Kiggavik Project

Final Environmental Impact Statement

Tier 3 Technical Appendix 5O: Conceptual Erosion and Sediment Control Plan

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	First Issue with Draft Environmental Impact Statement
02	September 2014	Issued for Final Environmental Impact Statement

A management plan is a living document which is continually reviewed and revised throughout the life of the Project to ensure it meets health, safety, and environmental performance standards. This process of adaptive management and continual improvement (Tier 2, Volume 2, Section 17) is consistent with the Inuit Qaujimajatuqangit (IQ) principles of Qanuqtuurunnarniq *being resourceful and flexible to solve problems* and Pilimmaksarniq *maintaining and improving skills through experience and practice.*

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1 Introduction

The value of the aquatic environment and importance of protection the aquatic environment was noted during AREVA's community engagement events and Inuit Qaujimajatuqangit interviews (EN-WC KIA Apr 2007[1], EN-KIV OH Oct 2009[2], IQ-RB01 2009[3], EN-RI COC Mar 2013[4]). Sediment and erosion control measures are important mitigation measures which limit changes to the aquatic environment from activities in and around water. The objective of this Conceptual Erosion and Sediment Control Plan (the Plan) is to minimize the amount of erosion that occurs and to limit the transport of sediment into the receiving environment using best management practices, thereby maintaining compliance with federal and territorial legislation, regulations and guidelines. The plan covers a wide range of site construction, operation, and decommissioning activities that were identified as requiring erosion and sediment controls on land, and within streams and water bodies.

The Plan will be reviewed and revised prior to the construction phase and updated as required throughout operations and decommissioning. A management plan is a living document which is continually reviewed and revised throughout the life of the Project to ensure it meets health, safety, and environmental performance standards. This process of adaptive management and continual improvement (Tier 2, Volume 2, Section 17) demonstrates the Inuit Qaujimajatuqangit (IQ) principles of Pilimmaksarniq *maintaining and improving skills through experience and practice* and Qanuqtuurunnarniq *being resourceful and flexible to solve problems* (Nunavut 2008).

Best Management Practice (BMP) is a term used to describe widely acceptable practices that can be implemented to prevent or minimize an environmental effect during construction activities. BMPs are solutions determined to be an effective and practicable means of protecting water quality and promoting soil conservation. The BMPs detailed in this Plan form the basis for planning and implementing erosion and sediment controls (ESC) for the development of the Kiggavik Project. Further details regarding site specific BMP's to be used will be developed during the detailed design stage of the Project**.**

[1] EN-WC KIA Apr 2007: *there are a lot of rivers in that area. Will contaminants flow in the rivers or lakes?*

[2] EN-KIV OH Oct 2009: *What about water pollution?*

[3] IQ-RB01 2009: *People drink water and get ice from the rivers. Many people won't drink tap water.*

[4] EN-RI COC Mar 2013: *Will there be affects on water?*

Protecting and managing water and sediment is important in minimizing environmental effects, including sensitive receptors such as vegetation, wildlife, fish, fish habitat, and aquatic ecosystems. The proposed ESC and monitoring plan associated with each Project activity meets several objectives (COE, 2005):

- Limit soil exposure;
- Minimize unnecessary stripping and grading;
- Immediately stabilize exposed soils;
- Protect waterways and stabilize drainage pathways;
- Protect steep slopes and cuts;
- Install perimeter controls;
- Employ advanced sediment settling controls; and
- Monitor water quality and quantity.

The plan has been developed based on BMPs defined in the *National Guide to Erosion and Sediment Control on Roadway Projects* (Transportation Association of Canada, 2005),t the Measures to Avoid Causing Harm to Fish and Fish Habitat (Fisheries and Oceans Canada [DFO] 2013a), and Adaptive Management Monitoring and Mitigation Strategies. The conceptual plan associated with each set of Project activities has been designed to effectively and efficiently meet the legislative requirements and guidelines under the following acts:

- *Fisheries Act*
- *Navigable Waters Protection Act*
- *Migratory Birds Convention Act*
- *Environmental Protection Act*
- *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (*WAPPRIITA*)*
- *Species at Risk Act*
- *Nunavut Wildlife Act*

The Plan provides generalized practices that may be considered during the detailed ESC design that will be completed prior to construction commencing. The detailed ESC design will be completed using site specific data that describes the physical and biological environment of the affected area. This information will identify any environmentally sensitive receptors (e.g. fish, plants, etc.) and consider local morpholology, hydrology, and geology. A detailed ESC plan will include components covering surface water management, erosion control, and sediment management, using many of the BMPs presented in this conceptual ESC plan. The detailed ESC plan will describe a schedule coordinated with the construction sequence, and contain information covering monitoring, maintenance and re-design planning, contingency planning, and shut-down planning. If necessary, the detailed ESC plan will be reviewed by regulatory bodies.

1.1 Best Management Practices

The 2005 Transportation Association of Canada (TAC) describes thirty BMPs that can be applied under varying circumstances to minimize erosion and manage sediment and water during construction activities. Effective application of these BMPs can prevent and control potential effects of sediment and erosion on water and soil quality. Not all BMP's are suitable for remote tundra conditions, but the most practicable will be selected from among these for the ESC plan at individual sites.

A BMP can be a physical structure such as runoff diversion or silt fence used to control erosion. A BMP can also be part of the process used to plan, conduct, and close-out the construction activity. Examples include identifying Valued Environmental Components (VECs) such as sensitive vegetation, waterbodies,or habitat to effectively plan for their protection during the construction activity.

These BMPs are summarized in Table 1 and a selection of applicable BMPs are included in Attachment A.

Table 1 Transportation Association of Canada Best Management Practices

BMP	Name	Description	Erosion Control	Sediment Control
BMP1	Topsoiling	The covering of exposed mineral soils with soils of high organic content to minimize raindrop erosion potential	X	
BMP2	Seeding	The planting or placing seed into soils of cut slope or fill embankment slopes after a layer of organic topsoil is spread over the slope	X	
BMP3	Mulching	Application of organic material or other normally biodegradable substances as a protection layer to the soil surface	X	
BMP4	Hydroseeding-Hydromulching	The spraying-on of a slurry to a slope or channel surface to provide a layer of seed and growth bedding medium	X	
BMP5	Sodding	Use of grass sod to cover and stabilize disturbed areas of bare soil	X	X
BMP6	Planting Trees and Shrubs	The planting of live indigenous plant stakes or placing layers of live brush	X	
BMP7	Riparian Zone Preservation	Protection of existing plants and trees adjacent to all natural water bodies (riparian zones) adjacent to construction areas	X	X
BMP8	Riprap Armouring	Large, loosely placed cobbles or boulders placed along channel banks or slopes to protect underlying soil from erosion due to flowing water	X	
BMP9	Gabions	Consist of rock placed inside wire baskets to protect steep or erodible slopes from sheet flow erosion	X	
BMP10	Aggregate Cover	Crushed stone or gravel layer/blanket placed directly on erodible slopes susceptible to surface water erosion and groundwater seepage piping erosion	X	
BMP11	Stabilized Worksite Entrance	Comprised of a gravel pad located at site access points (entrances) that are used to reduce the amount of sediment carried off construction sites by vehicles	X	
BMP12	Rolled Erosion control Products (RECP)	Biodegradable or synthetic soil coverings used for temporary or permanent protection of disturbed soils at slopes and channels	X	
BMP13	Cellular Confinement System	3-dimensional, plastic matting with open cells filled with topsoil or aggregate	X	
BMP14	Chemical Stabilization	Chemical substances that are sprayed onto disturbed soils to effect a change of soil properties, generally by aggregating finer soil particles	X	
BMP15	Slope Texturing/Grading	Texturing of slopes, either by roughening the surface, tracking the surface, or installing grooves or serrations	X	
BMP16	Slope Drains	Heavy duty, flexible pipe that carries water from top to bottom of fill or cut slope to prevent concentrated water flowing downslope and eroding face of slope	X	
BMP17	Groundwater Control	Drains that intercept and collect subsurface flow and divert it from slope, thus lowering the groundwater table to minimize piping erosion, reduce seepage flow on slopes and increase slope stability	X	
BMP18	Synthetic Permeable Barrier	Double panel, low profile, uni-body porous synthetic barriers used to dissipate flow energy and reduce velocity	X	X
BMP19	Fibre Rolls and Wattles	Bundles of natural fibre or fascines staked into the soil along slope contours	X	X
BMP20	Check Dam	Small dam constructed across a drainage channel	X	X
BMP21	Diversion Ditch	Channels or swales commonly located along the crest of cuts slopes to intercept and convey runoff away from bare soil slopes and to minimize erosion of slopes from sheet flow	X	
BMP22	Energy Dissipator	Hard armour (rip rap, gravel, sand bags, concrete) used to minimize scour at flow impact locations	X	
BMP23	Silt Fence	Permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff		X
BMP24	Brush or Rock Berm	Temporary barriers of brush and/or rock wrapped in geotextile and secured in place to intercept sediment laden stormwater runoff from disturbed areas, retain sediment, and release water as sheet flow	X	
BMP25	Drain Inlet Sediment Barrier	An sediment barrier (silt fence, aggregate filled sand bags, gravel barriers, or gravel filter or concrete blocks) around the inlet entrance to a drain/pipe		X
BMP26	Continuous Berm	A sand or gravel filled geotextile used to divert flow or form ponds.		X

Table 1 Transportation Association of Canada Best Management Practices

BMP	Name	Description	Erosion Control	Sediment Control
BMP27	Earth Dyke Barrier	Barrier constructed of compacted soil to intercept and divert flow of runoff water away from sensitive areas or water bodies.		X
BMP28	Sediment Traps and Basins	Low height dam enclosure for impoundment of sediment laden storm water, sedimentation and release of treated runoff		X
BMP29	Storm Sewer Protection	Temporary modifications to storm sewer barrels to minimize that amount of sediment transported downstream through the storm sewer system		X
BMP30	Pumped Silt Control System	Sediment is extracted by pumping sediment laden runoff into a bag manufactured from a permeable geotextile. Water will filter through while sediment is retained within the filter bag.		X

1.2 DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat

Fisheries and Oceans Canada (DFO) provides advice intended for use during projects that may cause serious harm to fish. Serious harm refers to the *death of fish, or any other permanent alteration to, or destruction of, fish habitat* (DFO 2013b). Serious harm may include impediments to fish passage, killing fish by means other than fishing, changing water flow in a watercourse, or other works, undertakings or activities that may impact fish habitat. The Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a) should be followed for reviews and authorizations; the advice statements provided therein are categorized according the to the following:

- Project Planning;
- Erosion and Sediment Control;
- Shoreline Re-vegetation and Stabilization;
- Fish Protection; and
- Operation of Machinery.

Advice statements associated with Timing (i.e., exclusion periods for in-water works), Site Selection and Contaminant and Spill Management are addressed collectively under the heading of Project Planning (DFO 2013a).

1.3 Adaptive Management through Monitoring and Mitigation Activities

Erosion, water quality, water quantity, total suspended solids (TSS) monitoring, and fish salvage activities will be incorporated into construction, operation, and decommissioning phases associated with Project activities. While the frequency and specific methods will be adjusted according to the objectives and specific environmental concerns of each activity, the following describes the general approach for each activity:

- Erosion: visual inspections will be completed to identify areas susceptible to erosion, or areas in which erosion may be occurring. Results from these surveys can be used to plan maintenance or further sediment or water control activities.
- Water quality: water quality samples will be collected from required water bodies and analyses will include physical parameters (e.g., pH, temperature, dissolved oxygen, and specific conductivity).
- Water quantity: water quantity will be measured through water levels (e.g. staff gauge readings, rod and level measurements, and/or level logger data) and discharge measurements.
- Turbidity: turbidity will be measured using a turbidity meter and these data will be correlated with lab tested total suspended solids (TSS). Turbidity/TSS measurements higher than acceptable levels will result in cessation of in-water construction until ways to

complete the project with reduced levels of disturbance can be developed. See Attachment B for a discussion on acceptable levels of turbidity/TSS during the monitoring program.

- Fish Salvage: fish salvage programs will be completed once construction areas have been contained within turbidity curtains. Salvaged fish will be released outside the contained area prior to construction commencing.
- Fish Passage: Fish passage studies will be completed by visual inspections and observations, velocity measurements, and if necessary, the use of fyke nets during the spring spawning period.

2 Project Activities

For the purpose of this Plan, Project activities identified as requiring ESC and/or monitoring during construction, operations and decommissioning phases have been classified into nine groups. The mitigation measures and monitoring activities provided in this document provide a conceptual basis; some combination of BMPs identified for each activity group will be used. Many activities specified in Table 2 will involve multiple occurrences (e.g., the installation of culverts in fish bearing streams) and each will require site-specific considerations and adaptive management.

Table 2 Project Activities and Erosion and Sediment Control and Monitoring Plan Summary

Activities	Transportation Association of Canada BMPs	DFO Measures to Avoid Causing Serious Harm	Monitoring Activities
Clear span bridges	BMP1/BMP2/BMP6 BMP8/BMP10 BMP11 BMP23 BMP15 BMP18	Timing Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Operation of Machinery	Turbidity Water Quality Erosion
Fish-bearing Culverts	BMP1/BMP2/BMP6 BMP7 BMP8/BMP10 BMP11 BMP15 BMP23	Timing Site Selection Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Fish Protection Operation of Machinery	Turbidity Water Quality Fish salvage (if necessary) Fish Passage Erosion
Non-fish bearing Culverts	BMP1/BMP2/BMP6 BMP7 BMP8/BMP10 BMP11 BMP15 BMP18 BMP23		Turbidity Erosion
Coarse Rock Fills	BMP8/BMP10		Water quantity
Ice Bridges Snow Fills	BMP23	Site Selection Erosion and Sediment Control	
Ferry Landings Baker Lake docking facility	BMP1/BMP2/BMP6 BMP7 BMP8/BMP10 BMP11 BMP15 BMP18 BMP23	Timing Site Selection Contaminant and Spill Management Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Fish Protection Operation of Machinery	Turbidity Water Quality Fish salvage, if necessary Erosion
General site clearing Stream Diversion Channels Pointer Lake Airstrip	BMP1/BMP2/BMP6 BMP8/BMP10 BMP11 BMP15 BMP18 BMP23 BMP20/BMP21/BMP24 BMP26/BMP27	Timing Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Fish Protection Operation of Machinery	Turbidity Erosion Water Quantity Water Quality

Table 2 Project Activities and Erosion and Sediment Control and Monitoring Plan Summary

Activities	Transportation Association of Canada BMPs	DFO Measures to Avoid Causing Serious Harm	Monitoring Activities
Intake & Discharge Structures Water Withdrawal & Discharge	BMP1/BMP2/BMP6 BMP7 BMP11 BMP15 BMP18 BMP23	Timing Site Selection Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Fish Protection Operation of Machinery	Turbidity Water Quality Fish salvage Erosion
Andrew Lake Pit Andrew Lake Berm	BMP1/BMP2/BMP6 BMP8/BMP10 BMP11 BMP15 BMP23 BMP26/BMP28	Timing Contaminant and Spill Management Erosion and Sediment Control Shoreline Re-vegetation and Stabilization Fish Protection Operation of Machinery	Turbidity Water Quantity Water Quality Fish salvage Erosion

2.1 Clear Span Bridge

Clear span bridges will be designed and installed at crossings at a number of large and/or sensitive stream crossings along roads associated with the Project. The construction of these bridges will follow the appropriate timing window identified in DFO's Measure to Avoid Causing Serious Harm to Fish and Fish Habitat (DFO 2013a) and will not take place during relevant fish spawning periods, if any in-water work is required. Additional Measures to Avoid Causing Harm from DFO will be implemented, as needed (Table 2). A number of BMPs will be applied, including stabilizing the worksite entrance (BMP11) which will retain sediment on the site and will allow vehicles to wash off if necessary. Upland slopes will be textured/graded (BMP 15) and/or flattened as necessary to reduce erosion potential of disturbed areas; if additional sediment control is still necessary, a silt fence barrier (BMP 23) or synthetic permeable barrier (BMP18) will be used to prevent sediment from entering the stream. After completion, disturbed areas near the water will be covered in riprap/riverstone armouring (BMP8) or aggregate cover (BMP10), as described in the detailed design, and areas will be reclaimed by topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). If vegetation is used to reduce erosion and sediment transport, suitable indigenous plant species will be identified.

If any in-water work is necessary, a turbidity curtain may be used to contain sediment and turbidity in the stream will be monitored. If turbidity exceeds acceptable levels, then work will stop inside the curtain until appropriate corrections can be made (Attachment B). Turbidity curtains are geotextile barriers mounted on posts driven into the bed or suspended from ropes supported by flows and anchored. Turbidity curtains contain suspended sediment in slow flowing rivers, lakes or wetlands. Similar practices will be followed for the maintenance and decommissioning of clear span bridges, including DFO's Measure to Avoid Causing Harm advice statements. During operations, regular inspections will be completed to monitor potential erosion around the crossing and associated disturbed areas.

2.2 Fish Bearing Culverts

Fish bearing culverts will be designed and installed to minimize erosion and control sediment. The installation of these culverts will comply with DFO's timing windows, and will not take place during relevant fish spawning periods, as in-water work will be required. A temporary stream diversion or cofferdam may be necessary to permit work "in the dry". Various types of cofferdams can be used including large tubular vinyl bladders that are filled with water and drained and removed once construction is complete. Two preferred cofferdam options have been considered during the installation of fish bearing culverts. The first is a water filled PVC fabric tube called WaterBloc which is an engineered product designed for use as a cofferdam. WaterBloc are made in Saskatoon and come in a range of diameters and 15 m sections that can overlap to form a continuous cofferdam. WaterBloc are puncture resistant and conform to the channel bottom when filled. For smaller deep sections, large sand or earth-filled tote bags may be used. These totes can be placed in the deep

channel section and can be used in combination with WaterBloc tubes. The tote bags are approximately 1 m x 1 m x 1 m and can hold up to 1000 kg of material. The bags come with straps and could be placed in the channel from shore with an excavator bucket and lifted out once work is complete. Small sandbags can also be used to stop small leaks that occur in the cofferdam and a geotextile fabric may be placed beneath the WaterBloc and Tote bags to proved protection against punctures and reduce the likelihood of leaks.

While the cofferdam is in place, water will be pumped around the worksite and released downstream onto a small rock pad which will serve as an energy dissipater. This will allow flow to continue downstream while the culvert is being installed. This will help mitigate flow- and passage-related effects to fish and achieve compliance with the DFO Fish Protection Advice (DFO 2013a). Following culvert installation, a number of BMP's will be used to reduce erosion from disturbed areas including stabilizing the worksite entrance (BMP11) which will retain sediment on the site and will allow vehicles to wash off if necessary. Upland slopes will be textured/graded (BMP 15) and/or flattened as necessary to reduce erosion potential of disturbed areas; if additional sediment control is still necessary, a silt fence barrier (BMP23) or synthetic permeable barrier (BM20) will be placed on slopes (ditches) to prevent sediment from entering the stream. After completion, disturbed areas near the water will be covered in riprap/riverstone armouring (BMP8) or aggregate cover (BMP10), as described in the detailed design, and areas will be reclaimed by topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). While in-water work will be minimized, if these activities mobilize notable sediment, a turbidity curtain will be installed to contain sediment, fish will be salvaged within the confined areas, and turbidity in the stream will be monitored. If turbidity exceeds acceptable levels, then work will stop of work inside the curtain until appropriate corrections can be made (Attachment B).

During operation of the culvert, monitoring will occur to confirm fish passage and verify that ESC measures are functioning as intended.

2.3 Non-fish Bearing Culverts

Non-fish bearing culverts will be designed and installed to minimize erosion and control sediment. The installation and ESC measures are similar those for culverts installed on fish bearing streams. The culverts will be installed following a number of BMPs, including stabilizing the worksite entrance (BMP11) which will retain sediment on the site and will allow vehicles to wash off if necessary. Upland slopes will be textured/graded (BMP 15) and/or flattened as necessary to reduce erosion potential of disturbed areas; if additional sediment control is still necessary, a silt fence barrier (BMP23) or synthetic permeable barrier (BMP18) will be placed on slopes or in ditches draining to the stream to prevent sediment from entering the stream from these sources. After completion, disturbed areas near the water will be covered in riprap/riverstone armouring (BMP8) or aggregate cover (BMP10), as described in the detailed design, and areas will be reclaimed by topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). While in-water work will be

minimized, if these activities mobilize notable sediment, a turbidity curtain will be installed to contain sediment, and turbidity in the stream will be monitored. If turbidity exceeds acceptable levels, then work will stop of work inside the curtain until appropriate corrections can be made (Attachment B).

If the stream is flowing during the time of construction, a temporary stream diversion or cofferdam may be necessary to permit work “in the dry”. Various types of cofferdams can be used including water filled PVC fabric tube or large sand or earth-filled tote bags, as presented for fish-bearing culvers. While the cofferdam is in place, water will be pumped around the worksite and released downstream onto a small rock pad which will serve as an energy dissipater. This will allow flow to continue downstream while the culvert is being installed.

During operation of the culvert, monitoring will occur to confirm that ESC measures are functioning as intended.

2.4 Coarse Rock Fills

In some cases local runoff does not form a channel but rather involves areas where runoff tends to concentrate for a short period during snowmelt. At these locations, Coarse Rock Fills along proposed road crossings will be constructed to minimize the introduction of fine sediment in the watercourse. A stabilized worksite entrance will reduce fine sediment introduced from machinery, and riprap/riverstone armoring (BMP8) or aggregate covers (BMP10) will be used as necessary. During operations, these crossings will be monitored so that maintenance activities can be tailored to reduce any potential erosion and maintain water passage.

2.5 Ice Bridges and Snow Fills

Ice bridges and snow fill along the proposed winter road will be constructed and maintained so that gravel, rock, or woody material will not be used and water flow will be maintained to preserve existing fish habitat. If logs are used to stabilize the crossing approach they will be removed before or immediately after the spring freshet.

2.6 Ferry Landings and Baker Lake Docking Facility

The Thelon River ferry landings and Baker Lake docking facility will be designed and installed following a number of relevant BMPs. The installation of these facilities will comply with DFO’s Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a), and will not take place during relevant fish spawning periods, as in-water work will be required. The construction will involve a stabilized worksite entrance (BMP11) which will retain sediment on the site and will allow vehicles to wash off as necessary. Upland slopes will be textured/graded (BMP 15) and/or flattened as necessary to reduce erosion potential of disturbed areas. If additional sediment control is necessary,

a silt fence barrier (BMP23) or synthetic permeable barrier (BMP18) will be placed on slopes or in ditches to limit sediment from entering the water body. For in-water work at the Baker Lake docking facility, a turbidity curtain will be used to contain suspended sediments if practicable, considering the potential for high winds and waves. If a turbidity barrier is employed fish will be salvaged within the containment area, and turbidity will be monitored inside and outside the turbidity curtain. If turbidity exceeds acceptable levels, then work will stop of work inside the curtain until appropriate corrections can be made (Attachment B). At the ferry landing it may be necessary to construct landing ramps that extend a short distance into the channel. Turbidity curtains may be used to isolate the work area from the river, depending on the extent of work required and the velocity of river flows in the work area.

After completion, disturbed areas near the water will be covered in riprap/riverstone armouring (BMP7) or aggregate cover (BMP10), as described in the detailed design, and areas will be reclaimed topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). Similar practices will be followed for the maintenance and decommissioning of the landings and docking facilities. During operations, regular inspections will be completed to monitor potential erosion around the facilities and associated disturbed areas.

2.7 General Site Clearing, Stream Diversion Channels, and Pointer Lake Airstrip

General site clearing and the construction of diversion channels will follow a number of BMPs to limit erosion and sediment transport and manage water. Work near fish bearing waters will comply with DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a), and will not take place during relevant fish spawning periods. For work around water bodies, a stabilized worksite entrance (BMP11) will be used, as necessary, which will retain sediment on the site and will allow vehicles to wash off if necessary. Upland slopes will be textured/graded (BMP 15) and/or flattened as necessary to reduce erosion potential of disturbed areas; if additional sediment control is still necessary, silt fence barriers (BMP23) or synthetic permeable barriers (BMP18) will be used on slopes to prevent sediment from entering nearby water bodies. After completion, areas particularly prone to erosion will be covered in riprap/riverstone armouring (BMP8) or aggregate cover (BMP10), as described in the detailed design, and other areas will be reclaimed by topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). Barriers (BMP18), berms (BMP24/BMP26), dykes (BMP27), diversion ditches (BMP21) and check dams (BMP 20) have been designed (DEIS, Tier 3, Volume 2, Appendix 2E *Water Diversion and Collection Design*) to divert runoff from the site, manage site runoff, and limit erosion and sediment transport. In constructed channels, a riprap armouring (BMP8) overlying a geotextile liner will be designed to resist maximum flow velocities and protected erodible underlying material. Energy dissipaters may be used to reduce velocities and dissipate energy of concentrated flows such as at a pipe outlet or terminal end of a diversion channel. Erosion on site will be closely monitored during construction, operations, and decommissioning, particularly regarding the performance of the berms, diversion ditches, check

dams, and armoring. Water quality and quantity will also be monitored on site and in the downstream receiving environments.

2.8 Intake and Discharge Structures

The construction, operation and decommissioning of the water intake and discharge structures in Siamese Lake, Judge Sissons Lake, and Mushroom Lake will aim to minimize erosion and disturbed area. The installation of water intake and effluent discharge structures will comply with DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a), and will not take place during relevant fish spawning periods, as in-water work will be required. Efforts will be made to preserve natural riparian zone (BMP7) while working around shorelines and erosion from slopes will be controlled by using synthetic permeable barriers (BMP18) in areas of concentrated flow or silt fence barriers (BMP23) across and along the toe of slopes where required. After work is complete, slopes will be further reclaimed by slope texturing/grading (BMP15), slope flattening, topsoiling (BMP1), seeding (BMP2), and/or planting of indigenous shrubs (BMP6). Work in the water will follow DFO's advice statements regarding Timing, Site Selection, Erosion and Sediment Control, Shoreline Re-vegetation and Stabilization, and Fish Protection, as required and applicable. Turbidity curtains will be used to contain sediment produced by construction. Turbidity outside the curtain will be monitored and if turbidity exceeds acceptable levels, then work will stop of work inside the curtain until appropriate corrections can be made (Attachment B). Fish will be salvaged within the contained area prior to work commencing, and turbidity will be monitored while curtains are installed. Energy dissipaters will be used at intake and discharge locations to prevent disturbing lake sediments.

At this time, detailed design for the diffusers has not been undertaken and conceptual designs may be altered during the detailed design stage. Currently, both the Kiggavik mine site and Sissons mine site diffusers will release into Judge Sissons Lake at separate locations as shown in Figure 1. A single or multi port diffuser may be installed; depending on the results of further assessment during detailed design. The conceptual design is based on a minimum water depth (below low water) at the Kiggavik mine site diffuser of 6 to 7 m to provide a dilution factor of 5. The diffuser location from the Sissons mine site would terminate in slightly shallower water (5+ m).

The general details of each of the diffusers (including the estimated footprint on the lake bed) are summarized in Table 3. The pipeline from the shore to the diffuser will be buried at the shoreline to a minimum depth of 2.5 m below low water to minimize the effects of ice. This will be accomplished through excavation of the shoreline or mounding with suitably sized rock (or a combination of the two) to protect the pipeline. The remainder of the pipeline will be weighted with concrete weights (see typical photo in Figure 2) and lie on the lake bed.

560000 565000 570000 575000

7135000 7130000 7125000 7120000 7115000

N

EAST BASIN

Discharge Point

Kiggavik Site Diffuser

NORTHWEST BASIN

Discharge Point

Sissons Site Diffuser

SOUTHWEST BASIN

Statistics at Time of Survey	
Surface Area	95,500,000 sq. m.
Volume	440,000,000 cu.m.
Mean Depth	4.6 m

0 250 500 1000 1500 2000
Meters

Projection: NAD 1983 UTM Zone 14N
Creator: TAH
Date: 17/12/12 Scale: 1:60,000
File:
Data Sources: *BEAK 1990, AREVA 2006*

FIGURE 1
DIFFUSER LOCATIONS
JUDGE SISSONS LAKE

KIGGAVIK PROJECT - EIS

Golder Associates

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3XS

Table 3 Diffuser details

Diffuser Discharge Rate (m^3/day)	Minimum Water Depth (m)	Estimated Underwater Pipeline Length (m)	Estimated Footprint (m^2)
Kiggavik - 3000	7	500	1500
Sissons - 1700	5+	700	1400

Detailed fish habitat assessments were completed in 2013 to document fish habitat at the conceptual sites of the two proposed diffuser locations in Judge Sissons Lake. The objective was to select potential diffuser locations that avoid, and do not impact, critical fish habitats.

Figure 2 Typical Installation of Anchor Blocks on Pipeline

Installation: The diffuser will be installed by floating the weighted pipeline and anchors out onto the lake and then slowly filling the pipeline with water to sink it in a controlled manner onto the lakebed. The only area that may experience some disturbance of sediments would be at the shoreline where excavation may be required to bury the pipeline to protect it from ice action. Excavation at the shoreline will need to be monitored for potential generation of suspended sediment and appropriate mitigation employed (i.e., use of silt curtains, slower work production, etc.) to meet appropriate environmental regulations.

Maintenance and Operations: The diffuser port has been designed to be 1 m above the lake bed to minimize entrainment of lake bed sediments. Maintenance may include clearing any debris or growth

from the diffuser ports and ensuring proper protection of the pipeline at the shoreline by repairing any damage to the riprap protection.

Decommissioning: Full removal of the diffuser is anticipated at decommissioning of the project. This will be accomplished through removal of any protective fill at the shoreline and then filling the pipeline with air to float the line and pull it back onto the shore. The only area that may experience some disturbance of sediments would be at the shoreline where excavation may be required to remove the pipeline. Excavation at the shoreline will need to be monitored for potential generation of suspended sediment and appropriate mitigation employed (i.e. use of silt curtains, slower work production, etc.) to meet appropriate environmental regulations.

2.9 Andrew Lake Pit and Berm

The Andrew Lake Pit and associated berm will be constructed according to DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a). Following these advice statements will preserve spring spawning and rearing habitats, and will also limit construction to after the spring freshet when water levels have dropped. The construction will begin with the development of berms (Earth Dykes), barriers (BMP23), diversion ditches (BMP28) and check dams (BMP 26) to limit flow into the Andrew Lake Pit area (FEIS, Tier 3, Volume 2, Appendix 2F, Design of Andrew Lake Dewatering Structure). The Andrew Lake Berm (BMP26) will be built in an area isolated from the remainder of Andrew Lake with a turbidity curtain, which is expected to be effective given the very shallow (< 1 m) depths in the lake. Once the dyke is completed fish salvaging and dewatering of the contained area can proceed.

Throughout construction, water quality (including turbidity) and quantity will be monitored in Andrew Lake and downstream to confirm that effective erosion control measures are in place. Any disturbed areas along the shoreline, slopes, and berm crest will be stabilized by topsoiling (BMP1), seeding (BMP2), planting of indigenous shrubs (BMP6), riprap armouring (BMP8) and/or aggregate cover (BMP10) sized to resist wave action. Silt fence barriers (BMP23) will be used to control sediment while shoreline stabilization is in progress. While construction techniques from the Meadow Bank Project have been considered, Andrew Lake is relatively shallow <1m, and should not impose the additional constraints of the deeper and larger lake at Meadowbank. Throughout the operation and decommissioning of the Andrew Lake Pit and berm, water quality, water quantity, and erosion will be closely monitored near the site and downstream.

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Attachment A BMPs

Topsoiling

Erosion Control:
Exposed Surface Protection – Vegetated

BMP1

Description and Purpose

- The covering of exposed mineral soils with soils of high organic content to minimize raindrop erosion potential
- Provides a medium for vegetation to grow

Applications

- Permanent measure
- May be used to provide a bedding medium for seed germination and a cover to exposed soil that is not suitable to promote vegetation growth
- May be used on slopes with a maximum gradient of 2H:1V
- Normally topsoil is placed prior to seeding, mulching, hydroseeding-hydromulching, seeding and installing rolled erosion control products (RECP), or planting of trees/shrubs

Advantages

- Placing topsoil provides enriched organic medium for vegetation root structure to grow
- Topsoil organic content provides nutrients to promote plant growth
- Absorbs raindrop energy to reduce erosion

Limitations

- Not appropriate for slopes steeper than 2H:1V
- Dry topsoil may be removed by blowing wind
- Topsoil may not be readily available in some areas

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Prepare ground surface to final grade by removing large rocks or other deleterious materials
- Apply topsoil with dozer or light track equipment to design thickness
- Track walk upslope or downslope (do not overcompact topsoil by heavy equipment; only track walk one pass) to provide a contour of roughness of topsoil to further minimize erosion

Topsoiling

Erosion Control:
Exposed Surface Protection – Vegetated

BMP1

Construction Considerations

- Topsoil should be free of weeds which may inhibit re-vegetation of desirable plants
- Subgrade should be roughened by track walking up/down the slope prior to topsoiling to promote adhering of topsoil to subgrade (surface roughening of subgrade is especially required if topsoiling is not scheduled immediately after completion of the grade)
- Topsoil should be moistened regularly during periods of hot dry weather to minimize wind erosion
- Hydroseeding-hydromulching topsoil will minimize wind erosion of topsoil
- All available topsoil stripped for construction should be stockpiled and reused
- Seeding should follow as soon as possible after the topsoil has been placed, to reduce the possibility of it being eroded away by water or wind

Inspection and Maintenance

- Inspect topsoiled areas at least once per month after initial application or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rilling should be regraded and re-topsoiled immediately

Similar Measures

- Hydroseeding-hydromulching
- Mulching
- Rolled erosion control products (RECP)

Seeding

Erosion Control:
Exposed Surface Protection – Vegetated

BMP2

Description and Purpose

- The planting or placing seed into soils of cut slope or fill embankment slopes after a layer of organic topsoil is spread over the slope
- Provides erosion protection through development of a shallow root structure from seed germination and plant growth

Applications

- Permanent or temporary measure
- Temporary seeding with rapidly growing plants may be applied to stockpile or excavation areas which will be exposed for more than 30 days
- Permanent seeding may be applied to exposed bare soil areas which have been graded to final contours
- Permanent seeding may be applied to landscape corridors, slopes and channels by broadcasting, furrowing or spraying on with mulch tackifier
- Provides habitat for wildlife after vegetation establishment
- Can be enhanced with a protective layer of mulches or rolled erosion control products (RECP) to improve growth environment

Advantages

- Enhances terrestrial and aquatic habitat with vegetation growth re-establishment
- Aesthetically pleasing with vegetation cover
- Grows stronger with time as root structure develops
- Generates vegetation to enhance infiltration of runoff and evapotranspiration
- Seeding with a mixture of grasses and herbaceous legumes in disturbed areas is an inexpensive method of stabilizing soil, particularly if the area is flat or gently sloping
- Cost of seeding disturbed areas is relatively low and its effectiveness on a long-term basis is relatively high

Limitations

- Grasses may require regular maintenance (mowing) along ditches
- Uncut dry grass may present a fire hazard and site distance obstruction adverse to highway safety
- Seeding of steep slopes may be difficult without using measures such as RECP's or hydroseeding-hydromulching methods
- Seasonal windows on planting (early spring or fall) may not coincide favourably with construction schedule
- Areas that have been covered with seeded topsoil are susceptible to erosion until vegetation is established if RECP are not used.

  - Use of topsoil and mulch can reduce rain drop erosion potential during germination and until vegetation is established
  - Additional erosion control measures, such as RECP, may be required for steep slopes and channels
- Reseeding will be required in areas of limited plant growth
- Time to establish root structure may be unacceptable for some high risk areas; sodding should be considered for these areas

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- The site to be seeded should be prepared prior to seeding
  - Surface should be graded to design grades and then topsoiled
  - Topsoil should be roughened, harrowed, or grooved
  - Seedbed should be 75 to 150 mm deep, with the top 75 mm consisting of topsoil free of large clods or stones
- Seed should be applied immediately after seedbed preparation using broadcast seed spreaders, cyclone (broadcast) spreaders, or seed drills to ensure uniformity of application
- Seedbed should be harrowed, raked, or chain-dragged to ensure proper seed-soil contact
- If soil tests indicate that fertilization is necessary, an appropriate soil amendment should be selected and applied with care; fertilizer use should be carefully controlled as this may increase nutrient loading to receiving streams if runoff is not controlled properly

Construction Considerations

- Selection of proper vegetation seed mix depends on soil conditions, climate conditions, topography, land use, and site location
  - Selected seed mixes must be appropriate for site specific conditions
  - Some jurisdictions have developed recommended seed mixes for specific regions based on historic performance results
  - Qualified agronomists or agrologists should be consulted if a suitable seed mix is not identified
- Seeding rate should be specified according to the type of grass being sown. Natural grasses and high quality tame mixes may require lower rates of application
- Fall rye or oats may be added as a companion crop to provide early growth and protection from soil erosion

- Planting of seeds by hydraulic seeding and mulching techniques should be considered for slopes steeper than 3H:1V, or where application of seed, mulch, and fertilizer in one continuous operation is desirable
- Sod may be installed for faster results, however it is very costly but essential for high risk sensitive areas
- If mulch is placed as a germination medium for seeds, the mulch layer may be further protected with a biodegradable matting to prevent mulch from being washed or blown away

Inspection and Maintenance

- Inspect seeded areas one year after initial seeding or after significant storm events to evaluate germination and seedling density results
- Freshly seeded areas should be inspected frequently to ensure growth is progressing
- Additional erosion control measures should be considered for areas damaged by runoff
- Reseedings may be required within 1 to 5 year intervals after initial seeding
- Small bare spots may need to be reseeded several times at subsequent years after initial application; larger areas may need to be completely retreated
- Cutting or mowing grasses will encourage the establishment and spread of the grass
- If a proper window for seeding is not available, then temporary seeding with fall rye or oats can take place; the area can be overseeded with a permanent mix when a proper seeding window is open

Similar Measures

- Hydraulic seeding and mulching
- Sodding

Design Considerations

- Seeding rate should be specified based on the mix and type of grasses; native seeds should be applied on a pure live seed (PLS) basis
- When using a seed drill or brillion seeder, grasses and legumes should not be planted deeper than 1 cm
- Bacterial inoculants must be used when seeding with legumes
- Seeding should occur during periods when germination can be successful and plants have sufficient time to become established before the end of the growing season
- If seeding occurs after the 50% frost probability date for the site, a dormant seeding method should be used; the seed should be applied late in the season when there is

no chance of germination, and applied with a seed drill so cold temperatures do not damage the seed

- Mulch is required when broadcast seeding or if seeding is carried out after the date specified in which fall seeding should not be carried out
- For specific needs of local growth environment, specific design and advice from local seed supplier or professional agrologist may be required
- Soil testing should be performed to determine an appropriate fertilizer, if any, and rate of application

Tree and Shrub Planting

Erosion Control:
Exposed Surface Protection – Vegetated

BMP6

Description and Purpose

- Consists of installing woody plantings (trees and shrubs) to develop a root matrix within the soil, increasing subsurface soil strength and stabilizing slopes with deeper root systems than grasses
- Reduces erosion potential of slopes and channel banks

Applications

- Permanent measure
- May be used on slopes stable enough to support vegetation; however, there is a low success rate for steep slopes and channel banks with gradients greater than 1H:1V
- May be used on slopes and channel banks with adequate sunlight, moisture, and wind protection to support vegetation
- May be used as bio-engineering stabilization of historical shallow slope instability soil movements on eroded slopes and gullies
- May be used along channels to provide higher channel roughness to reduce flow velocity

Advantages

- Promotes development of organic mat
- Dense leaves and large diameter plant stalks increase channel roughness and reduce flow velocities in channel thus decreasing erosion potential
- Traps sediment laden runoff and stabilizes soil
- Aesthetically pleasing once developed
- Grows stronger with time as root structure develops
- Usually has deeper root penetration than grass with greater depth of stabilization
- Manual planting may be attempted on steep slopes that are sensitive to machinery disturbance or represent an area of high erosion potential

Limitations

- Can be labour intensive to install
- Some level of uncertainty related to success of plant growth
- Revegetated areas are susceptible to erosion until vegetation develops; trees and shrubs should be planted in conjunction with hydroseeding and/or mulching
- Plants may be damaged by wildlife
- Potential for low success rate

Tree and Shrub Planting

Erosion Control:
Exposed Surface Protection – Vegetated

BMP6

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Live Staking
  - Used on cut or fill slopes or in ditches/channels
  - Comprised of willow or poplar stakes inserted into the ground; other indigenous plants may be acceptable
  - Individual dormant willow or poplar stakes should be cut to a minimum length of 0.5 m using pruning shears
    - Cuts should be made at a 45° angle a minimum of 5 cm below a leaf bud
    - All side shoots should be trimmed to within 5 cm of the main stem
  - Install live stakes in a 1 m by 1 m grid
  - Make a pilot hole a minimum of 0.3 m in depth to insert live stake into
    - Use iron bar, broom handle or other tool to make pilot hole
  - Insert live stake into pilot hole and lightly tamp soil around live stake
  - A minimum of two leaf buds should remain above grade
- Brush Layers
  - Used on cut or fill slopes or on channel/ditch walls susceptible to erosion
  - Comprised of layers of live branches placed on terraces on slopes
  - Excavate terraces perpendicular to direction of slope spaced approximately 1 m apart across entire width of slope to be protected
    - Slope terraces at an angle of 10° upwards from the back of the terrace towards the slope face
  - Place layers of branches on the terrace
    - Use individual dormant willow or poplar branches a minimum length of 1 m and a minimum diameter of 2.5 cm
    - Place brush layer approximately 0.075 to 0.2 m thick
    - Ensure a minimum length of 0.1 to 0.2 m of the branch is protruding from face of slope
  - Backfill and tamp soil over brush layer

Construction Considerations

- Successful installation requires the use of freshly cut branches or stakes
- Storage time of cut branches/stakes on-site prior to installation should be kept to as short a time period as possible
- Successful growth dependant on soil moisture and rainfall conditions
- Consultation with agrologist, greenhouse growers, local expertise can be beneficial in selecting and procuring appropriate species for planting

Tree and Shrub Planting

Erosion Control:
Exposed Surface Protection – Vegetated

BMP6

Inspection and Maintenance

- Inspect planted areas at least twice per year or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or erosion rilling should be replanted immediately
- Additional erosion control measures should be considered for severe rilling areas damaged by runoff
- Watering is required for first one to two months after planting

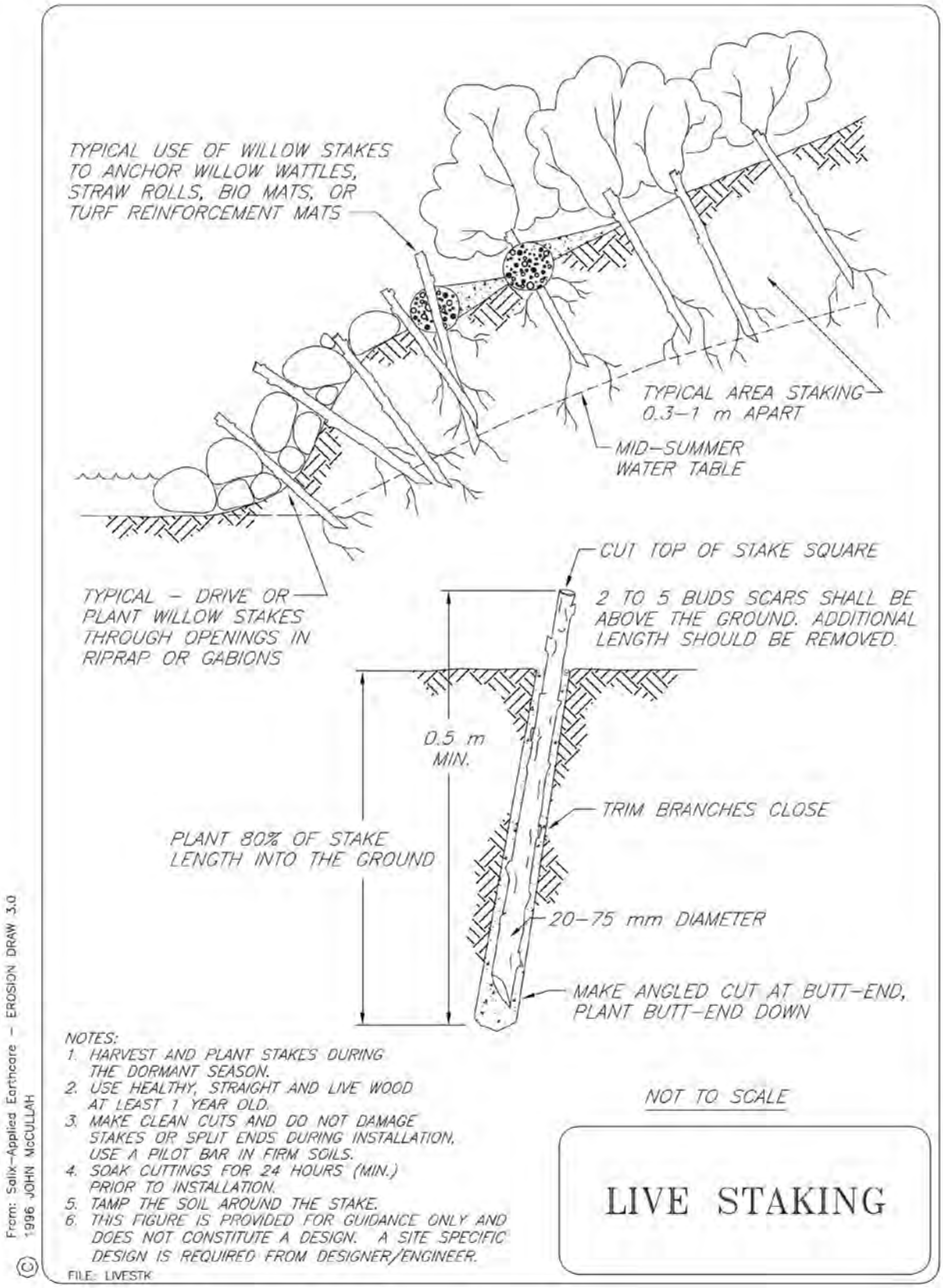
Similar Measures

- Seeding
- Mulching
- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)

Tree and Shrub Planting

Erosion Control:
Exposed Surface Protection – Vegetated

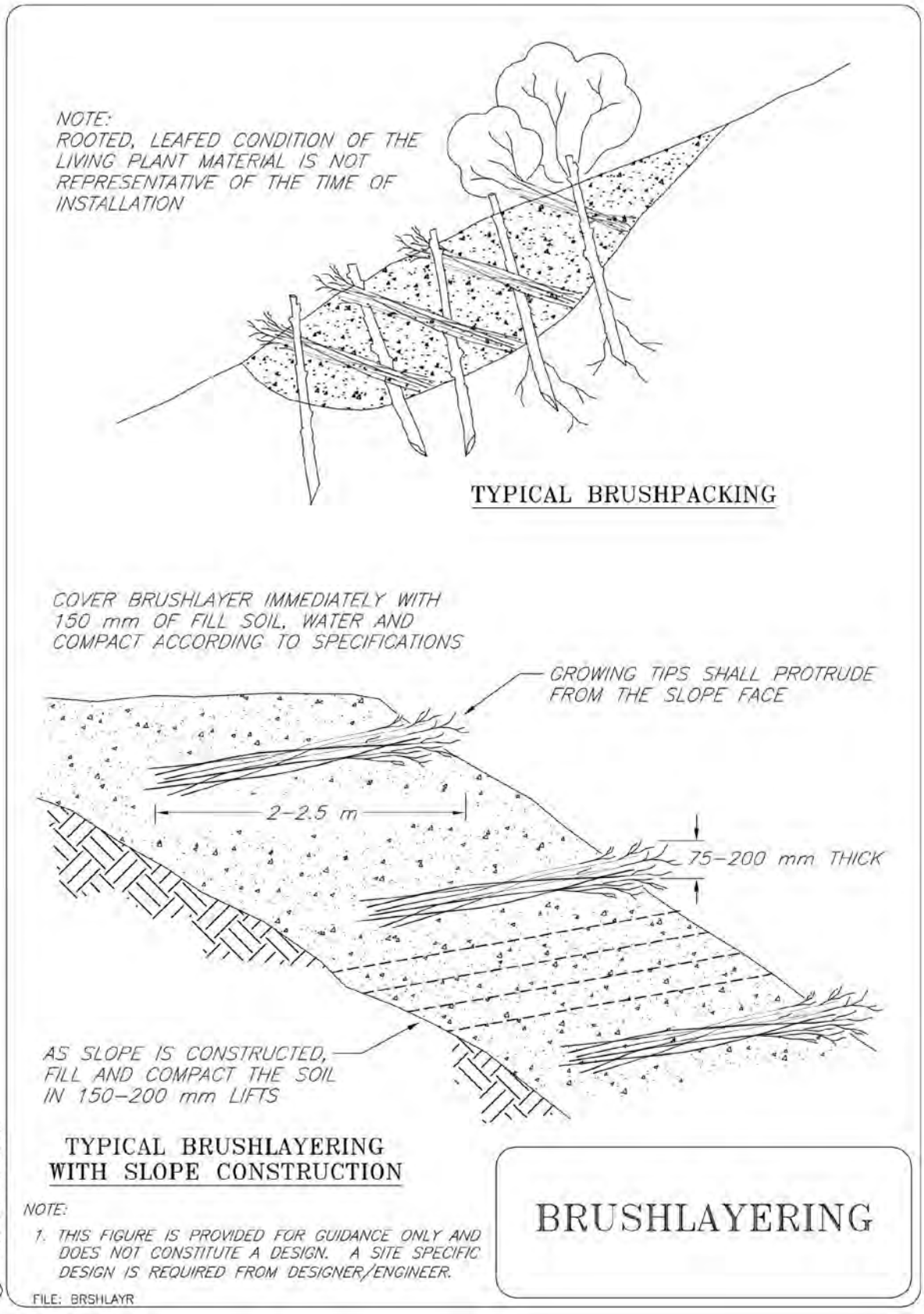
BMP6



Tree and Shrub Planting

Erosion Control:
Exposed Surface Protection – Vegetated

BMP6



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Riparian Zone Preservation

Erosion Control:
Exposed Surface Protection – Vegetated

Sediment Control:
Infiltration – Trapping

BMP7

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 erosion control buffer strip barrier to slow down flows and allow infiltration and sediment trapping to occur

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 slopes with erodible soil will be detrimental and increase long-term sedimentation yield; it is important only to strip necessary areas along the footprint of construction. Preservation of riparian zones is generally mandatory along river valley slopes and along the edges of waterbodies

Limitations

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

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- 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, as much existing vegetation as possible should be retained between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize off site sediment transport

Riparian Zone Preservation

Erosion Control:
Exposed Surface Protection – Vegetated

Sediment Control:
Infiltration – Trapping

BMP7

- Define and delineate riparian zones to be preserved in the Erosion and Sediment Control Plan prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field 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

Inspection and Maintenance

- Maintain fences protecting riparian zones from traffic

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8

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
- May be used for protection at culvert inlets and outlets
- Riprap only needs to be placed at lower portion of channel section to the anticipated flow height (mean annual peak flow) plus freeboard; other forms 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 or filter gravel 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

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- 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
- The following riprap sizes may be used as a guide to specifying gradation and mass:

		Riprap Size			
Nominal Mass **Nominal Diameter**	**Kg** **mm**	**7** **175**	**40** **300**	**200** **500**	**700** **800**
None heavier than:	kg or mm	40 300	130 450	700 800	1800 1100
No less than 20% or more than 50% heavier than:	kg or mm	10 200	70 350	300 600	1100 900
No less than 50% or more than 80% heavier than:	kg or mm	7 175	40 300	200 500	700 800
100% heavier than:	kg or mm	3 125	10 200	40 300	200 500

Percentages quoted are by mass.
Sizes quoted are equivalent spherical diameters, and are for guidance only.
Source: Alberta Transportation Bridge Specification (2001)

- Non-woven geotextile fabric underlay below riprap should meet typical specifications and physical properties as illustrated below:

Non-Woven Geotextile Filter Fabric Specifications and Physical Properties

	Riprap Nominal Diameter	
Specified Parameter	**500 mm and Smaller**	**Greater than 500 mm**
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: Alberta Transportation Bridge Specification (2001)

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8

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
- On channel banks, the riprap blanket should be keyed in to a depth equal to the anticipated scour depth; alternatively, a self-launching apron of extra rock can be provided

Inspection and Maintenance

- Little maintenance is required
- Periodic inspections to check for erosion of protected material or movement of riprap

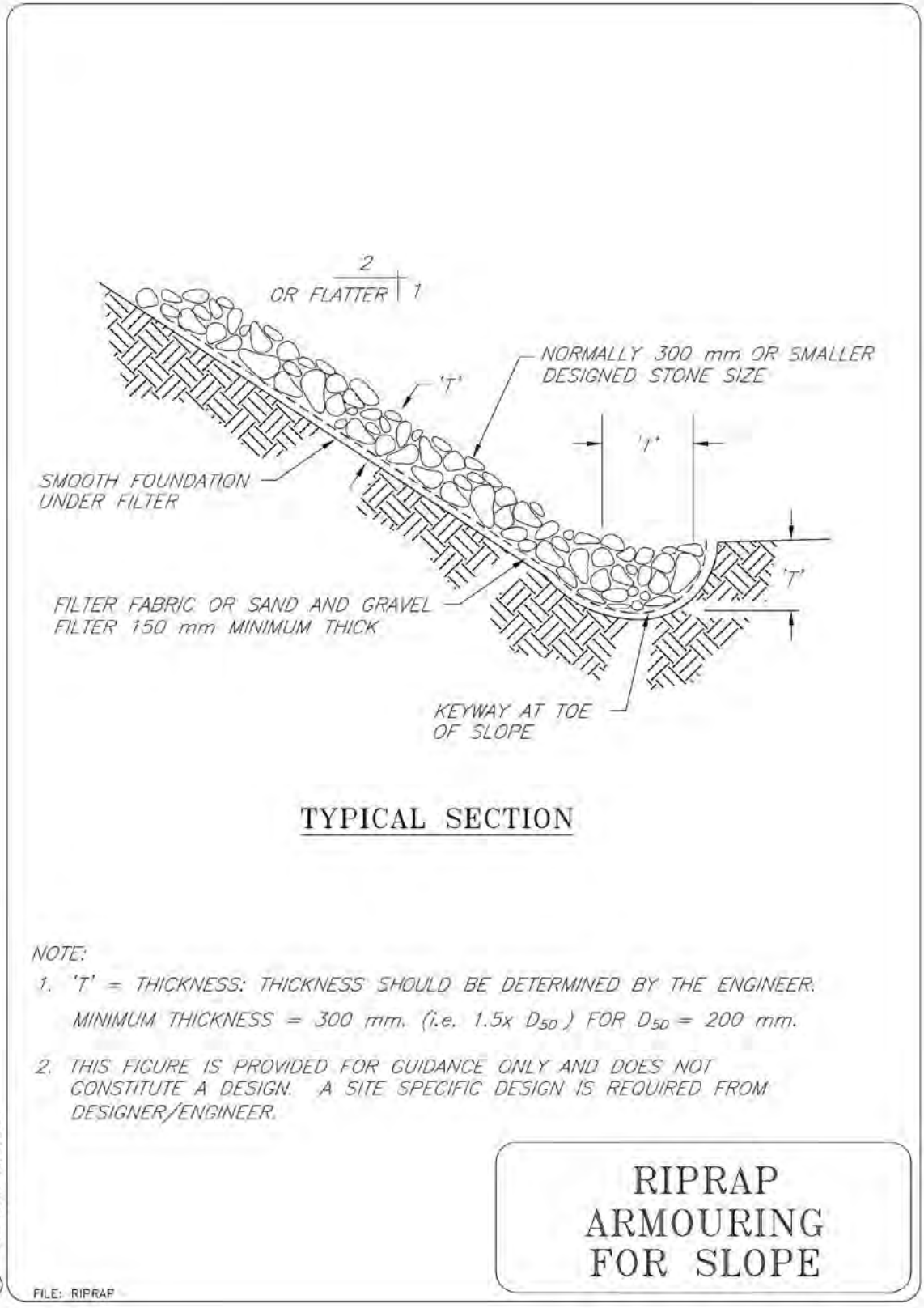
Similar Measures

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

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

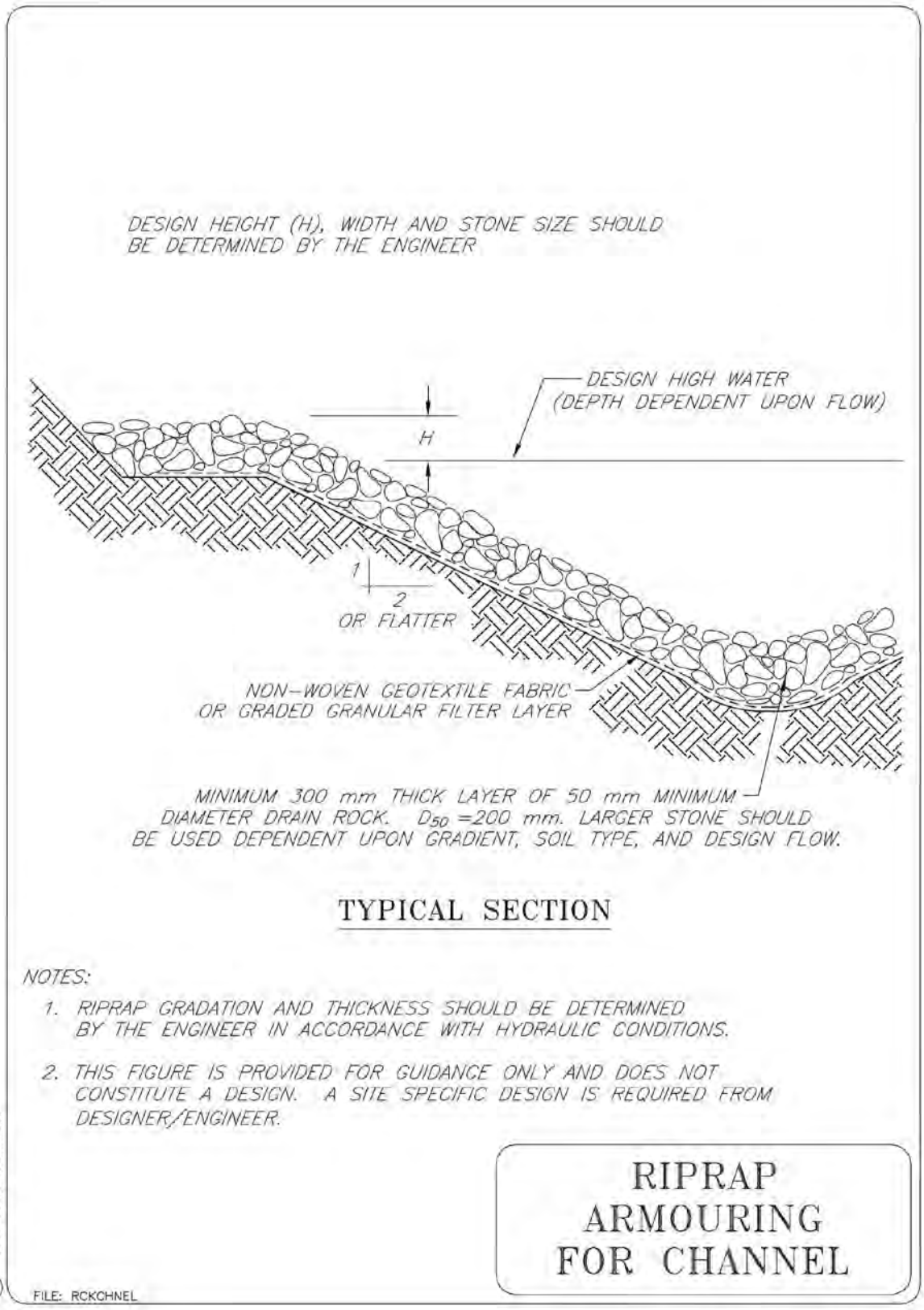
BMP8



Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8



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Aggregate Cover

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP10

Description and Purpose

- Crushed stone or gravel layer/blanket placed directly on erodible slopes susceptible to surface water erosion and groundwater seepage piping erosion
- To secure the soil, reduce erosion, and provide continuous all-weather protection
- For remediation of unstable slopes caused by piping loss of soil resulting from strong groundwater exit gradients and subsurface erosion.
- Protects against piping erosion of underlying soil as well as surface erosion from raindrop impact, and sheet flow
- Prevents transport of soil from areas subject to groundwater seepage
- Acts as a filter to minimize seepage erosion of soil from areas subject to groundwater seepage
- Provides hard armour protection for slopes

Applications

- Permanent measure
- May be used on highly erodible slopes (silt and sand) that cannot be effectively stabilized by vegetative methods
- May be used when cover must be placed immediately as a toe filter to minimize seepage erosion due to strong groundwater seepage exit on cut slopes
- For areas of high groundwater seepage gradients, must be used in conjunction with a non-woven geotextile fabric underlay
- In most situations, aggregate covers are installed in conjunction with subsurface drains

Advantages

- Easily constructed and implemented

Limitations

- Must be designed by qualified geotechnical personnel
- Requires equipment and transport of gravel to site
- May not be feasible in areas where suitable aggregate is not readily available
- Areas of high groundwater seepage may require other subsurface drainage measures

Aggregate Cover

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP10

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Place non-woven geotextile as underlay, as a general good practice to provide filtration separator with subgrade soils
- Place aggregate
- Grade aggregate blanket to design thickness

Construction Considerations

- Aggregate must be placed evenly over slope
- On slopes of highly erodible materials (silt and sand) aggregate blanket thickness should be 0.4 m minimum thickness and should be assessed by a qualified geotechnical engineer
- Generally for slope protection for subground piping erosion, the blanket can be constructed of clean pit run gravel (as specified in the following table) to 0.4 m thickness

Metric Sieve Size (□m)	Percent Passing
125,000	100
50,000	5-100
25,000	38-100
16,000	32-85
5,000	20-65
315	6-30
80	2-10

Inspection and Maintenance

- Inspect gravel blanket after significant storm events and repair any damaged or wash out sections immediately
- Sections washed out may need to be regraded prior to replacing gravel and geotextile

Similar Measures

- Subdrain systems

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP11

Description and Purpose

- Comprised of a gravel pad located at site access points (entrances) that are used to reduce the amount of sediment carried off construction sites by vehicles
- Collects sediment from vehicle washing and retains sediment on construction site
- Should include water supply to wash off excess soil from vehicles prior to exiting the construction site

Applications

- Temporary measure
- For use anywhere vehicles enter or exit a construction site

Advantages

- Retains sediment on the construction site
- Reduces deposition of sediments on public roads which may be carried by runoff into natural watercourses or drains

Limitations

- Sediment control measures should be installed to collect sediment laden runoff from gravel pad
- Installation of gravel pads may be limited by space constraints
- A supply of water is required for washing

Implementation

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Install gravel pad at planned entrances to worksite
  - Gravel pad (minimum of 15 m in length) should be of sufficient length to accommodate longest anticipated vehicle entering or exiting the site
  - Width of pad should be sufficient to accommodate the widest anticipated vehicle entering or exiting the site (minimum of 3.6 m in width)
  - Thickness of gravel pad should be a minimum of 0.30 m thick and should comprise 50 to 150 mm diameter coarse aggregate placed on top of woven geotextile filter fabric
- Water supply with pump system should be incorporated to wash vehicle undercarriages and wheels
- Install temporary sediment control measures (such as straw bale barriers or silt fences) to collect washed off sediment from gravel pad

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP11

Construction Considerations

- Should be constructed at all access points to construction sites
- If impractical to construct at all access points, limit vehicle access traffic to stabilized worksite entrances only
- Entrances located with steep grades or at curves on public roads should be avoided
- Woven geotextile filter fabric should be used as underlay below gravel pad as strength requirement
- Install an elevated ridge adjacent to roadway if gradient of the gravel pad is steeper than 2%, sloped towards the roadway

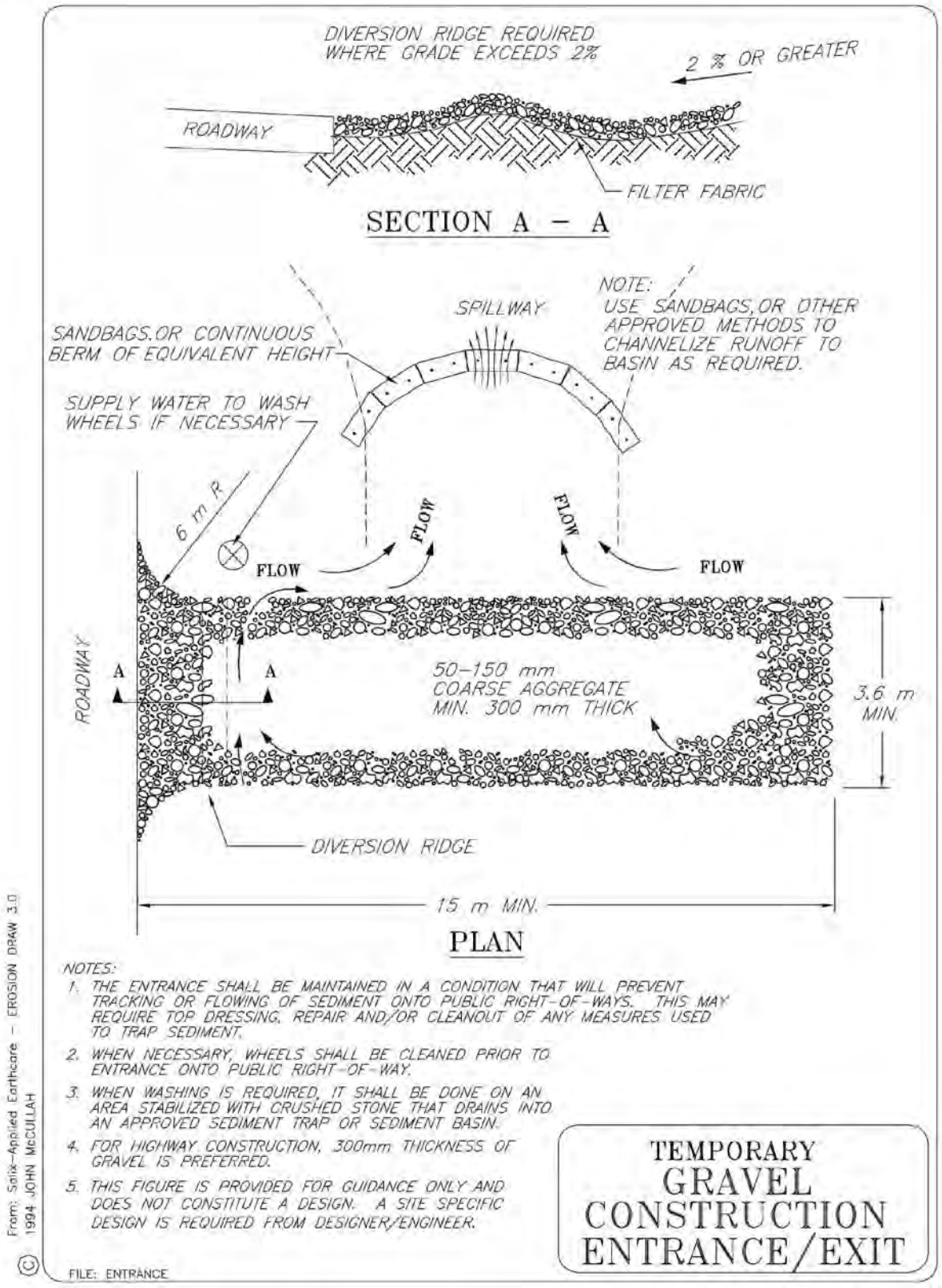
Inspection and Maintenance

- Granular material should be regraded when required
- Material may need to be added to fill large voids to maintain a minimum pad thickness of 0.30 m
- Inspect and clean out downstream sediment control measures at least once per week and after periods of significant rainfall
- Material accidentally deposited onto public roads should be cleaned as soon as possible

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP11



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Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP15

Description and Purpose

- Texturing of slopes, either by roughening the surface, tracking the surface, or installing grooves or serrations
- Texturing reduces the runoff velocity, traps sediment, and increases the infiltration of water into the soil

Applications

- Temporary or permanent measure
- May be used to roughen the exposed soils on the slope surface in the direction of water flow to minimize erosion and to entrap some sediments
- May be used on fresh cut or fill slopes (8 m length or longer practical travel reach of a dozer) with gradients of generally 3H:1V or steeper (2H:1V as general steepness limit) constructed in cohesive soils
- May be used on slope subgrade that will not be immediately topsoiled, vegetated or otherwise stabilized
- May be applied to topsoiled slope to provide track serration to further reduce erosion potential
- May be used in graded areas with smooth and hard surfaces
- Benching of slopes is discouraged for a number of reasons. Benches increase local slope gradients over those which can be achieved without benches. Ponding and discharge from benched areas can concentrate flows and result in gully erosion. If benches must be installed for equipment access, it is important that positive downslope gradients are constructed in all areas.

Advantages

- Reduces erosion potential of a slope
- Texturing will create protrusions to increase surface roughness to reduce overland flow velocities and erosion energy
- Texturing will create minor spaces to entrap a portion of the coarse sediment and reduces amount of sediment transported downslope
- Texturing of slopes will benefit development of vegetation
- Texturing of slopes aids in performance of mulches and hydroseeding
- Texturing with track-walking up/downstream may effect a 10% reduction of sediment yield compared with untracked slope

Limitations

- Surface roughening and tracking may increase grading costs
- Surface roughening and tracking may cause sloughing in certain soil types (i.e. sandy silt) and seepage areas; geotechnical advice is recommended

Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP15

- Texturing provides limited erosion and sediment control and should be used as a temporary measure prior to topsoiling
- Texturing should be used in conjunction with other erosion and sediment control measures (i.e. offtake ditches) to limit the downslope sheet flow

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Surface Roughening
  - Leave soil in rough grade condition, do not smooth grade soil
  - Large lumps of soil will aid in decreasing runoff velocities, trap sediment, and increase infiltration of water
- Surface Tracking
  - Using tracked construction equipment to move up and down the slope, leaving depressions perpendicular to the slope direction; limit passes to prevent overcompaction of the surface
  - Depressions in the soil will aid in decreasing runoff velocities, trap sediment, and increase infiltration of water
- Grooving
  - Excavating shallow furrows across the width of the slope, perpendicular to the direction of the slope
  - If used, contour grooves should be approximately 0.1 to 0.2 m in depth
- Grooves can be made by using equipment or hand

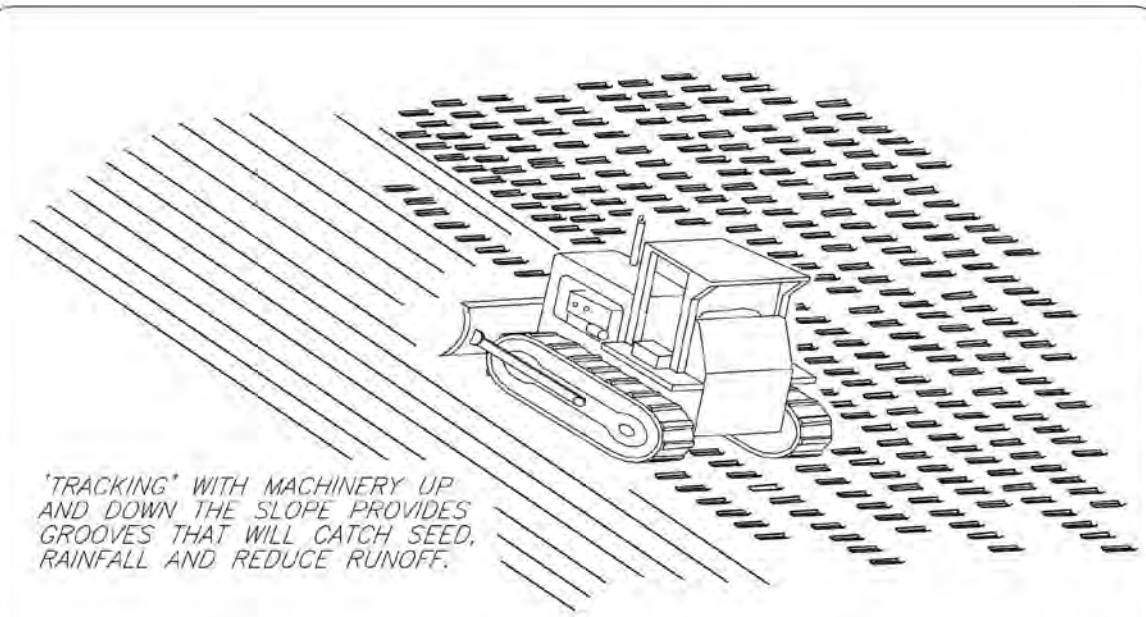
Construction Considerations

- During tracking operations, care must be taken to minimize disturbance to the soil where the equipment turns or changes direction
- Minimize the number of tracking passes to 1 to 2 times to avoid overcompaction, which can negatively impact the vegetation growth
- It is practical to track roughen a slope length of greater than 8 m by up- and down-slope operation of a small bulldozer. It is important to minimize the loosening of soil caused by turning movement of the bulldozer at the end of each pass. As the erosion potential is lower for slopes of low vertical height (<3 m height and 3H:1V slope), the tracking of low height slopes is not required and not practical for a bulldozer tracking operation.

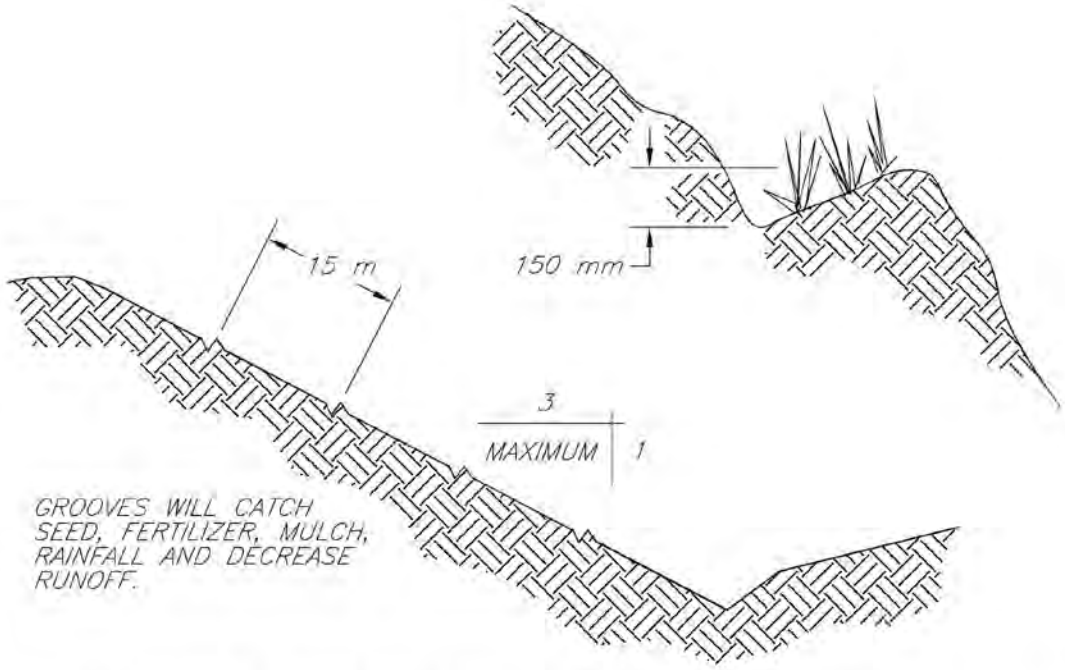
Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP15



TRACKING



CONTOUR FURROWS

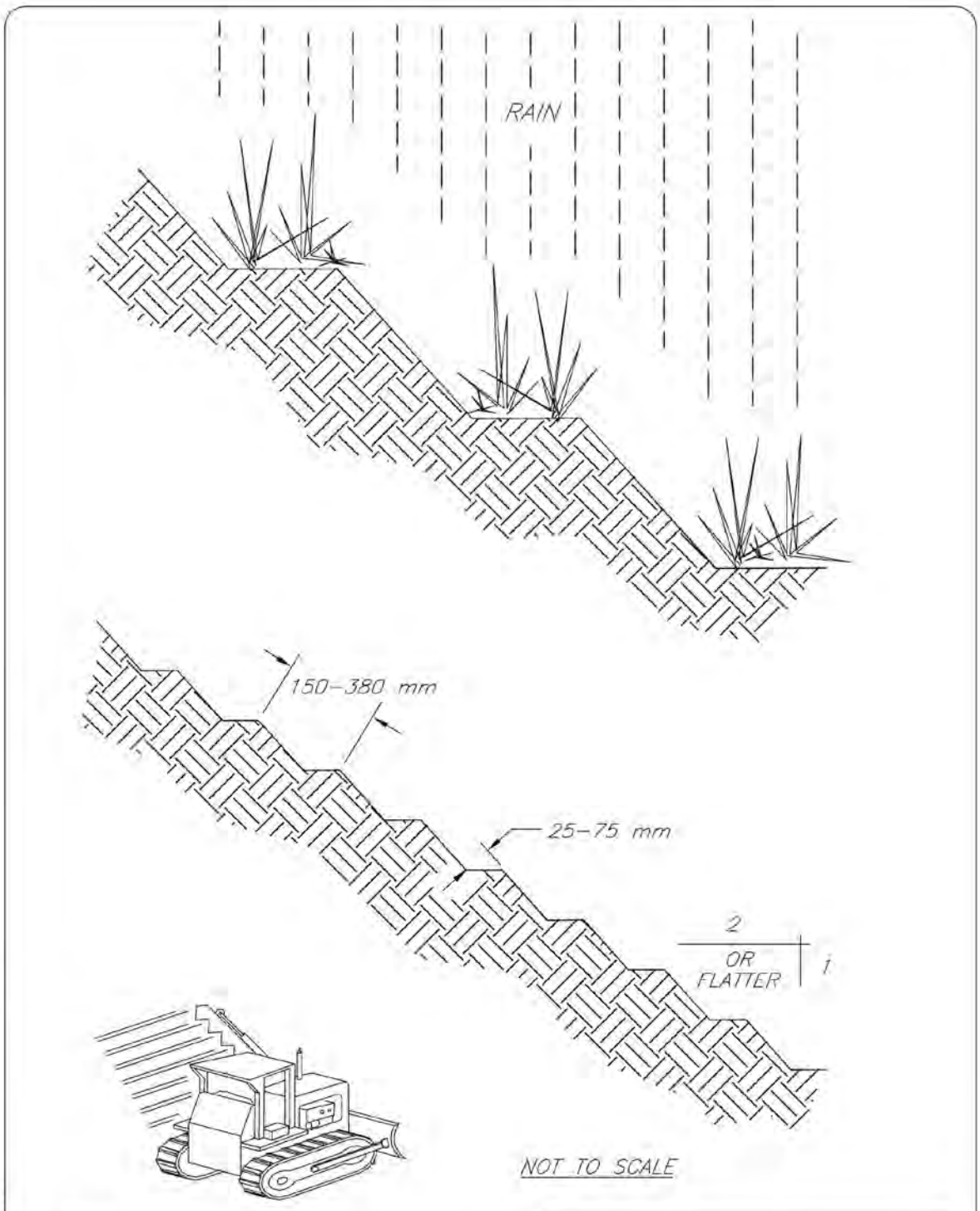
SURFACE ROUGHENING

FILE: SRFROUGH

Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP15



Synthetic Permeable Barrier

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP18

Description and Purpose

- Double panel, low profile, uni-body porous synthetic barriers used to dissipate flow energy and reduce velocity
- Barriers of patented design constructed of lightweight and durable synthetic materials
- May be used to create a grade break to reduce flow energy and velocities allowing some sediment to settle out at the upstream barrier panel of the barrier structure
- Can be used to dissipate flow energy and trap sediment during the period of revegetation; should be removed at successful re-establishment of vegetation

Applications

- Temporary structure
- May be placed across trapezoidal ditch to dissipate flow energy and reduce flow velocities
- Can be used to supplement as grade breaks along ditch interval between permanent drop structures along steep ditch grades
- May be used as midslope grade breaks along contours of midslope or at toe of disturbed slopes
- Usually used as grade breaks along ditch (3 to 7% grade) in conjunction with erosion control matting or non-woven geotextile as soil covering mattings; usually used in conjunction with permanent gabion structure at steep grade (>6%) areas
- Designed to be reusable

Advantages

- Prefabricated
- Reusable/moveable
- More appropriate for installing at transition areas of changing grades of channels so that hydraulic jumps (or change of flow regime from supercritical to subcritical) may be triggered to dissipate flow energy, thus minimizing erosion potential
- Provide portable drainage control for construction sites, ditches, channels, roads and slopes
- The double panel porous barrier may cause significant energy loss as the flow of water undergoes from supercritical flow to subcritical flow from the upstream panel to the downstream panel with a more laminar flow evolving downstream and roughly parallel to the stream bed. Less turbulence and erosion energy may be created when compared with cascading, over-topping and tumbling flow from drop structures (i.e. gabions or check structures)
- Barriers constructed of UV resistant material may be left in place for final channel stabilization as UV degradation is low

- Observed to enhance aggregation of silt material and to function as a sediment barrier with the formation of an earth block behind the upstream barrier panel area; the downstream flow exiting at the downstream barrier panel may be less erosive

Limitations

- More appropriate for use as a grade break and may be installed between permanent drop structures
- Partially effective in retaining some sediment and reducing flow velocities
- Less sturdy as drop structures in resisting high flow impact
- Not to be designed as drop structures
- Must be hand installed
- Become brittle in winter and may be easily damaged by highway maintenance activities or by public
- At the time of deactivation of the structure after vegetation establishment, metallic anchor pins, if not biodegradable, may require removal at time of completed revegetation
- Stick-up of metallic anchor pin above ground may be a nuisance and, may present a hazard to human safety and maintenance equipment
- The use of biodegradable anchor pins may be advisable

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Install as per manufacturers recommended installation instructions
- Normally installed in conjunction with erosion control matting in ditches and channels
- Prepare soil surface
- Install basal layer of erosion mat or geotextile fabric; key-in basal mat/fabric at upstream end
- Place and anchor barrier panels with adequate pin anchors to basal soils

Construction Considerations

- Maintain intimate contact between base of barrier and soil with laying of basal matting/fabric intimate to ground surface
- Ensure side panel of barrier is extended to outer edges of channel to sufficient height to provide freeboard of channel flow

Inspection and Maintenance

- Inspect barriers at bi-weekly intervals and after each significant rainfall event

Synthetic Permeable Barrier

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP18

- Remove sediment build-up before it reaches one-half the check structure height
- Do not damage barrier panel during removal of sediment
- Partial or non-removal of sediment build-up will create a non-permeable barrier and low level earth mini-drop structure which will force water flow over-topping the barrier. The option of non-removal of sediments may be open to converting the sediment build-up into a "vegetated earth mini-drop structure" along the ditch with the non-removal of synthetic permeable barrier in-place. This will require topsoil and seeding (or intensive mulch seeding) to promote vegetation growth.
- If erosion is noted at the toe or upslope edges of the structure, hand regrading or suitable repairs should be made immediately to prevent failure of the structure
- Remove and deactivate one year after vegetation is established

Similar Measures

- Silt fences are equally effective at retaining sediment
- Brush or rock filter berms

Design Considerations

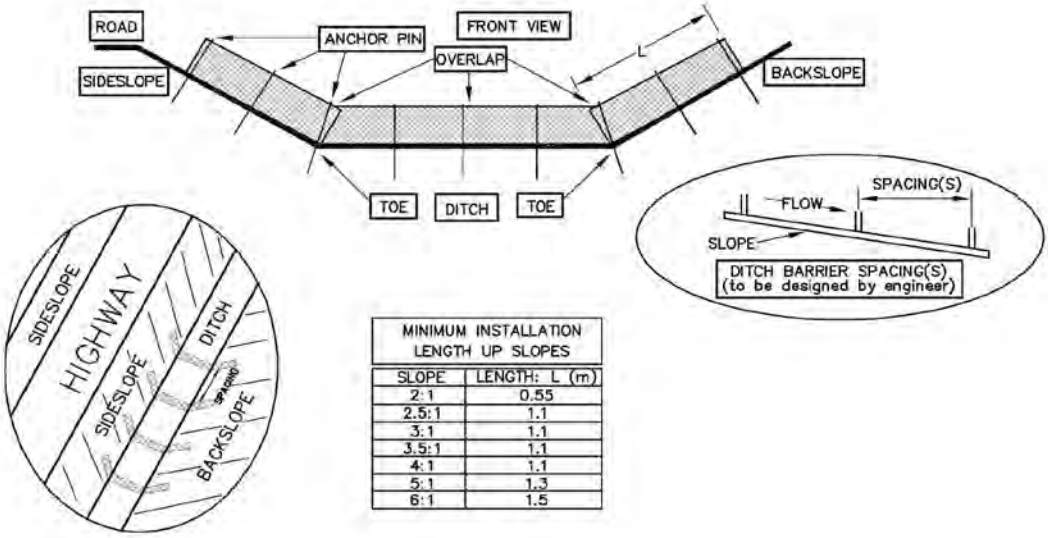
- Install synthetic permeable barrier along ditch interval between permanent drop structures (i.e. gabion); can be economic alternative and supplemental to total hard armouring of complete channel length, or high frequency of gabion installation required for high flow applications in steep ditch grade

Synthetic Permeable Barrier

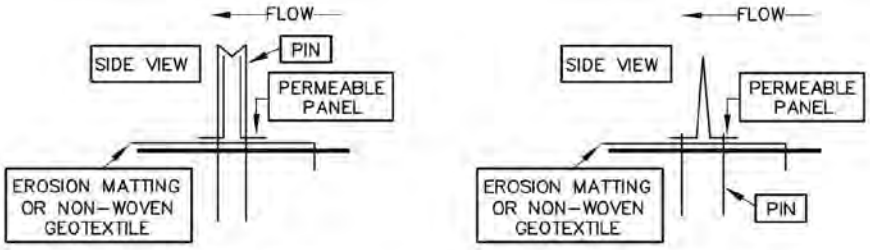
Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP18



MINIMUM INSTALLATION LENGTH UP SLOPES	
SLOPE	LENGTH: L (m)
2:1	0.55
2.5:1	1.1
3:1	1.1
3.5:1	1.1
4:1	1.1
5:1	1.3
6:1	1.5



1) DOUBLE PANEL

2) TRIANGLE PANEL

SYNTHETIC PERMEABLE DITCH BARRIER

N.T.S.

NOTES:

1. *FOR USE MAINLY AS A GRADE BREAK STRUCTURE FUNCTIONING AS A FLOW ENERGY DISSIPATOR AND VELOCITY RETARDER.*
2. *FOR SECONDARY USE AS SEDIMENT BARRIER.*
3. *REQUIRES NON-WOVEN GEOTEXTILE FABRIC OR BIODEGRADABLE (COCONUT FIBRE PREFERABLE) EROSION BLANKET MAT AT BASE AND KEY-IN TO SOIL AT UPSTREAM END.*
4. *MAY BE INSTALLED AS GRADE BREAK AT GRADE TRANSITION AREAS TO CREATE DISSIPATION OF FLOW ENERGY AND A MORE LAMINAR FLOW REGIME DOWNSTREAM OF STRUCTURE.*
5. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

SYNTHETIC PERMEABLE (ditch) BARRIERS

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20

Description and Purpose

- Small dam constructed across a drainage channel
- May be constructed of rock, aggregate-filled sandbags, straw bales or logs
- Ponded water decreases flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is retained, allowing sediment to settle out

Applications

- Temporary or permanent measure
- Reduces long steep grade to intervals of gentle grades between structures
- Reduces flow velocities 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 or less (2ha or less for straw bales)
- May be used in steep channels where runoff velocity is less than 1.5 m/s (limited to 0.3 m/s for straw bales)

Advantages

- Cheaper than using riprap armouring or gabion structures in a ditch
- Rock, sandbag and straw bale structures are relatively easy to construct
- Cement can be incorporated into sandbag aggregates for a permanent application
- Timber structures are suited to areas where timber can be salvaged from clearing operations and other materials are in short supply

Limitations

- Not appropriate for flow velocities greater than 1.5 m/s (0.3 m/s for straw bales)
- Not appropriate for channels draining areas larger than 4 ha (2 ha for straw bales)
- Not appropriate for grass lined channels unless erosion is anticipated
- Susceptible to failure if water undermines or outflanks structure
- Timber structures are labour intensive to construct, gaps between logs may render them ineffective and they will decay and rot with time
- Straw bales should only be used as a temporary measure and have a short service life (1-2 years); they are susceptible to failure if bales are not properly trenched and anchored

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20

Construction (Rock Check Dam)

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- 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 structure
- Construct structure by machine or hand
- Structure should extend from one side of the ditch or channel to the other
- 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 3H:1V (minimum)
- Upstream slope of the check dam should be 2H:1V (minimum)

Construction Considerations (Rock Check Dam)

- 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 in channels with significant high flows, they must be properly designed for stone size and structure spacings

Construction (Sandbag Check Dam)

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Place sandbags by hand at check structure location with geometry similar to that shown for the rock check dam
- Check structure should extend from one side of the ditch or channel to the other
- 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 check structures should be less than 0.8 m to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 2.5H:1V (minimum)
- Upstream slope of the check dam should be 1.5H:1V (minimum)

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20

Construction Considerations (Sandbag Check Dam)

- Height and spacing of check structures should be designed to reduce channel slope to intervals of flatter gradient
- Sandbags should only be filled ¾ full to allow bag to mould to contours, allowing continuous contact between the bag and the soil

Construction (Straw Bale Check Dam)

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Excavate a trench approximately 0.15 m deep with a width of two straw bales at the straw bale check structure location
- Place two rows of straw bales in excavated trench perpendicular to flow direction ensuring bales are staggered so that no joints are aligned on the upstream and downstream rows. Ensure twine or wire is not in contact with the soil
- Infill all joints with straw
- The centre of the crest of the check structure should be at least 0.15 m lower than the outer edges along the channel walls
- Drive two 1.2 m long square section wooden stakes through each straw bale, ensuring each stake is embedded a minimum of 0.15 m into soil
- Backfill and compact the upstream and downstream edges of the check structure to seat the straw bales into the base of the ditch
- Geotextile wrapping may be specified; the geotextile should be pinned to the straw bale subgrade

Construction Considerations (Straw Bale Check Dam)

- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- To avoid impounding large volumes of runoff, check structures should be a maximum of one straw bale high
- Straw bales should be:
  - Machine-made
  - Weed free cereal crop straw such as wheat, oats, rye, or barley
  - Tightly compacted and bound with two rows of wire or synthetic string and shall show no signs of weathering
  - No more than year old

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20

Construction (Log Check Dam)

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Embed ends of logs at least 0.5 m into channel or ditch bed
- Ensure there are minimal gaps between logs
- Install horizontal cross brace at top of the downstream side of structure to connect logs together providing integral support
- Structure should extend from one side of the ditch or channel to the other
- 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
- To avoid impounding large volumes of runoff, check structures should be less than 0.5 m in height above the base of the ditch.

Construction Considerations (Log Check Dam)

- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- Wood check dams should have their spacing and height design according to the anticipated hydraulic condition (flow depth and velocity)
- Bracing should be installed to provide support to embedded logs

Inspection and Maintenance

- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- 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 materials immediately or consider a more robust structure

Similar Measures

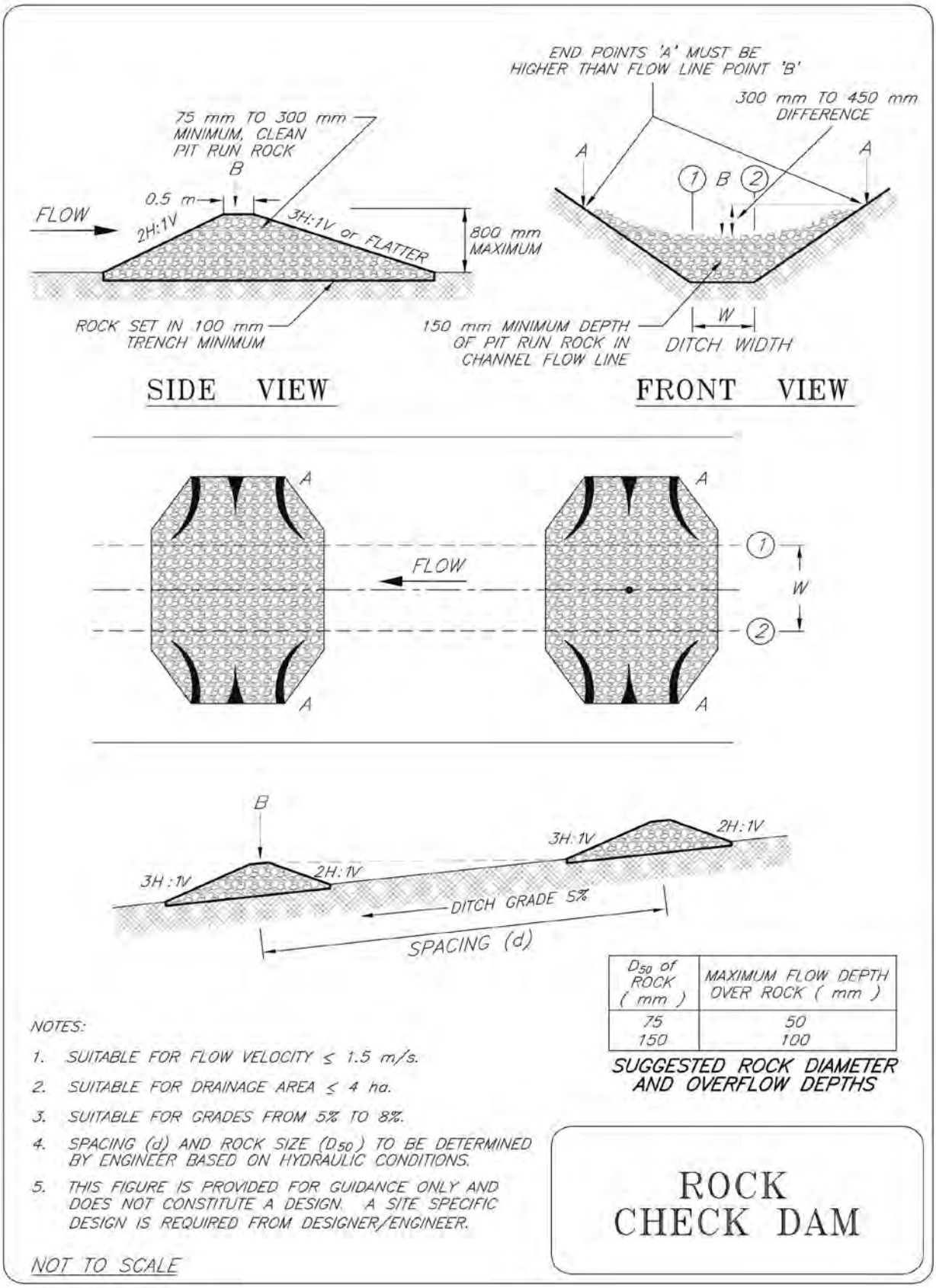
- Synthetic permeable barrier

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20



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

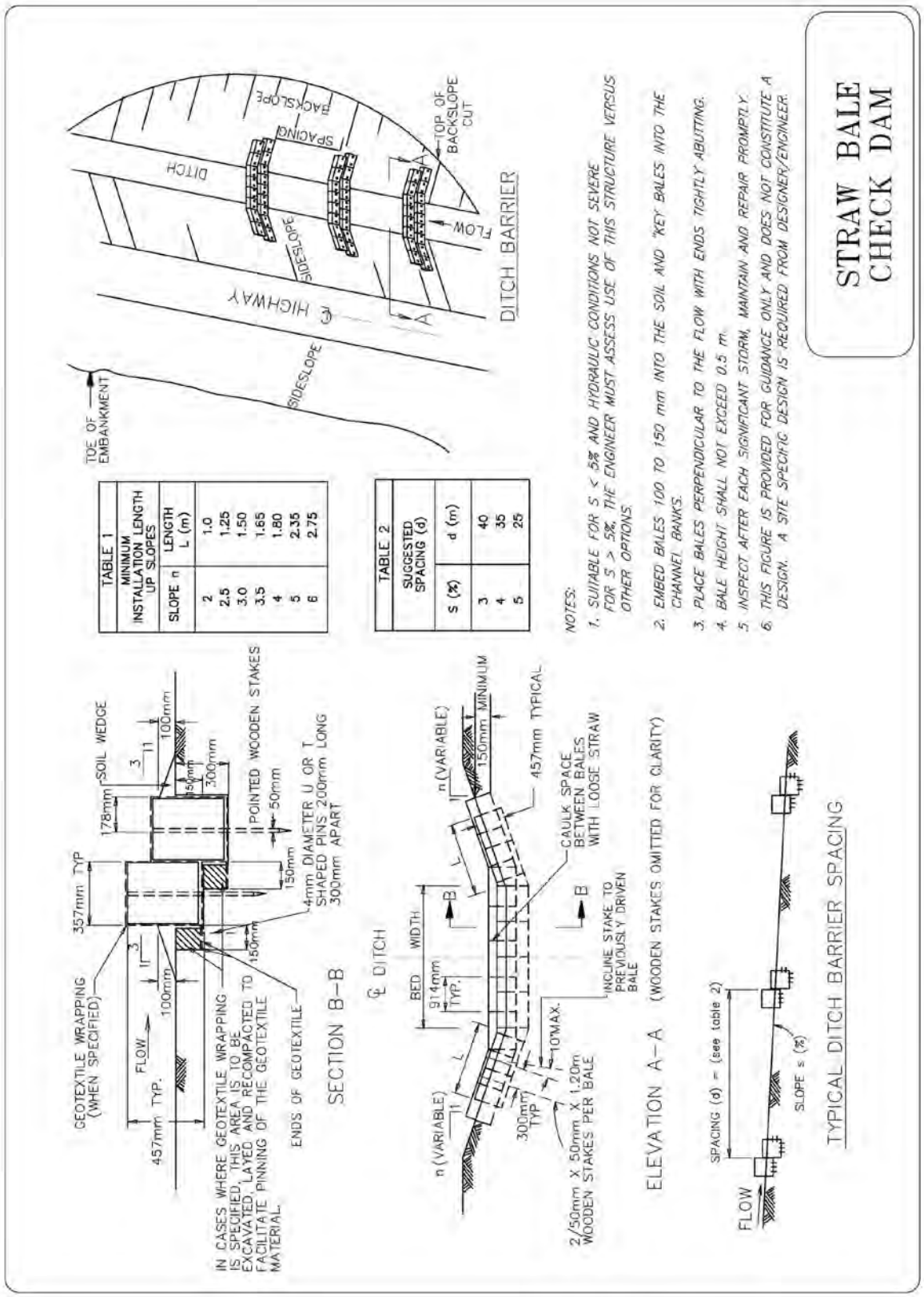
ROCK CHECK DAM

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20

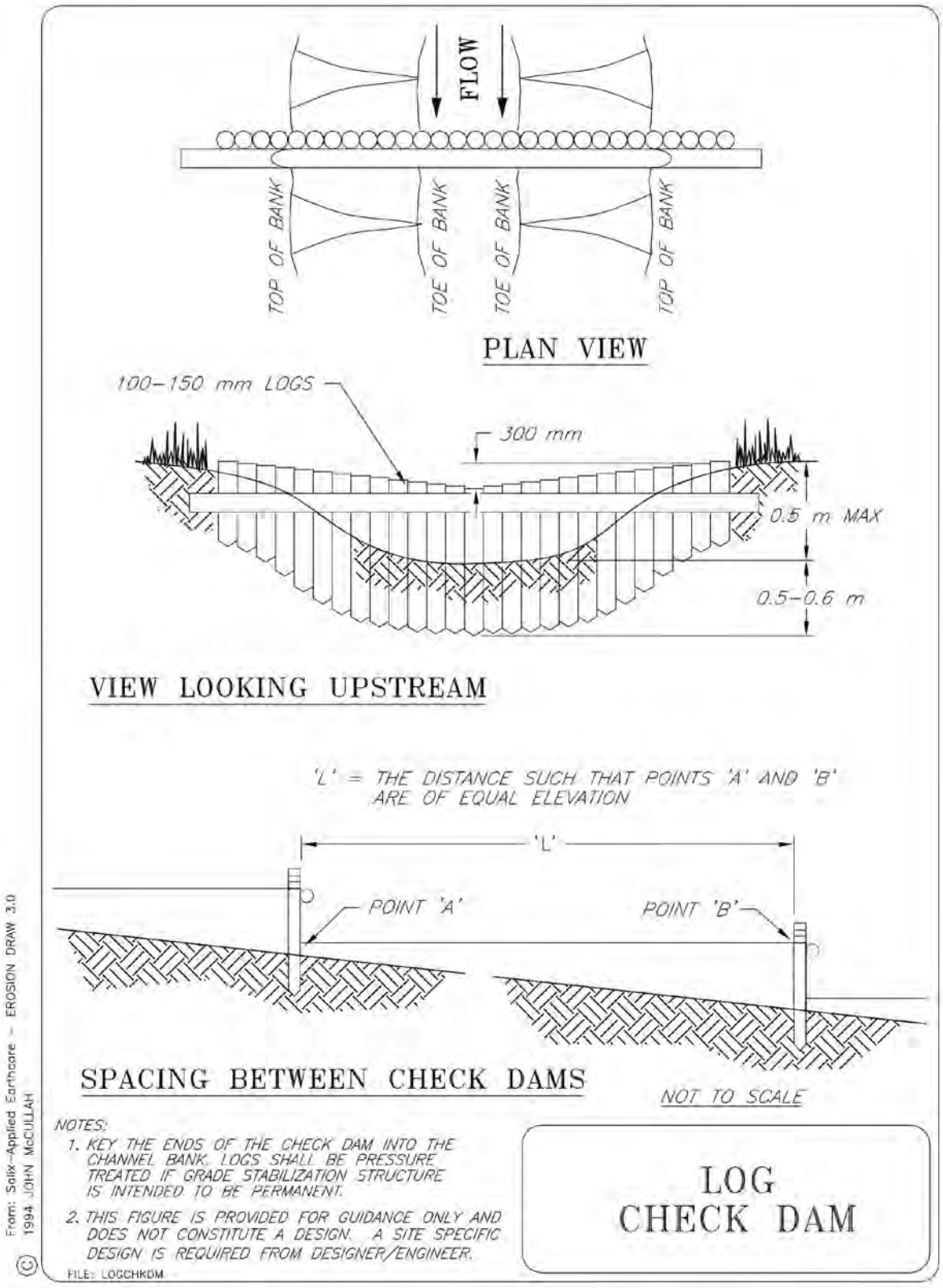


Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP20



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Diversion Ditch

Erosion Control:
Runoff Control

BMP21

Description and Purpose

- Channels or swales commonly located along the crest of cuts slopes to intercept and convey runoff away from bare soil slopes and to minimize erosion of slopes from sheet flow
- Often convey water to slope drains which carry water downslope

Applications

- Permanent measure
- Effective method of intercepting runoff to avoid excessive sheet flow over slope
- Effective at reducing erosion on cut slopes in highly erodible soils
- Can be used in conjunction with slope drains
- May be lined with vegetated or non-vegetated erosion control BMPs, but this requirement may be appropriate only in highly sensitive areas
- Can be used in conjunction with sediment control measures, such as check structures or permeable synthetic barriers, but this requirement may be appropriate only in highly sensitive areas

Limitations

- Ditch may require lining to minimize soil erosion from concentrated flow
- Ditch may require detailed design by qualified personnel if flow velocities and/or volumes are large
- Channel must be graded to maintain adequate depth and positive drainage; ponding and breaching of the channel could lead to overtopping of the channel and downslope erosion
- Removal of sediment build up and ditch maintenance may be difficult due to limited access space, because diversion ditches are commonly constructed at slope crests

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Use backhoe to excavate the ditch a minimum offset distance of 2 m between the crest of the cut slope and the top of the diversion ditch sideslope
- Place and compact excavated soil to form a dyke between crest of highway slope and diversion ditch channel to provide adequate depth of the diversion ditch
  - The consequence of failure of this dyke will determine the level of compaction effort required
  - Sideslopes of the diversion ditch should not be steeper than 2H:1V (depending upon material type)

  - The depth of the diversion ditch (from base of ditch to top of embankment) should be a minimum of 1 m in depth; the width of ditch should be 1 m minimum
  - The ditch should be graded at a minimum of 1% to promote positive drainage and outfall

Construction Considerations

- Channel should be graded towards nearest outfall or drainage pipe

Inspection and Maintenance

- Inspect ditches at least at biweekly intervals and after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Repair any damage to channel immediately

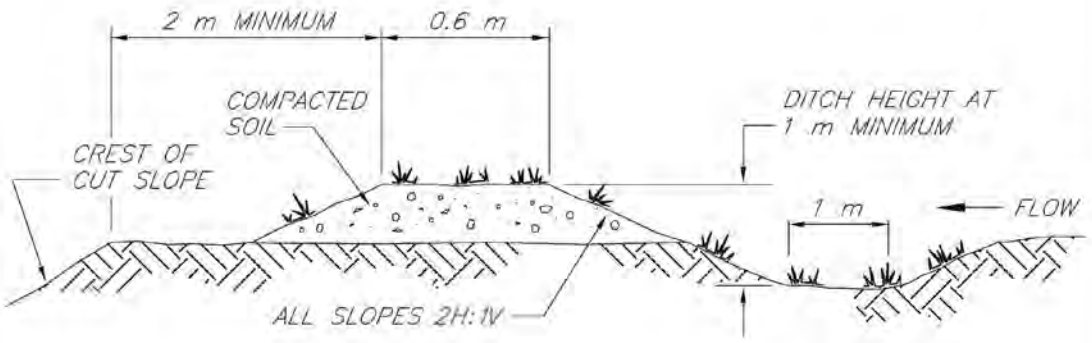
Similar Measures

- Berms
- Barriers

Diversion Ditch

Erosion Control:
Runoff Control

BMP21



TYPICAL DIVERSION 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.

DIVERSION DITCH

FILE: TEMPDIKE

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Energy Dissipators

Erosion Control:
Runoff Control

BMP22

Description

- Minimizes scour at flow impact location with dissipated flow energy
- Hard armour (rip rap, gravel, sand bags, concrete) placed at pipe outlets, in channels and downstream of check structures to reduce velocity and dissipate energy of concentrated flows
- Standard drain trough terminal protection structure generally used on bridge headslopes

Applications

- Permanent measure
- May be used at outlets of pipes, drains, culverts, conduits, or channels with substantial flows
- May be used at slope drain outlets located at the bottom of mild to steep slopes
- May be used where lined channels discharge into unlined channels
- May be used as a splash pad downstream of gabions, check structures, berms, barriers, and silt fences to prevent erosion caused by overtopping

Advantages

- Reduces flow energy in a relatively small area

Limitations

- Small rocks or stones can be dislodged during high flows
- Grouted rip rap may break up due to hydrostatic pressure, frost heave, or settlement
- May be expensive if construction materials (rip rap, gravel, or concrete) are not readily available
- May be labour intensive to place and construct
- Extreme flow velocities may require paved outlet structures, stilling basins, plunge pools, drop structures, baffles, or concrete splash pads which will require special design by qualified personnel. Energy dissipators constructed of rip rap may not be adequate for extreme flow velocities

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Grade the area to final design grades and elevations
- Sub-excavate energy dissipator location to thickness of energy dissipator
- Place filtration bedding material on base of excavation

  - Bedding can be comprised of well graded sand and gravel or non-woven geotextile
  - Acts as separating filter between fine grained subgrade and riprap size energy dissipator material
- Place energy dissipator material (rip rap, gravel, sand bags, concrete) over filtration bedding material
  - Top of energy dissipator should be flush with surrounding grade

Construction Considerations

- Length of energy dissipator (L_a) at outlets shall be of sufficient length to dissipate energy
  - L_a = 4.5 x D (where D is the diameter of the pipe or channel at the outlet)
  - Energy dissipator should extend upstream of the outlet approximately a minimum distance of 0.5 x D
- Width of energy dissipator (W_a) at outlets shall be of sufficient width to dissipate energy
  - W_a = 4 x D
- Thickness of energy dissipator (d_a) at outlets shall be of sufficient thickness to dissipate energy
  - d_a = 1.5 x maximum rock diameter (with a minimum thickness of 0.30 m)
- Energy dissipator (splash pad, apron) shall be set at zero grade and aligned straight, with the direction of flow at the outlet
- Bedding (filtration) layer can comprise either non-woven geotextile or a minimum of 0.15 m well graded sand and gravel layer
- Energy dissipator should be constructed of well-graded rip rap
  - Minimum d_{50} = 150 mm. Preferable d_{50} = 300 mm
  - Minimum thickness = a) 1.5 x d_{50} or b) 0.30 m to 0.45 m thickness. (a or b whichever is greater)
- Energy dissipator shall be designed to accommodate a 10-year peak runoff or the design discharge of the upstream channel, pipe, drain, or culvert, whichever is greater

Inspection and Maintenance

- Periodic inspections to check for damage should occur at least once a month, or after storm events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Any damage should be repaired immediately

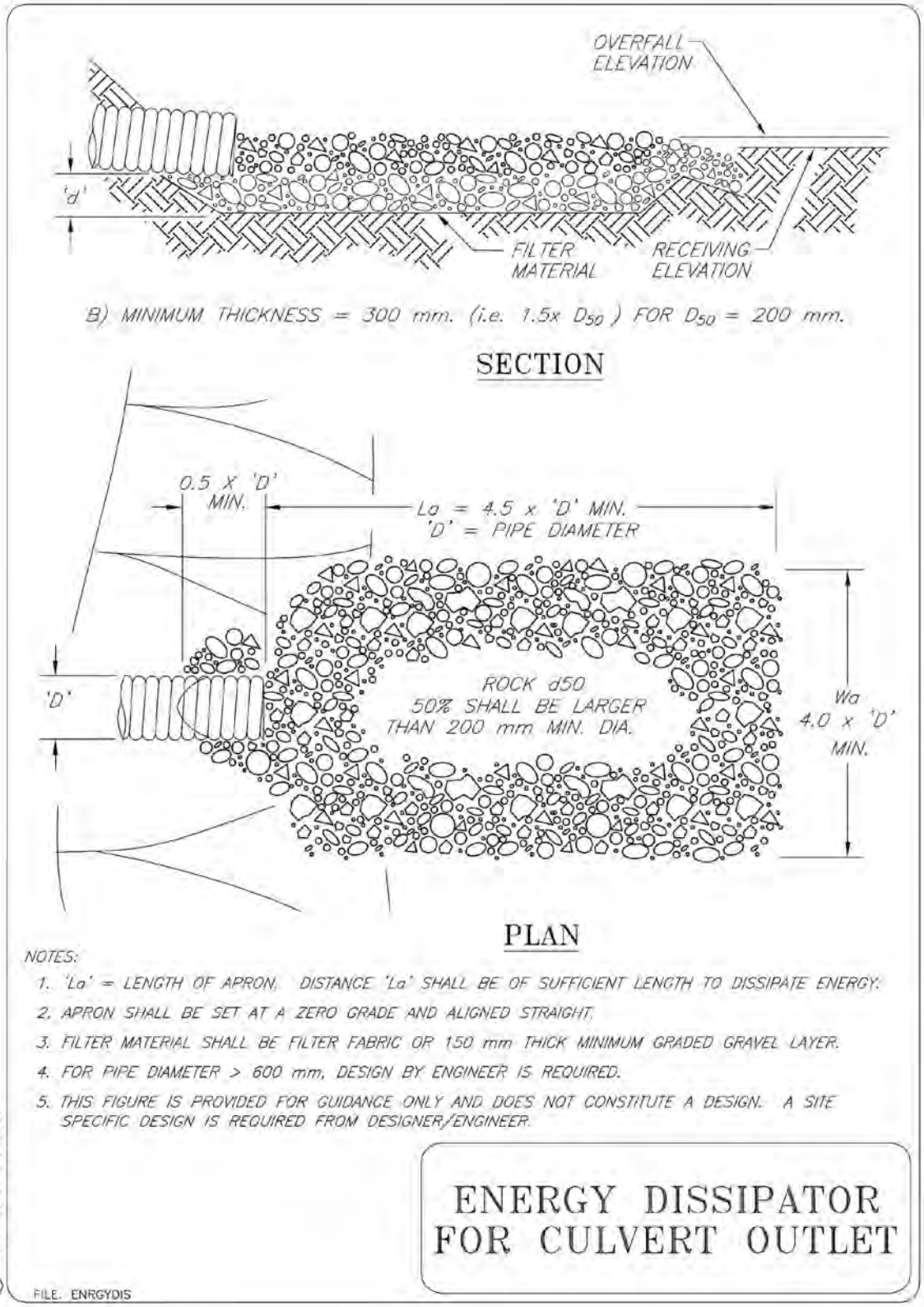
Similar Measures

- Gabion mattresses

Energy Dissipators

Erosion Control:
Runoff Control

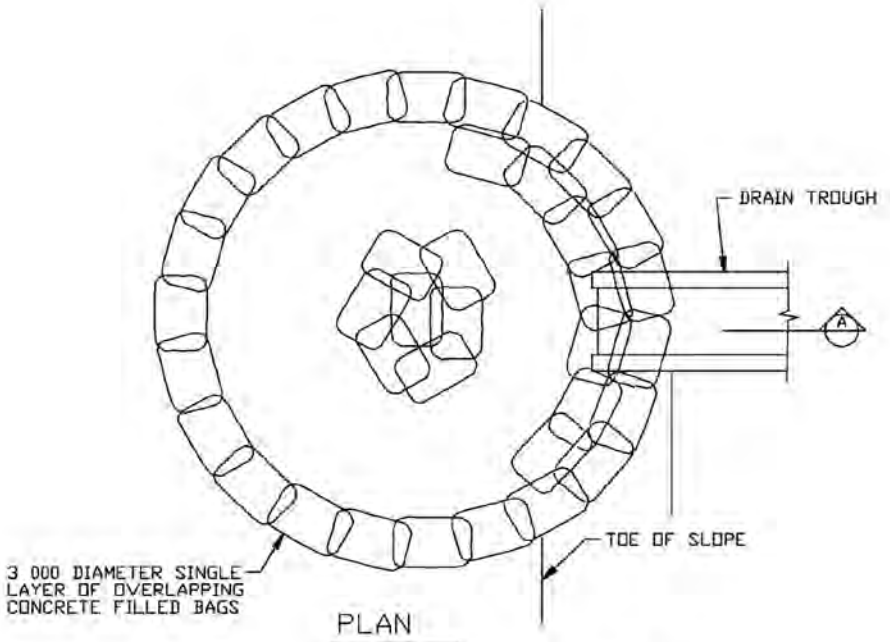
BMP22



Energy Dissipators

Erosion Control:
Runoff Control

BMP22



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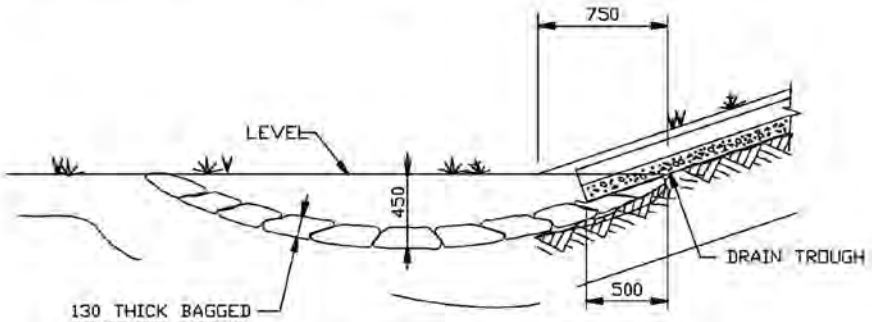


A SECTION

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- PLACING OF BAGGED CONCRETE RIPRAP SHALL START AT THE BOTTOM CENTRE OF THE DISHED AREA AND SHALL PROCEED IN A CONTINUOUS SPIRAL FASHION OUTWARD UNTIL THE ENTIRE DISH IS COVERED. EACH CONCRETE FILLED BAG SHALL LAP OVER THE EDGES OF THE PREVIOUSLY PLACED BAGS.

  SOURCE: ALBERTA TRANSPORTATION SPECIFICATIONS FOR BRIDGE CONSTRUCTION
  DRAWING S-1410-91

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

ENERGY DISSIPATOR
FOR SEMI-CIRCULAR TROUGH DRAIN TERMINAL PROTECTION FOR BRIDGE HEADSLOPE

Silt Fence

Sediment Control: Settling

BMP23

Description and Purpose

- Permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff
- Causes water to pond and sediment to settle out as fabric impounds water
- Decreases flow velocity in channels with low to moderate flows (<0.03 m^3/s)
- Entraps and minimizes coarse sediment from sheet flow or overland flow from entering waterbodies
- Perimeter control for sediment transport and deposition
- Also known as “sediment control fence”

Applications

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

Advantages

- Low permeability silt fences have high ponding and settling capabilities for fine sand to coarse silt

Limitations

- **Successful performance is highly dependent on proper installation**; silt fence is commonly installed incorrectly and failures can cause erosion
- Applicable for sheet flow, normally cannot handle concentrated channel flow volumes
- May fail under high runoff events or due to damage caused during sediment removal
- Limited 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 posts)
- Sediment build up needs to be removed at 1/2 height and on a regular basis
- Has a useable life of approximately one year, depending on maintenance and sediment requirement

Silt Fence

Sediment Control: Settling

BMP23

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Two methods of installation are commonly used:
  - Trench method
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent)

  The mechanical installation method is recommended because it results in less disturbance to native ground and in general provides a stronger end product
- Trench Method
  - Select the location of the silt fence (usually along contours)
  - Excavate a trench 0.30 m deep by 0.15 m wide for the entire length of fence
  - Drive the support posts a minimum of 0.6 m into the ground along the downstream side of the trench, spaced a maximum of 2 m apart; use a spacing of 1 m for critical water-retaining areas
  - Attach the wire mesh or snow fencing, if used as reinforcement to fence fabric, to the upstream side of each post with staples
  - Extend the filter fabric to the base of the trench and attach it over the wire mesh or snow fence, if used, on the upstream side of posts
  - Backfill and compact the soil in the trench, being careful not to damage the fence
- Mechanical Installation Method
  - Select the location of the silt fence (usually along contours)
  - Use a mechanical installation machine to embed the fabric a minimum of 0.2 m to 0.3 m into the ground. One mechanical installation method involves slicing (with special equipment) the geotextile fabric to embed it into the ground without excavation or backfill. This results in only minor disturbance of the ground and only minor tamping of the ground is required for compaction.
  - Drive the support posts a minimum of 0.6 m into the ground, spaced a maximum of 2 m apart; use a spacing of 1 m for critical water-retaining areas
  - Attach the wire mesh or snow fencing, if used as reinforcement, to the silt fence fabric and to the upstream side of posts with staples
- Note on Type 2 Silt Fence
  - Heavy grade silt fence may be required by regulatory agencies for installation near watercourses
  - Type 2 silt fence uses steel posts, with filter fabric supported by wire fencing material and a compacted gravel toe anchorage

Construction Considerations

- Site Selection
  - Size of drainage area to a silt fence should be no greater than 0.4 ha

  - 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 the contour to produce proper ponding
- Fence should be placed far enough away from the toe of slope to provide an adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of the 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, depending on design and ground conditions
- Posts should be placed on the downstream side of the fence
- Posts should be driven at least 0.6 m into the ground
- Posts should not be spaced greater than 2 m apart
- Wire mesh or snow fencing may be placed between the posts and the filter fabric to provide additional strength and support reinforcement
- Filter fabric should be cut from a continuous roll to avoid joints. If joints are necessary, filter fabric should be wrapped around the fence post with a minimum overlap of 0.2 m, and staples should be used to attach the fabric to the post
- Fence (and wire mesh or snow fence, if used) should be attached to the 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 0.30 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
  - The 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

- Inspections should occur twice per week and after significant storm events (1:2 year storm event and/or >40 mm rainfall over 24 hours duration)
- Repair undercut fences and repair or replace split, torn, slumping or weathered fabric immediately
- Sediment build up should be removed once it accumulates to a depth of 0.2 m or at 1/2 height of fence
- Remove fence after vegetation is established
- Deactivate fabric by cutting off the top portion of fabric above ground; the bottom trenched-in portion can be left in-ground to minimize ground disturbance

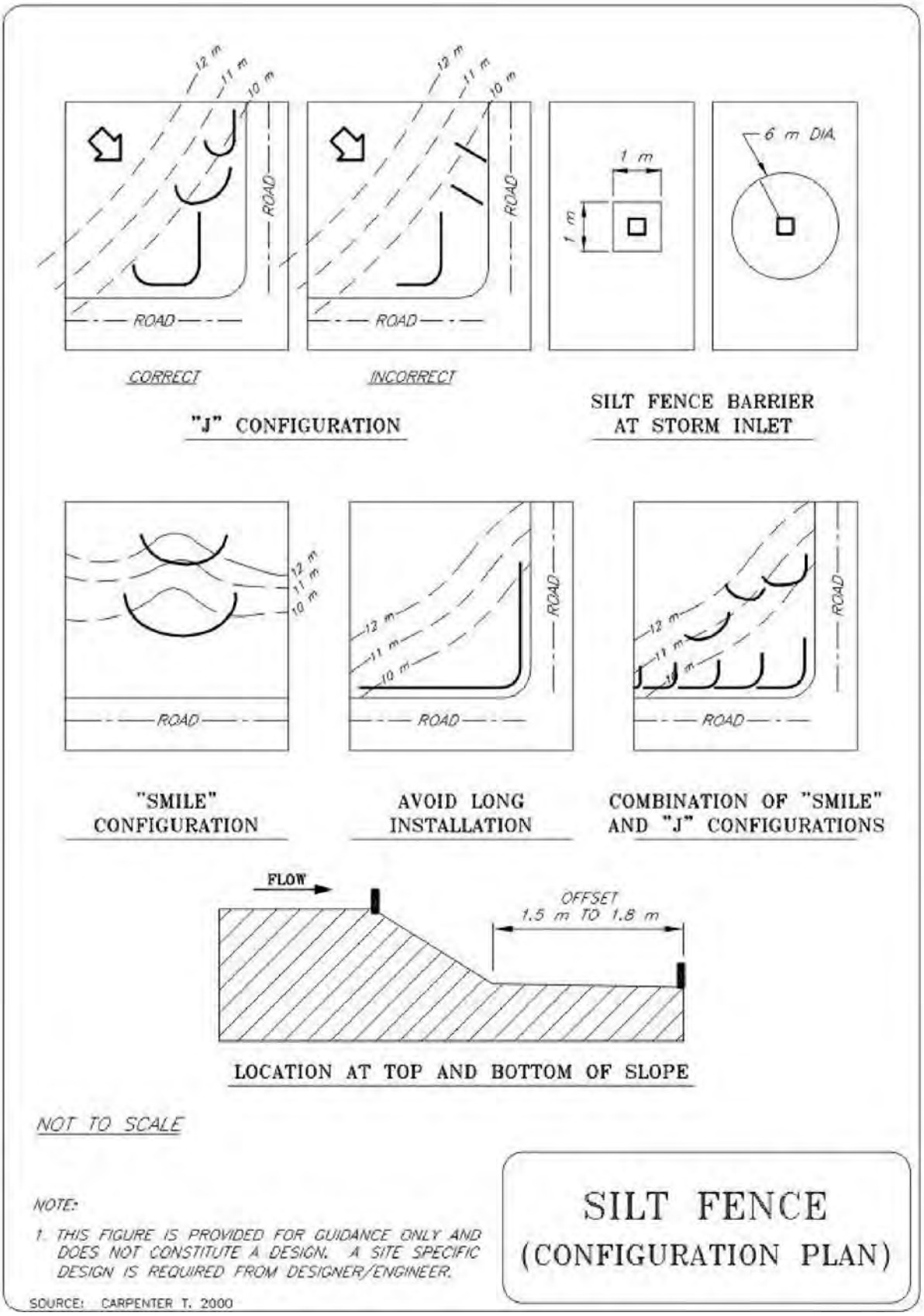
Similar Measures

- Check Dams
- Permeable synthetic barriers

Silt Fence

Sediment Control:
Settling

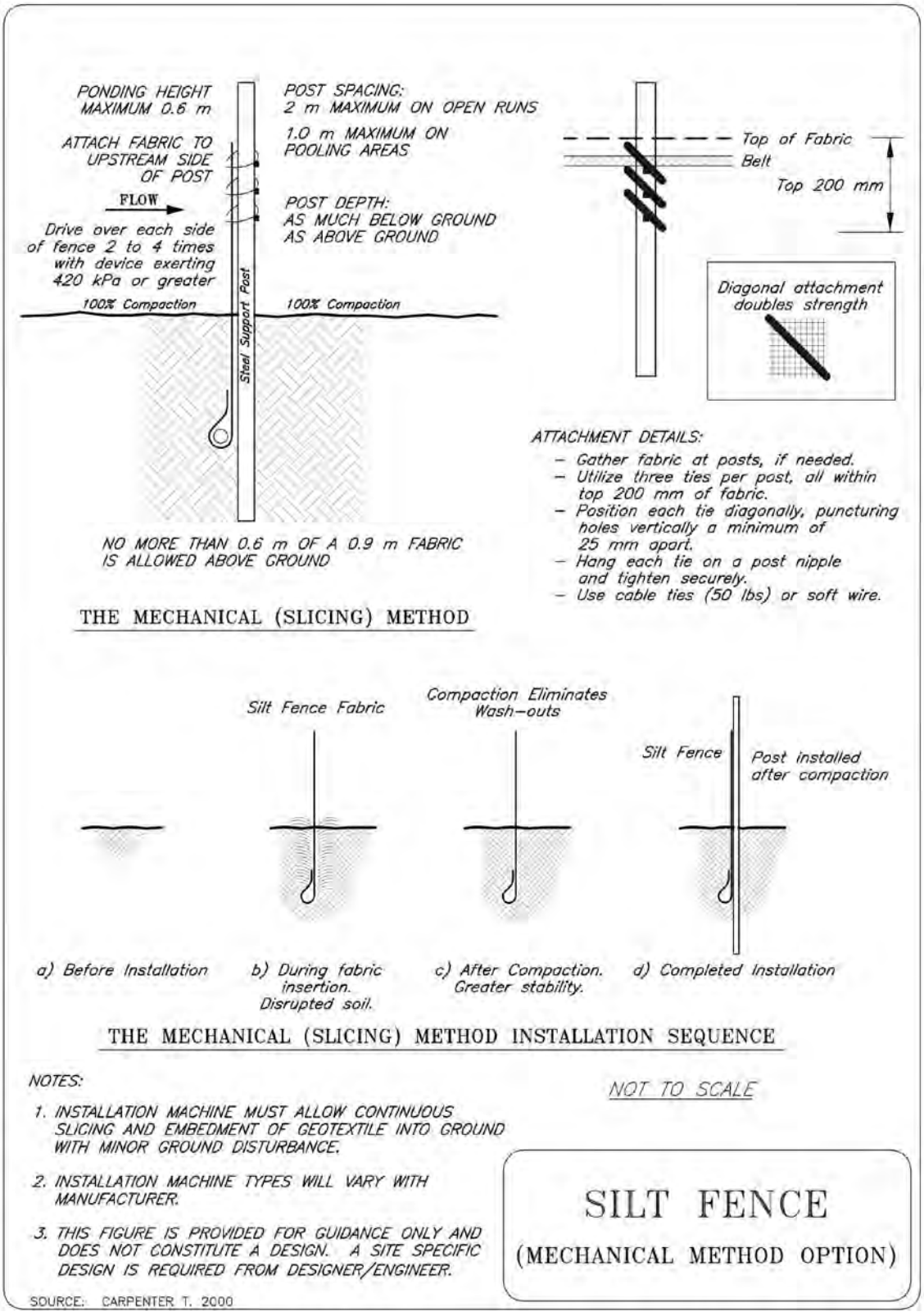
BMP23



Silt Fence

Sediment Control: Settling

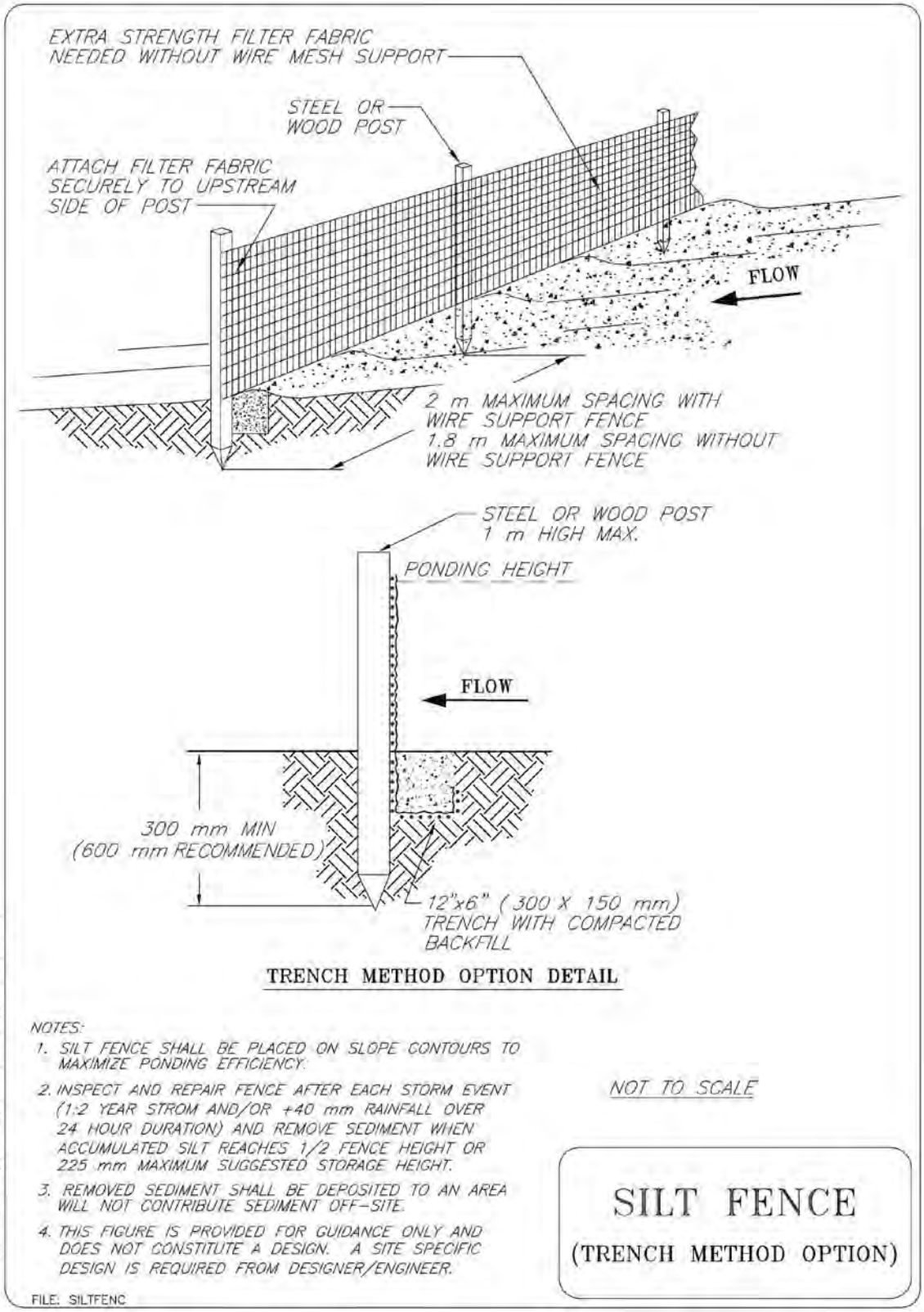
BMP23



Silt Fence

Sediment Control:
Settling

BMP23



Brush or Rock Berm

Sediment Control:
Settling

BMP24

Description and Purpose

- Temporary barriers of brush and/or rock wrapped in geotextile and secured in place to intercept sediment laden stormwater runoff from disturbed areas, retain sediment, and release water as sheet flow

Applications

- Temporary measure
- Perimeter control
- Near toe of slopes subjected to sheet flow and rill erosion
- Along crest or tops streams and channels
- Around drain inlets
- Maximum drainage area of 250 m^2 per 25 m length of barrier

Advantages

- May be equally effective as silt fences

Limitations

- Temporary measure only
- Maximum drainage area of less than 250 m^2 per 25 m length of barrier
- Sufficient area behind berm required for ponding and clean out of sediment
- Not effective for diverting runoff (allows runoff to seep through)
- Rock berms are expensive to remove at completion of service life
- Not to be used across ditches, channels, or swales where high concentrated flows are anticipated

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Brush berm
  - Size of the brush berm will vary depending upon amount of material available and condition of the site
  - The height of the berm shall be at least 1 m and the width shall be a minimum of 1.5 m at its base
  - Berm is constructed by piling brush, roots, stumps and/or stones into a mounded row along contours
    - During clearing and grubbing, equipment can push the material into windrows along toe of slopes or other areas prone to erosion

  - Geotextile is then laid across the berm, with edges overlapping, and secured in a trench immediately upstream of the berm
    - Trench shall be 15 cm wide and 15 cm deep and shall run for the entire length of the berm
  - The geotextile in the trench shall be staked down with stakes spaced approximately 1 m apart
  - The trench is then backfilled and compacted over the staked geotextile
  - The geotextile is anchored with twine/wire to stakes on the downstream side of the berm
- Rock filter berm
  - Constructed similar to brush berm, replacing brush with rock (D_{50} = 75 mm to 150 mm)

Construction Considerations

- Use rock or brush material smaller than 150 mm in diameter, or use geotextile to encapsulate the material
- There is no predetermined shape for berms
- Water must be forced to pond behind the berm to encourage settling
- Brush barriers can generally be constructed of clean organic material made available from clearing and grubbing operations that is normally burned or discarded
- Rock and brush berms are temporary measures and should be removed upon completion of service life, after revegetation of areas upslope

Inspection and Maintenance

- Inspect berms on a weekly basis and before and after significant rainfall events (1:2 year storm event and/or 40 mm rainfall over 24 hours duration)
- Reshape berms as needed and replace lost or dislodged rock, brush, and/or geotextile
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-third the berm height or 300 mm, whichever occurs first
- Inspect for toe undercutting, weathered/deteriorated geotextile, and end runs and erosion of the berm and repair immediately

Similar Measures

- Berms/barriers
- Check dams
- Permeable synthetic barriers

Brush or Rock Berm

Sediment Control:
Settling

BMP24

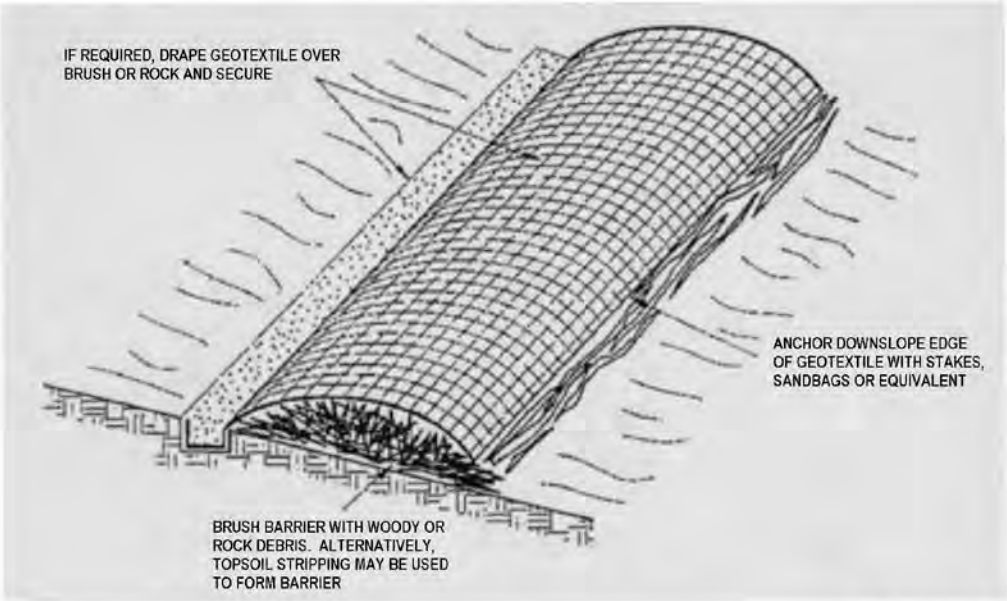
Design Considerations

- Material properties
  - Rocks
    - Shall consist of hard, durable, clean mineral particles free of organic matter, clay lumps, soft particles, or other substances that might interfere with drainage and filtering properties
    - D_{50} of 75 mm to 150 mm preferable
  - Brush
    - Material shall be less than 150 mm in diameter

Brush or Rock Berm

Sediment Control:
Settling

BMP24



NOT TO SCALE

NOTES:

1. EXCAVATE 150 mm X 150 mm TRENCH ALONG UPSTREAM SIDE OF BRUSH OR ROCK BERM.
2. DRAPE GEOTEXTILE OVER BRUSH OR ROCK BERM ENSURING UPSTREAM SIDE IS IN TRENCH.
3. BACKFILL AND COMPACT SOIL OVER GEOTEXTILE IN EXCAVATED TRENCH.
4. SECURE GEOTEXTILE OVER BRUSH OR ROCK BERM BY STAKING ON DOWNSTREAM SIDE OF BERM.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

BRUSH or ROCK BERMS

Continuous Berm

Sediment Control:
Settling

BMP26

Description and Purpose

- Constructed of sand or gravel-filled geotextile
- Used to divert and intercept sheet or overland flow
- May be used to form ponds and allow sediment to settle out

Applications

- Temporary measure
- May be used in place of silt fences to retain sediment on construction sites

Advantages

- Trenching not required as weight and flexibility of berm allows continuous contact with ground surface

Limitations

- Requires Continuous Berm Machine (CBM) for construction

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Use CBM to form berm a minimum of 2 m away from toe of slope to provide adequate ponding area on upstream side of berm
- Follow operating procedures for CBM
- Use of woven geotextile is preferred due to higher tensile strength and small deformation
- If required, 50 mm diameter (recommended) PVC drainage pipes may be inserted in downstream side of berm, spaced 100 to 150 mm apart, to facilitate drainage
- If required and appropriate, slits may be cut in upstream side of berm to facilitate filtering and drainage

Construction Considerations

- Berm constructed of sand, aggregate, or other pervious soil encased in geotextile fabric
- Maximum berm height is approximately 0.4 m
- Higher permeability fill materials should be used in ‘drainage chambers’ in low areas

Continuous Berm

Sediment Control:
Settling

BMP26

Inspection and Maintenance

- Minimal maintenance is required
- Inspect berms on a weekly basis and before and after significant rainfall events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-third the berm height
- Inspect for toe undermining, weathered/deteriorated filter fabrics, and end runs and erosion of the filter and repair immediately
- Damaged sections may be repaired by restapling or placing another section of continuous berm upstream of the damaged section to provide seal-off
- Removal of berm is accomplished by splitting the berm, spilling fill material and removing fabric

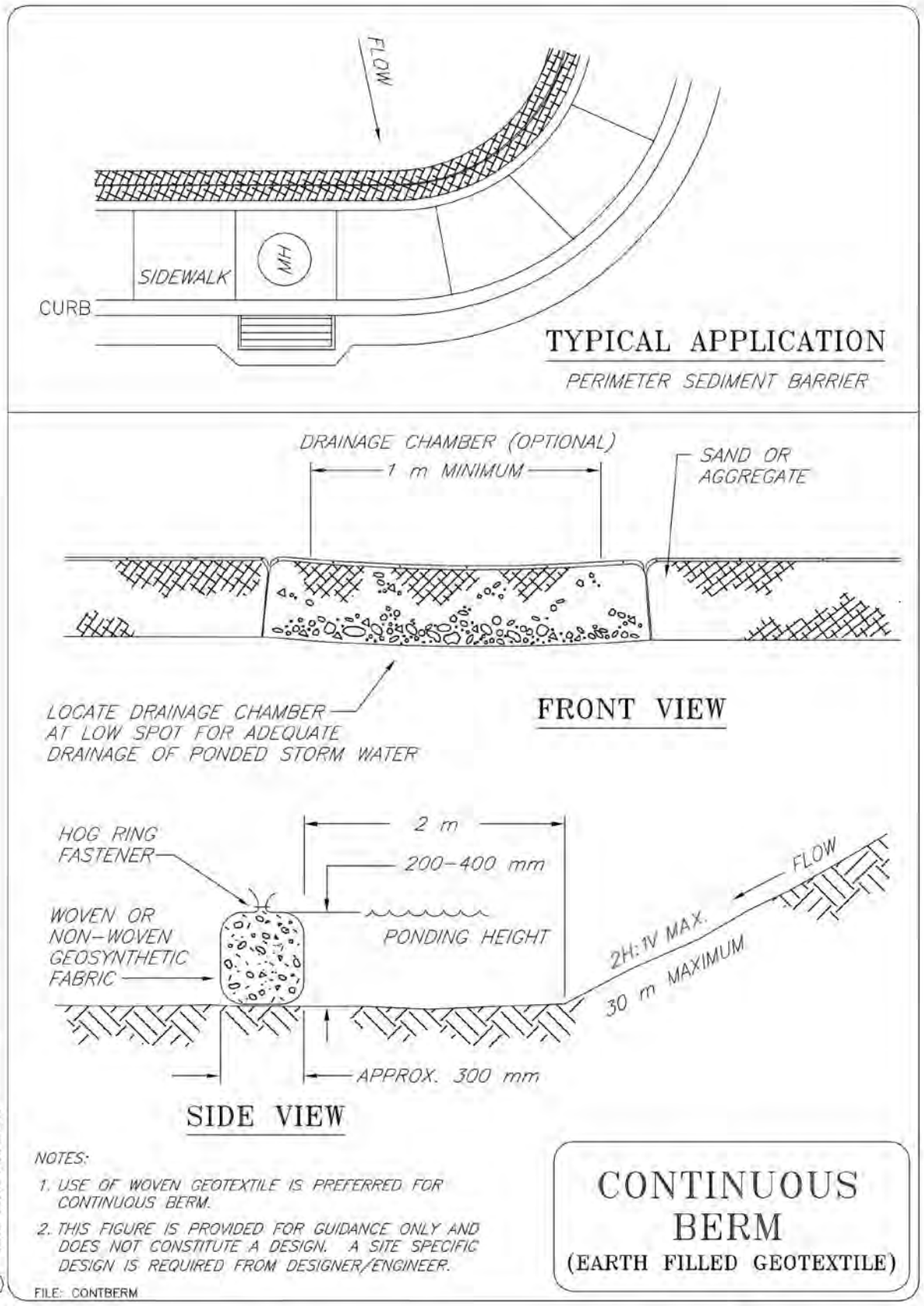
Similar Measures

- Berms/barriers
- Sand/gravel bag barriers

Continuous Berm

Sediment Control:
Settling

BMP26



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Earth Dyke Barrier

Sediment Control:
Settling

BMP27

Description and Purpose

- Barrier constructed of compacted soil to intercept and divert flow of runoff water away from sensitive areas or water bodies
- May require a spillway outlet of erosion-resistant granular material constructed to allow exit of diverted water to less sensitive areas.

Applications

- Temporary or permanent measure
- Used instead of (or in conjunction with) diversion ditches
- Placed along contours at toes of slopes to divert runoff from sensitive areas
- Used to divert water to sediment control structures

Advantages

- Easy to construct
- Can be converted to sediment basin or trap with the design of a permeable filter berm at the exit spillway area

Limitations

- Generally, an earth dyke barrier can be 1 to 2 m in height. Design by a geotechnical engineer is required for barriers greater than 3 m in height in accordance with dam design guidelines and regulatory requirements. The consequences of failure will influence the level of design and construction requirements.

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Construct barrier from bottom up by placing and compacting subsequent lifts of soil
- Degree of compaction of each lift to be determined by the design engineer based on consequences of failure

Construction Considerations

- The barrier shall be trapezoidal in section
- Low barriers should have the slopes tailored to the construction material used
  - 1.5H:1V for granular soils (predominantly gravel)
  - 2H:1V or flatter for compacted mixed or fine grained soils
  - Slope should be a minimum of 3H:1V for uncompacted fine grained soils

Earth Dyke Barrier

Sediment Control:
Settling

BMP27

Inspection and Maintenance

- The degree and extent of inspection and maintenance performed on an earth dyke barrier is directly related to the consequences of failure. Depending on the consequences of failure, an engineer experienced in embankment design and inspection may be required for inspection, design of remedial measures and supervision of their implementation.
- Inspect barriers on a weekly basis and before and after significant rainfall events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Piping failures may be remedied by replacing saturated soils with drier compacted soil and/or by placement on the failed area of a stabilizing toe berm constructed of granular materials over non-woven geotextile
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-half the barrier height
- Deactivate and remove barrier once soils upslope have stabilized and return barrier location to conditions that are equivalent or better than prior to barrier construction

Similar Measures

- Continuous berms
- Sand/gravel bag barriers

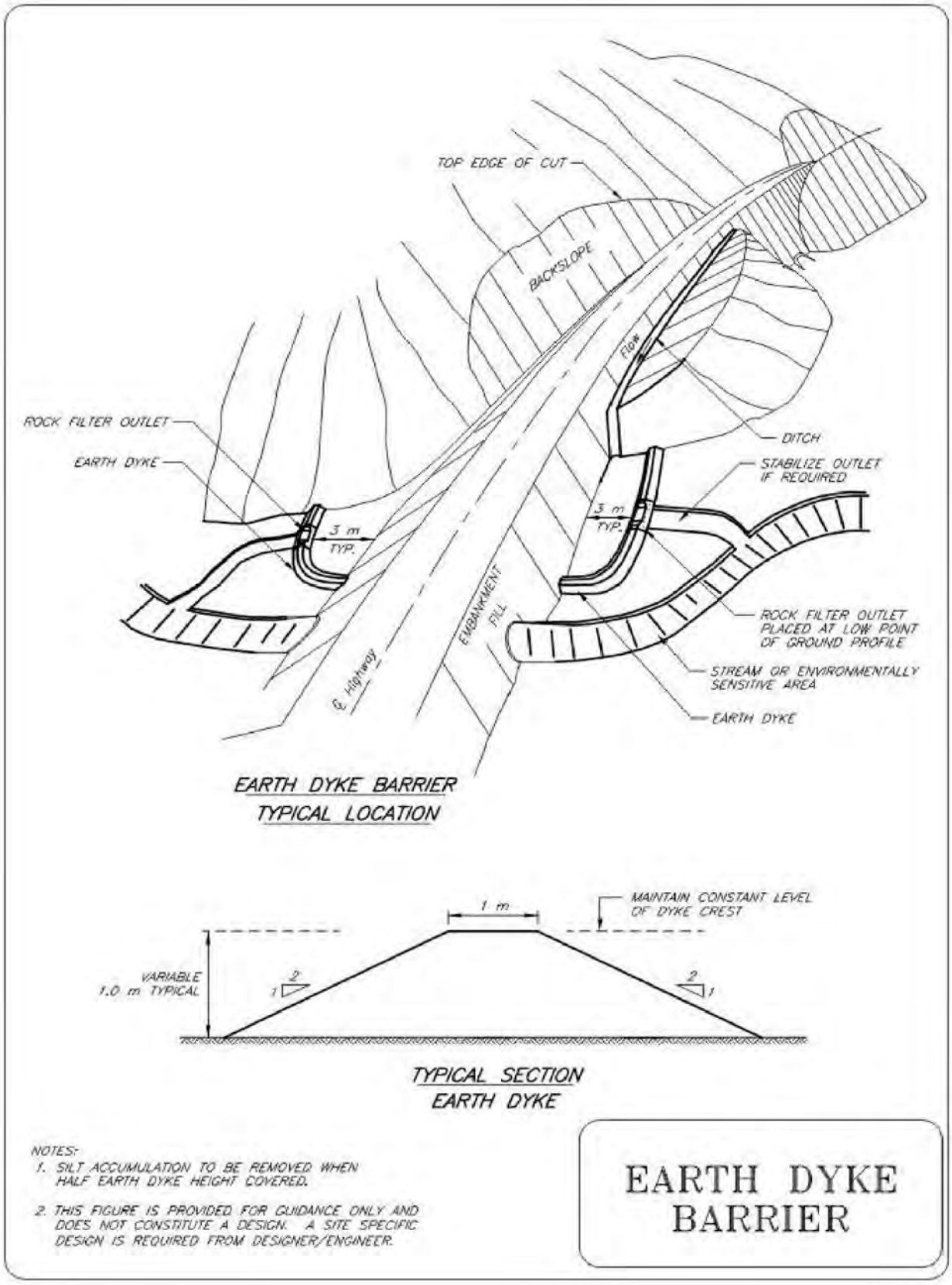
Design Considerations

- Geotechnical design required for barriers constructed of fine grained soils and greater than 3 m in height

Earth Dyke Barrier

Sediment Control:
Settling

BMP27



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Sediment Traps and Basins

Sediment Control:
Settling

BMP28

Description and Purpose

- Low height dam enclosure for impoundment of sediment laden storm water, sedimentation and release of treated runoff
- Used to trap sediment laden run off and promote settlement of sediment prior release
- Constructed by excavating a pond or building embankments above the original ground surface
- Sediment traps and basins can be divided by size of pond impoundment enclosure
  - Basin (Type I) for pond area $\geq$500 m^2
  - Trap (Type II) for pond area $\leq$500 m^2

Applications

- Temporary (for construction period) or permanent measure
- Used at terminal or selected intermediate points of concentrated runoff for impoundment of runoff and sedimentation of silt prior to release of treated runoff
- Used as a sediment control measure at outlets from construction sites where runoff may enter watercourses, storm drains, or other sensitive areas
- Used where there is a need to impound a significant amount of sediment from significant areas of land disturbance
- Removal of small diameter particles may require use of flocculants. This should be done with caution to prevent adverse effects on aquatic life
- Sediment basins (Type I) used for disturbed drainage areas greater than 2.0 ha
- Sediment traps (Type II) used for disturbed drainage areas of 2.0 ha or less
- Where practical, contributing drainage areas should be subdivided into smaller areas and multiple sedimentation impoundment installed

Advantages

- High capacity of runoff impoundment and more efficient means of sedimentation necessary along perimeters of construction sites with high risk sensitive environmental areas and watercourses
- Sediment can be cleaned out easily
- Robust
- Can be deactivated easily by breaching the enclosure dyke

Limitations

- Requires specialized design by qualified personnel
- Sediment traps and basins do not remove 100% of the sediment; net efficiency for sedimentation of silt may be around 50% dependent on design
- Anticipated service life of 3 years or longer due to possible clogging of outlets in the long-term

- Sedimentation traps and basins with a riser outlet should have an auxiliary spillway with adequate erosion protection to permit overflow in the event that the riser pipe outlet clogs during a storm event
- For drainage areas greater than 40 ha, multiple basins may be required
- Efficiency of sedimentation is very dependent on surface area; sediment basins require large surface areas to permit settling of sediment
- Fences and signage may be required to reduce danger to the public
- May provide breeding habitat for mosquitoes and other pests
- Sediment traps only remove medium and large diameter silt particles and upstream erosion or sediment control measures are required to reduce the amount of sediment laden to the runoff at downstream sensitive areas
- Periodic removal of accumulated sediment is required

Construction

(Note: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- The consequences of failure for any water retaining structure will determine the level of effort in the design and construction phases. The construction guidelines presented herein are minimum requirements. A geotechnical engineer should design water retaining structures if warranted by the consequences of failure
- All footprint areas for embankment dykes should be stripped of vegetation, topsoil, and roots to expose a mineral soil subgrade
- Embankment fill material should be clean mineral soil with sufficient moisture to allow proper compaction
- Fill should be placed in lifts not exceeding 150 mm in compacted thickness and should be compacted to a minimum of 95% Standard Proctor maximum dry density (SPD)
- The main outlet structure should be installed at farthest possible point from inlet
  - The outlet should be placed on firm, smooth ground and should be backfilled to 95% SPD
  - Proper inlet and outlet protection should be installed to protect from scour
  - The outlet pipe should consist of corrugated steel pipe to protect against pinching and blockage
- The embankment should be topsoiled, seeded or protected with gravel or riprap immediately after construction
- Construct an emergency spillway to convey flows not carried by the principal outlet
  - The emergency spillway should consist of an open channel (earth or vegetated) over native undisturbed soil (not fill)
  - If the spillway is elevated, it should be constructed of rip rap
  - The spillway crest should be depressed at least 0.15 m below embankment

Sediment Traps and Basins

Sediment Control:
Settling

BMP28

Construction Considerations

- It is preferable to strip to mineral soil only along the footprint area required for dyke construction; the pond floor centre area can be left cleared but unstripped
- The pond can be constructed by excavating, constructing embankments, or a combination of the two methods
- Baffles should be provided to prevent short-circuiting of flow from inlet to outlet. The optimum ratio of flow length to flow width is 5:1
- Construct sediment ponds and basins at the construction site perimeter prior to wet season and construction activities
- Sediment pond/basin bottom should be flat or gently sloping towards outlet
- Dyke slopes should not be steeper than 2H:1V and should be well-compacted
- Basins should be located where:
  - Low embankment can be constructed across a swale or low natural terrain
  - It is accessible for maintenance work, including sediment removal

Inspection and Maintenance

- Regular inspection is required to identify seepage, structural soundness, outlet damage or obstruction and amount of sediment accumulation
- Inspections should be performed weekly and after significant storm events (1:2 yr storm and/or 40 mm rainfall in 24 hours)
- Sediment should be removed upon reaching 1/2 height of the containment berm or within 0.4 m of crest of embankment
- Sediment traps may be deactivated or removed after vegetation of previously disturbed upstream areas has been established

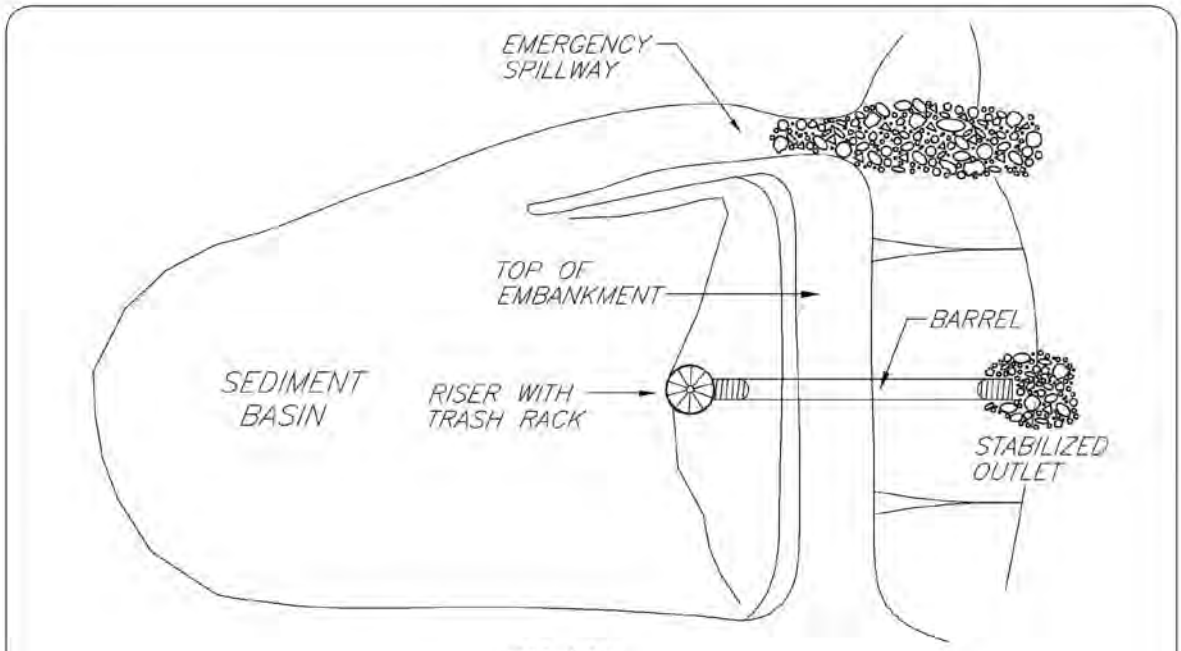
Design Considerations

- The design can use a riser outlet option or a permeable rock berm outlet option. The permeable rock berm outlet option is recommended for most applications
- Minimum particle size for rock rip rap shall be 200 mm
- If the design of a riser outlet is utilized
  - Main outlet pipe shall be fabricated from corrugated steel pipe conforming to CSA standard CAN 5-G401-M81 or the latest revision thereof
  - Outlet pipe shall consist of a horizontal pipe welded to a similar vertical riser at a 45° mitre joint
- Close to the base of the riser pipe, a 100 mm diameter hole shall be fabricated and a mesh with 12 mm square openings tack welded over the hole as a screen
  - A similar hole shall be provided along the riser pipe immediately above the elevation of the maximum sediment buildup (usually 0.4 m below crest of embankment)

Sediment Traps and Basins

Sediment Control:
Settling

BMP28



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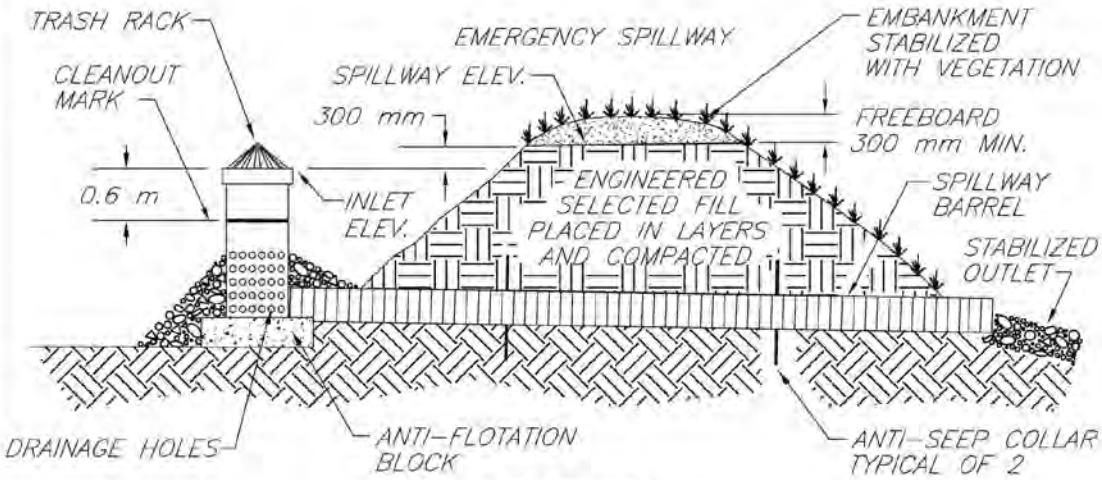


SECTION

NOTES:

1. THE TEMPORARY SEDIMENT BASIN, DESIGNED BY A QUALIFIED PROFESSIONAL, IS REQUIRED FOR DISTURBED AREAS GREATER THAN 2.02 HECTARES (5 ACRES) WITH A DRAINAGE AREA LESS THAN 40.4 HECTARES (100 ACRES).
2. THE SEDIMENT BASIN MAY BE REMOVED WITHIN 3 YEARS.
3. HEIGHT OF ENGINEERED SELECTED FILL EQUAL TO 1 m.
4. FOR CONFIGURATION AND FLOW CHAMBER DESIGN (i.e. LENGTH(L) & WIDTH(W_e) OF BASIN), REFER TO NEXT PAGE.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

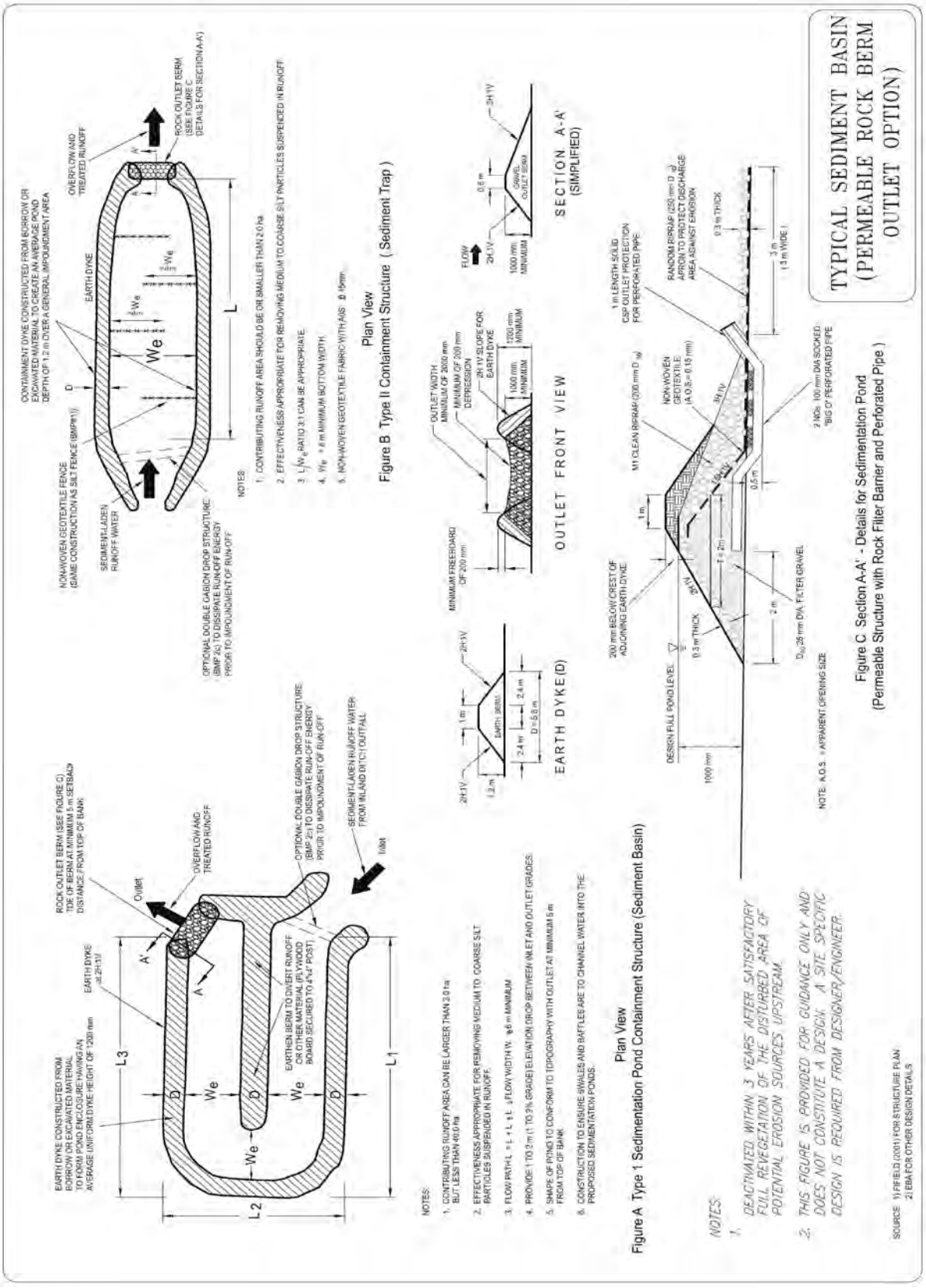
TYPICAL SEDIMENT BASIN (RISER OUTLET OPTION)

FILE: SEDBASIN

Sediment Traps and Basins

Sediment Control:
Settling

BMP28



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Attachment B Operational Statements

BRIDGE MAINTENANCE

Fisheries and Oceans Canada
Nunavut 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:

- 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),
- this Operational Statement is posted at the work site and is readily available for reference by workers,
- 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, 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 Nunavut DFO office, at the address shown below, 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, 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 Nunavut DFO office.

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Nunavut Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the Nunavut DFO office. 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, 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 territorial fisheries timing windows (see the *Nunavut In-Water Construction Timing Windows*), with the exception of ice build-up removal, which can occur 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.

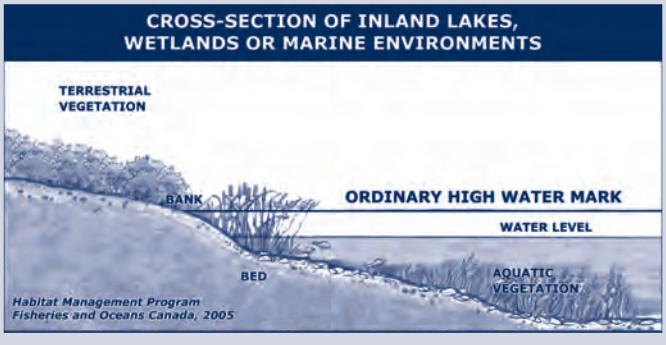
10. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in

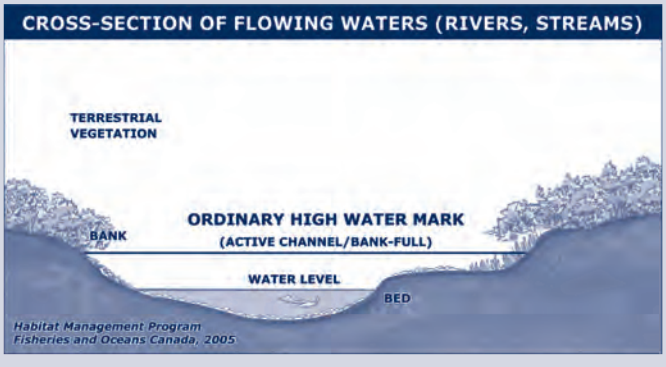
the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should 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).





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DFO/2007-1329

CLEAR-SPAN BRIDGES

Fisheries and Oceans Canada
Nunavut 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 often 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:

- the bridge is placed entirely above the ordinary high water mark,
- 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 Nunavut DFO office, at the address shown below, 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, 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 Nunavut DFO office.

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Nunavut Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the Nunavut DFO office. 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 *Nunavut In-Water Construction Timing Windows*), or alternatively, carry out the project when the water body 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.

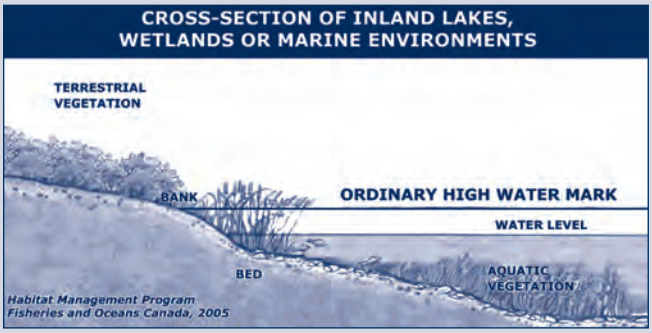
10. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with preferably native grass or shrubs.

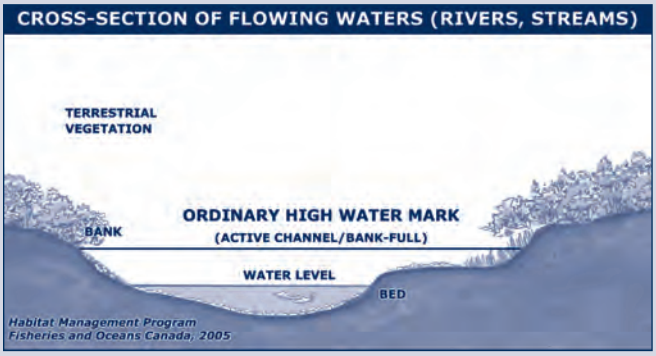
11. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas 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).





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DFO/2007-1329

CULVERT MAINTENANCE

Fisheries and Oceans Canada
Nunavut 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:

- 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 Nunavut DFO office, at the address shown below, 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, 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 Nunavut DFO office.

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Nunavut Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the Nunavut DFO office. 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 *Nunavut 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.

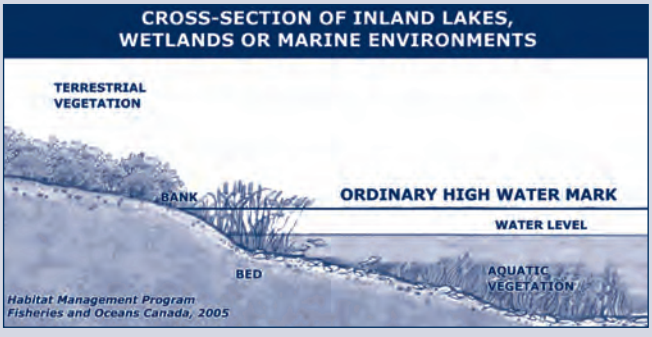
10. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

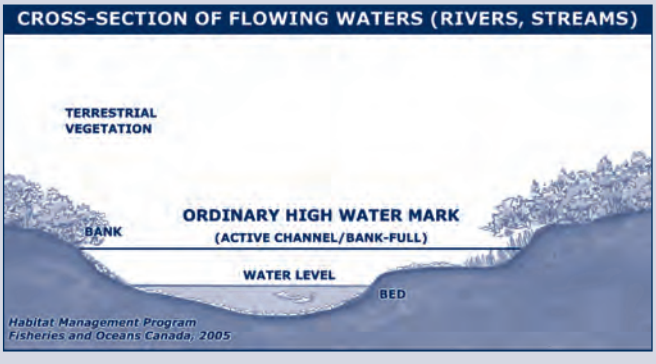
11. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas 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

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.

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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

ISOLATED OR DRY OPEN-CUT STREAM CROSSINGS

Fisheries and Oceans Canada
Saskatchewan Operational Statement

Version 1.0

For the purpose of this Operational Statement, the term "Isolated Crossing" means a temporary stream crossing technique that allows work (e.g., trenched pipeline or cable installation) to be carried out "in-the-dry" while diverting the natural flow around the site during construction. These types of open trenched crossings are isolated using flume or dam and pump techniques (see *Pipeline Associated Watercrossings*, 2005 at **http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=96717**). The term "Dry Open-cut Stream Crossing" means a temporary stream crossing work (e.g., trenched pipeline or cable installation) that is carried out during a period when the entire stream width is seasonally dry or is frozen to the bottom.

The risks to fish and fish habitat associated with isolated open cut stream crossings include the potential for direct damage to substrates, release of excessive sediments, loss of riparian habitat, stranding of fish in dewatered areas, impingement/entrainment of fish at pump intakes, and disruption of essential fish movement patterns. Similarly, dry open-cut stream crossings pose a risk to fish and fish habitat due to potential harmful alteration of substrates, loss of riparian habitat, and release of excessive sediment once stream flows resume.

The order of preference for carrying out a cable or pipeline stream crossing, in order to protect fish and fish habitat, is: a) punch or bore crossing (see *Punch & Bore Crossings* Operational Statement); b) high-pressure directional drill crossing (see *High-Pressure Directional Drilling* Operational Statement); c) dry open-cut crossing; and d) isolated open-cut crossing. This order must be balanced with practical considerations at the site.

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 isolated or dry open-cut stream crossing project without a DFO review when you meet the following conditions:

- for dry, open-cut crossings the watercourse is dry or frozen completely to the bottom at the site,
- for isolated crossings, the channel width of the watercourse at the crossing site is less than 5 meters from ordinary high water mark to ordinary high water mark (HWM) (see definition below),
- the isolated crossing does not involve the construction or use of an off-stream diversion channel, or the use of earthen dams,
- the isolated crossing ensures that all natural upstream flows are conveyed downstream during construction, with no change in quality or quantity,
- the site does not occur at a stream location involving known fish spawning habitat, particularly if it is dependent on groundwater upwelling,
- the use of explosives is not required to complete the crossing, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Carrying Out an Isolated or Dry Open-cut Stream Crossing* listed below.

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 municipal, provincial and 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* (SARA) (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Saskatchewan DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work, by filling out and sending the Saskatchewan 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 Carrying Out an Isolated or Dry Open-Cut Stream Crossing

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

2. Locate crossings at straight sections of the stream, perpendicular to the banks, whenever possible. Avoid crossing on meander bends, braided streams, alluvial fans, active floodplains or any other area that is inherently unstable and may result in the erosion and scouring of the stream bed.

3. Complete the crossing in a manner that minimizes the duration of instream work.

4. Construction should be avoided during unusually wet, rainy or winter thaw conditions.

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

6. Machinery fording a flowing watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and is to occur only if an existing crossing at another location is not available or practical to use. Operational Statements are also available for *Ice Bridges and Snow Fills*, *Clear-Span Bridges*, and *Temporary Stream Crossing*.

    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 is 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. Time the one-time fording to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the *Saskatchewan In-Water Closed Construction Timing Windows*).
    6.5. Fording should occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding.

7. Operate machinery in a manner that minimizes disturbance to the watercourse bed and banks.

    7.1. Protect entrances at machinery access points (e.g., using swamp mats) and establish single site entry and exit.
    7.2. Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
    7.3. Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent deleterious substances from entering the water.
    7.4. Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.

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

9. Stabilize any waste materials removed from the work site, above the HWM, 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 soil 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.

    10.1. Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved.

Measures to Protect Fish and Fish Habitat when Carrying Out an Isolated Crossing

Temporary isolation is used to allow work “in-the-dry” while maintaining the natural downstream flow by installing dams up and downstream of the site and conveying all of the natural upstream flow into a flume, or pumping it around the isolated area. In addition to measures 1 to 10, the following measures should be carried out when conducting an isolated stream crossing:

11. Time isolated crossings to protect sensitive fish life stages by adhering to fisheries timing windows (see Measure 6.4).

12. Use dams made of non-earthen material, such as water-inflated portable dams, pea gravel bags, concrete blocks, steel or wood wall, clean rock, sheet pile or other appropriate designs, to separate the dewatered work site from flowing water.

    12.1. If granular material is used to build dams, use clean or washed material that is adequately sized (i.e., moderately sized rock and not sand or gravel) to withstand anticipated flows during the construction. If necessary, line the outside face of dams with heavy poly-plastic to make them impermeable to water. Material to build these dams should not be taken from below the HWM of any water body.
    12.2. Design dams to accommodate any expected high flows of the watercourse during the construction period.

13. Before dewatering, rescue any fish from within the isolated area and return them safely immediately downstream of the worksite.

13.1. You will require a permit from DFO to relocate any aquatic species that are listed as either endangered or threatened under SARA. Please contact the DFO office in your area to determine if an aquatic species at risk is in the vicinity of your project and, if appropriate, use the DFO website at **www.dfo-mpo.gc.ca/ species-especes/permits/ sarapermits_e.asp** to apply for a permit.

14. Pump sediment laden dewatering discharge into a vegetated area or settling basin, and prevent sediment and other deleterious substances from entering any water body.

15. Remove accumulated sediment and excess spoil from the isolated area before removing dams.

16. Stabilize the **streambed** and restore the original channel shape, bottom gradient and substrate to pre-construction condition before removing dams.

17. Ensure **banks** are stabilized, restored to original shape, adequately protected from erosion and re-vegetated, preferably with native species.

18. If rock is used to stabilize banks, it should be clean, free of fine materials, and of sufficient size to resist displacement during peak flood events. The rock should be placed at the original stream bank grade to ensure there is no infilling or narrowing of the watercourse.

19. Gradually remove the downstream dam first, to equalize water levels inside and outside of the isolated area and to allow suspended sediments to settle.

20. During the final removal of dams, restore the original channel shape, bottom gradient and substrate at these locations.

21. Pumped Diversions
Pumped diversions are used to divert water around the isolated area to maintain natural downstream flows and prevent upstream ponding.

21.1. Ensure intakes are operated in a manner that prevents streambed disturbance and fish mortality. Guidelines to determine the appropriate mesh size for intake screens may be obtained from DFO (e.g., *Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995), available at **www.dfo-mpo.gc.ca/ Library/223669.pdf**).

21.2. Ensure the pumping system is sized to accommodate any expected high flows of the watercourse during the construction period. Pumps should be monitored at all times, and back-up pumps should be readily available on-site in case of pump failure.

21.3. Protect pump discharge area(s) to prevent erosion and the release of suspended sediments downstream, and remove this material when the works have been completed.

Measures to Protect Fish and Fish Habitat when Carrying Out a Dry Open-Cut Stream Crossing

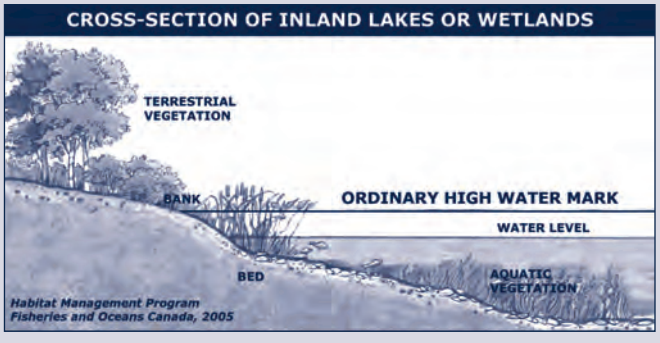
In addition to measures 1 to 10, the following measures should be carried out when conducting a dry open-cut stream crossing:

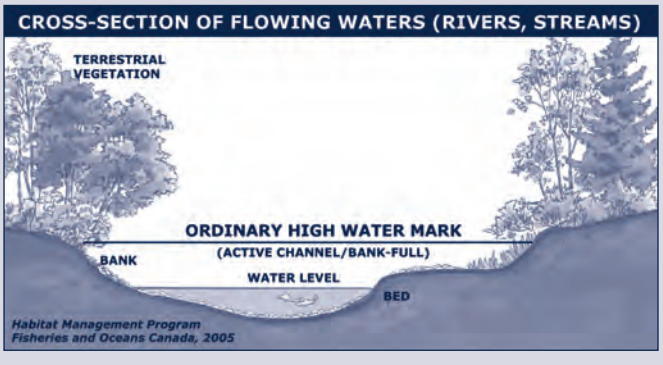
22. Stabilize the **streambed** and restore the original channel shape, bottom gradient and substrate to pre-construction condition.

23. Ensure **banks** are stabilized, restored to original shape, adequately protected from erosion and re-vegetated, preferably with native species.

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 or wetlands, 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

TIMING WINDOWS

Fisheries and Oceans Canada
Nunavut Operational Statement

Version 3.0

NUNAVUT IN-WATER CONSTRUCTION TIMING WINDOWS FOR THE PROTECTION OF FISH AND FISH HABITAT

Restricted activity timing windows have been identified for Nunavut 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 or fall, 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.

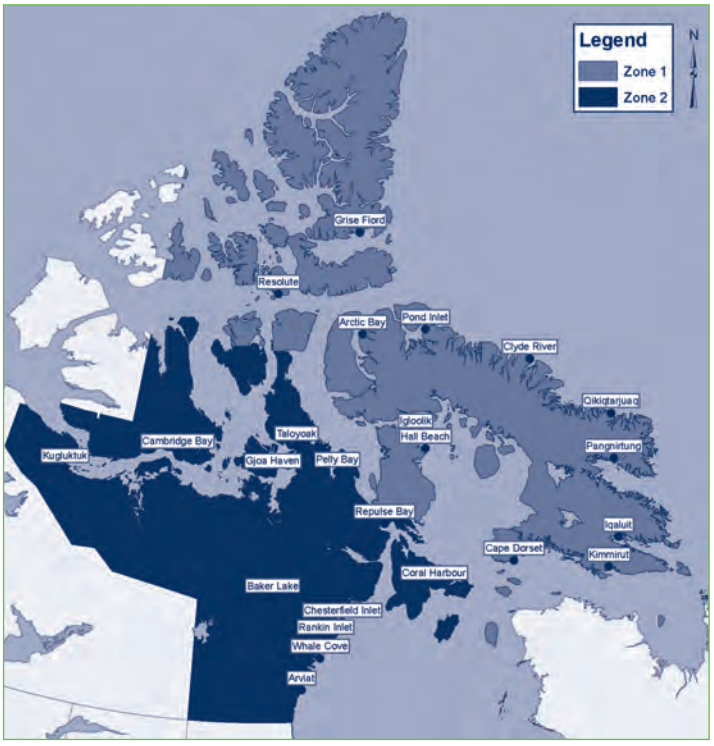

Figure 1:
Fish Timing Zones for Nunavut.

How To Determine Timing Windows

1. Determine if the water body is in Zone 1 or 2 according to Figure 1.
2. If the water body is in Zone 2, determine the fish species living in the water body where you wish to do work. Consult with local sources such as hunter and trapper organizations (HTO), wildlife officers, or contact Fisheries and Oceans Canada (DFO).
3. Determine whether the fish living in the water body spawn in the spring or fall according to Table 1. Where both spring and fall spawning fish are present, or if it is unknown what species are in the water body, both timing windows should be combined to adequately protect all species.
4. Using Table 2 below determine the in-water work timing restrictions according to the location of a water body (Zone 1 or 2) and whether the species in the water body spawn in the spring or fall. During these periods, in-water or shoreline 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 Nunavut.

Species	Spawning Period (Spring/Fall)
Arctic Char	Fall
Lake Trout	Fall
Whitefish [1]	Fall
Arctic Grayling	Spring
Northern Pike	Spring

[1] Includes Broad, Lake and Round Whitefish

Table 2:
Timing Window when In-Water Activities are NOT permitted, by Zone and Spawning Period.

Zone	Spring Spawning Species	Fall Spawning Species	Spring & Fall Spawning, or Unknown Species
1	N/A	September 1 – June 30	N/A
2	May 1 - July 15	August 15 – June 30	August 15 – July 15

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

DFO/2007-1329

ROUTINE MAINTENANCE DREDGING FOR NAVIGATION

Fisheries and Oceans Canada
Pacific Region Operational Statement

Version 3.0

Routine maintenance dredging refers to the removal of accumulated sediment from channel beds to maintain the design depths of existing public use facilities such as navigation channels, harbours, marinas, boat launches and port facilities. It does not include clean-out of channels for other purposes, such as agricultural drains or water intake installation. Routine maintenance dredging is conducted regularly (e.g., at least once every five years) and does not include any expansion of the previously dredged area. Dredging is typically conducted by mechanical methods such as clam buckets, draglines or backhoes. The greatest threat to fish habitat is from the increased amount of suspended sediments introduced to the water column during the dredging process and the resulting disruption of sensitive fish life stages.

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 routine maintenance dredging project without a DFO review when you meet the following conditions:

- the maintenance dredging is only for navigational purposes,
- the site has been previously dredged in the last 5 years and no expansion of the dredged area occurs,
- dredging of contaminated sediments does not occur,
- hydraulic methods such as suction dredging or propeller washing are not used,
- the dredged material will not be used to infill the shoreline or adjacent wetlands, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when doing Routine Maintenance Dredging* 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 comply with all municipal, provincial, territorial and/or federal legislation that applies to the work being carried out in relation to this Operational Statement. In British Columbia, please contact the Water Stewardship Division, Ministry of Environment (**http://www.env.gov.bc.ca/wsd/water_rights/licence_application/section9/index.html**) for information on the Provincial *Water Regulation* notification requirements when planning to conduct routine maintenance dredging for navigation in or around BC waters. For activities in marine areas, contact FrontCounter BC for provincial permitting requirements.

The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act.* For general information on aquatic SARA species visit the following web site: **http://www.dfo-mpo.gc.ca/species-especes/regions/Pac/pacific-index-eng.htm** and/or contact DFO by email at: **SARA@pac.dfo-mpo.gc.ca**

If you have questions regarding this Operational Statement, please refer to the list of **Frequently Asked Questions** (**http://www.pac.dfo-mpo.gc.ca/habitat/os-eo/faq-eng.htm**) or contact DFO Regional Headquarters at 1-866-845-6776.

Please notify DFO 10 working days before starting your work by filling out and sending the Pacific Region Operational Statement **notification form** directly to DFO Regional Headquarters. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement. It is recommended that you keep a copy of the Operational Statement at the work site to demonstrate to Habitat and Fishery Officer staff that the conditions and measures, as outlined in the OS, are being followed.

Area of Application
This Operational Statement applies to the province of British Columbia and Yukon Territory freshwater and marine systems only.

Measures to Protect Fish and Fish Habitat when doing Routine Maintenance Dredging

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

2. Minimize the riparian area temporarily disturbed by access activities along the adjacent upland property, and preserve trees, shrubs and grasses near the shoreline.

3. Time routine maintenance dredging to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries **timing windows** (**http://www.pac.dfo-mpo.gc.ca/habitat/timing-periodes/Index-eng.htm**).

4. Install effective sediment control measures around the perimeter of the work area before starting work and during dredging to prevent re-suspended sediment from spreading to adjacent areas. Inspect these measures regularly and make all necessary repairs if any damage occurs. Remove these control measures in a way that prevents the escape or re-suspension of sediments.

   4.1 Dredge on calm days to minimize the suspension of fine sediment particles into the water column and ensure the sediment control measures are not disturbed by wave action.

5. Restrict the amount dredged to the area and depth previously required for navigation.

   5.1. Avoid bottom stockpiling or side casting during dredging.
   5.2. Prevent fish from being trapped within the dredged area.

6. Operate machinery on land or on water (i.e. from a barge or vessel) in a manner that minimizes disturbance to the banks or bed of the water body.

   6.1. Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks, invasive species and noxious weeds.
   6.2. 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.
   6.3. Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
   6.4. Restore banks to original condition if any disturbance occurs.

7. For water–based operations, avoid placing vertical spuds or other anchors into sensitive fish habitat areas such as eel grass, kelp beds, salt marshes, shellfish harvesting areas and known spawning areas.

8. Dredgeate should be disposed of offsite and in accordance with appropriate legislation. For ocean disposal, dredgeate must be of a benign character (i.e. uncontaminated) and adhere to federal Disposal at Sea permitting requirements.

9. 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 or planting them with grass or shrubs.

10. Vegetate any disturbed areas by planting and seeding with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. All seeding and/or planting trees should follow the DFO guidance on **Riparian Revegetation** (**http://www.pac.dfo-mpo.gc.ca/habitat/reveg/index-eng.htm**). 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.

DFO REGIONAL HEADQUARTERS

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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/2007-1283

NOTIFICATION FORM

Fisheries and Oceans Canada
Pacific Region Operational Statement

Version 3.1

PROPONENT INFORMATION

NAME:	STREET ADDRESS:	
CITY/TOWN:	PROVINCE/TERRITORY:	POSTAL CODE:
TEL. NO. (RESIDENCE):	TEL. NO. (WORK):	
FAX NO:	EMAIL ADDRESS:	

CONTRACTOR INFORMATION (provide this information if a Contractor is working on behalf of the Proponent)

NAME:	STREET ADDRESS:	
CITY/TOWN:	PROVINCE/TERRITORY:	POSTAL CODE:
TEL. NO. (RESIDENCE):	TEL. NO. (WORK):	
FAX NO:	EMAIL ADDRESS:	

PROJECT INFORMATION

Select Operational Statements that are being used (check all applicable boxes):

- ❒ Aquatic Vegetation Removal in Lakes
- ❒ Bridge Maintenance
- ❒ Culvert Maintenance
- ❒ Directional Drilling
- ❒ Dock and Boathouse Construction in Fresh Water Systems
- ❒ Dry Open-Cut Crossings
- ❒ Ice and Snow Fill Bridges
- ❒ Isolated Pond Construction
- ❒ Maintenance of Riparian Vegetation in Existing Rights-of-Way
- ❒ Overhead Line Construction
- ❒ Public Beach Maintenance
- ❒ Punch and Bore Crossings
- ❒ Routine Maintenance Dredging for Navigation
- ❒ Small Moorings
- ❒ Small Clear-Span Bridges
- ❒ Temporary Ford Crossings
- ❒ Underwater Cables in Fresh Water Systems

Select the type of water body or watercourse at or near your project:

- ❒ River, Stream, Creek
- ❒ Lake (8 hectares or greater)
- ❒ Marine (Ocean or Sea)
- ❒ Estuary
- ❒ Pond or wetland (pond is less than 8 hectares)

PROJECT LOCATION (S) (fill out this section if the project location is different from Proponent Information; append multiple project locations on an additional sheet if necessary)

Name of water body or watercourse Nearest Town to site	Coordinates of the Project (UTM co-ordinate or Degrees, Minutes, Seconds), if available Easting: Northing: Latitude: Longitude:
Legal Description (Plan, Block, Lot, Concession, Township, Section, Range)	Directions to Access the Project Site (i.e., Route or highway number, etc.)
Proposed Start Date (YYYY/MM/DD):	Proposed Completion Date (YYYY/MM/DD):

Please notify DFO, preferably 10 working days before starting your work, by filling out and sending in, by mail, email or by fax, this notification form to the DFO Regional Headquarters. This information is requested in order to evaluate the effectiveness of the work carried out in relation to the Operational Statement.

I, _____ (print name) certify that the information given on this form is, to the best of my knowledge, correct and complete.

Signature _____ Date _____

Note: If you cannot meet all of the conditions and cannot incorporate all of the measures in the Operational Statement 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.*

Information about the above-noted proposed work or undertaking is collected by DFO under the authority of the *Fisheries Act* for the purpose of administering the fish habitat protection provisions of the *Fisheries Act*. Personal information will be protected under the provisions of the *Privacy Act* and will be stored in the Personal Information Bank DFO-SCI-605. Under the *Privacy Act*, Individuals have a right to, and on request shall be given access to, any personal information about them contained in a personal information bank. Instructions for obtaining personal information are contained in the Government of Canada's Info Source publications available at **www.infosource.gc.ca** or in Government of Canada offices. Information other than "personal" information may be accessible or protected as required by the provisions of the *Access to Information Act*.

This Notification Form (Version 3.1) may be updated as required by Fisheries and Oceans Canada. It is your responsibility to use the most recent version. Please refer to the Operational Statements web site at **http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_e.asp** to ensure that a more recent version has not been released.

DFO REGIONAL HEADQUARTERS

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Toll Free: 1-866-845-6776
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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/2007-1283

Attachment C Clarification of “Acceptable Levels” for TSS and Turbidity.

Based on modelling work by Newcombe and Jensen (1996), total suspended solids (TSS) thresholds can be developed based on TSS concentrations and duration of exposure. For short durations (e.g., days), TSS levels less than 75 mg/L are considered to be small in magnitude and behaviourally related. Medium magnitude levels of TSS are between 75 and 150 mg/L with some sublethal effects at longer durations (e.g., short-term reduction in feeding success). Total suspended solids levels that exceed 150 mg/L would be considered to be of high magnitude and would cause severe effects over a long duration exposure (e.g., reduce growth, potential habitat damage).

A TSS value of 150 mg/L can be used as the threshold beyond which in-water construction projects are stopped in order to find ways to complete the project with reduced levels of disturbance. At this concentration the severity-of-ill-effect rankings are relatively low for short duration exposure and remain in the sublethal range for longer exposures. Therefore, this is a conservative and acceptable threshold which allows time for implementing a response if necessary.

As real-time field measurement of TSS is considered impractical, turbidity can be measured readily in situ and can be used as a surrogate for TSS. Various site-specific factors (e.g., particle size distribution or shape, colour, presence of algae or tannic acids) affect the relationship between TSS and turbidity. Therefore, a site-specific TSS/turbidity calibration curve must be developed for the particular waterbody involved using laboratory measurements of TSS. Based on the development of the curve, the turbidity level that represents a TSS value of 150 mg/L will be determined. If field-measured turbidity values exceed the threshold turbidity outside of the silt curtain then work inside the silt barrier would stop and appropriate corrections made prior to work re-starting.

Newcombe CP, Jensen OT. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Qualitative Assessment of Risk and Impact. North American Journal of Fisheries Management. 16:693-727.