Government of Canada

Norman Wells Wharf Rehabilitation – Sediment and Erosion Control Plan

Prepared by:

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Project Number: 60539384

Permit and License Conditions

Permit #	Conditions of Permit	How plan meets conditions in permit
S16L8-002	Part B: General Condition 14	Outlines sediment and erosion control measures

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Revision History

Revision #	Date	Revised By:	Revision Description
0			

Conformity Table

Date Submitted	Date Approved	Version	Reason for Submission

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AECOM: 2017-01-13

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Executive Summary

AECOM Canada Ltd. (AECOM) was retained by Public Services and Procurement Canada (PSPC)/Government of Canada (GOC) to complete this Sediment and Erosion Control Plan (SECP) to satisfy the requirements of the water license issued for the rehabilitation and maintenance work for the Canadian Coast Guard (CCG) wharf located in Norman Wells, Northwest Territories (NT) Canada. The SECP outlines the specific aspects of the project that present a risk of sedimentation and erosion and provides suggested mitigation methods to reduce or avoid impacts.

There are two primary construction phases to the CCG wharf project: in-water dredging to improve vessel access to the wharf and wharf rehabilitation. This SECP covers only land-based activities, as no sediment and erosion control measures are planned for the in-water dredging. Construction activities for the dredging work are anticipated to occur during February-March 2018 to make use of ice thickness and minimal water depths for dredging access. The use of erosion control measures for dredging during winter in a river are not considered practical or feasible.

The wharf rehabilitation work is anticipated to start and finish in the summer of 2018 when the Mackenzie River levels are low and the work will occur in a dry environment above the waterline.

Glossary & Acronyms

AECOM	AECOM Canada Ltd.
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Agency
DFO	Department of Fisheries and Oceans Canada
EA	Environmental Assessment
EMP	Environmental Management Plan
EPP	Environmental Protection Plan
GOC	Government of Canada
NT	Northwest Territories
PSPC	Public Services and Procurement Canada
RAP	Restricted Activity Period
RPSS	Real Property Safety and Security
SECP	Sediment and Erosion Control Plan
WMP	Waste Management Plan

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1. Introduction & Background

This Sediment and Erosion Control Plan (SECP) has been developed for the rehabilitation and maintenance work for the Canadian Coast Guard (CCG) wharf located in Norman Wells, Northwest Territories (NT) Canada (the Project). This plan has been prepared to satisfy condition Part G, Section 1 of the "Type B" Water Licence (NO. S16L8-002) issued to Department of Fisheries and Oceans Canada.

The CCG Wharf in Norman Wells, originally constructed in the early 1980's, consists of an earthfill contained within sheet piles driven into the riverbed. Over the years, the top of the sheet pile has suffered substantial ice damage during spring break-up. Some maintenance was carried out to repair ice damage during the first decade. During the past 2 decades, annual maintenance has consisted of clearing the ice of the wharf after breakup and replacing gravel that was washed off the surface. Maintenance dredging has also occurred every few to several years to remove sediments deposited in front of the wharf. The last dredging program was completed in 2015.

The CCG Wharf in Norman Wells is currently owned by the Department of Fisheries and Oceans (DFO). In 2017, DFO initiated a project to rehabilitate the sheet pile and complete maintenance dredging in front of the wharf to improve vessel access at low water.

The project was originally tendered in August 2017, but did not proceed at that time because the single tender received was higher than the budget. The project is now scheduled for completion during 2018. It is anticipated that dredging will occur during February working off the ice cover (see **Appendix A** for a Site Plan for the dredging project). Repair of the sheet pile is scheduled to occur during summer of 2018.

Dredging was last completed in 2015; however, further dredging is necessary due to additional accumulation of sediment Discussions that occurred earlier on the project confirmed that the nature of the activities did not require an Environmental Assessment (EA). The Department of Fisheries and Oceans Canada (DFO) completed a Canadian Environmental Assessment Agency (CEAA) 2012 Project Effects Determination – Self Assessment, and prepared a report of the findings. The DFO Real Property Safety and Security (RPSS) Regional Director approved this self-assessment. The self-assessment that was reviewed by DFO included a turbidity curtain as the dredging was scheduled to occur during summer. The dredging is now proposed to be completed during winter when the use of sedimentation control in a river is not practical. This revised schedule and methodology was submitted to DFO in October 2017, and DFO determined that the project would not require an Authorization under the *Fisheries Act*.

During the construction phases of the Project the following activities are planned:

Dredging (February-March 2018)

- Mobilization of equipment and materials,
- Thickening the ice by flooding, starting 2 to 3 weeks prior to dredging;
- Dredging 15 m out beyond the existing footprint of the wharf to a depth of approximately 1-2 m,
- Transportation of dredging spoils off site to the town landfill

Wharf Repairs (Summer 2018)

- Mobilization of equipment and materials,
- Staging of equipment and materials,
- Excavation of materials from the dry environment of the existing wharf,
- Removal of the upper 2 m of sheet-piling of the wharf,

- Welding new sheet-piling,
- Concrete pouring within the wharf, and
- Backfilling the wharf.

1.1 Objectives & Project Scope

This SECP describes the Project construction activities, the potential impacts to environmental components, and the recommended mitigation measures to reduce sedimentation and erosion to the Mackenzie River from land-based activities. This document includes only mitigations for sediment and erosion control. Mitigations for other environmental aspects (e.g., spills, wildlife, etc.) are presented in other documents related to the project.

1.2 Related Documents

The following documents are associated with the SECP for the Project:

- Waste Management Plan (WMP),
- Spill Contingency Plan (SCP),
- Environmental Management Plan (EMP), and;
- Written permission for disposal of excavated materials.

1.3 Applicable Regulations

The following regulations apply to sediment and erosion control planning in the NWT:

- *Northwest Territories Waters Act* and Regulations,
- *Fisheries Act* and Regulations,
- *Mackenzie Valley Resource Management Act* and Regulations,
- *Arctic Waters Pollution Prevention Act* and Regulations, and;
- *Territorial Lands Act* and Regulations.

1.4 Updates

The mitigations described in this document will be updated as required by regulatory commentary and changing site conditions. Significant updates to the measures and mitigations described below will require review and approval by the Authorities Having Jurisdiction (AHJ).

2. Project Description

2.1 Overview

This section provides a description of the major components of the Project. There are two primary components to the Project: in-water dredging to improve vessel access to the wharf and wharf rehabilitation.

2.1.1 Dredging

The dredging program is currently scheduled to occur in January with construction of an access on the ice cover, followed by dredging to be completed in February-March 2018, working off the ice cover. The dredging project will include the following activities:

- Starting about 20 to 30 days prior to dredging, the contractor will remove the show off the ice cover and flood a work area 2-3x the width of the impacted area. Access to shore will be at the downstream edge of the wharf.
- When there is sufficient ice thickness to support the weight of the construction equipment, the backhoe will walk out along the access up to the upstream most part of the face of the wharf and work his way downstream. The procedure will involve breaking the ice cover and placing the broken ice blocks along the offshore part of the dredged area.
- The backhoe will then excavate the riverbed to a target elevation of 37.0 m. Excavated material will be placed into trucks that will back in behind the backhoe, and taken downstream along the access and stockpiled at the Town's landfill for use as cover.
- As the backhoe completes dredging in an area, he will move downstream to the next area and proceed as described above until the entire area has been dredged. The ice cover will be allowed to form naturally as the backhoe moves on to the next area.

2.1.2 Wharf Rehabilitation

The wharf rehabilitation is scheduled for construction during the summer of 2018 when water levels are low. As this work is to be tendered in 2018, the specifics of the construction activities have yet to be finalized; however it is anticipated that no work will occur in the water. Wharf rehabilitation will include the following:

- Excavation of the top 2.5 m of gravel around the inner edge of the sheet-pile,
- Cutting and removal of the top 2 m of existing damaged sheet-pile,
- Welding of the sheet-pile,
- Repairing tie-backs,
- Backfilling the excavation,
- Casting a concrete collar around the inner edge of the sheet-pile,
- Welding ladder rungs, and;
- Placing 20 mm minus gravel on the upper deck of the wharf.

Table 1. Anticipated Project Schedule

Task	Estimated Commencement	Estimated Completion
Dredging Work	February/March 2018	March 2018
Wharf Rehabilitation	Summer 2018	Fall 2018

3. Sediment and Erosion Control

The *Government of the Northwest Territories, Department of Transportation Erosion and Sediment Control Manual* (GNWT 2013) and Fisheries and Oceans Canada's *Measures to avoid causing harm to fish and fish habitat including aquatic species at risk* website (DFO 2017a) maintain lists of recommendations and best practices to control sediment and erosion during work near water. Relevant best practices that will be used during the Project are described below. Land-based activities during the project will be limited to the existing footprint of the wharf.

3.1 Dredging

Environment Canada maintains a long-term dataset of turbidity (NTU) levels measured in the Mackenzie River at Norman Wells (ECC 2017). Turbidity levels are typically very low during the winter months when the dredging is scheduled to occur (Table 2). The work is scheduled to occur during the Restricted Activity Period (RAP) of December 1st – April 15th for winter spawning fish in the Mackenzie River near Norman Wells (DFO 2017b).

Dredging is scheduled to occur through the ice in February-March 2018, during the period of maximum ice thickness and lowest river flows. The dredging will take place in the nearshore area, existing river ice will be at or near the bottom, flow velocities will be very low and migration of suspended sediment will be limited to the localized area.

Table 2. Average Monthly Turbidity Readings in the Mackenzie River at Norman Wells (2001 - 2015)

Month	Turbidity (NTU)	Standard Deviation
January	1.9	0.6
February	1.5	0.0
March	2.1	0.7
April	3.1	1.7
May	220.5	209.6
June	299.3	598.9
July	102.7	40.4
September	40.7	30.2
December	38.2	61.3

The following ESC measures will be employed during land-based activities to support the dredging operations.

- No material will be stockpiled on site. All dredged material will be placed into trucks and stockpiled at the Town Landfill site.
- No impact to shoreline is expected as the work will occur on top of the ice cover. Where the access reaches land the ground will be frozen so no impact is expected.
- Remove all construction materials from site upon project completion.
- Remove any spoils materials spilled on the ice before leaving site.

3.2 Wharf Rehabilitation

The wharf rehabilitation is scheduled for construction during the summer of 2018 when water levels are low. As this work is to be tendered in 2018, the specifics of the construction activities have yet to be finalized; however it is anticipated that no work will occur in the water. The following ESC measures will be employed during land-based activities to support the wharf rehabilitation operations.

- Stockpiled materials will be limited in height to prevent wind related sediment migration,
- Stockpiled materials will be covered with a tarpaulin, or similar material, during rainy or windy conditions to prevent migration of sediment,
- Installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body.
- Compact material immediately after placement to prevent silt from entering the river during rainfall???
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, then ensure that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Remove all construction materials from site upon project completion.

3.3 Government of Northwest Territories Best Management Practices

The following best management practices (BMP's) from Government of the Northwest Territories, Department of Transportation Erosion and Sediment Control Manual (GNWT 2013) will be employed during both aspects of the project discussed above in Sections 3.1 and 3.2 above (**Table 3** and **Appendix B**).

Table 3. Government of Northwest Territories Sediment and Erosion Control Best Practices Relevant to the Project

GNWT BMP #	BMP Name	Purpose
1	Sediment Fence	Provides instructions for the installation and maintenance of sediment fence
25	Scheduling	Provides best practices for scheduling work to avoid erosion and sedimentation
29	Rolls (Coir Roll and Fibre Roll)	Provides instructions for straw rolls that can be installed along riverbanks and shorelines to prevent erosion into a waterbody.

4. Monitoring

The contractor will be responsible for regular inspection of all erosion and sediment control methods. These inspections will include visual monitoring of all erosion and sediment control structures and visual monitoring of areas downslope of these structures. Any deficiencies noted during the inspections should be repaired immediately, and structures should be upgraded or replaced if sedimentation and/or erosion is observed downstream of the structures.

Indigenous and Northern Affairs Canada (INAC) will have an inspector on site during construction to monitor the works.

5. Contingencies

Should any sediment and erosion control measures be deemed insufficient on site, the contractor shall temporarily halt work until appropriate measures can be implemented. Significant updates to the measures and mitigations described herein may require review and approval by the Authorities Having Jurisdiction (AHJ).

6. References

DFO (Department of Fisheries and Oceans Canada). 2017a. *Measures to avoid causing harm to fish and fish habitat including aquatic species at risk*. http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html. Accessed 30 November 2017.

DFO (Department of Fisheries and Oceans Canada). 2017b. *Projects Near Water - Northwest Territories Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat*. http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/nwt-eng.html. Accessed 1 December 2017.

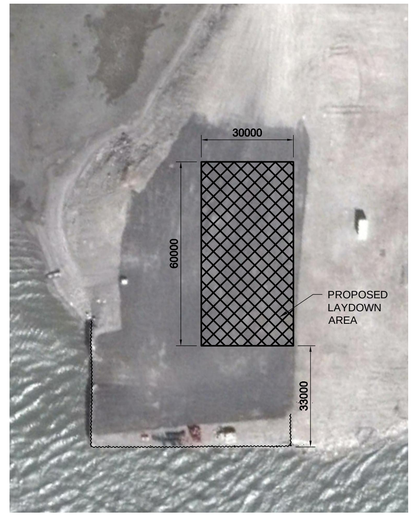
ECC (Environment and Climate Change Canada). 2017. *Mackenzie River at Norman Wells*. http://open.canada.ca/data/en/dataset/0177c195-13a8-4078-aa85-80b17e9e2cfe. Accessed 30 November 2017.

7. Appendices

Appendix A – Site Plan
Appendix B – Government of the Northwest Territories – Best Management Practices

NOTE:
1. DO NOT DREDGE STIFF SHALE IF ENCOUNTERED BEFORE FINAL ELEVATION.
2. CONTRACTOR SHALL NOT STOCKPILE ANY MATERIAL WITHIN 10m OF SHEET PILES.

LEGEND
- PROPOSED CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR



SITE PLAN
Scale 1:1000

	NORTHING	EASTING	ELEVATION
WP1	7240413.777	603566.440	43.130
WP2	7240411.486	603575.693	43.000

PLAN
Scale 1:200

PWGSC – A1 – 841X594

0 10 20 30 40 50 60 70 80 90 100mm

A000

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region
SERVICES IMMOBILIERS
Région de l'ouest

AECOM

Revision	Description	Date
5		
4		
3		
2		
1		
0	ISSUED FOR REGULATORY PERMIT APPLICATION	2017/12/04

Client / client

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Project title / Projet

NORMAN WELLS CCG WHARF REPAIRS

Designed by / Conçu par: AJP
Drawn by / Dessiné par: KC
Approved by / Approuvé par: EBL
PWGSC Project Manager / Administrateur de Projets TPSGC: ML

Drawing title / Titre du dessin

SURVEY PLAN FOR DREDGING REGULATORY APPLICATION

Project no./No. du projet	Drawing no./No. du dessin	Revision no.
R.084190.001	S01 OF 1	0

Sediment Fence Sediment Control	B.M.P. #1

- Useable life of approximately one year dependent on regular maintenance

Construction

- Two methods of installation are commonly used
  - Trench method (common method)
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent) (used in areas where soil depth is not a concern, therefore has not been included in this manual)
- Trench Method
  - Select location of sediment fence (fence must be level - along contours)
  - Excavate a trench approximately 0.15 m deep by 0.15 m wide for entire length of fence along upstream side of posts;
  - With fabric on the upstream or upslope side toward the flow, drive support posts a minimum of 0.3 m into ground, spaced a maximum of 2 m apart;
  - Extend the loose flap of filter fabric the bottom to cover the base of trench (see figure);
  - Backfill and compact soil in trench, being careful not to damage fence or dislodge posts;
  - Where extra support is required, attach the wire mesh or snow fencing, as reinforcement, to upstream side of posts with staples or other type of ties. If using fencing material which is not stapled to the posts, place the w ire mesh or snow fencing first and then line the upslope side with the fabric. Secure all tightly to the posts.

Construction Considerations

- Site Selection
  - Size of drainage area upslope of the sediment fence should be no greate r than 0.1 ha for each 30 m length of sediment fence;
  - Maximum slope length above sediment fence should be no greater than 30 m;
  - Maximum slope gradient above the sediment fence should be no greater than 2H:1V;
- Fence should be placed on contour (level) to produce proper water detention;

Sediment Fence Sediment Control	B.M.P. #1

- Fence should be placed far enough away from toe of slope to provide adequate retention area (minimum of 1.8 m away from toe of slope is recommended) which will also permit access by equipment to conduct maintenance;
- Fence should not be installed immediately adjacent to a stream. The fence should be as far from the stream edge as possible and at a minimum far enough (>1.0 m is recommended) from the stream bank to allow room for a second fence to be installed, should the first one fail or become damaged; Ends of fence should be angled upslope (smile) to collect runoff;
- Fence fabric should not extend more than 0.7 m above grade when installed correctly;
- Fence fabric (and wire mesh or snow fence, if used) should be dug into a trench at least 0.15 m deep (six inches) and lay across the bottom of the trench 0.15 m to prevent undercutting of fence by runoff; Fence stakes can be wood or metal material dependent on design and ground conditions;
- Stakes are to be placed on downstream side of fence, fabric on the same side as the material to be contained;
- Posts should not be spaced greater than 2 m apart;
- Wire mesh or standard snow fencing may be placed on the upslope side of the fencing to provide additional strength and support reinforcement;
- Fence material should be cut from a continuous roll to avoid joints. If joints are necessary, the wrapping of fabric 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 material (and wire mesh or snow fence, if used) should be attached to posts with heavy duty staples, tie wires, or hog rings;
- Trench backfill should be compacted.
- Long sections of silt fence are more prone to failure than short sections.
  - Maximum length of each section of silt fence should be 40 m.
  - Sediment fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours (level). The J pattern allows for an escape path for detained water (minimizes pushing over or overtopping of the fence structure).

Inspection and Maintenance

- Inspection frequency should be in accordance with the PESC and TESC Plans. Sediment fences should be inspected daily but at a minimum of once every 7 days, as well as after significant storm events and spring melt.

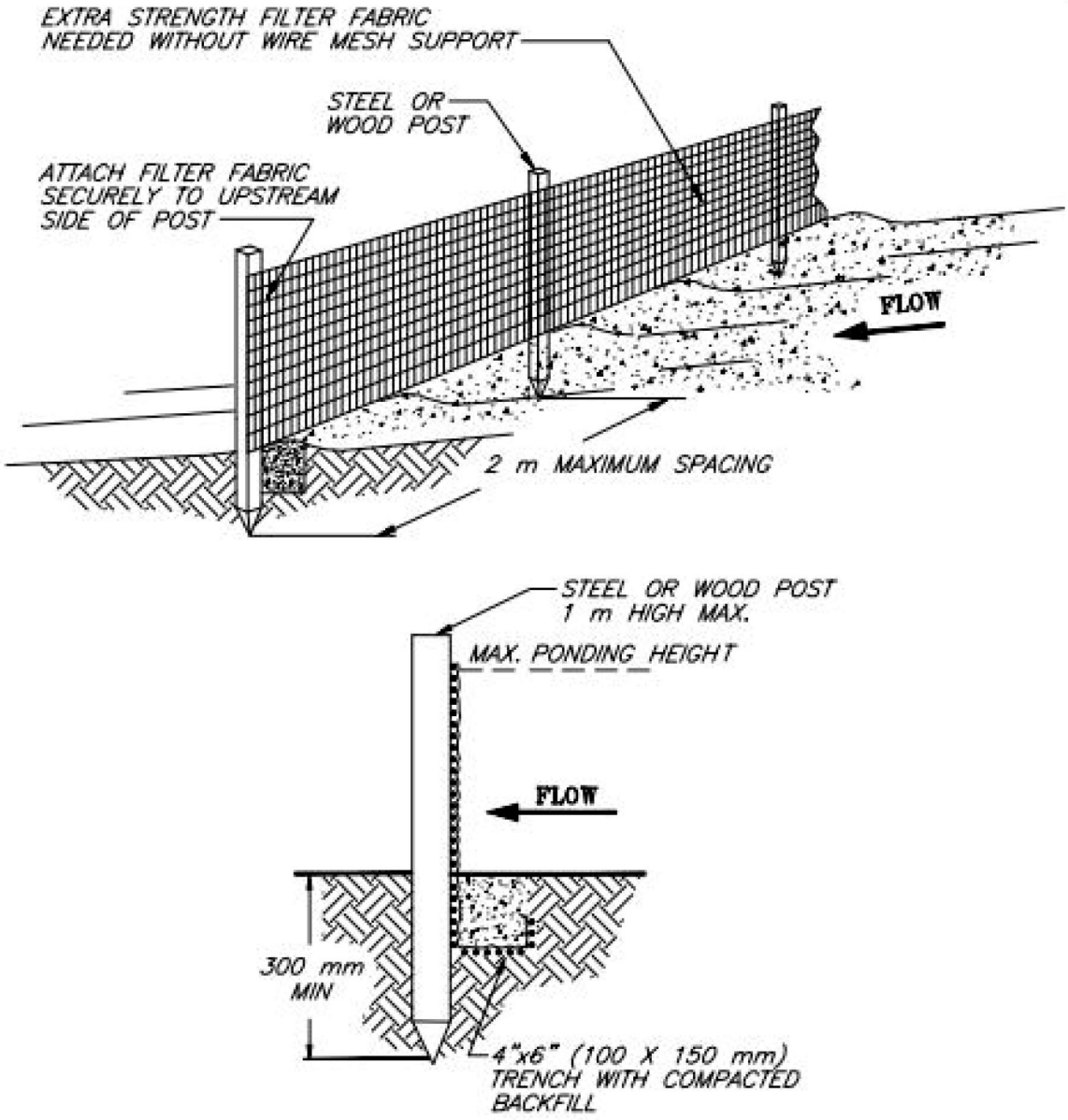
- Repair undercut fences. This is a sign that the fence was incorrectly installed or overloaded. Repair or replace damaged fencing (split, torn, loose or weathered) fabric immediately.
- Sediment build up should be removed once it accumulates to a depth of 0.3 m (one foot).
- Sediment should be removed and stored at a suitable stockpile location with no surface flow;
- Remove fence after vegetation is established;
- Deactivate fabric by cutting the fencing material between the stakes and pulling to remove; bottom trenched-in portion of fence fabric should be removed from the ground to avoid groundwater interception and potential for wildlife entanglement.

Similar Measures

- Straw Bales
- Rock Barrier
- Permeable/Synthetic Barriers

Design Considerations

- For sediment fence to work as a system, the following factors should be considered:
  a) quantity – adequate number, location, and spacing of fences for efficient detention and sedimentation
  b) installation – must be done correctly and on contour
  c) compaction – backfill and trenching of fabric
  d) support – posts adequately embedded, appropriate selection of post material and spacing
  e) attachment – secure fabric to post
- Install sediment fence in a 'J' hook or 'smile' configuration, so that the ends are higher than the fenceline to contain the water and sediment



TRENCH METHOD DETAIL

NOTES:

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

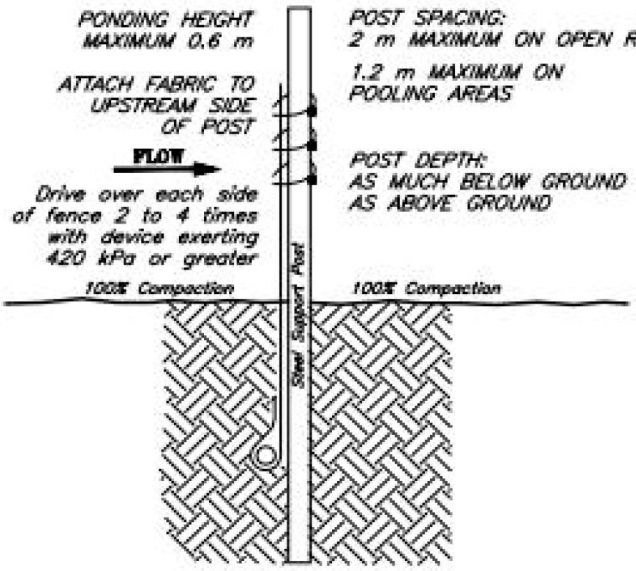
NOT TO SCALE

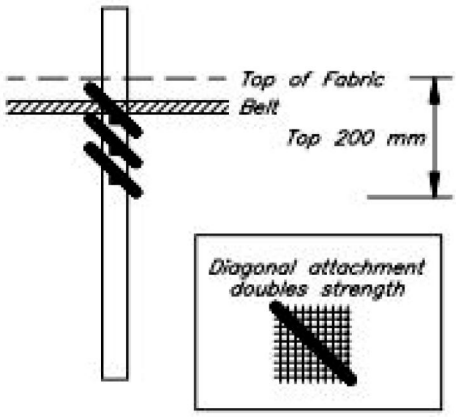
Sediment Fence (Trench Method)

From: Safa—Applied Earthcare — EROSION DRAW 3.0

FILE: SILTFENC

Government of the Northwest Territories – Transportation

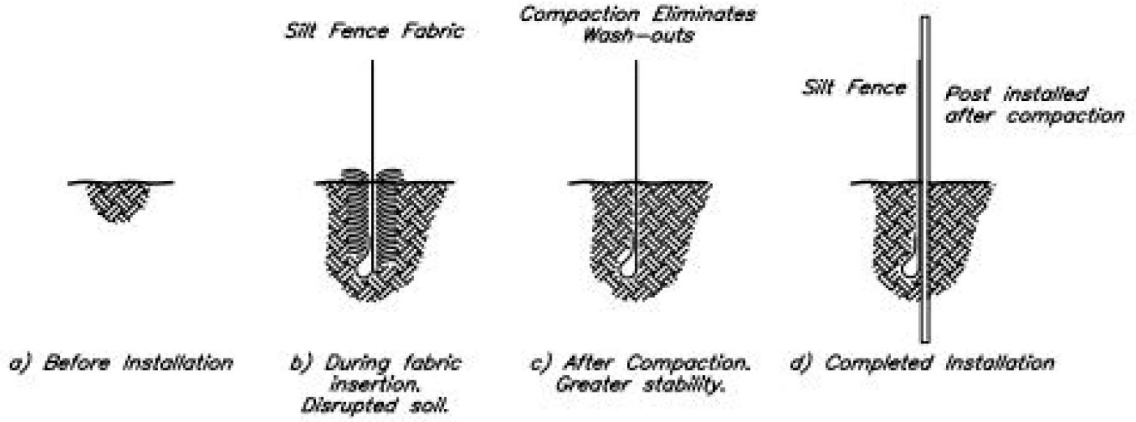




ATTACHMENT DETAILS:

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

MECHANICAL (SLICING) METHOD



MECHANICAL (SLICING) METHOD INSTALLATION SEQUENCE

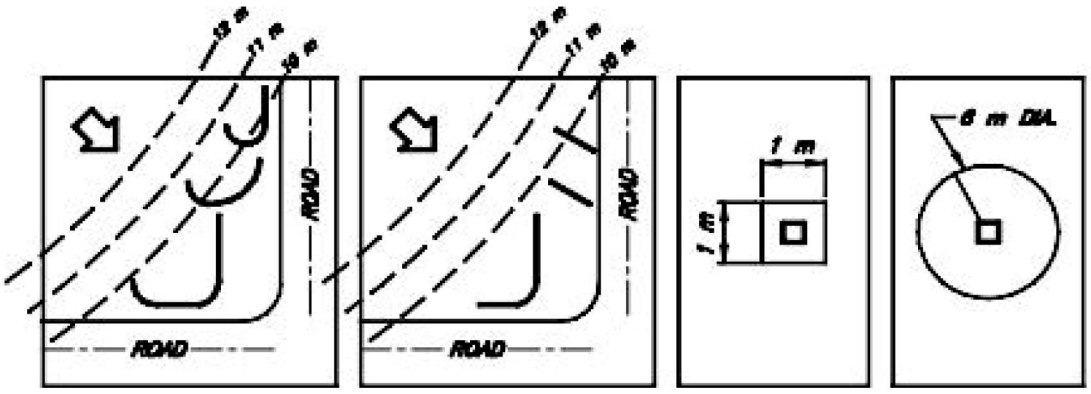
NOTES:

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

NOT TO SCALE

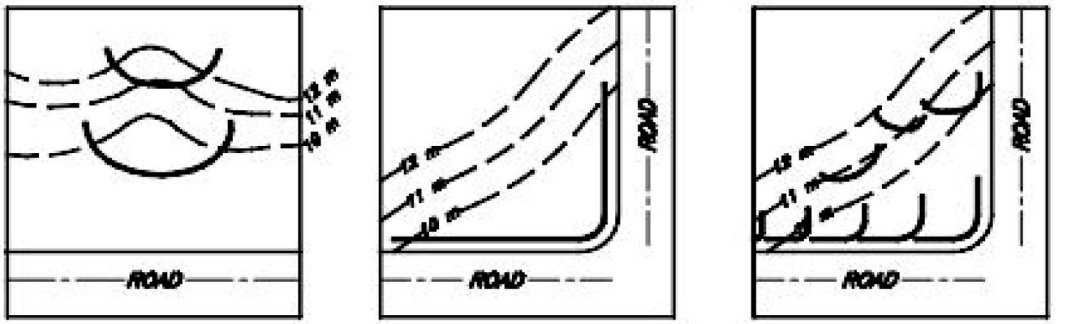
SOURCE: CARPENTER T. 2000

Sediment Fence (Mechanical Method)



"J" CONFIGURATION

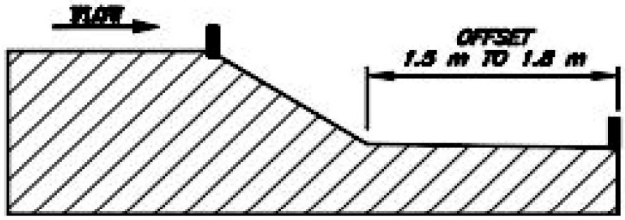
SILT FENCE BARRIER AT STORM INLET



"SMILE" CONFIGURATION

AVOID LONG INSTALLATION

COMBINATION OF "SMILE" AND "J" CONFIGURATIONS



LOCATION AT TOP AND BOTTOM OF SLOPE

NOT TO SCALE

NOTE:

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

SOURCE: CARPENTER T. 2000

Sediment Fence (Configuration Plan)

Government of the Northwest Territories – Transportation

Scheduling Sediment Control and Erosion Control	B.M.P. #25

Description and Purpose

- Schedule the sequence and timing of construction activities in order to:
  - Efficiently maximize the amount of erosion protection installed (such as topsoiling and seeding) as soon as a portion of grade construction is completed, and
  - Limit the por tion of land disturbance from c onstruction compatible with the efficient and achievable rate of erosion control measures constructed Incorporate erosion and sedimentation control concerns during the sched uling phase which w ill minimize the amount and duration of bare soi l exposure to erosion elements and ensure erosion and sedimentation control measures are implemented at an appropriate time
- An operational schedule may be designed during planning stages by the contractor and altered during actual construction to suit variable conditions as these are encountered

Applications

- Temporary measure

Advantages

- Ensures erosion and sedimentation control issues are identified during the planning stage by the contractor
- Promotes timely implementation of erosion and sediment control practices
- Planning for activities to be completed during dry seasons to reduce erosion due to rainfall and sediment transport due to excessive overland flows (avoid flooding periods)
- Planning may avoid fish and wildlife sensitive periods (spawning and nesting)
- Planning to ensure timely mobilization of equipment and labour
- Plan to have all needed ESC materials on hand when required
- May be used to minimize bare soil exposure and erosion hazards
- Promotes efficient utilization of equipment where needed for erosion and sedimentation control on construction projects
- Promotes the installation of permanent erosion control measures (such as topsoiling and seeding) immediately after completion of each phase to get vegetation establishment underway

- Avoids the cost of costly remobilization if equipment is moved off site and is then required for implementing an erosion control measure.
- Finishes the project as it progresses rather than leaving all of the finish work until the end. Promotes good will, allows erosion and sediment controls to be removed and reduces liability while the labour is on site to do the work. No re-deployment required.
- Promotes good housekeeping

Limitations

- May not have been accounted for in the bidding and contract finalization or planning stages

Implementation

- Incorporate a schedule for erosion control and protection structures as part of the overall construction plan
- Determine sequencing and timetable for the start and end of each item, such as clearing, grubbing, stripping, etc., as part of the construction schedule
- Incorporate installation of appropriate erosion and/or sediment control measures in the construction schedule
- Allow sufficient time before construction operations and seasonal rainfall periods to install erosion and/or sediment control measures
- Whenever possible, schedule work to minimize the extent of site disturbance (soil exposure) at any one time
- Incorporate staged topsoiling and revegetation of graded slopes as work progresses
  - Don't leave all topsoiling and revegetation until the very end of the project
  - Remove un-necessary ESC controls as and when they are no longer needed

Inspection and Maintenance

- Routinely verify that construction activities and the installation of erosion and sediment control measures are progressing in accordance with the approved schedule
  - If progress deviates from schedule, take corrective action
  - An ESC Plan is a living document and is expected to be updated as required.
- When changes to the project schedule are unavoidable, alter the schedule as soon as practical to maintain control of erosion

- If previously unidentified erosion issues occur, install control measures to correct the problem and, if significant, add to the inspection plan and amend the Erosion and Sediment Control Plan.

Rolls
a) Coir Roll
b) Fibre Roll
Streambank Stabilization Techniques and Erosion Control

B.M.P. #29

Description and Purpose

- Coir rolls are long cylindrical tubes that are composed of interwoven coconut fibres which are bound together with durable coir netting. Coir rolls are particularly applicable for wetland, streambank, and shoreline projects. Coir rolls are most commonly available in 0.3 m diameters and 6 m lengths. These rolls can be linked together to form longer tubes, and are often used in combination with other biotechnical techniques, such as brush layering or live siltation methods or branch staking. Coir logs encourage siltation and wetland/floodplain maintenance
- Fibre rolls are installed along slope contours as a grade break to reduce erosion potential by reducing overland flow velocities
- Straw rolls consist of bundled straw (or natural fibre) wrapped in photo-degradable open-weave plastic or natural fiber netting staked into the soil along slope contours as a grade break to reduce erosion potential
- Live stakes or branches can be installed to anchor the fibre rolls to provide deep rooted vegetation with potential favourable moisture retention provided by fibre roll
- Fibre rolls may capture sediment, organic matter, and seeds carried by runoff

Applications

- The tough, long-lasting coconut fibres make coir rolls appropriate for wetland, streambank, and shoreline applications. Coir rolls work well when immediate erosion control is needed. Brush layers work well with coir roll applications, adding further stabilization with a live root system , while also providing excellent habitat features. The coir roll provides a base for the brush layer cuttings to be laid upon at an appropriate angle which benefits the growth of cuttings. The cuttings provide further protection from breaking waves and high flows
- Fibre rolls may be used on slopes stable enough to support vegetation (steep, confined slopes and channel banks with gradients greater than 1H:1V may have low success potential)
- Fibre rolls may be used on long slopes as a grade break to shorten the length of slope between other slope retention features
- Fibre rolls may be used as grade breaks, where slopes transition from flatter to steeper gradients

Advantages

- The coir material is natural and long lasting (5 to 7 years), and has high tensile strength

- The coir rolls and fibre rolls accumulate sediment while the plant roots develop. Eventually the coir material biodegrades and the cohesive strength of the root systems and flexible nature of the roots become the primary stabilizing element
- The coir roll/brush layering combination provides immediate shoreline and streambank protection, with additional benefits of riparian enhancement when the cuttings become established
- Coir rolls address ecological concerns by encouraging vegetation and small wildlife habitat, and are an alternative to stone revetments or other structural measures
- The high tensile strength coconut fibres, the fibre netting and the wooden stakes used to anchor the material make up the initial structural components of the system, while plant root and to p growth increase the strength and water velocity reduction and sediment capture effects of the structure
- Fibre rolls can be used on slopes too steep for sediment fences or straw bale sediment barriers
- In time, the plastic netting will degrade due to the sunlight an d straw will degrade and be incorporated into the soil. Natural fiber netting (Bionet^{TM}) is also available
- The primary purpose of fibre rolls is erosion control, however fibre rolls do provide a small amount of sediment control as a secondary benefit.

Limitations

- This technique should be implemented during the dormancy period of the cut tings used for brush layering and staking
- Coir rolls are relatively expensive
- Fibre rolls are designed for low sheet flow velocities
- Fibre rolls are designed for short slopes with a maximum gradient of 1H:1V
- Fibre rolls may be labour intensive to install
- Straw rolls have a shorter life span due to natural degradation
  - Usually only functional for two seasons
  - Susceptible to undermining and failure if not properly keyed into the soil
- Labour intensive maintenance may be required to ensure rolls are in continuous contact with the soil, especially when used on steep slopes or sandy soils

Construction

- Determine the annual maximum water elevation
- Mark the water level on a stake driven into the substrate, 0.3 or 0.6 m offshore. Installing the materials and plants at the correct elevation is the most important aspect to assure success of the installation. Determine, on site, where the installation will begin and end
- Determine soil level by laying a straight cutting on the coir roll with approximately 20% of the cutting sticking out past the roll, and with the basal ends dipping down into the soil
- Begin installation at the downstream end (if using in a streambank project)
- Prepare the site for installation of coir rolls by removing any large rocks, obstructions or material that may prevent the coir from making direct and firm contact with the soil. Coir rolls must be level, installed along a horizontal contour. Place coir rolls parallel to the stream bank or shoreline. It is very important to key the ends of the coir rolls firmly into the shoreline or stream bank, so waves and flows will not scour behind the rolls and compromise the integrity of the structure
- Install the coir roll such that 0.05 m of the roll extends above the annual water elevation
- Adjacent rolls shall be laced together, end-to-end, tightly and securely
- If using brush layer cuttings, prepare the soil bed behind the installed coir rolls for brush laying. It is important that the bud ends of the live cuttings angle up to some degree from the basal ends. Lay cuttings in this fashion, slightly crisscrossed for additional strength
- Next, backfill over the cuttings with soil, covering the lower 80% of the branches. At this time, the soil can be levelled and prepared for a soil wrap for additional height and soil stability
- If simply covering the cuttings with soil, compact slightly and grade slope to appropriate angle. Use water to wash soil in between branch layers
- If using plant materials, such as container-grown, pre-rooted plant plugs or willow stakes, they should be planted into the coir rolls and through the coir mats and netting
- To install plant plugs and willow stakes into the coir roll, use a planting iron or pilot bar into the roll and wedge it back and forth to create a hole for the plant. It is extremely important that the root system of the plant be placed below the water

table for certain species. All plants shall be checked to ensure that they have been firmly installed through the fibre material, into the soil

- Mulch and seed exposed areas with native species
- Prepare the slope face and remove large rocks or other deleterious materials
- Excavate small trenches a minimum of 0.15 m deep and 0.15 m w ide across the width of the slope, p erpendicular to the slop e direction, starting at the toe of the slope and working upwards towards the crest of slope
- Space trenches a maximum of 3 to 8 m apart along the slope incline, with steeper slopes having trenches spaced closer together
- Place fibre rolls into the trenches, ensuring continuous contact between the fibre roll and the soil surface
- Butt-joint adjacent fibre roll segments tightly against one another and lace together
- Use a m etal bar to make a pilot hole through middle of th e fibre roll a m inimum depth of 0.3 m into underlying soil
- Pilot holes should be spaced a maximum of 1 m apart
- Secure fibre roll to soil using wooden stake or other appropriate anchor. Live stakes may be used as alternate anchors
- Place soil excavated from the trench on the upslope side of fibre roll Seed the soil along the upslope and downslope sides of the fibre roll to promote vegetation growth
- Compact the soil upslope of the fibre roll to minimize undermining by runoff

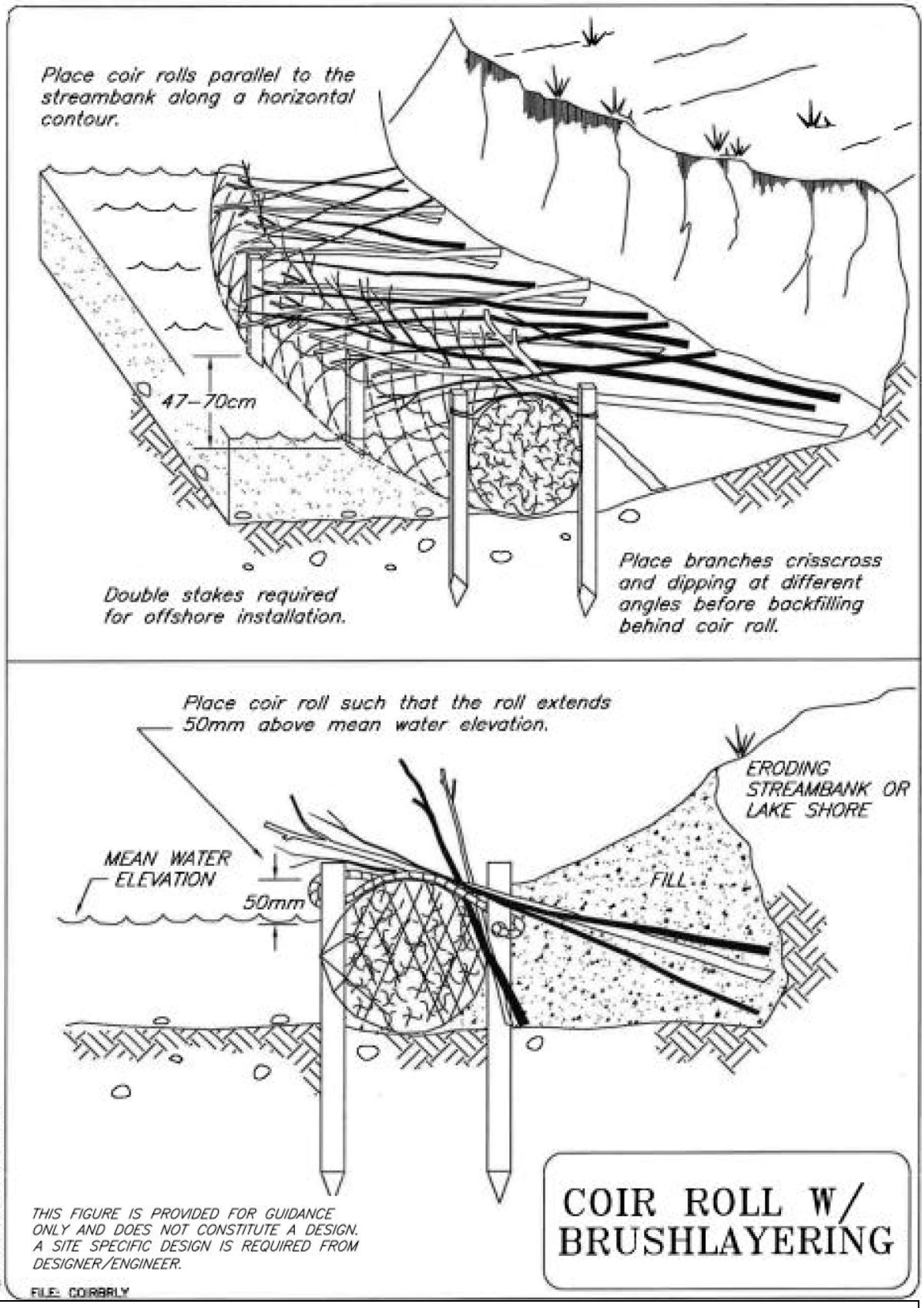
Construction Considerations

- All work site disturbance should be minimized. Protect any existing plants, when possible, and avoid additional disturbance that can lead to erosion and sedimentation
- Install additional erosion and sediment control measures such as temporary diversion dikes, sediment fences and continuous berms, as needed, before beginning work
- Coir rolls can be used in the stream as a sediment barrier, silt curtain, and/or coffer dam to control sediment while work is being done in the water
- Topsoil should be saved, if possible, and replaced once the subsoil has been removed or regraded. Soil shall be stored away from the water's edge and it sha ll be moved to its final location and stabilized as quickly as possible

- For typical applications at the water's edge, coir rolls are held in place with a single row of stakes, spaced 0.3 m apart. Stakes may be driven through the netting on the outer edge of the roll. It is very difficult to drive stakes through the high-density rolls, however, a stake can be driven with the help of a pilot hole through the low density part of the coir rolls
- Lacing among the stakes is recommended for coir mats exposed to extreme conditions such as ice, waves, or flooding
- Coir rolls shall be placed along streambanks or shorelines at a height sufficient to protect the bank from flows or waves. Additional coir rolls may be placed above the lower rolls, in a tile-like fashion, to protect the upper shore or stream bank
- Use live stakes in place of wooden stakes for streambank coil rolls
- If the slope soil is loose and uncompacted, excavate a trench to a minimum depth of 2/3 of the diameter of the coir roll
- For steep slopes, additional anchors placed on the downslope side of the coir roll may be required

Inspection and Maintenance

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Check plants to ensure that they have been firmly installed into the soil below the fibre material
- Water plants, if necessary, during the establishment phase
- Check all materials periodically or after major storms to ensure they remain properly secured. Make necessary repairs promptly
- All temporary and permanent erosion control measures shall be maintained and repaired as needed to ensure continued performance of their intended use
- Areas damaged by washout (rilling or gulleying) should be repaired immediately
- Additional stormwater control measures should be considered for erosion (rilling or gulleying) areas damaged by runoff



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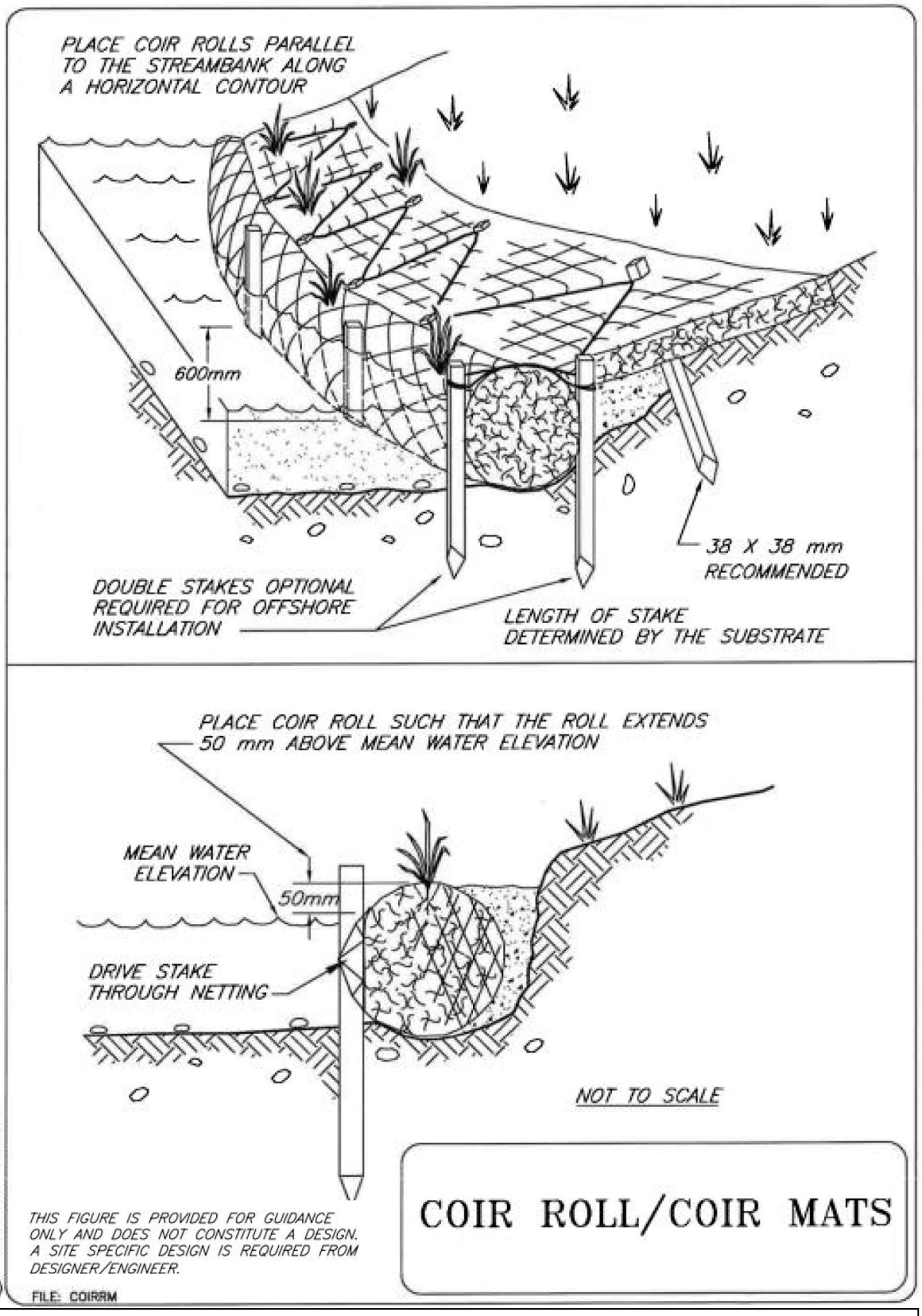
PLACE COIR ROLLS PARALLEL TO THE STREAMBANK ALONG A HORIZONTAL CONTOUR
600mm
38 X 38 mm RECOMMENDED
DOUBLE STAKES OPTIONAL REQUIRED FOR OFFSHORE INSTALLATION
LENGTH OF STAKE DETERMINED BY THE SUBSTRATE
PLACE COIR ROLL SUCH THAT THE ROLL EXTENDS 50 mm ABOVE MEAN WATER ELEVATION
MEAN WATER ELEVATION
50mm
DRIVE STAKE THROUGH NETTING
NOT TO SCALE
THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.
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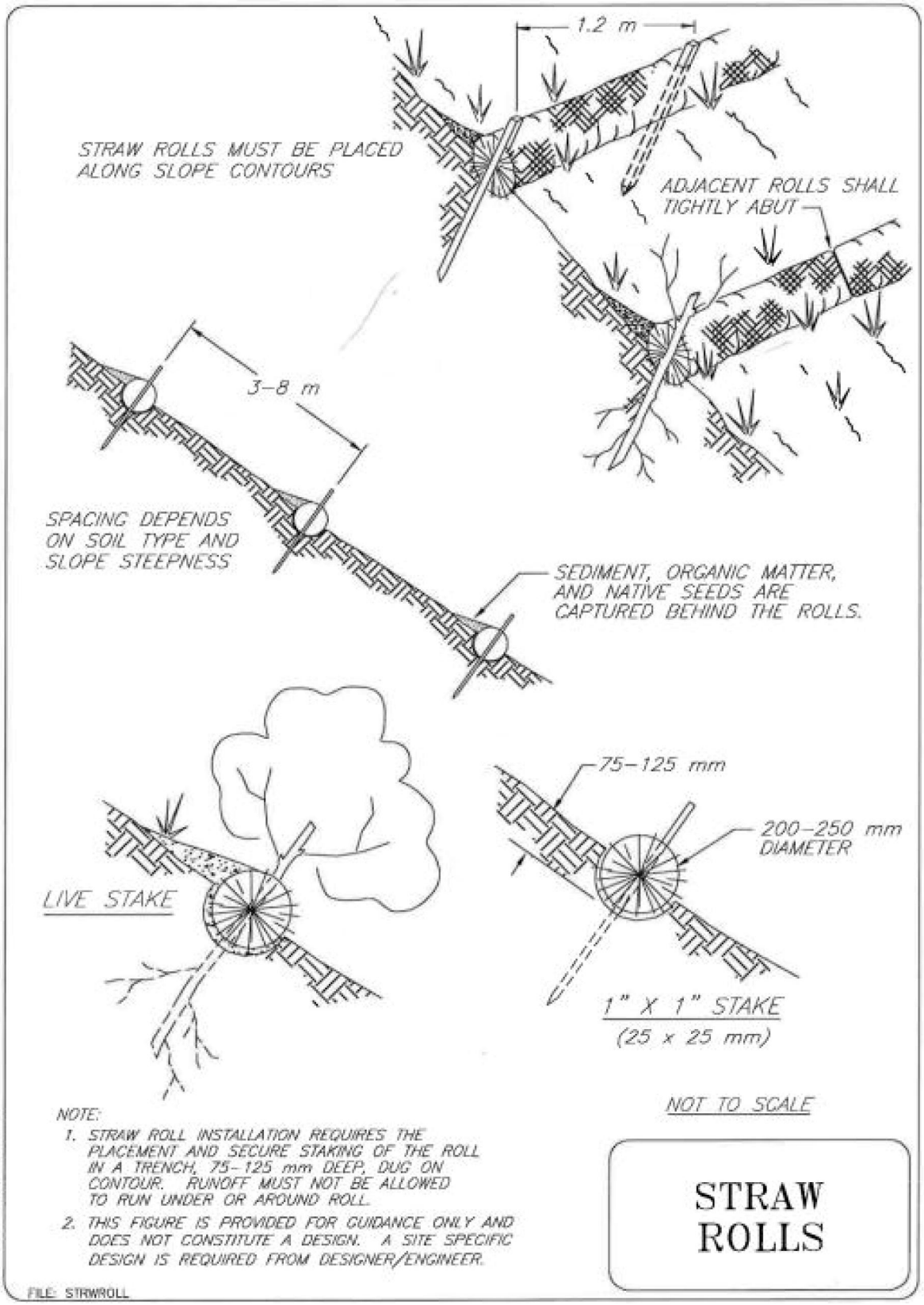
COIR ROLL/COIR MATS



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