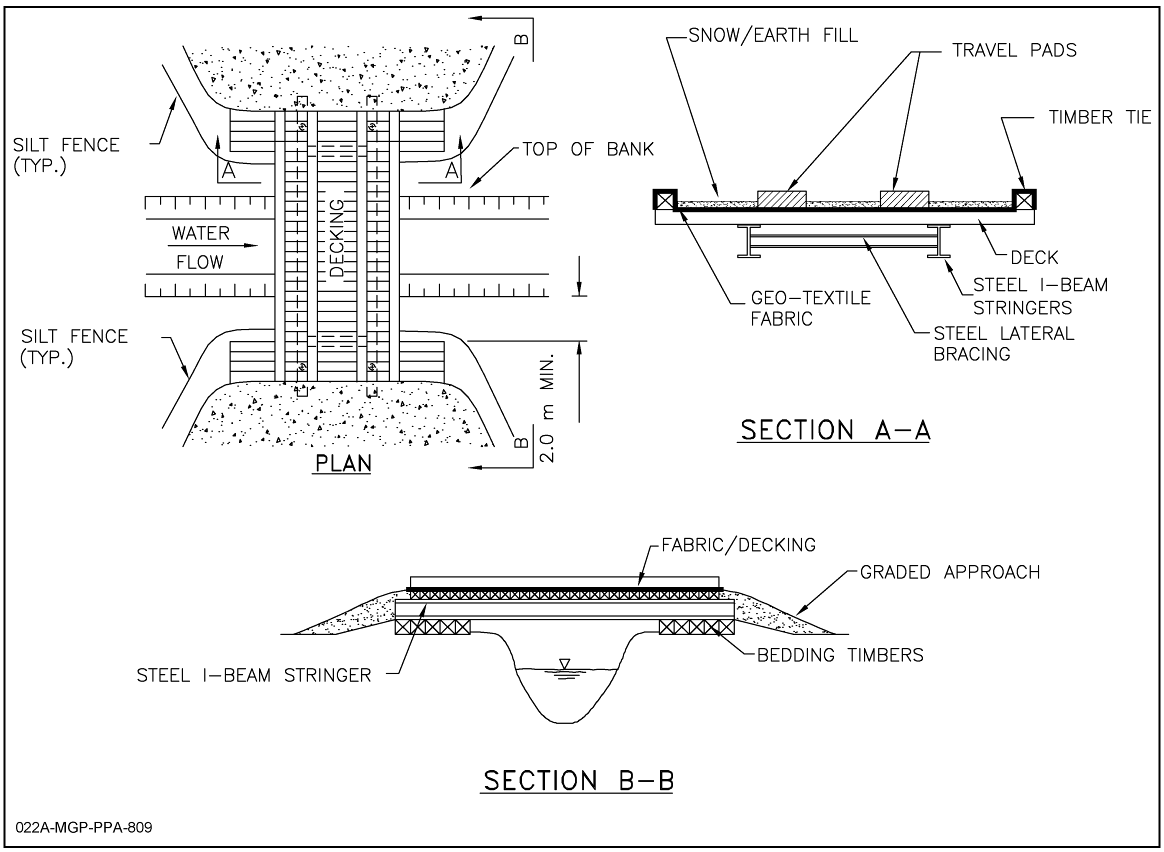

Figure 3-45: Typical Temporary Bridge Structure

Culvert Crossings

Culverts might be used where sediment control and continuous passage of fish is required. Culverts are often used in all-weather roads. The culverts will be put into place, the ends are sandbagged and ramps will be installed, covered with clean granular fill, and compacted for traffic. The outlet sides might be rip-rapped for erosion control. If used for winter construction only, the culverts and ramps will be removed before spring breakup.

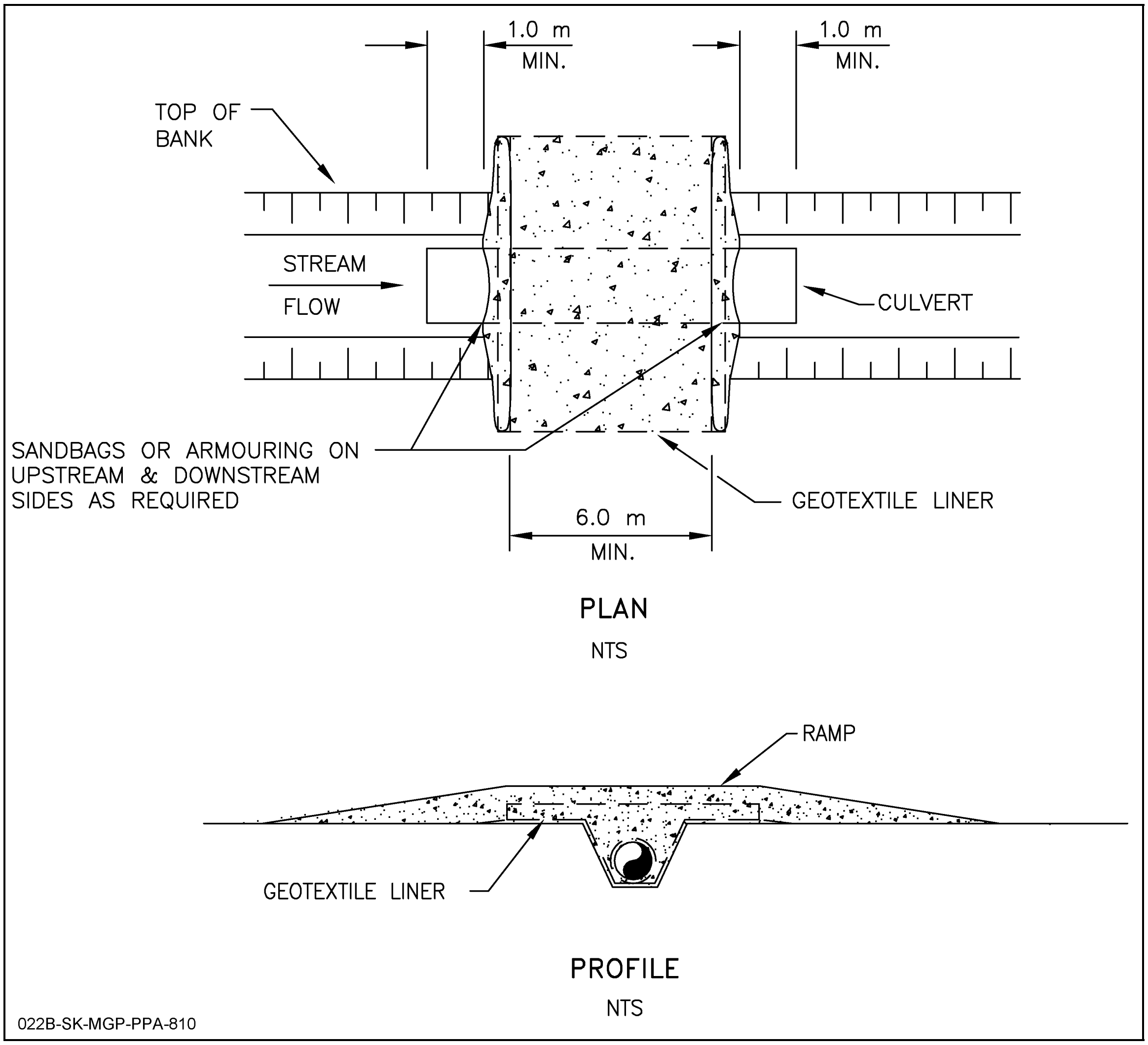

Figure 3-46: Typical Culvert Crossing

Timber Fill Crossings

Timber fill crossings might be used to cross shallow streams with intermittent flow, gently sloping banks, and no fish passage concerns. They might also be warranted in seasons or areas with low snow, where there might not be enough material for a snow or ice fill crossing. Timber mats or timber logs cabled together are used as a base, which is covered with compacted snow to bring the crossing up to grade. Timber and debris will be removed before spring breakup.

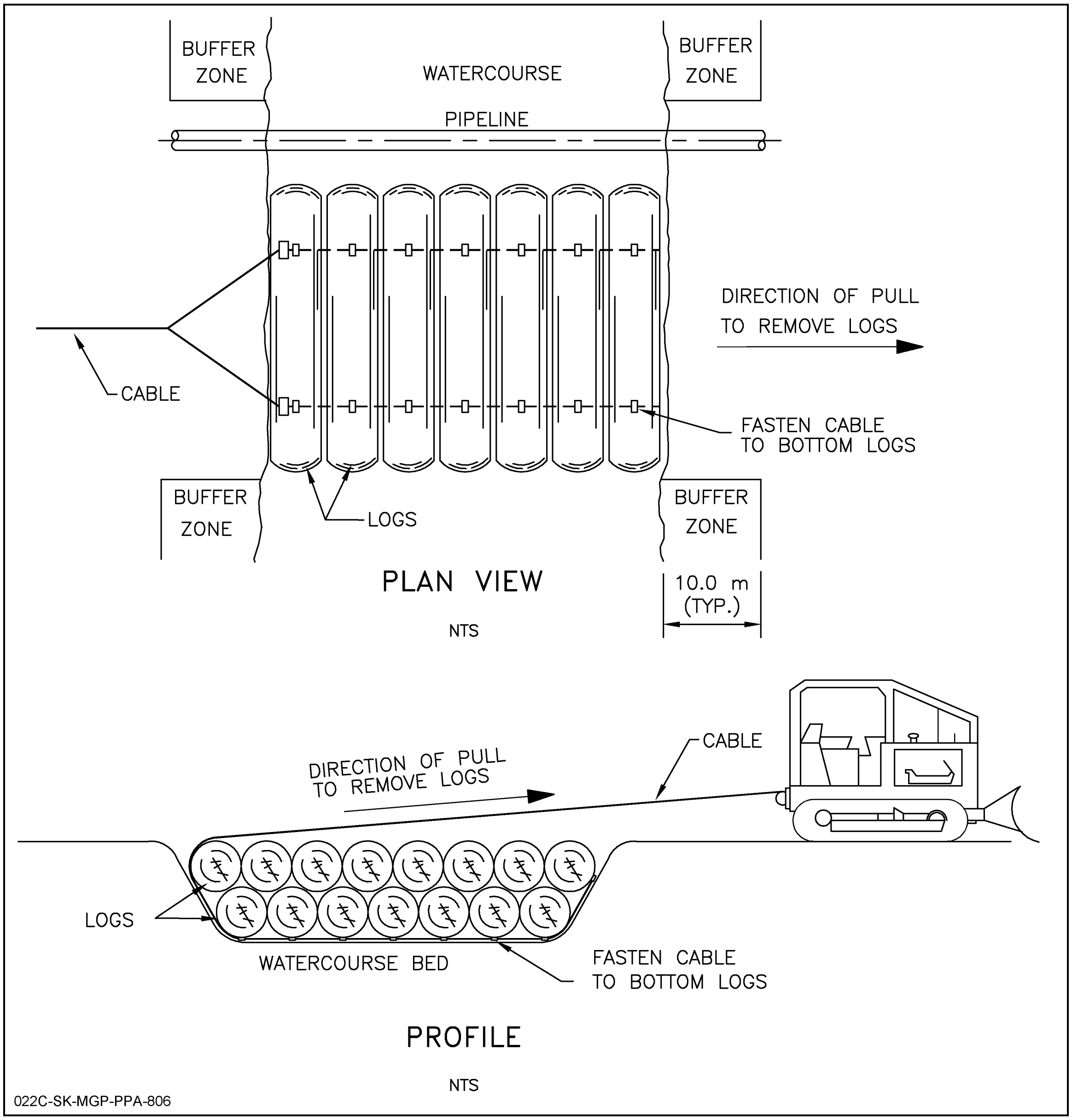

Figure 3-47: Typical Timber Fill Crossing

Ice Bridge Crossings

Ice bridges might be used where there is ample supply of water and the crossing location has gently sloping banks. Once a safe ice thickness at the crossing is reached, snow cats will be used to push snow berms onto each side of the crossing. The travel surface will be flooded in repeated lifts, between the snow berms, to increase the load bearing capacity. Regular maintenance will be required and the bridges will be notched before spring breakup, thereby ensuring free flowing melt water.

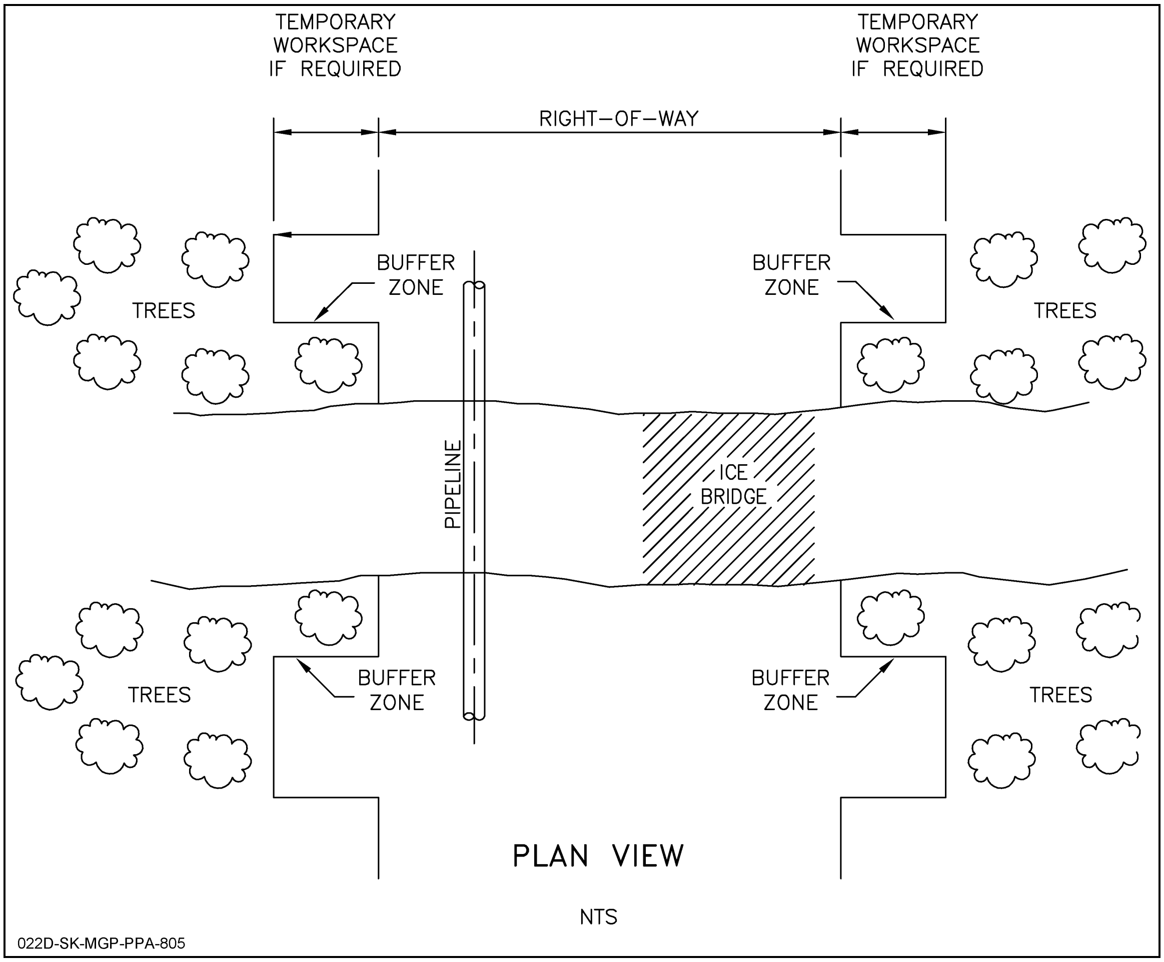

Figure 3-48: Typical Ice Bridge Crossing

Snow Fill Crossings

Snow fill crossings might be used where there is intermittent or no winter flow, the crossing has gently sloping banks, there is ample snow supply, and an ice bridge or temporary bridge structure is not warranted. Snow will be collected from nearby areas or made artificially by snowmaking systems. The travel surface will be built up with repeated lifts of compacted snow and water. As with ice bridges, snow fill crossings will be notched before spring breakup.

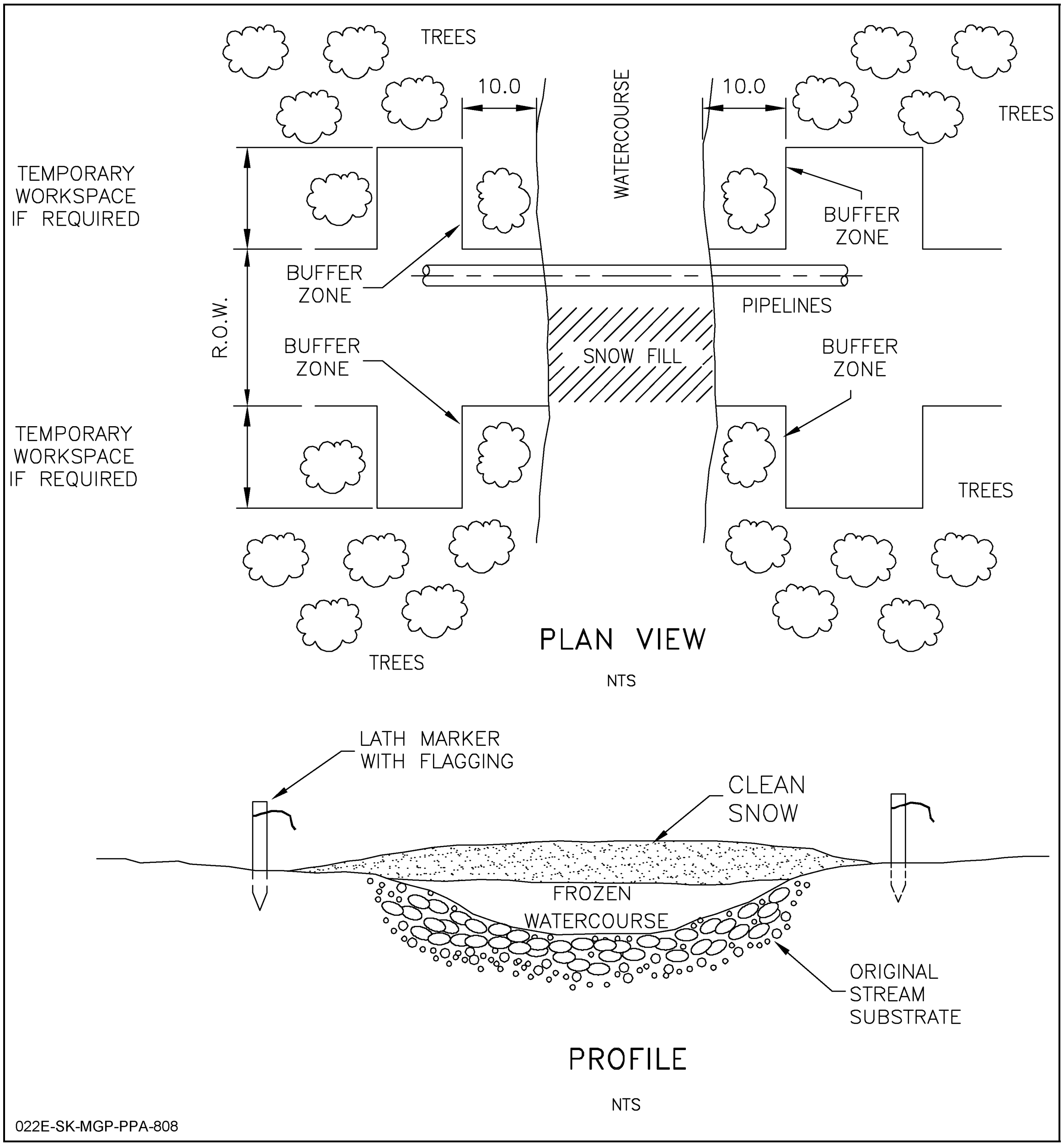

Figure 3-49: Typical Snow Fill Crossing

HIGHWAY, ROAD AND PIPELINE CROSSINGS

The minimum cover at road crossings will comply with the requirements of the jurisdiction responsible for the road. Six pipeline and 29 road crossings, requiring an estimated 10.4 ha of temporary workspace, will be required in the SSA.

Crossings will generally be installed using an open cut method. However, if the road has a high usage rate, or if required by the responsible jurisdiction, the road crossing will be bored, if the soil conditions are suitable for this method.

All existing pipelines will be positively located before the pipeline is installed. A 0.3 m minimum vertical separation distance will be maintained from other pipelines crossed. Test leads will be attached to each pipeline to enable potential cathodic protection interference to be identified and resolved.

The potential for frost heave or thaw settlement will be investigated during detailed engineering. If it is a potential concern for a road, highway or pipeline crossing, mitigative measures will be used, such as constructing the pipeline with a deeper burial depth, using imported fill, insulating around the pipeline, placing insulation in the pipeline trench, or a combination of these methods.

Typical crossings are shown in Figure 3-50 and Figure 3-51.

Figure 3.50 has been moved to reduce file size. To view it, click on the link to the figure in the web page List of Figures for this document.

Figure 3.51 has been moved to reduce file size. To view it, click on the link to the figure in the web page List of Figures for this document.

SUMMARY OF PROJECT EFFECTS AND MITIGATION

An overview of the potential effects of the proposed development activities on the biophysical and human environmental settings in the SSA, along with a brief description of the primary strategies for mitigating those effects, is contained in this subject. Detailed descriptions of potential effects and primary mitigation strategies are provided in Section 8. Site-specific environmental protection plans (EPPs) will be developed. The framework is described in Section 11.

The potential biophysical effects of the proposed pipelines and components have been assessed within a 1 km wide corridor generally centred along the proposed pipeline route.

In addition, environmental studies have been conducted outside the pipeline corridor where needed to include infrastructure sites required for construction, such as barge landings, borrow sites, camps, access roads and water sources. The study results have been used to identify the potential environmental effects of the development activities in this application.

Biophysical Effects

Typical project activities could result in a number of potential effects on the biophysical environment in the SSA, depending on the type of activity, location, climate and the timing of construction. Typical effects from construction, before mitigation, include but are not limited to:

- increased gaseous emission
- changes in ground and slope stability, drainage patterns and water and wind erosion
- alteration of uncommon landforms
- soil loss and changes in soil quality, drainage, and physical and chemical characteristics
- removal, burial, mechanical damage or alteration of vegetation
- removal, burial, mechanical damage or alteration of heritage sites
- localized direct and indirect effects on wildlife habitat, localized disruptions to wildlife movement and limited wildlife mortality

- localized alteration to fish and fish habitat
- changes in water and sediment quality
- increased intermittent and continuous noise levels

Primary Biophysical Mitigation

Examples of typical measures that might be used to reduce the effects of development activities include but are not limited to:

- employment of local environmental and wildlife monitors
- constructing primarily in the winter and other periods that avoid sensitive wildlife and fish timing windows
- reducing the footprint of disturbance
- reducing grading and levelling to that required for a safe and efficient working surface
- implementing appropriate drainage, sediment, erosion and slope stability controls
- enforcing traffic and access controls
- avoiding environmentally sensitive areas where practical
- protecting heritage resources
- applying best site management practices for dust suppression
- considering efficiency in equipment selection
- applying best management practices to reduce fuel use
- maintaining equipment exhaust systems

EFFECTS ON THE HUMAN ENVIRONMENT

An overview of the potential effects of the proposed development activities on the human environment in the SSA, including effects on the people and the economy of the region, on traditional culture, on non-traditional land and resource use, on protected areas and on heritage resources is contained in this topic.

Effects

The focus has been on identifying the potential effects of development sites and activities that are closest to the communities, or that could affect resources and activities with high local values, or that might be important to the functioning of the community. Examples of the latter include roads, airports and barge landings.

Economic effects were determined from simulations using employment and expenditure estimates. The simulations (of direct, indirect and induced economic effects) were done using the Statistics Canada's inter-regional input-output model. However, because this model only produces results at a territorial or provincial level, effects in the Northwest Territories were allocated to the SSA and the other regions.

Summary of Effects on the People and Economy of the SSA

The proposed development activities are expected to have a long term, positive influence on the people and economies in the communities and in the SSA as a whole. Among other things, this influence will be reflected in increased employment, income and business opportunities, capacity development, and the potential for new infrastructure. The influences are assessed and explained at a regional level. General trends are applicable to all SSA communities, and where appropriate, community specific effects are described.

In the shorter term, however, spending decisions by some individuals will affect the quality of life of these income earners, their families and their communities. These decisions will also increase the demands on resources and facilities that deliver social, health and protection services to the communities. Inflationary pressures, including on housing, might also occur in the early phases of the project.

Both facilitating and inhibiting influences on traditional harvesting might result from the development. Time spent on harvesting activities might be reduced for some workers and families. However, the wages from project employment might also be used to acquire new and better equipment for more efficient and productive harvesting. Project-related employment might also add to a slow, ongoing decline in Aboriginal language use and culture preservation within the SSA.

During construction, the potential project effects on the people and economy of the SSA include:

- capital expenditures and project-related procurement estimated at over $61 million

- some expanded business and labour force capacity and opportunities

- increased labour force participation rates, to 71.7% from 62.6%
- decreased unemployment rates, to 9.9% from 21.4%
- population increases, mostly in Norman Wells, estimated at about 100 people in the peak activity year of 2007. However, the effects on the local populations in Fort Good Hope should be moderate. Effects on populations in other SSA communities will likely be low in magnitude.
- temporary creation of up to 190 project-related positions filled by SSA residents
- generation of about $41 million in labour income, including $27 million in direct project related income
- increased levels of alcohol abuse and related violence and illness, family relationship stress, contagious diseases and STIs

During the operations phase, potential project effects on the people and economy of the SSA include:

- a part of $140 million in average annual operations expenditures in the NWT will be spent in the SSA
- some expanded business and labour force capacity and opportunities
- an average of 38 positions filled by SSA residents, generating about $3 million a year in labour income

Norman Wells, an SSA regional centre, is expected to experience most of the procurement, employment and labour income effects from activities in the SSA because of its size, location and function as a regional transportation and administrative centre. However, as only 10% of the operations and maintenance jobs created during operations will relate to the activities of the Norman Wells operations centre, only a minor population increase is expected in Norman Wells.

Primary Human Environmental Mitigation

In recognition of the potential for adverse effects, mitigation strategies have been developed that might be implemented by the project in conjunction with the GNWT, communities, local authorities, service providers, and other third parties. Given the range and magnitude of potential effects, a co-coordinated and collaborative response from the project and these other parties is necessary.

Examples of primary mitigation strategies include:

- developing a procurement plan to build business capacity in the SSA and manage project-related procurement and expenditures
- giving preference to qualified, competitive businesses for the provision of certain good and services
- working with the GNWT, educational institutions, and Aboriginal associations and communities to address education and training needs to optimize project-related employment for NWT residents
- developing a database of potential workers to match skill sets and identify training needs
- implementing hiring policies that provide preference for direct project hiring in the North
- initiating money management programs and enabling workers to assign part of their wages to savings accounts to encourage positive lifestyle choices
- enforcing policies for alcohol and drug-free workplaces and camps
- implementing measures to help sustain community health
- providing Aboriginal workers with flexible work schedules to accommodate traditional harvesting and other Aboriginal cultural, family and community needs, where practical
- supporting community-based traditional lifestyle initiatives that promote traditional harvesting and positive relationships with communities
- negotiating harvester compensation agreements with the hunters' and trappers' committees or other relevant authorities
- providing cultural awareness training to all workers on the project to promote appreciation and respect for Aboriginal people and their culture
- supporting cultural activities and events that are consistent with the project principles and practices
- periodically providing country foods in the construction camps
- providing construction camps with Aboriginal language reading material, and Aboriginal language radio and television broadcasts, tapes and CDs, where available