



**PR 304 TO BERENS RIVER ALL-SEASON ROAD  
ENVIRONMENTAL IMPACT ASSESSMENT**

Volume 4

APPENDIX 7.2 – BEST MANAGEMENT PRACTICES

August 2009



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## 1.0 INTRODUCTION

The following is a synthesis of Best Management Practices (BMPs) that has been assembled for the East Side Road Authority drawing upon BMPs prepared by organizations such as:

- The Transportation Association of Canada (TAC);
- Ministry of Transportation Ontario (MTO);
- Transportation Alberta; and
- Manitoba Ministry of Infrastructure and Transportation (MIT)

This document is a “dynamic living document” that will be amended and revised from time to time as the PR 304 to Berens River All-Season Road Project proceeds through Functional Design, Environmental Approvals, Construction, and Operations.

This document serves to illustrate the practices that should be applied to during construction and maintenance operations to minimize or mitigate adverse environmental effects.

The BMPs in concert with the **Environmental Protection Guidelines** will be used in the development of Construction Contract Documents (e.g., Tender Packages, and Contract Specifications). They will also be used to support environmental awareness training of construction contractors at the outset in any construction contract.

The Project’s Environmental Manager(s) will also use the BMPs and the Environmental Protection Guidelines to review construction procedures that are being applied at particular locations as the construction proceeds.

## **1.1 PART 1 - BEST MANAGEMENT PRACTICES**

The following list of Best Management Practices (BMPs) that have direct application to the PR 304 to Berens River All-Season Road Project.

These BMPs have been derived from BMPs commonly used by various provincial ministries, departments, or agencies across Canada.

<b>List of BMPs</b>	
<b>Riprap Armouring</b>	BMP 1
<b>Gabions</b>	BMP 2
<b>Stabilized Work Site Entrance</b>	BMP 3
<b>Rolled Erosion Control Products (RECP)</b>	BMP 4
<b>Slope Texturing / Grading</b>	BMP 5
<b>Synthetic Permeable Barrier</b>	BMP 6
<b>Straw Bale Barrier</b>	BMP 7
<b>Earth Dyke Barrier</b>	BMP 8
<b>Brush or Rock Berm</b>	BMP 9
<b>Check Dam</b>	BMP 10
<b>Temporary Streams Diversions</b>	BMP 11
<b>Energy Dissipators</b>	BMP 12
<b>Cellular Confinement System</b>	BMP 13
<b>Slope Drains (Temporary Pipes)</b>	BMP 14
<b>Offtake Ditch (Intercept Ditch)</b>	BMP 15
<b>Planting Trees and Shrubs</b>	BMP 16
<b>Fibber Rolls and Wattles</b>	BMP 17
<b>Silt Fence (Filter Fence)</b>	BMP 18
<b>Continuous Berm</b>	BMP 19

**List of BMPs**

<b>Sediment Traps and Basins</b>	BMP 20
<b>Storm Drain Inlet Sediment Barrier</b>	BMP 21
<b>Turbidity Curtains</b>	BMP 22
<b>Pumped Silt Control Systems</b>	BMP 23
<b>Cofferdam</b>	BMP 24
<b>Seeding</b>	BMP 25
<b>Mulching</b>	BMP 26
<b>Hydroseeding</b>	BMP 27
<b>Topsoiling</b>	BMP 28
<b>Soil Tackifiers (Chemical Stabilization)</b>	BMP 29
<b>Riparian Zone Vegetation</b>	BMP 30
<b>Gravel Blankets</b>	BMP 31
<b>Scheduling</b>	BMP 32

## 1.2 PART 2 – APPLICATIONS OF BEST MANAGEMENT PRACTICES

The following tables provide examples of where particular BMPs have application to road construction or maintenance activities.

**Table A7-1** describes the mitigation measures and BMPs that apply to the protection of exposed surfaces during either construction or maintenance works.

**Table A7-2** outlines the range of measures and practices applicable to the control of runoff.

**Table A7-3** addresses normal range of BMPs that apply to the general control of erosion and sediment control.

**Table A7-4** summarizes key Project Planning/Scheduling Strategies that should be applied to Construction Contracts or work activities for effective application of sediment and erosion control measures.



Table A7 - 1: Erosion Control Measures - Protection of Exposed Surface

BMP Reference #	Name	Applications				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
28	Topsoiling	X	X	X	X	Placing topsoil provides excellent medium for vegetation root structure to develop in; organic content promotes plant growth, reuse organics (topsoil or peat) stripped from the site at start of grading; absorb raindrop energy to minimize erosion potential	Cannot be effective without seeding and allowing time for plant growth; not appropriate for slopes steeper than 2H:1V (steep slopes will require soil covering over topsoil and specialized design); dry topsoil susceptible to wind erosion, susceptible to erosion prior to establishment of vegetation Must be applied over prepared surface (topsoiled), grasses may require periodic
25	Seeding	X	X	X	X	Inexpensive and relatively effective erosion control measure, effectiveness increases with time as vegetation develops, aesthetically pleasing, enhances terrestrial and aquatic habitat	maintenance (mowing), uncut dry grass may be a fire hazard, seeding for steep slopes may be difficult, seasonal limitations on seeding effectiveness may not coincide with construction schedule, freshly seeded areas are susceptible to runoff erosion until vegetation is established, reseeded may be required for areas of low growth
26	Mulching	X	X	X	X	Used alone to protect exposed areas for short periods, protects soil from rainsplash erosion, preserves soil moisture and protects germinating seed from temperature extremes, relatively inexpensive measure of promoting plant growth and slope protection	Application of mulch on steep slopes may be difficult, may require additional specialized equipment not commonly used in typical highway construction
27	Hydroseeding - Hydromulching	X	X	X	X	Economical and effective on large areas, mulch tackifiers may be used to provide immediate protection until seed germination and vegetation is established, allows re-vegetation of steep slopes where conventional seeding/mulching techniques are very difficult, relatively efficient operation, also provides dust and wind erosion control	Site must be accessible to hydroseeding-hydromulching equipment (usually mounted on trucks with a maximum hose range of approximately 150 m), may require subsequent application in areas of low growth as part of maintenance program
1	Riprap Armoring	X	X			Stabilizes soil surface with rock lining thus minimizing erosion, permits construction traffic in not easily established, effective for high velocities or concentrations, permits infiltration, dissipates energy of flow from culvert inlets/outlets, easy to install and repair, very durable and virtually maintenance free, flexible lining for ditches with ice build-up	May be labour intensive to install (hand installation); generally thickness of riprap is higher when compared to gabion mattress Must be designed by qualified geotechnical personnel, expensive, may not be feasible in
31	Gravel Blankets Rolled Erosion	X	X			Stabilizes soil surface with rock lining minimizing erosion, permits construction traffic in adverse weather, may be used as part of permanent base construction of paved areas, easily constructed and implemented, can be used to stabilize seepage piping erosion of slope Provides a protective covering to bare soil or topsoiled surface where degree of erosion	areas where gravel is not readily available, areas of high groundwater seepage may require placement of non-woven geotextile underlay and additional drainage measures RECP use must be based on design need and risk assessment of site, certification on QA/QC of RECP products must be issued by the AT approved supplier on pre-approved products, certification of physical properties and performance criteria (tractive resistance) is
4	Control Products (RECP)	X	X			Provides a protective covering to bare soil where degree of erosion protection is high, can be more uniform and longer lasting than mulch, wide range of commercially available products	required (permissible velocities can be provided as reference), labour intensive to install, temporary blankets may require removal prior to restarting construction activities, RECP not suitable for rocky slopes, proper site preparation is required to seat RECP onto soil correctly; high performance is tied to successful vegetation growth
13	Cellular Confinement	X			X	Lightweight cellular system and easily installed, uses locally available soils or grout for fill to reduce costs,	Not readily used in Alberta highway construction, expensive, installation is labour intensive (hand installation), not suitable for slopes steeper than 1H:1V

BMP Reference #	Name	Applications				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
16	Planting Trees and Shrubs	X		X	X	Establishes vegetative cover and root mat, reduces flow velocities on vegetative surface, traps sediment laden runoff, aesthetically pleasing once established, grows stronger with time as root structure develops, usually has deeper root structure than grass	Expensive, may be labour intensive to install, not readily used in Alberta highway construction projects, revegetated areas are subject to erosion until plants are established, plants may be damaged by wildlife, watering is usually required until plants are established
29	Soil Tackifiers (Chemical Stabilization)	X	X		X	Increase cohesion of soil thus reduces soil moisture evaporation and erosion, easily applied, may be applied in conjunction with hydroseeding-hydromulching, longevity increases as application rate increases	Not commonly used in highway construction projects, may be expensive, site must be accessible to spraying equipment, may require specialized equipment, temporary measure only, higher application rates may prevent seed germination and growth, crust-forming chemical stabilizers may crack during freeze-thaw cycles, requires specialized design
30	Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
32	Scheduling	X	X	X	X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposure and erosion hazard; allows early installation of perimeter control for sediment entrapment; and early installation of runoff control measures; good construction practice	
5	Slope Texturing	X			X	Roughens slope surface to reduce erosion potential and sediment yield; suitable for clayey soils	Additional cost; not suitable for silty and sandy soils; not practical for slope length <8 m for dozer operation up/down slope

**Source:** Appendix C, Erosion and Sediment Control – Best Management Practices, Alberta Transportation - Design Guidelines for Erosion and Sediment Control for Highways, - March, 2003 (Revised May 2003)

Table A7 - 2: Erosion Control Measures - Control of Runoff

BMP #	BMP NAME	APPLICATIONS				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow and Stockpile Area	Advantages	Limitations
5	Slope Texturing	X		X	X	Contouring and roughening (tracking) of slope face reduces runoff velocity and increases infiltration rates; collects sediment; holds water, seed and mulch better than smooth surfaces; promotes development of vegetation, provides loss of soil reduction in soil erosion compared with untracked slopes	May increase grading costs, may cause sloughing in sensitive (wet) soils, tracking may compact soil, provides limited sediment and erosion control and should not be used as primary control measure
15	Offtake Ditch	X		X	X	Collects and diverts sheet flow or runoff water at the top of a slope to reduce downslope erosion potential, incorporated with permanent project drainage systems	Channel must be sized appropriately to accommodate anticipated flow volumes and velocities, lining may be required, may require design by qualified personnel, must be graded to maintain positive drainage to outlets to minimize ponding
12	Energy Dissipator	X	X			Rip rap or sandbags slow runoff velocity and dissipate flow energy to non-erosive level in relatively short distances, permits sediment collection from runoff	Small diameter rocks/stones can be dislodged; grouted rip-rap armouring may breakup due to hydrostatic pressures, frost heaves, or settlement; may be expensive, may be labour intensive to install; may require design by qualified personnel for extreme flow volumes and velocities
14	Slope (Down) Drains	X				Directs surface water runoff into drain pipe instead of flowing over and eroding exposed soils of slope face	Pipes must be sized appropriately to accommodate anticipated flows, erosion can occur at inlet/outlet if protection is not incorporated into design, slope drain must be anchored to slope
2	Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, commercially available products, commonly used in highway construction projects; suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials
10	Rock Check Dam		X		X	Permanent drop structure with some filtering capability, cheaper than gabion and armouring entire channel, easily constructed, commonly used in highway construction projects	Can be expensive in areas of limited rock source, not appropriate for channels draining areas larger than 10 ha (4 acres), requires extensive maintenance after high flow storm events, susceptible to failure if water undermines or outflanks structure
10	Aggregate Filled Sand Bag Check Dam		X		X	More effective as energy dissipator to slow flow velocities, cheaper than gabions or armouring entire ditch, easily constructed and reusable	Not appropriate for channels draining areas larger than 2 ha (5 acres), requires extensive maintenance after high flow storm events, low filtering capabilities, labour intensive to install (hand installation), temporary measure only
10	Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	May be expensive, not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)
10	Straw Bale Check Dam		X		X	Temporary drop structures appropriate for channel slopes with 3% to 5% grades, straw bales are readily available in most areas of the province, biodegradable	Temporary measure only; not appropriate for: channels draining areas larger than 2 ha (5 acres), channels steeper than 5%, and/or flow velocities greater than 0.3 m/s; requires extensive maintenance after high flow storm events,

BMP #	BMP NAME	APPLICATIONS				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow and Stockpile Area	Advantages	Limitations
							must be installed by hand with keying and staking; maximum height of one straw bale
6	Synthetic Permeable Barriers		X			Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in conjunction with sturdy permanent drop structures along steep grades	Not to be used as check structures, must be installed by hand in conjunction with RECP, become brittle in winter and are easily damaged by construction equipment or recreational vehicles, only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation
31	Groundwater Control (Subsurface Drain)	X				Relief subsurface groundwater seepage and winter ice build-up; lower groundwater table to minimize piping erosion; enhance slope stability performance	Requires design by a geotechnical engineer; can be a slope instability issue
17	Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2H:1V, not widely used on highway construction projects
32	Scheduling		X		X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposure and erosion hazard; early installation of perimeter control for sediment entrapment; and early installation of runoff control measures; good construction	

**Source:** Appendix C, Erosion and Sediment Control – Best Management Practices, Alberta Transportation - Design Guidelines for Erosion and Sediment Control for Highways, - March, 2003 (Revised May 2003)

**Table A7 - 3: Erosion Control Measures – Sediment Control Measures**

BMP #	BMP NAME	APPLICATIONS				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow and Stockpile Area	Advantages	Limitations
29	Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
7	Straw Bale Barrier			X	X	Relatively inexpensive if bales are locally available, biodegradable, cheaper and easier to install than other barriers	Short service life due to biodegradation, straw bales may not be readily available in all areas of the province, maximum barrier height of one straw bale, require extensive maintenance after high flow storm events, require proper keying and staking.
9	Brush or Rock Filter Berm	X	X	X	X	More effective than silt fences, uses timber and materials salvaged from site during clearing and grubbing, can be wrapped and anchored with geotextile fabric envelope	More expensive than silt fences, temporary measure only, not effective for diverting runoff, expensive to remove, not to be used in channels or ditches with high flows
17	Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2H:1V, not widely used on highway construction projects
23	Pumped Silt Control Systems (Silt Bags)		X			Filter bag is lightweight and portable, simple set up and disposal, sediment laden water is pumped into and contained within filter bag for disposal, different aperture opening sizes (AOS) available from several manufacturers; for emergency use only under overflow conditions	May be expensive, requires special design needs for use, not readily used in highway construction projects, requires a pump and power source for pump, suitable for only short periods of time and small volumes of sediment laden water, can only remove particles larger than aperture opening size (AOS)
18	Silt Fence	X	X		X	Economical, most commonly used sediment control measure, filters sediment from runoff and allows water to pond and settle out coarse grained sediment, more effective than straw bale barriers	May fail under high runoff events, applicable for sheet flow erosion only, limited to locations where adequate space is available to pond collected runoff, sediment build up needs to be removed on a regular basis, damage to filter fence may occur during sediment removal, usable life of approximately one year
8	Earth Dyke/Barrier		X		X	Easy to construct, relatively inexpensive as local soil and material is used; can be easily converted to Sediment Pond/Basin (BMP #20)	Geotechnical design required for fill heights in excess of 3 m, may not be suitable for all soil types or sites; riprap spillway and/or permeable outlet may be required
2	Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, commercially available products, commonly used in highway construction projects; suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials
10	Rock Check Dam		X		X	Permanent drop structure with some filtering capability, cheaper than gabion and armouring entire channel, easily constructed, commonly used in highway construction projects	Can be expensive in areas of limited rock source, not appropriate for channels draining areas larger than 10 ha (4 acres), requires extensive maintenance after high flow storm events, susceptible to failure if water undermines or outflanks structure
10	Aggregate Filled Sand Bag Check Dam		X		X	More effective as energy dissipator to slow flow velocities, cheaper than gabions or armouring entire ditch, easily constructed and reusable	Not appropriate for channels draining areas larger than 2 ha (5 acres), requires extensive maintenance after high flow storm events, low filtering capabilities, labour intensive to install (hand installation), temporary measure only
10	Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	Not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)

BMP #	BMP NAME	APPLICATIONS				COMMENTS	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow and Stockpile Area	Advantages	Limitations
10	Straw Bale Check Structures					Temporary drop structures appropriate for channel slopes with 3% to 5% grades, straw bales are readily available in most areas of the province, biodegradable	Temporary measure only; not appropriate for: channels draining areas larger than 2 ha (5 acres), channels steeper than 5%, and/or flow velocities greater than 0.3 m/s; requires extensive maintenance after high flow storm events, must be installed by hand with keying and staking; maximum height of one straw bale
6	Synthetic Permeable Barriers		X		X	Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in conjunction with sturdy permanent drop structures along steep grades	Partially effective as check dam structure, must be installed by hand in conjunction with RECP, become brittle in winter and are easily damaged by construction equipment or recreational vehicles, only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation
19	Continuous (earthfilled geotextile) Berm	X		X	X	Temporary measure; divert and intercept sheet or overlaid flow to form pond and allow sedimentation; flexibility of shape of construction; no trenching	Require specialized continuous berm machine to manufacture earth-filled geotextile berm on site; sandy/gravel soil is preferable fill material
21	Storm Drain Inlet - /Sediment Barrier		X			Temporary measure; easy to install and remove	Limited sediment entrapment capacity; requires regular clean-out maintenance
32	Scheduling	X	X	X	X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposure as erosion hazard; early installation of perimeter control for sediment entrapment; early dimension planning of runoff control measures; good construction practice	
20	Sediment Pond/Basin		X		X	May be constructed of a variety of materials, collects sediment laden runoff and reduces velocity of flow and deposition of sediment, can be cleaned and expanded as needed, capable of handling large volumes of sediment laden runoff	Normally requires 250 m <sup>3</sup> /ha storage volume per area of exposed soil, Can require large areas of land, requires periodic maintenance to remove sediment build up, requires design by qualified personnel, usually requires 'back-up' control measures in case pond/basin overflows,
11	Temporary Stream Diversions		x			Protects environmentally sensitive areas, can convey larger flows compared to dam and pumping, not at risk of power failure (e.g. pumps), maintain fish passage.	Requires erosion protection, risk of export of sediment downstream if not properly staged.
24	Cofferdam		x			Permits work to be carried out in the dry, allows boat and fish passage, does not unduly affect flow in the stream.	Use in areas of shallow flow depth (less than 1.5 m), constant pumping may be required to keep work area dewatered.
22	Turbidity Curtain		x			Permits settlement of fine sediments in slow flowing rivers, lakes, or wetlands that have long settling times.	Not feasible in higher currents (greater than 0.5 m/s), not feasible in higher or breaking wave conditions, not feasible in the presence of ice.

**Source:** Appendix C, Erosion and Sediment Control – Best Management Practices, Alberta Transportation - Design Guidelines for Erosion and Sediment Control for Highways, - March, 2003 (Revised May 2003)

**Table A7 - 4: Project Planning/Scheduling Strategies for Construction Works - Erosion and Sediment Control**

Measures	Applications				Comments	
	Slope	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
<b>Minimize Exposed Soils</b>	X	X	X	X	Minimizes disturbed soil area, decreases erosion potential and decreases quantity of sediment and sediment control measures required thus decreasing costs	May require efficient scheduling of topsoiling/seeding/mulching completed areas, limits the stripping of new areas
<b>Operate During Fisheries Windows</b>	X	X	X	X	Minimizes possible negative impacts on aquatic wildlife	May affect schedule of adjoining works
<b>Maximize Favourable Weather</b>	X	X	X	X	Increasing work capacity in favourable conditions, minimizes volume of work required in less desirable (wet) conditions, thus decreasing potential for erosion and sediment loss	May require additional equipment and resources to increase scale of production/construction
<b>Install BMP's Early</b>	X	X	X	X	Early installation of sediment and erosion control measures ensures sediment losses are minimized during construction and provide good housekeeping	May cause difficulties with site access or traffic
<b>Avoid Wet Weather Periods</b>	X	X	X	X	Avoiding construction in wet weather periods minimizes erosion potential	Shutdowns may prolong/delay construction activities
<b>Topsoil and Seed Early</b>	X	X	X		Topsoiling and seeding as early as possible covers exposed soil and reduces erosion potential	
<b>Surface Roughen (Slope Texturing)</b>	X			X	Texturing of soils along contours reduces erosion potential by as much as 10%	Equipment may need to be related at a slight increase in costs
<b>Preserve and Use Existing Drainage Systems</b>	X	X	X	X	Minimize disturbance of drainage pattern	Care must be taken to observe drainage directions
<b>Control Construction Traffic</b>				X	Controlling where traffic is allowed avoids over-trafficking sensitive areas or areas with increased disturbance	Forcing traffic into localized areas may increase disturbance in high-traffic areas
<b>Signage</b>	X	X	X	X	Clearly labeling sensitive zones or areas not to be disturbed ensures all workers on-site are aware of where work can occur and where it cannot thus minimizing confusion	Increased costs of signs

**Source:** Appendix C, Erosion and Sediment Control – Best Management Practices, Alberta Transportation - Design Guidelines for Erosion and Sediment Control for Highways, - March, 2003 (Revised May 2003)

### **1.3 PART 3 – DETAILED DESCRIPTIONS OF BEST MANAGEMENT PRACTICES**

The following provided textual descriptions of the BMPs listed in Part 1 and discussed in Tables 1 to 4 in Part 2. Illustrative drawings are provided for a number of the BMPs to show how they are commonly applied to construction activities.

<b>List of BMPs</b>	
<b>Riprap Armouring</b>	BMP 1
<b>Gabions</b>	BMP 2
<b>Stabilized Work Site Entrance</b>	BMP 3
<b>Rolled Erosion Control Products (RECP)</b>	BMP 4
<b>Slope Texturing / Grading</b>	BMP 5
<b>Synthetic Permeable Barrier</b>	BMP 6
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<b>Soil Tackifiers (Chemical Stabilization)</b>	BMP 29
<b>Riparian Zone Vegetation</b>	BMP 30
<b>Gravel Blankets</b>	BMP 31
<b>Scheduling</b>	BMP 32



### Description and Purpose

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

### Applications

- Permanent measure
- May be used on channel banks and slopes with flow velocities ranging from 2 m/s to 5 m/s (dependent on rock size and thickness); appropriate for slopes that do not exceed 2H:1V
- Riprap only needs to be placed at lower portion of channel section to the anticipated flow height (mean annual peak flow) plus freeboard; other 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

### Construction

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- 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

### Construction Considerations

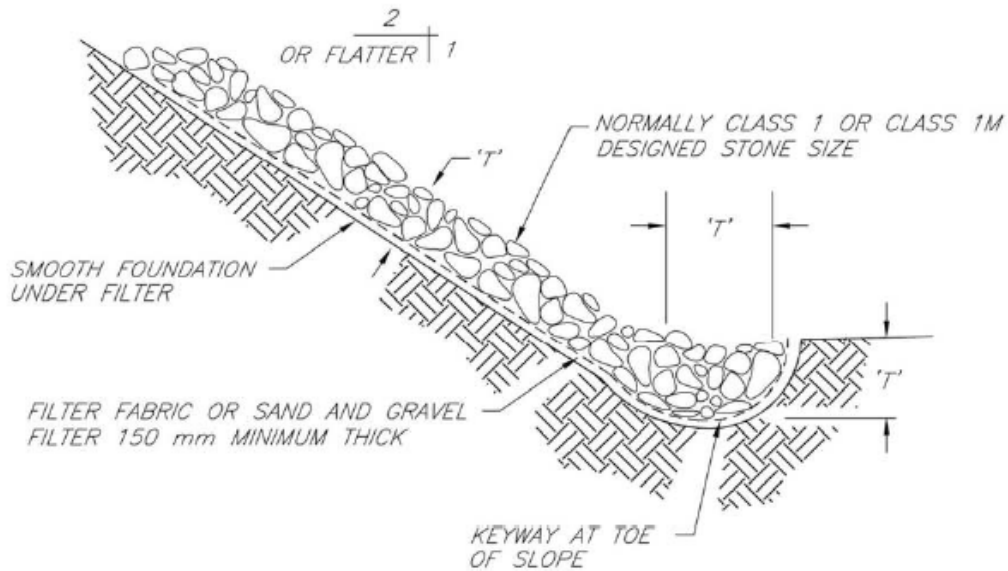
- Riprap should be placed in a uniform thickness across the channel so as not to constrict channel width
- Blasted rock is preferred (if available)
- Riprap layer should be 1.5 to 2 times the thickness of the largest rocks used, 1.5 to 3 times the thickness of the d50 material, and not less than 300 mm in thickness

### 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



**TYPICAL SECTION**

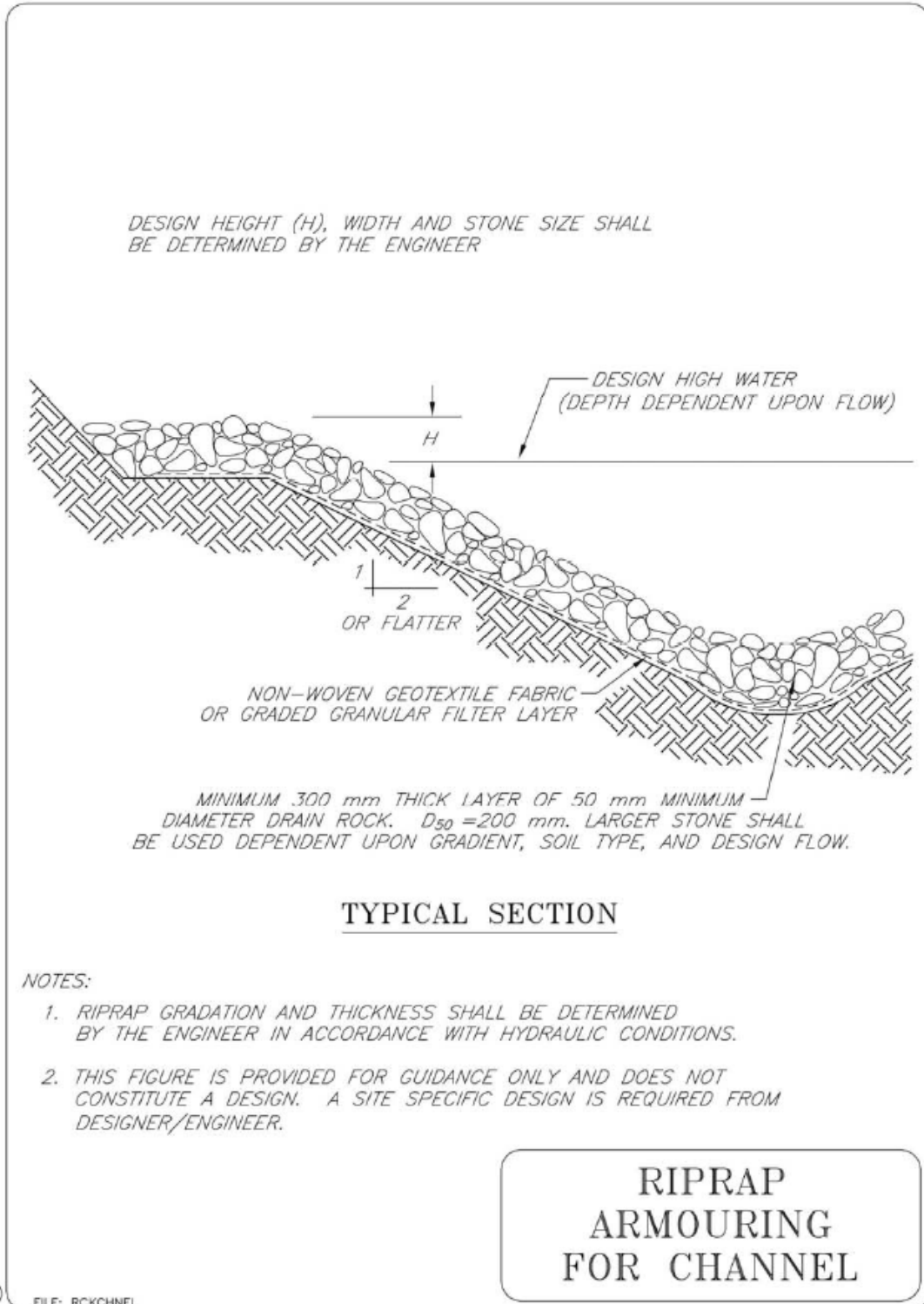
**NOTE:**

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

**RIPRAP  
ARMOURING  
FOR SLOPE**

From: Solix-Applied Earthcare - EROSION DRAW 3.0  
1994 JOHN McCULLAH  
© FILE: RIPRAP

Source: Ontario BMP 7-4



Source: Ontario BMP 7-5

### Description and Purpose

- Consist of rock placed inside wire baskets to protect steep or erodible slopes from sheet flow erosion
- Protects erodible stream channel banks from potentially high erosive concentrated flow velocities or high tractive forces • Can be applied to:
  - Slope and banks
  - Single gabion drop structure for ditch channel
  - Double gabion "energy dissipator" drop structure for ditch channel

### Applications

- Permanent measure
- May be used on stream bank aprons and blankets where flow velocities do not exceed 6 m/s
- May be constructed to 0.5H:1V as a low height toe protection structure of slope
- May be used on slopes up to 1.5H:1V as slope protection, a grade break and sediment barrier
- Gabion mattresses are an alternative to riprap armouring of channels
- May be used to construct dikes or weirs
- Used as a drop structure (check structure) to reduce grade between structures and as sediment barrier in channels
- Used as a splash pad to reduce flow velocity and dissipate flow energy

### Advantages

- Relatively maintenance free
- Long lasting and sturdy structure
- Lower thickness requirement for gabion (can be 1/2 to 1/3 riprap thickness) compared with riprap thickness for identical severe hydraulic conditions. with riprap placement
- Gabions are porous, free-draining and flexible so they are less affected by frost heaving and hydrostatic pressures
- Trap sediment and support plant growth to effect higher channel resistance to flow

### Limitations

- Construction is labour intensive
- Extra costs associated with wire for mesh cages and rock fill plus geotextile fabric or sand filter layer

### Construction

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- Prepare subgrade on mineral soil at designated gabion location
- Subexcavate trench a minimum of 0.15 m deep to 'key-in' gabion structure
- Construct gabion basket as per manufacturers recommendations
- Line interior of basket with non-woven geotextile OR a gravely sand filter layer (if required by design) along areas where the basket is in contact with soil
- Backfill basket with rock with wire bracing at 1/3 points (or 0.3 m spacings)
- Install gabion basket top
- Backfill trench and compact soil around edges of completed basket

**Construction Considerations**

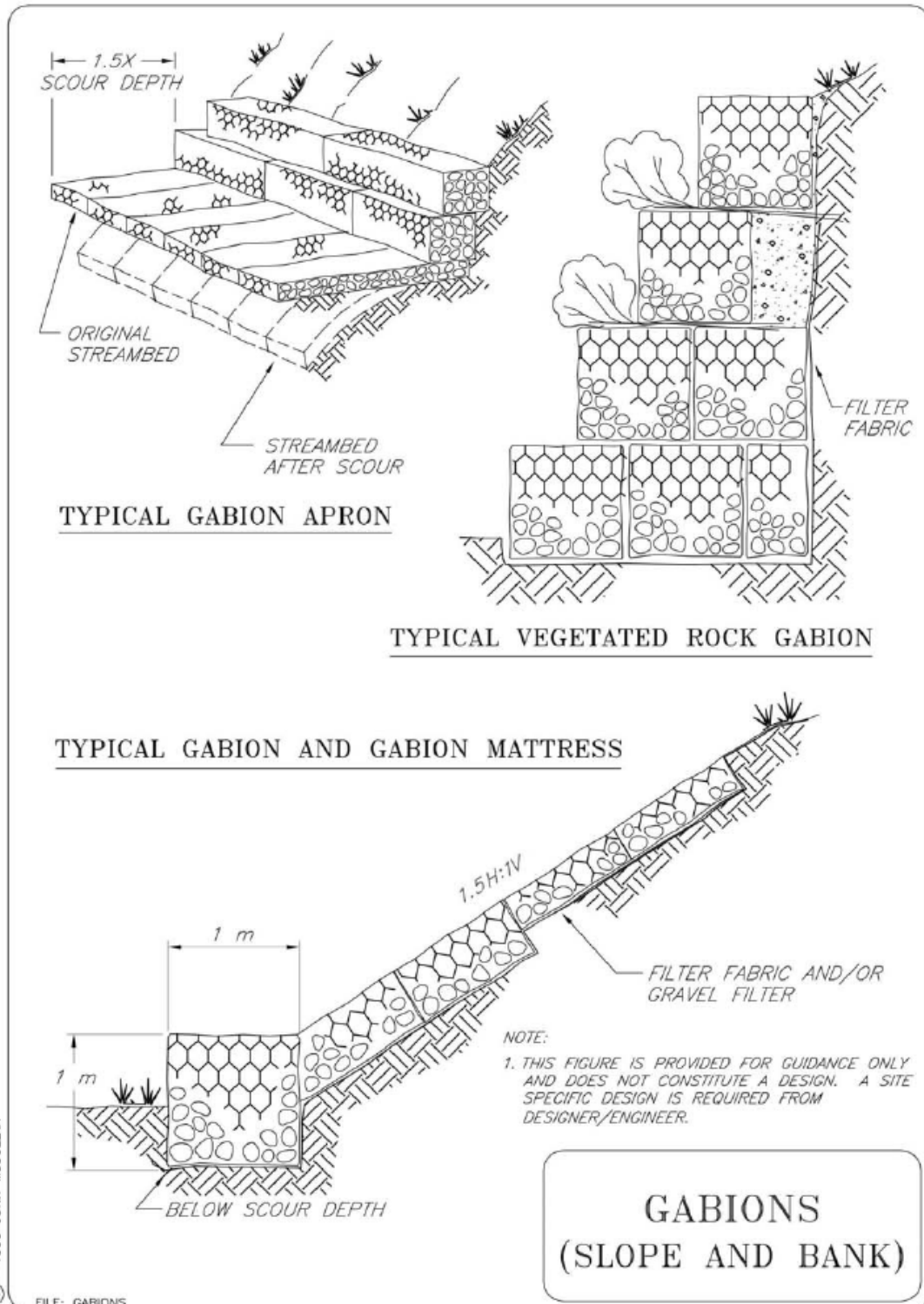
- Gabions should be placed on a properly graded surface
- Non-woven geotextile should be used to prevent loss of underlying material and infiltration of fine grained particles into the gabion structure
- Rock in the baskets may be placed by hand to enhance dense packing of stones and decrease void spaces
- Construct gabions with internal wire diaphragms to maintain structural stability (shape)

**Inspection and Maintenance**

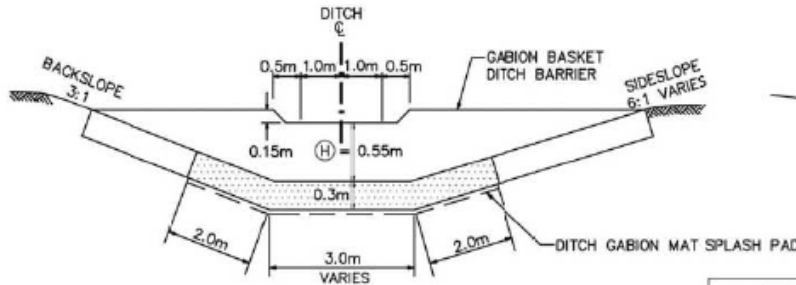
- Should be inspected after major storm events, especially where undermining at the toe of the basket is a concern
- Repairs should be performed immediately when required; repairs may include hand grading and/or infilling undermined area with rocky material

**Similar Measures**

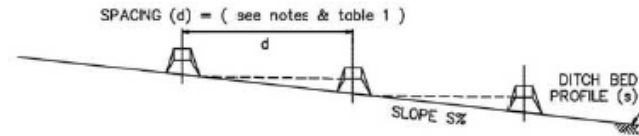
- Berms/barriers
- Check dams
- Permeable/synthetic barriers
- Rock/brush barriers
- Sand/gravel bag barriers



Source: Ontario BMP 8-4



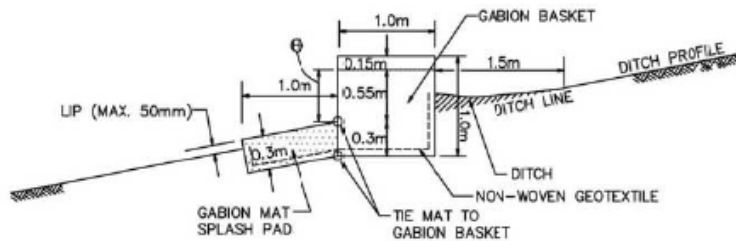
FRONT VIEW FROM DOWNSTREAM  
TYPICAL DITCH CROSS-SECTION  
GABION BASKET DITCH BARRIER  
N.T.S.



TYPICAL BARRIER SPACING  
N.T.S.

SUGGESTED SPACING (d)		REMARKS
S (%)	(m)	
5-7	30	OPTION TO INSTALL A GRADE BREAK (s.o. WEAVE BARRIER) BETWEEN STRUCTURES.
7-8	25	A DOUBLE GABION FOLLOWS EVERY 2 SINGLE GABIONS.
>8%	≤15	DESIGN BY ENGINEER REQUIRED.

TABLE 1



CROSS-SECTION VIEW  
"SINGLE GABION" BASKET DITCH BARRIER  
& GABION MAT SPLASH PAD  
N.T.S.

NOTES:

- SUITABLE FOR MEDIUM TO STEEP GRADES AND CHANNELS LEADING TO WATER COURSE  $4% < S < 10%$ .
- i) SPACING TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS. - -  
ii) USE IN CONJUNCTION WITH DOUBLE GABIONS OR OTHER BARRIER STRUCTURES.
- SOIL COVERING BETWEEN STRUCTURES SUGGESTED FOR STEEP GRADE SOIL DITCH.
- THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

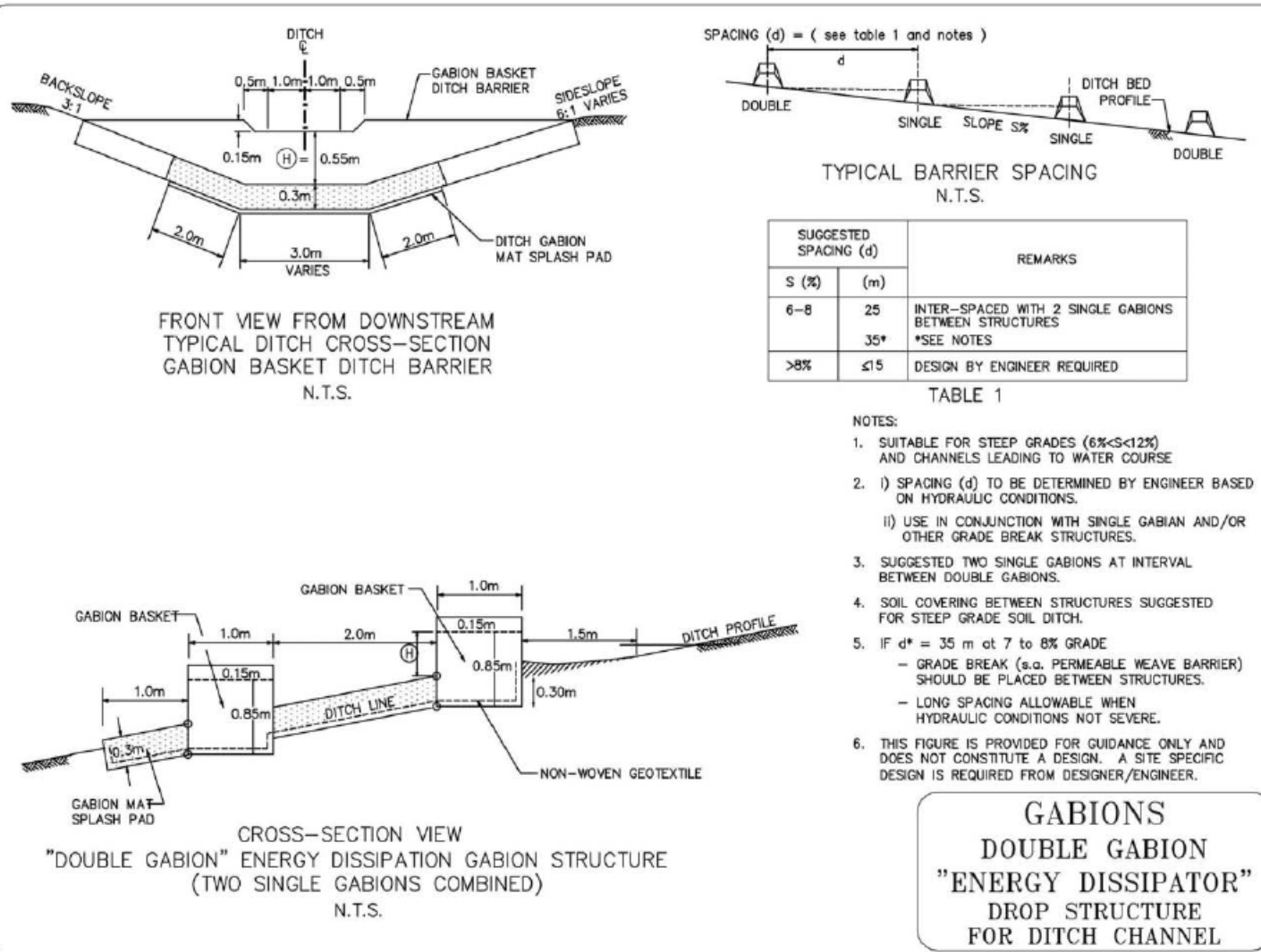
**GABIONS  
SINGLE GABION  
DROP STRUCTURE FOR  
DITCH CHANNEL**

Source: Ontario BMP 8-5

# Gabions

## Erosion Control

# BMP 2



Source: Ontario BMP 8-6



### 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

### Construction *(Note: For guidance only. A site specific design is required from designer/engineer.)*

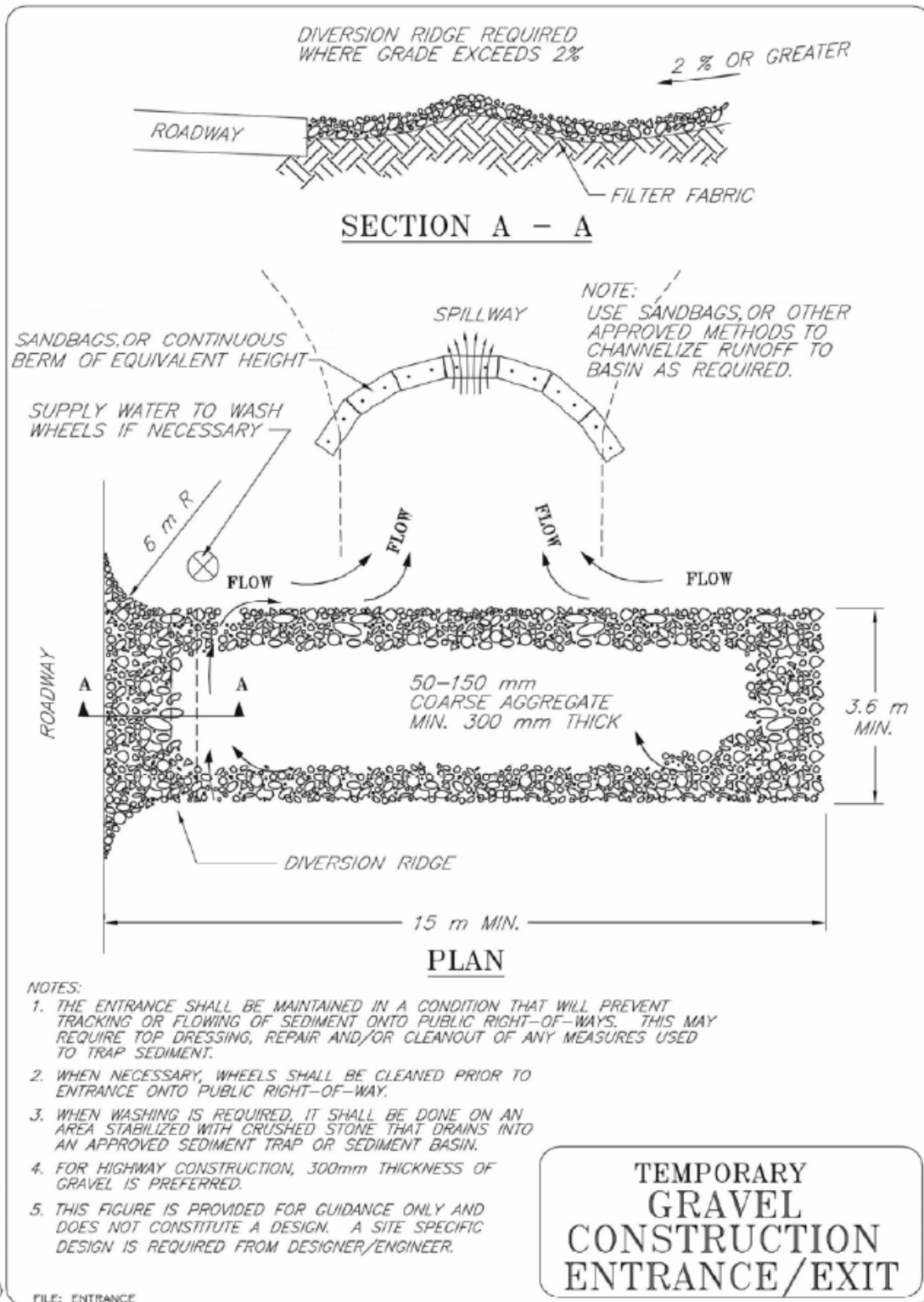
- Install gravel pad at planned entrances to worksite
  - Gravel pad (minimum of 15 m in length) should be of sufficient length to accommodate longest anticipated vehicle entering or exiting the site
  - Width of pad should be sufficient to accommodate the widest anticipated vehicle entering or exiting 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

### 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



Source: Ontario BMP 10-3

**Description and Purpose**

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

**Applications**

- Temporary or permanent measure
- May be used to protect disturbed, exposed soils for cut or fill slopes at gradients of 2.5H:1V or steeper
- May be used on slopes where erosion potential is high
- May be used on slopes where vegetation is likely to develop slowly
- May be used to protect disturbed exposed soils in ditches and channels by providing additional tractive resistance cover in conjunction with high density vegetative growth

**Advantages**

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

**Limitations**

- Non-performance of RECP may result from the following:
  - Low density vegetation growth (beneath RECP) due to non-favorable weather and growth conditions (i.e. soil type, moisture, storm events at critical times). The effectiveness of RECP, especially along channels, is dependent on successful vegetation growth. It is important that the designer assess the effectiveness of RECP for site-specific soil, terrain and vegetation growth conditions.
  - Hydraulic uplift of RECP and erosion of underlying soils can occur under rapid snow melt conditions when dammed melt water generates a hydraulic head and high flow velocity in a constricted snow melt channel. This situation can occur along steep channels interlaced with drop structures and with RECP lining installed in between the drop structures. Ponding of melt water and non anchored RECP joint areas allow flow entry beneath the RECP and generate hydraulic heads to uplift the RECP. This can occur along un-anchored edges of RECP at upper edges of ditch when snow melt occurs at tops of ditch and flow beneath the RECP. This is especially critical when underlying soil is easily erodible. It is important to trench-in and anchor the edges of the RECP installations and installed anchor pin (staples) at sufficient frequent intervals.
  - Ice buildup from groundwater seepage can uplift and dislocate the RECP and cause flow beneath the RECP to erode the substrate soils. Winter ice accumulation may be related to groundwater regime and investigative design on subsurface drainage by a geotechnical engineer is required.
- Can be labour intensive to install
- Must be installed on unfrozen ground
- Temporary blankets may require removal before permanent measures are installed
- Rolled erosion control products (RECP) are not suitable for rocky sites
- Proper surface preparation is required for intimate contact between blanket and soil Plastic sheeting can be used at sensitive slopes with precautions:

- Plastic sheeting RECP product can be easily torn, ripped, non-biodegradable, and should be disposed of in a landfill
- Plastic sheeting product, if used, results in 100% runoff, thus increasing erosion potential in downslope areas receiving the increased flow volumes
- Plastic sheeting should be limited to temporary covering of sensitive soil stockpiles or temporary covering of small critical unstable slope areas

**Construction (Slopes)**

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

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

**Construction (Channels)**

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- A blanket should be installed in accordance with manufacturers directions
- The following is a general installation method:
  - Prepare surface and place topsoil and seed
  - Surface should be smooth and free of large rocks, debris, or other deleterious materials
  - Begin by excavating a minimum 0.15 m deep and 0.15 m wide trench at the upstream end of channel and place end of RECP into trench
  - Use a double row of staggered anchors approximately 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
  - Backfill and compact soil over RECP in trench
  - Roll centre RECP in direction of water flow on base of channel
  - Place RECP end over end (shingle style) with a minimum 0.15 m overlap downgrade
  - Use a double row of staggered anchors approximately 0.1 m apart to secure RECP to soil
  - ull length edge of RECP at top of sideslopes must be anchored in a minimum 0.15 m deep and 0.15 m wide trench
  - Use a double row of staggered staple anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
  - Backfill and compact soil over RECP in trench
  - Overlap RECP on sideslopes (shingle style down channel) a minimum of 0.1 m over the centre RECP and secure RECP to soil with anchors spaced a maximum of 0.2 m apart
  - In high flow channels, a check slot across the width of the channel is recommended at a maximum spacing of 10 m to anchor the ends of the RECP to the underlying soil
  - Use a double row of staggered staple anchors a maximum of 0.1 m apart (0.2 m linear spacing) to secure RECP to soil in base of check slot
  - Backfill and compact soil over RECP in check slot
- Anchor terminal ends of RECP in a minimum 0.15 m deep and 0.15 m wide trench

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

#### **Construction Considerations**

- Slopes should be topsoiled and seeded prior to placing RECP
- Ensure blanket is in intimate contact with the soil by properly grading soil, removing rocks or deleterious materials, prior to placing blanket
- In channels, blankets should extend above the anticipated flow height, with a minimum 0.5 m of free board
- For turf reinforcement mat (TRM), blanket should be placed immediately after topsoiling
- Blanket should be anchored by using wire staples, metal geotextile stake pins, or triangular wooden stakes
  - All anchors should be a minimum of 0.15 to 0.20 m in length
  - For loose soils, use longer anchors
- Blankets should be placed longitudinal to direction of flow, with fabric not stretched but maintaining contact with underlying soil
- It is essential to understand product specifications and follow manufacturers instructions on installation methods

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

RECPs should be certified by the supplier/manufacturer to ensure product performance and compliance with specified property requirements. A certificate for QA/QC testing of manufactured products is required. The performance and QA/QC testing should be carried out by reputable laboratories to ensure a commonly acceptable QA/QC standard. Depending on product type and intended performance, the product information certificate should be provided by the product supplier/manufacturer and include the following:

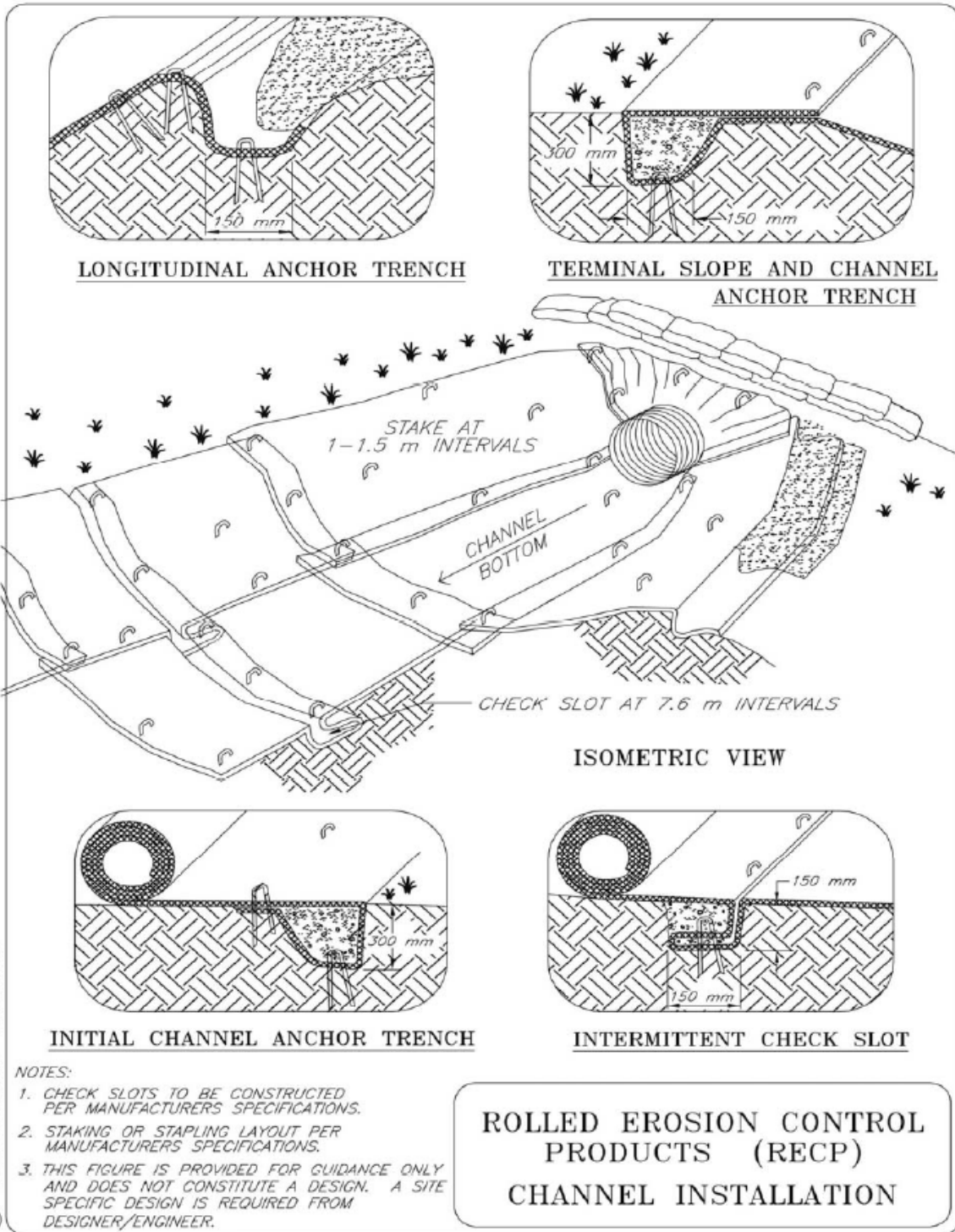
- Performance specification:
  - Permissible Tractive Resistance (include testing methods and vegetative growth conditions)
  - Permissible Flow Velocity (if available)
  - Longevity (for biodegradable or non-biodegradable products)
- Minimum Average Roll Values (MARVs) along with specified testing methods for:
  - Physical properties
  - Mass per unit area
  - Thickness
  - Tensile strength
  - UV Resistance
  
  - Other physical properties (for non-woven below Erosion Mat (if specified))
  - Grab tensile strength
  - Grab elongation
  - Puncture strength
  - Trapezoidal tear
  - UV Resistance

#### **Inspection and Maintenance**

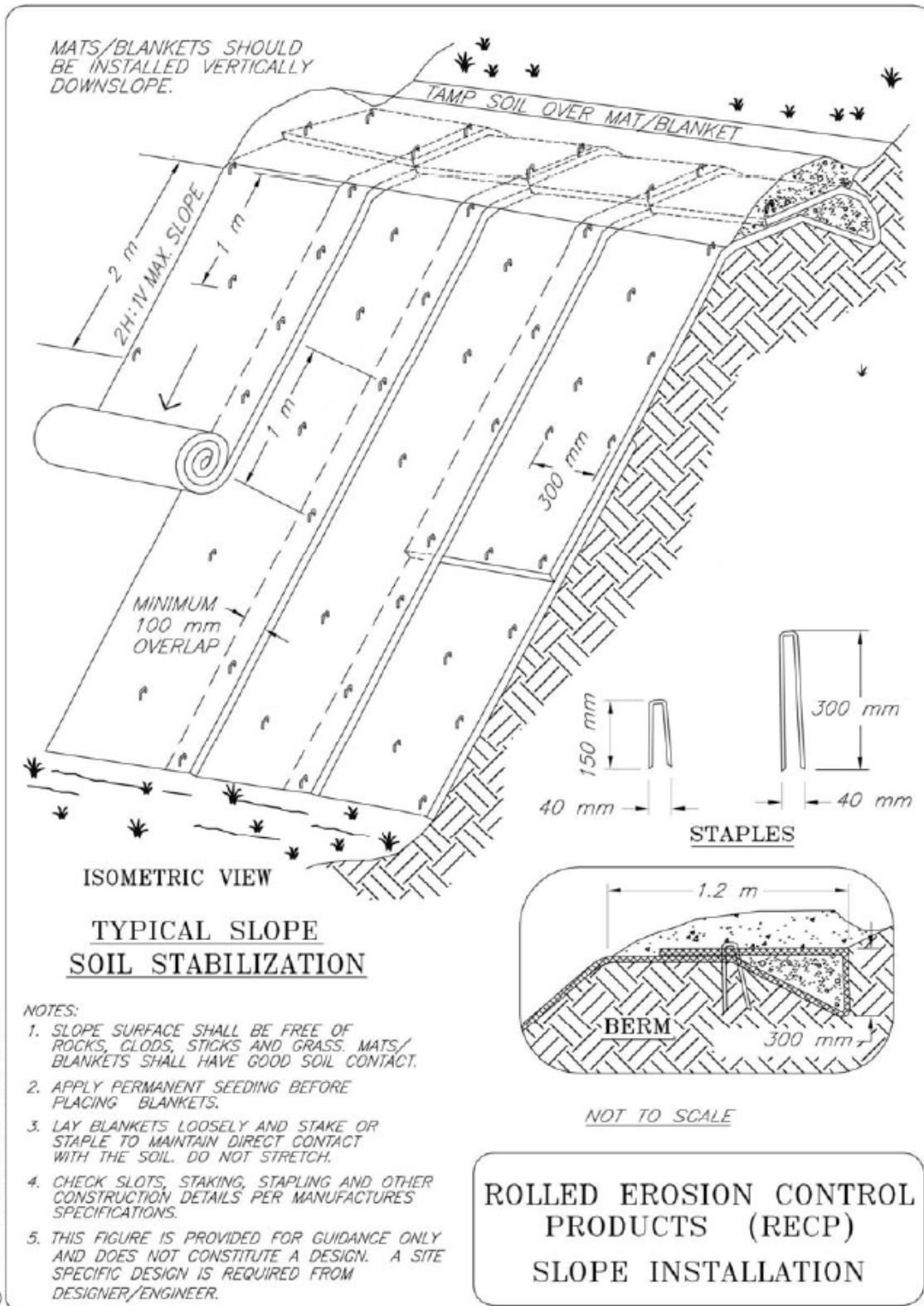
- Area covered with blankets should be regularly inspected/repared, especially after periods of severe rainfall or storm events, to check for blanket separation or breakage
- Any damaged or poorly performing areas should be repaired immediately. Regrading of the slope by hand methods may be required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

**Similar Measures**

- Mulching (for slopes only)
- Chemical stabilization (for slopes only, e.g. tackifiers)
- Rip rap (primarily in channels)
- Gabion mattresses (primarily in channels)
  
- **Design Considerations**
- Assess hydraulic flow conditions and tractive stress on channel
- Assess local soil, weather and growth conditions (favourable/non-favourable) for revegetation (within 3 to 12 months) to allow a determination on use or non-use of RECP as a protective measure. If the revegetation conditions are assessed favourable, the use of RECP can be considered
- Assess suitability of a RECP product using tractive resistance data tested for (i) bare soil, and (ii) vegetated (a specified duration of growth period) condition
- It is noted that tractive resistance data are adopted as selection criteria of RECP and permissible velocity data can be provided for reference.



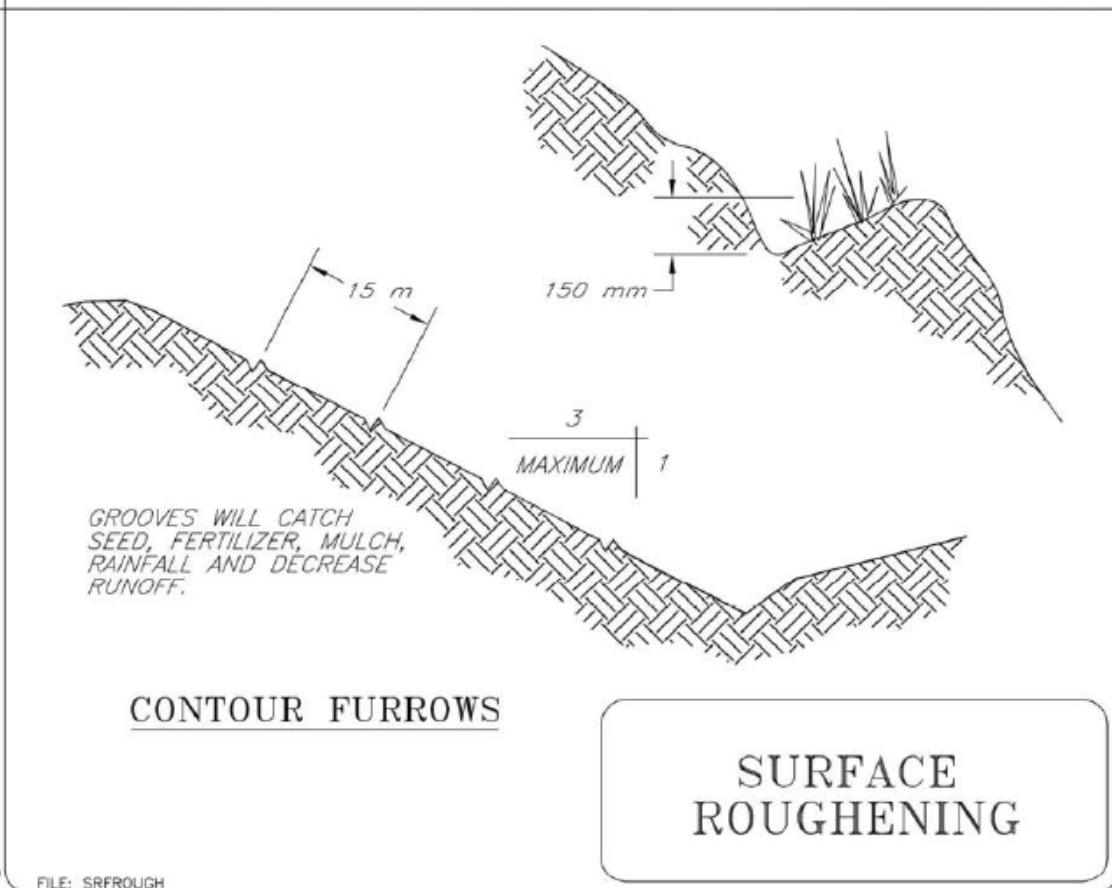
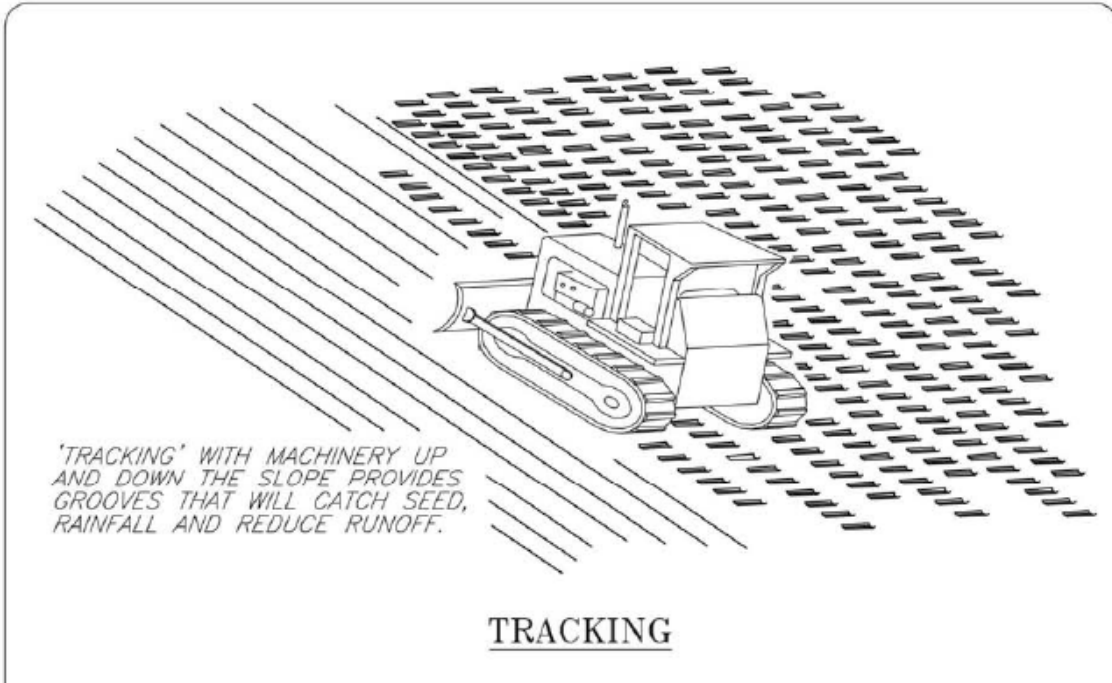
Source Ontario 11-7



From: Soils-Applied Earthcare - EROSION DRAW 3.0  
1994 JOHN MCCULLAH FILE: BLNKTSLP

Source: Ontario BMP 11-8





From: Salix—Applied Earthcare — EROSION DRAW 3.0  
1994—JOHN McCULLAH  
© FILE: SRFROUGH

Source: Ontario BMP 15-4

**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 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
- 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**

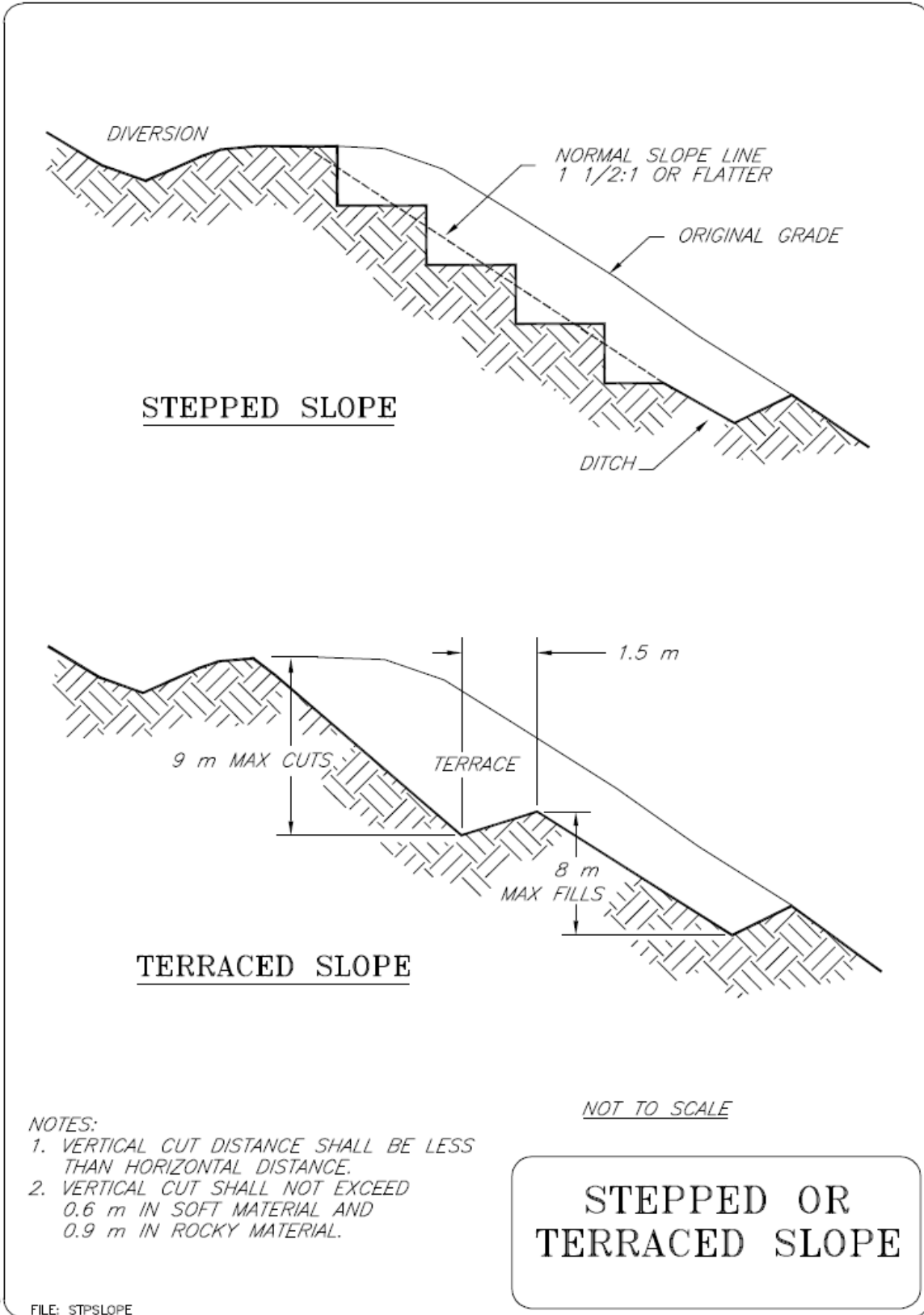
*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- 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

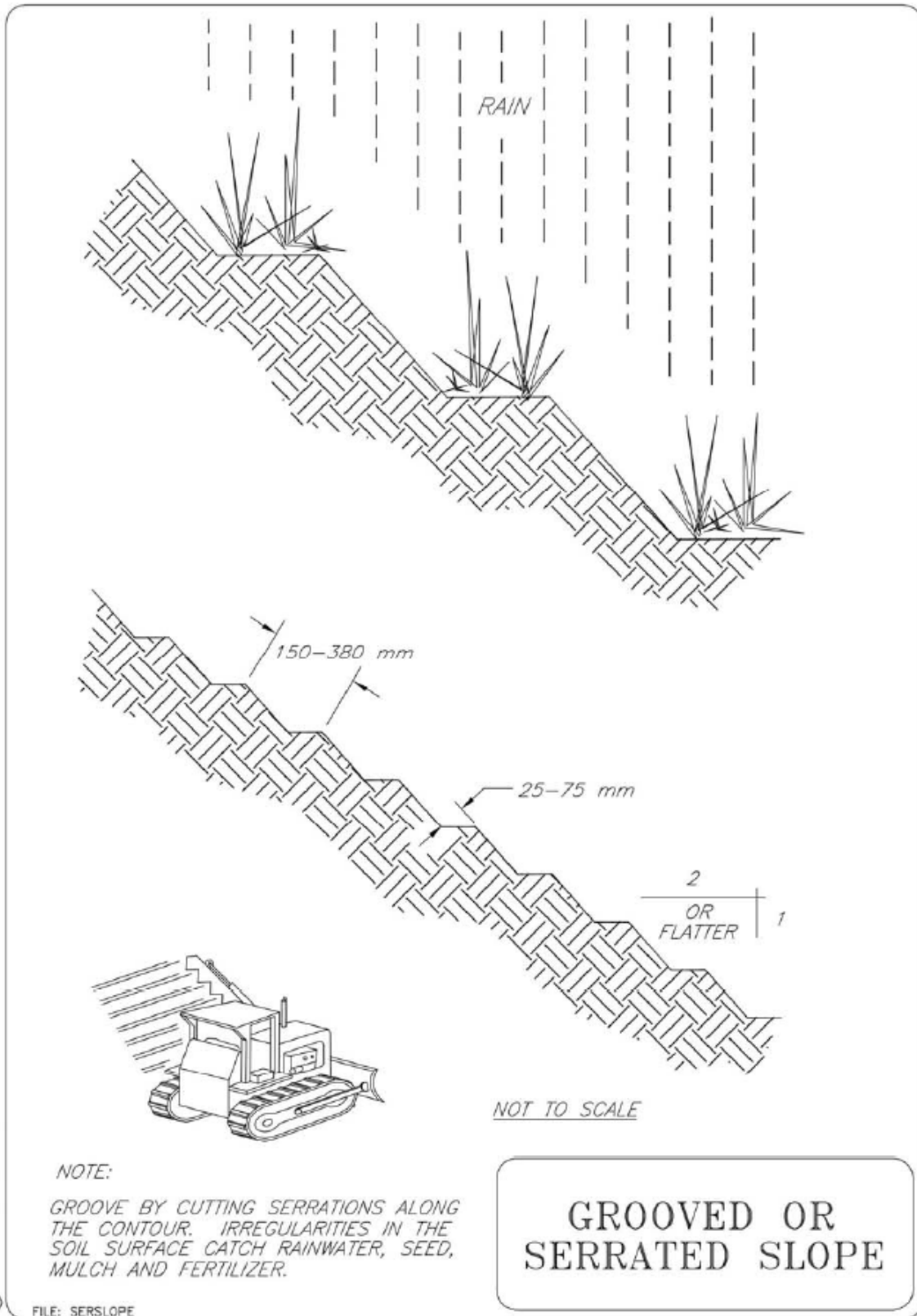
- Grooves can be made by using equipment or hand

**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 downslope 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.



Source: Alberta Transportation BMP #34c / Typical Section



From: Soil-Applied Earthcare - EROSION DRAW 3.0  
 1994 JOHN McCULLAH

Source: Ontario 15-5

**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**

- 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 (i.e. gabion) 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 simulated to dissipate flow energy, thus minimizing erosion potential
- Provide portable drainage control for construction sites, ditches, channels, roads, slopes
- The double panel porous barrier may allow significant energy loss as the flow of water undergoes from supercritical flow to sub-critical 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, check structures, straw bales)
- 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 at behind the upstream barrier panel area; the downstream flow exiting at the downstream barrier panel may be of laminar nature and 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 cause damage to human and maintenance equipment
- The use of biodegradable anchor pins may be advisable

**Construction**

*(Note: For guidance only. A site specific design is required from designer/engineer)*

- 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**

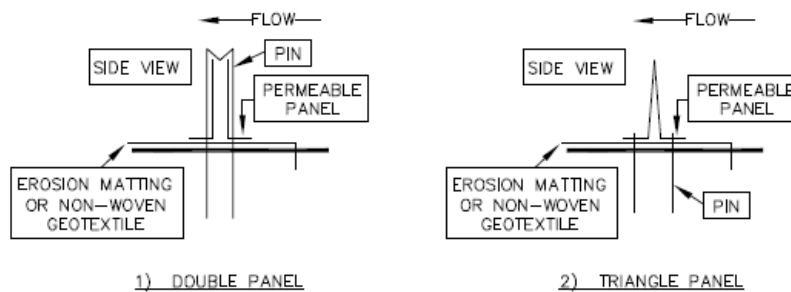
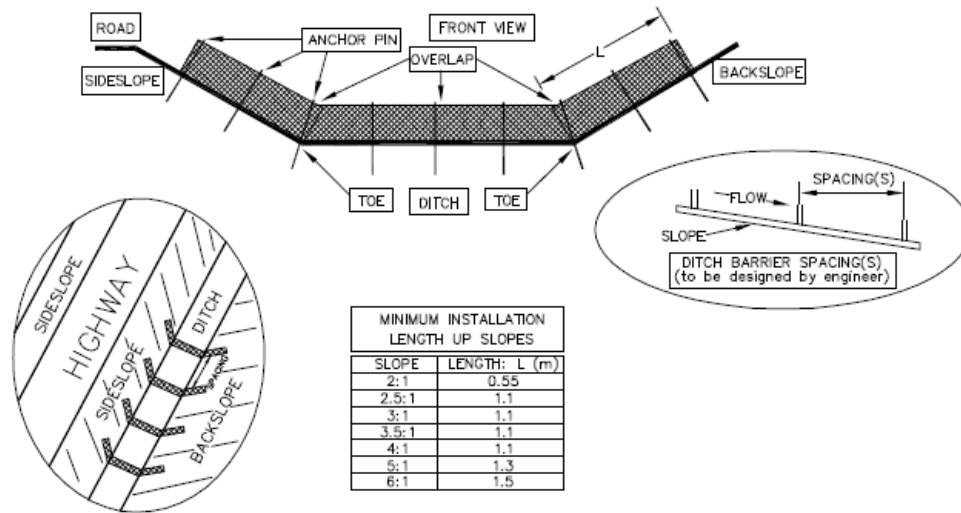
- Inspect barriers at bi-weekly intervals and after each significant rainfall event
- Remove sediment build-up before it reaches one-half the check structure height
- Do not damage barrier panel during removal of sediment
- Partial or non-removal of sediment build-up will create a non-permeable barrier 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 at 1 year after vegetation is established

**Similar Measures**

- Silt fences or straw bales partially equivalent in 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 (i) total hard armoring of complete channel length, or (ii) high frequency of gabion installation required for high flow applications in steep ditch grade



**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**

Source: Alberta Transportation BMP #10 / Typical Section



### **Description and Purpose**

- A barrier of strawbale primarily used as a perimeter sediment control measure
- May be used to intercept and retain sediment laden runoff allowing a portion of the sediment load to be retained

### **Applications**

- Temporary measure
- Suitable for flow velocities of 0.3 m/s or less
- Usually placed at 1m to 2 m offsets from toe of disturbed slopes
- Size of drainage area should be no greater than 0.1 ha per 30 m length of straw bale sediment barrier
- Maximum flow path length upstream of barrier should be less than 30 m
- Maximum slope gradient above the barrier should be no greater than 2H:1V
- May be used in conjunction with filter fabric as external wrap to encapsulate the bale

### **Advantages**

- Straw bales are biodegradable
- Only requires one row of straw bales
- Easier to install than other barriers and economical if straw bales are readily available

### **Limitations**

- Not appropriate for flow velocities greater than 0.3 m/s
- Require extensive maintenance following high velocity flows associated with storm events
- Not as robust as earth berms or continuous berms
- Susceptible to undermining and erosion damage if not properly keyed into substrate soil or if joints are not completely infilled with straw
- Short service life
- Must be installed by hand
- Not to be used on asphalt or concrete covered surfaces
- Availability of appropriate bales may be limited in certain areas of the province
- Maximum straw bale barrier height of one straw bale or 0.5 m maximum height

### **Construction**

*(Note: For guidance only. A site specific design is required from designer/engineer)*

- Straw bale barrier should be located a minimum distance 1.8 m away from the toe of the slope to provide adequate ponding and sedimentation area
- Excavate a trench approximately 0.10 m deep with a width of one straw bale at the straw bale barrier location
- Place straw bales in excavated trench along contour, perpendicular to flow direction
  - Ensure twine or wire is not in contact with the soil
  - Ensure straw bale is in continuous contact with base of trench
  - Ends of barrier should be angled upslope to form enclosure to contain runoff
- Infill all joints with loose straw
- Drive two 50 mm by 560 mm section wooden stakes 1.2 m long 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 subgrade

### **Construction Considerations**

- Maximum lengths of barriers should be 40 m, including 'J- hook' or 'smile' (similar to silt fence in BMP #18) configuration, to allow escape route for excess runoff
- Barrier should be placed far enough away from toe of slope to provide adequate ponding and sedimentation area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of barriers should be angled upslope (in a 'J-hook' or 'smile' configuration) to form enclosure to collect runoff
- Straw bales should be:

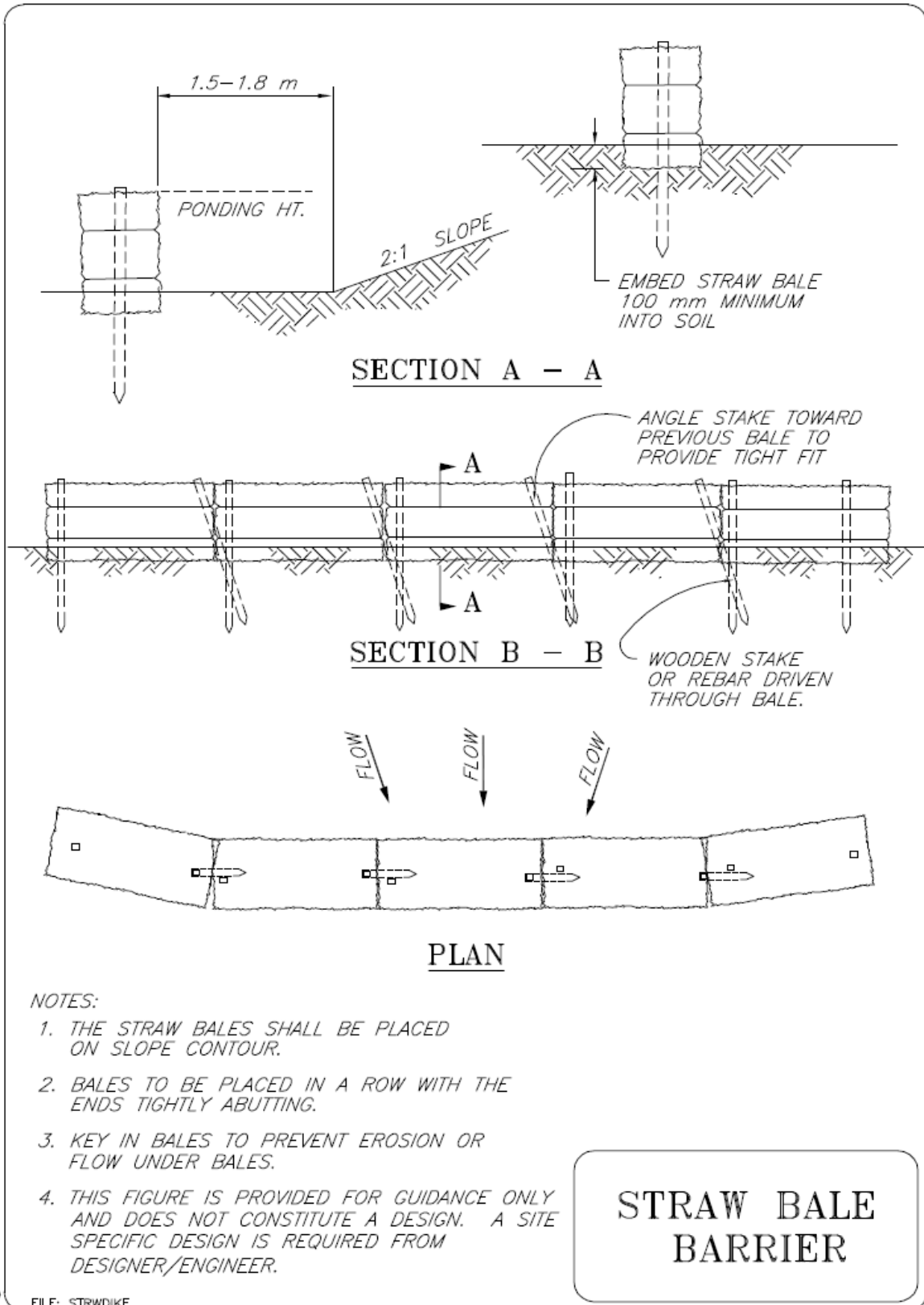
- Machine-made
- Weed free cereal crop straw such as wheat, oats, rye, or barley
- Tightly compacted and bound with two rows of wire or synthetic string and shall show no signs of weathering
- No more than one year old

**Inspection and Maintenance**

- Inspect barriers at least at weekly intervals 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 barrier height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace damaged, decayed or dislodged straw bales immediately

**Similar Measures**

- Silt fences
- Continuous (earth- filled geotextile) berms
- Earth Dyke Barrier



Source: Alberta Transportation BMP #12 / Typical Section

**Description and Purpose**

- Barrier constructed of compacted soil to intercept and divert flow of runoff water away from sensitive areas or water bodies
- 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
- Perimeter control
- Placed along contours at toe of slope to divert run-off from sensitive areas
- Used to divert water to sediment control structures

**Advantages**

- Easy to construct
- Can be converted to sedimentation/impoundment pond with the design of a permeable filter berm at the exit spillway area (see drawing)

**Limitations**

- Generally, 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: For guidance only. A site specific design is required from designer/engineer)*

- 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 flattened to a minimum of 3H:1V for uncompacted fine grained soils

**Inspection and Maintenance**

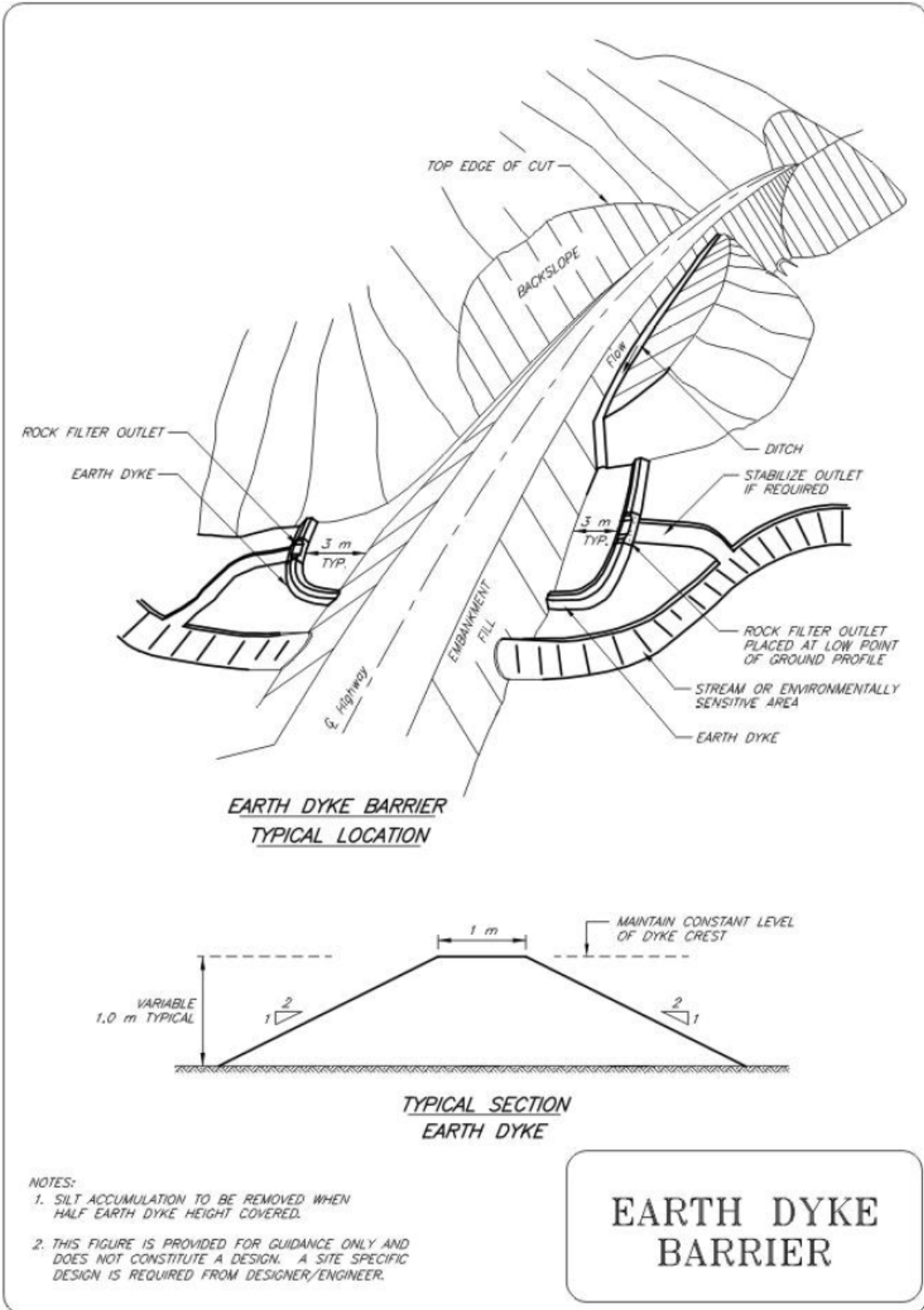
- The degree and extent of inspection and maintenance performed on an earth dyke barrier is directly related to the consequences of failure. Depending on the consequences of failure, an engineer experienced in embankment design and inspection may be required for inspection, design of remedial measures 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 of geotextile over the failed area and placing a stabilizing toe berm constructed in the granular materials over the non-woven materials where disturbance is evident
- 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**

- Berms
- Sand/Gravel Bag Barriers

**Design Considerations**

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



Source: Alberta Transportation BMP #5 / Typical Section

**Description and Purpose**

- Temporary barriers of brush wrapped in filter fabric and secured in place, or rock anchored in place to intercept and filter 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 less than 250 m<sup>2</sup> per 25 m length of barrier

**Advantages**

- May be equally effective filter as silt fences

**Limitations**

- Temporary measure only
- Maximum drainage area of less than 250 m<sup>2</sup> per 25 m length of barrier
- Sufficient area behind berm required for ponding and clean out of sediment
- Not effective for diverting runoff (filters allow runoff to seep through)
- Rock filter 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: For guidance only. A site specific design is required from designer/engineer)*

- Brush filter berm
  - Size of the brush filter 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 tall 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
  - Filter fabric 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 filter fabric in the trench shall be staked down with stakes spaced approximately 1 m apart
  - The trench is then backfilled and compacted over the staked filter fabric
  - The fabric is anchored with twine/wire to stakes on the downstream side of the berm

- Rock filter berm
  - Constructed similar to brush filter berm, replacing brush with rock (D50 = 75 mm to 150 mm)

#### **Construction Considerations**

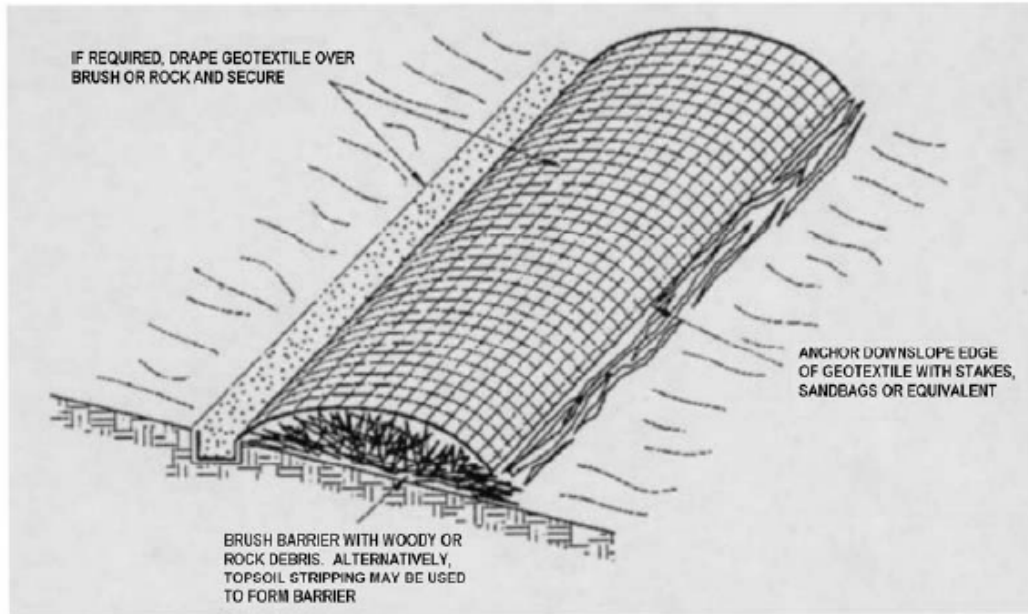
- Use rock or brush material smaller than 150 mm in diameter, or use filter cloth to encapsulate the material, to promote filtration
- There is no predetermined shape for filters
- Water must be forced to filter through the berm and not flow around it
- Brush barriers can generally be constructed of clean organic material made available from clearing and grubbing operations that is normally burned or discarded
- Rock and brush filter berms are temporary measures and should be removed upon completion of service life, but not prior to 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 filter fabric
- 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 filter fabric, and end runs and erosion of the filter and repair immediately

#### **Similar Measures**

- Berms/Barriers
- Check Dams
- Permeable/Synthetic Barriers
- Sand/Gravel Bag Barriers
  
- 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
    - D50 of 75 mm to 150 mm preferable
  - Brush
    - Material shall be less than 150 mm in diameter



*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**

Source: Ontario BMP 24-4



**Description and Purpose**

- Small dam constructed across a drainage channel
- May be constructed of rock, aggregate-filled sandbags or logs
- Decrease 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
- May be used in steep channels where runoff velocity is less than 1.5 m/s

**Advantages**

- More effective than straw bales for stabilizing medium to steep gradient ditches as a permanent measure
- Cheaper than using riprap armouring or gabion structures in a ditch
- Rock and sandbag 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
- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- 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

**Construction (Rock Check Dam)**

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- 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 (D50) 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: For guidance only. A site specific design is required from designer/engineer.)*

- 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)

**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  $\frac{3}{4}$  full to allow bag to mould to contours, allowing continuous contact between the bag and the soil

**Construction** (Log Check Dam)

*(Note: For guidance only. A site specific design is required from designer/engineer.)*

- 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)

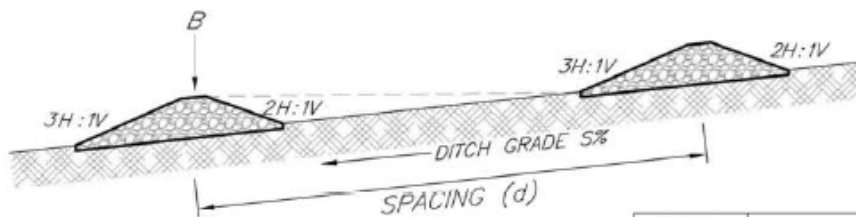
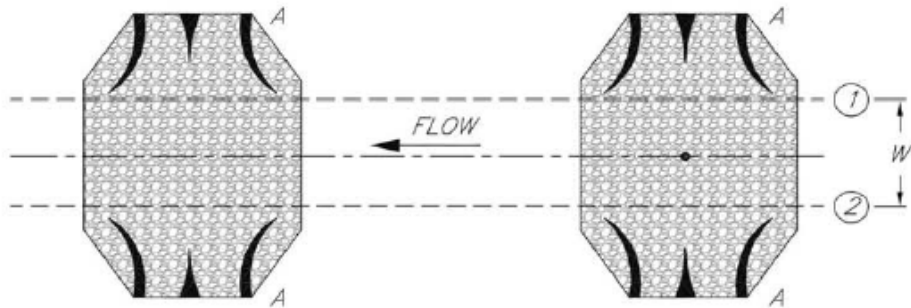
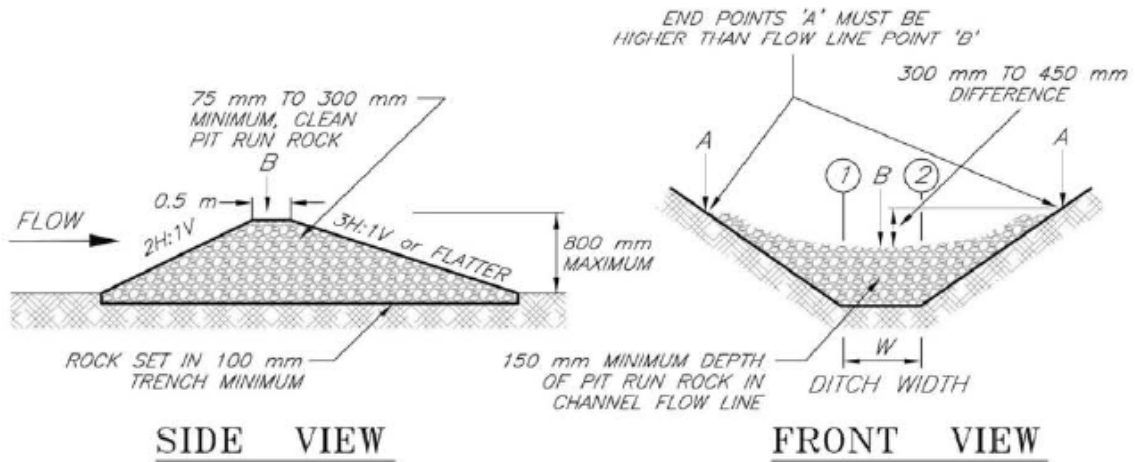
- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- Wood check dams placed in ditches with high anticipated flow velocity should have their spacing and height design according to the anticipated hydraulic condition
- Bracing should be installed to provide support 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



**NOTES:**

1. SUITABLE FOR FLOW VELOCITY  $\leq 1.5$  m/s.
2. SUITABLE FOR DRAINAGE AREA  $\leq 4$  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.

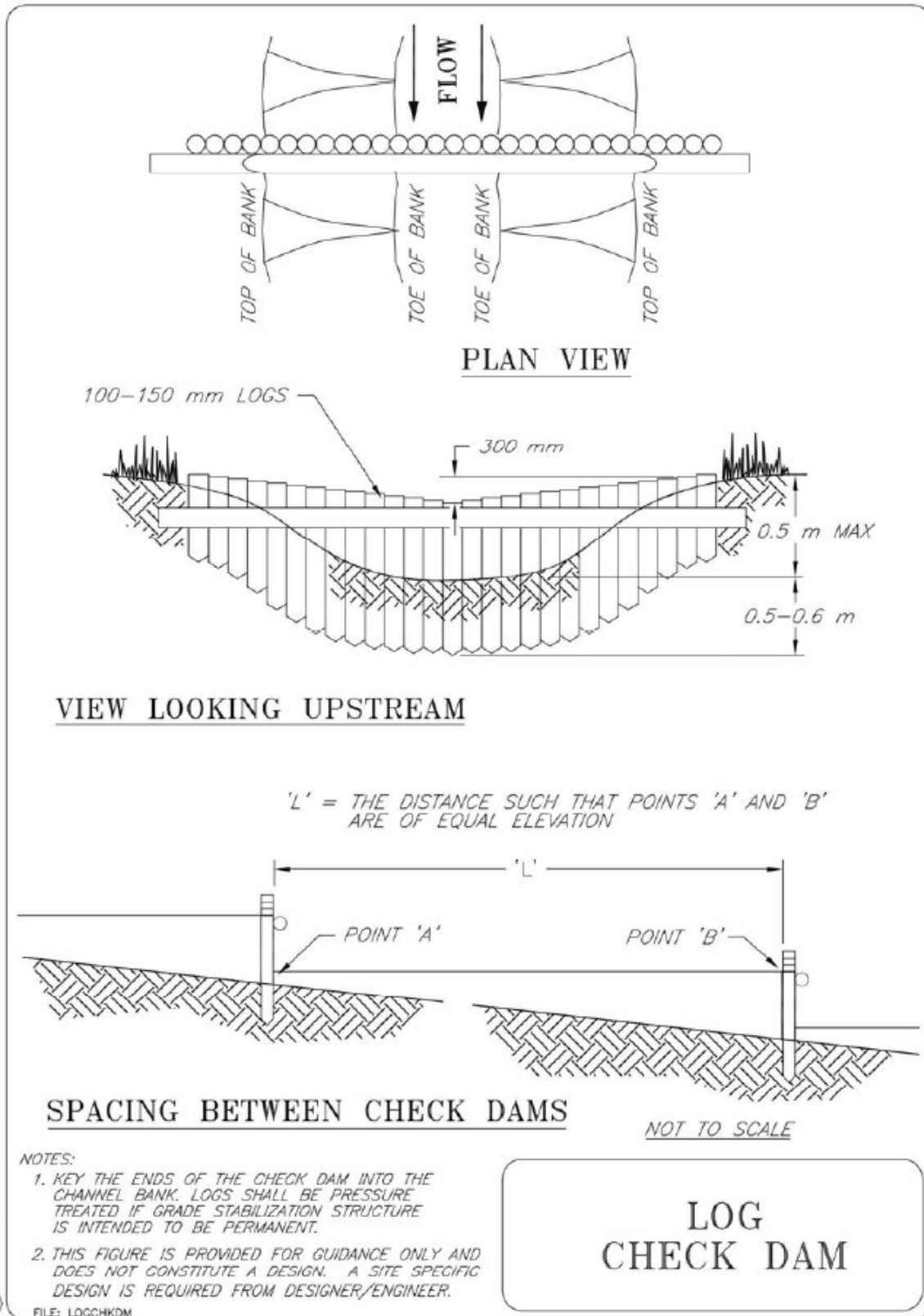
$D_{50}$ of ROCK (mm)	MAXIMUM FLOW DEPTH OVER ROCK (mm)
75	50
150	100

**SUGGESTED ROCK DIAMETER AND OVERFLOW DEPTHS**

**ROCK CHECK DAM**

NOT TO SCALE

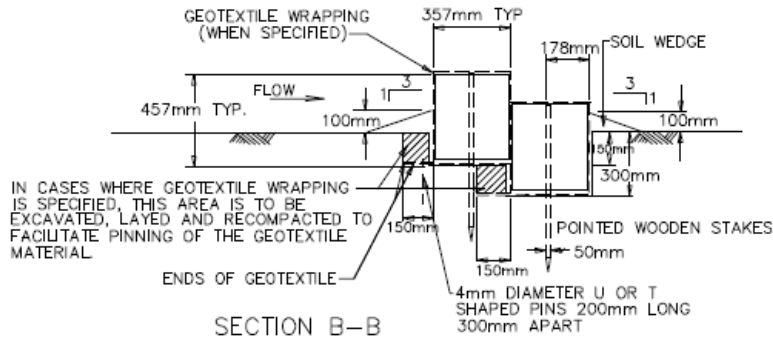
Source: Ontario BMP 26-5



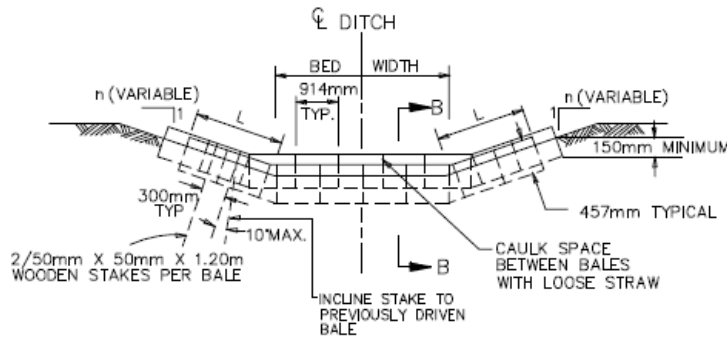
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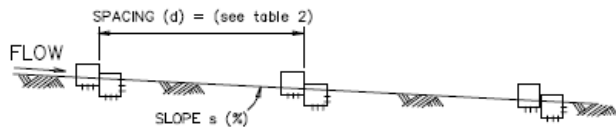
Source: Ontario BMP 26-6



SECTION B-B



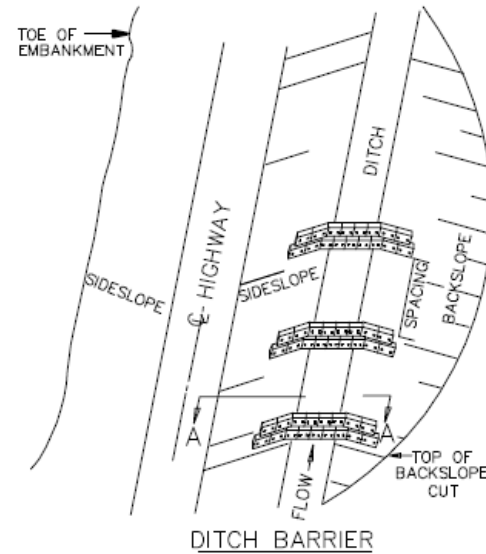
ELEVATION A-A (WOODEN STAKES OMITTED FOR CLARITY)



TYPICAL DITCH BARRIER SPACING

SLOPE n	LENGTH L (m)
2	1.0
2.5	1.25
3.0	1.50
3.5	1.65
4	1.80
5	2.35
6	2.75

s (%)	d (m)
3	40
4	35
5	25



NOTES:

1. SUITABLE FOR  $s < 5\%$  AND HYDRAULIC CONDITIONS NOT SEVERE FOR  $s > 5\%$ , THE ENGINEER MUST ASSESS USE OF THIS STRUCTURE VERSUS OTHER OPTIONS.
2. EMBED BALES 100 TO 150 mm INTO THE SOIL AND "KEY BALES INTO THE CHANNEL BANKS.
3. PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.
4. BALE HEIGHT SHALL NOT EXCEED 0.5 m.
5. INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

**STRAW BALE  
CHECK DAM**

Source: Alberta Transportation BMP #11 / Typical Section

**Description and Purpose**

- Diversion of a watercourse into an artificial channel to permit construction “in the dry” of a culvert or bridge
- Minimize erosion and sedimentation that can result from construction within a watercourse
- Isolates the construction site

**Applications**

- Temporary measure
- At proposed culvert and bridge crossings

**Advantages**

- Protects environmentally sensitive areas
- Can convey layer flows compared to dam and pumping
- Not at risk of power failure (e.g. to pumps)
- Maintain fish passage

**Limitations**

- Requires erosion protection (may be expensive)
- Risk of export of sediment downstream if not properly staged and potential from erosion

**Construction** (*Note: For guidance only. A site specific design is required from designer/engineer*)

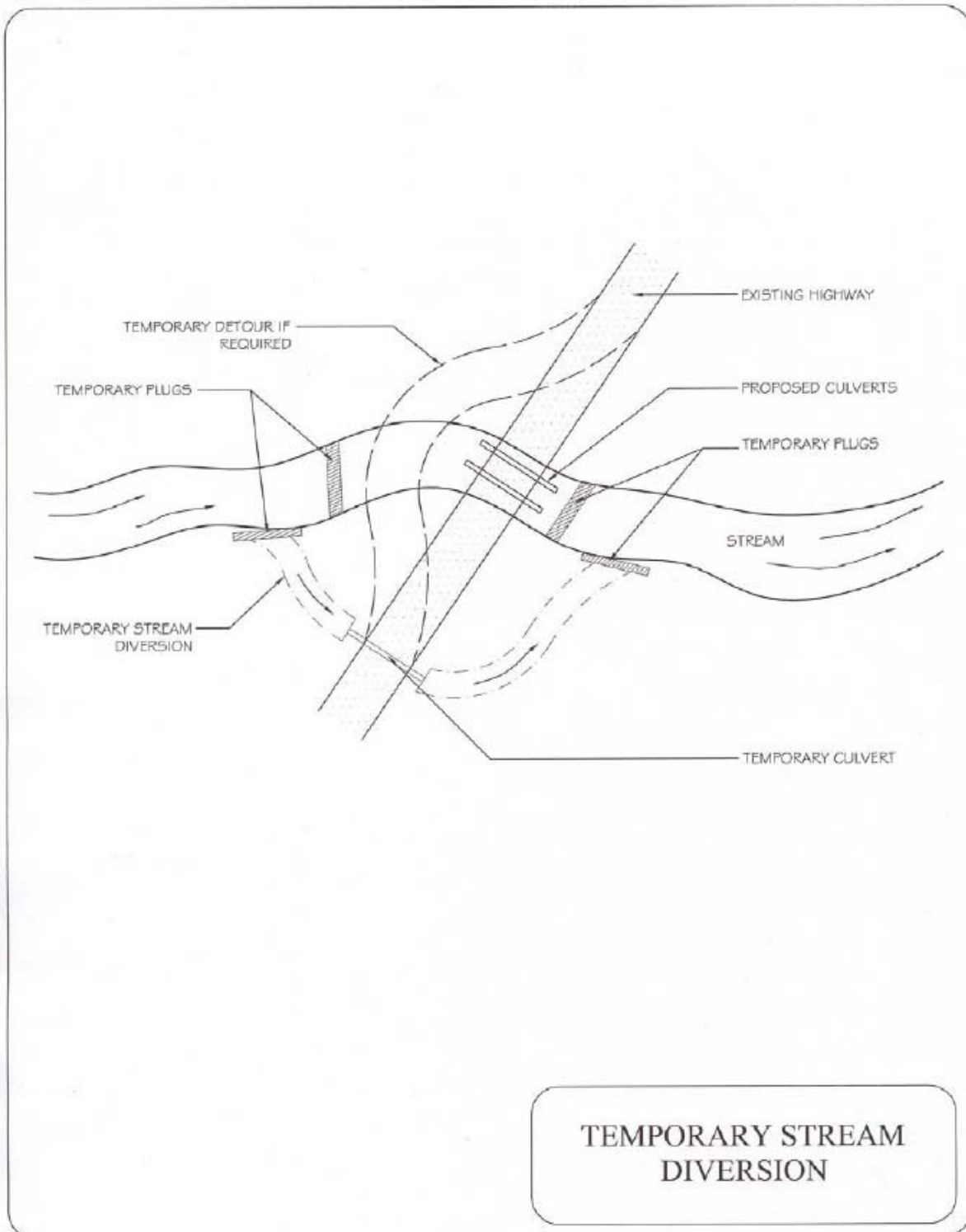
- Construct diversion channel “in the dry” by not excavating upstream and downstream ends of the channel
- Install erosion protection (sod mats, if available; rolled erosion controlled products; or rip rap in areas of high velocity)
- Open downstream end of channel and stabilize the connection of the diversion channel to the main watercourse. Pump flows around work site, if possible during construction of the channel connection
- Construct and stabilize upstream connection to the main watercourse while pumping flows, if possible, around the work area
- Divert flows from main watercourse to the diversion channel

**Construction Considerations**

- Fish out of the work section of main watercourse is required to prevent loss of fish before flows are diverted
- Fish out of diversion channel is required before flows are re-established to the main channel
- Diversion channel should be sized based on consultation with the regulatory agencies and on the duration of construction and risk to environmentally sensitive areas. For environmentally sensitive areas and long duration of construction, the diversion channel should be sized to convey a 10 year design flow
- Lower return periods may be considered in areas of low environmental sensitivity or if the duration of construction short.

**Inspection and Maintenance**

- The diversion channel should be inspected following a severe rainstorm, or at the end of the spring freshet to identify areas of incipient erosion. Eroded areas should be repaired promptly.



Source: Ontario BMP 29-3

**Description and Purpose**

- a) Hard armour (rip rap, gravel, sand bags, concrete) placed at pipe outlets, in channels, and at downstream side of check structures to reduce velocity and dissipate energy of concentrated flows
- b) Standard Drain Trough Terminal Protection Structure generally used at bridge headslope
  - Minimizes scour at flow impact location with dissipated flow energy

**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 splash pad on downstream side of gabions, check structures, berms, barriers, and silt fences to prevent erosion caused by overtopping of structure

**Advantages**

- Reduces flow energy in a relatively small area

**Limitations**

- Small rocks or stones can be dislodged during high flows
- Grouted rip rap may breakup due to hydrostatic pressure, frost heave, or settlement
- May be expensive if construction materials (rip rap, gravel, or concrete) is 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: For guidance only. A site specific design is required from designer/engineer*)

- 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
  - $L_a = 4.5 \times D$  (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  $0.5 \times D$
- Width of energy dissipator ( $W_a$ ) at outlets shall be of sufficient width to dissipate energy  $W_a = 4 \times D$
- Thickness of energy dissipator ( $d_a$ ) at outlets shall be of sufficient thickness to dissipate energy
  - $d_a = 1.5 \times \text{maximum rock diameter}$  (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)  $1.5 \times d_{50}$  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
- The energy dissipator shall be constructed flush with the surrounding grade and shall be directly in line with direction of outlet flow

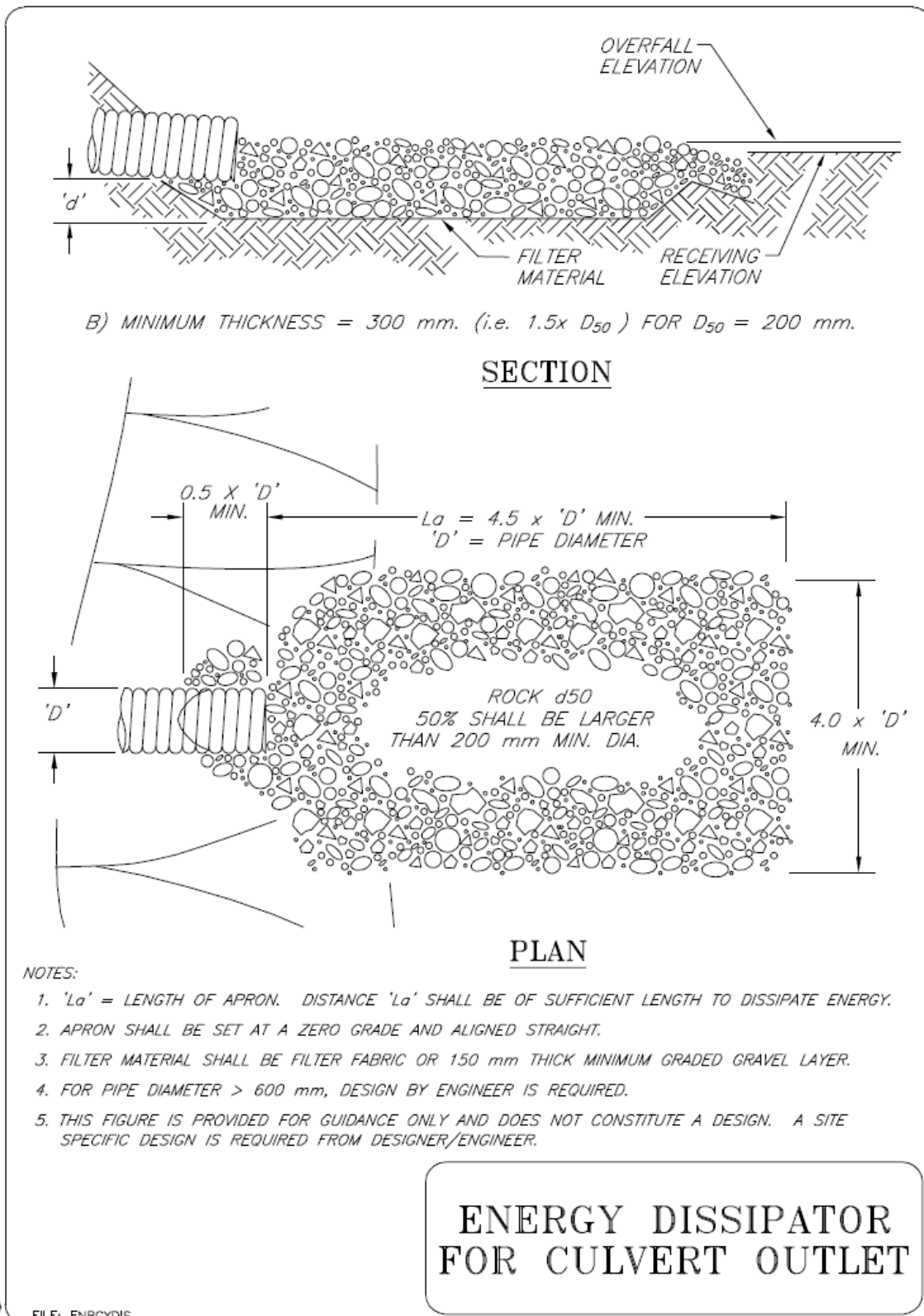
**Inspection and Maintenance**

- 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**

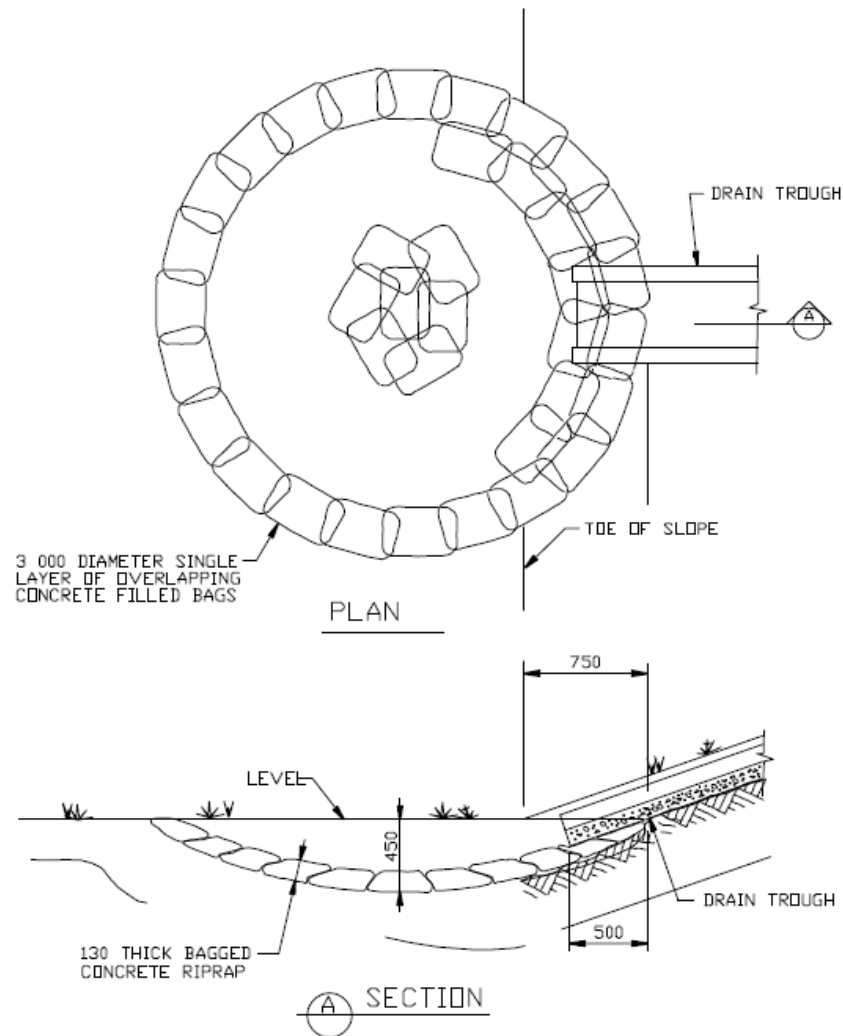
- Gabion mattresses





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Source: Alberta Transportation BMP #17a / For Culvert Outlet / Typical 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**

Source: Alberta Transportation BMP #17b / for Through at Bridge Headslope / Typical Section

### **Description and Purpose**

- 3-dimensional, plastic matting with open cells filled with topsoil or aggregate
- 3-dimensional structure stabilizes cut or fill slopes
- Cells confine infilled topsoil or aggregate and protect root zone while permitting surface drainage

### **Applications**

- Permanent measures
- May be used with granular infill on cut or fill slopes up to a slope of 1H:1V
- May be used with granular infill on slopes and in ditches where flow velocities are 3 m/s or less
- May be used as a flexible channel lining
- May be used in temporary low-water stream crossing as granular pad for stream fording
- Matting is light, expandable, and easy to transport and place
- Use of native fill materials reduces costs; local granular fill is preferred

### **Limitations**

- Availability can be limited, therefore expensive in some areas
- Installation can be labour intensive
- Not to be used on slopes steeper than 1H:1V
- Slopes of 1H:1V can be hazardous to work on

### **Construction** (*Note: For guidance only. A site specific design is required from designer/engineer*)

- Cellular Confinement System should be installed in accordance with manufacturer's directions
- The following is a general installation method
  - Slope should be graded to design elevations and grades
  - Rocks or other deleterious debris should be removed from matting location
  - Matting should be installed in a trench as deep as the matting is thick, extending 0.6 to 1.2 m beyond crest of slope, and matting should be installed so that the top of the matting is flush with surrounding soil
  - Every other cell along crest of slope should be anchored to soil using 'J' pins or other suitable sturdy anchoring device
  - The matting should be rolled out downslope
  - Where the blanket roll is not long enough to cover the entire length of the slope, the downslope section of matting should be butt-jointed to the upslope section and secured using staples, hog rings, or other suitable fasteners
  - Adjacent rolls of matting should be butt-jointed and secured using staples, hog rings, or other suitable fasteners
  - Anchors are placed at 1 m intervals down the slope
  - Additional anchors may be required to ensure matting is in intimate contact with soil
  - Additional anchors may be required along edges of matting
  - Backfilling should start at the crest of the slope and proceed downslope
  - For topsoil, overfill cells approximately 25 to 50 mm and lightly compact so that top of topsoil is flush with matting
  - For granular fill, overfill cells approximately 25 mm and tamp compact so that top of fill is flush with matting
  - Seeding should be applied after fill placement

### **Construction Considerations**

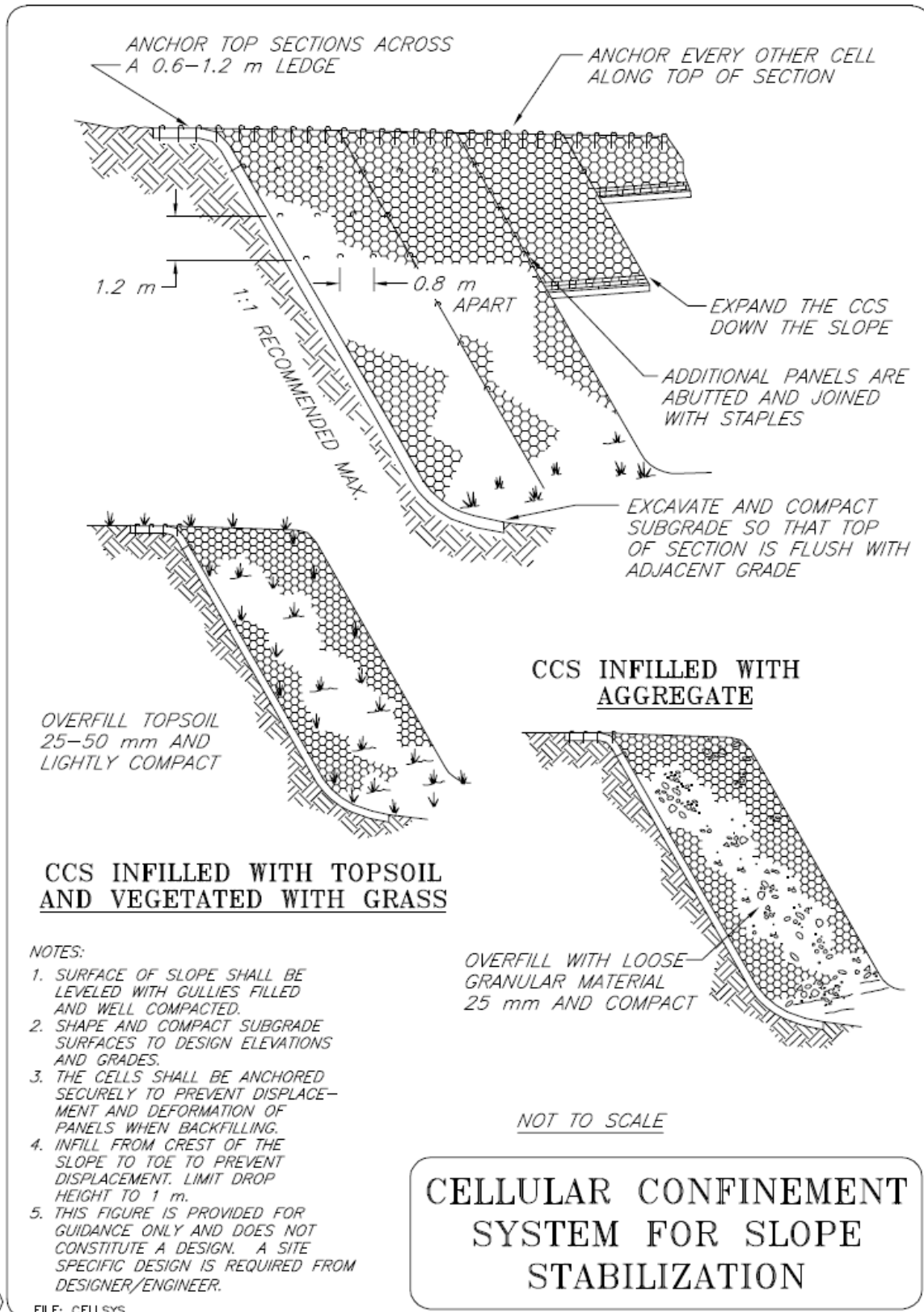
- Properly grading soil surface, removing rocks or deleterious materials, prior to placing matting to ensure matting is in intimate contact with the soil
- Matting should be placed longitudinal to direction of flow or downslope
- Use only a single layer of matting
- Matting elevation should be subexcavated to thickness of matting so that the top of the matting is flush with the adjacent terrain
- Infill from top of slope ensuring placement height of fill into cellular mat is less than 1 m

### **Inspection and Maintenance**

- Area covered with matting should be regularly inspected, especially after periods of heavy rainfall storms to check for damage or loss of material
  - Any damaged areas should be repaired immediately
  - Temporary inspection should continue until vegetation is established
  - Areas where vegetation fails to grow should be reseeded immediately
- If matting is broken or damaged and washout of the underlying soil occurs, the matting should be repaired or replaced after regrading the slope

**Similar Measures**

- Rolled erosion control products (RECP)
- Rip rap armouring



Source: Alberta Transportation BMP #15 / Typical Section

### **Description and Purpose**

- Heavy duty, flexible pipe "Big O" that carries water from top to bottom of fill or cut slope to prevent concentrated water flowing downslope and eroding face of slope

### **Applications**

- Temporary or permanent measure
- Used on cut or fill slopes where there is a high potential for upslope runoff waters to flow over the face of the slope causing erosion, especially at areas where runoff converges resulting in concentrated runoff flows (e.g. possible breach of low catchwater ditch at top of a cut slope)
- Used in conjunction with some form of water containment or diversion structures, such as diversion channels, berms, or barriers, to convey upslope runoff water and direct water towards slope drain

### **Limitations**

- Pipes must be sized correctly to accommodate anticipated flow volumes
- Water can erode around inlet if inlet protection is not properly constructed
- Erosion can occur at base if outlet protection or energy dissipator is not constructed
- Slope drain must be anchored securely to face of slope

### **Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

- Construct diversion or intercept channel, ditch block, barrier, or other inflow apron structure at crest of slope to channel flow toward the slope drain inlet
- Install slope drain through inlet berm or barrier with a minimum of 0.45 m of soil cover above top of drain pipe to secure the inlet
  - Install scour inlet protection (such as rip rap, sand bags)
- Install energy dissipator (such as rip rap, gravel, concrete) at downslope outlet end of slope drain
  - Outlet must not discharge directly onto unprotected soil
- Secure the pipe from movement by tying to steel anchor stakes, hold-down grommets, or other approved anchor method
  - Space anchors on each side of drain pipe at maximum 3 m intervals along entire length of drain pipe

### **Construction Considerations**

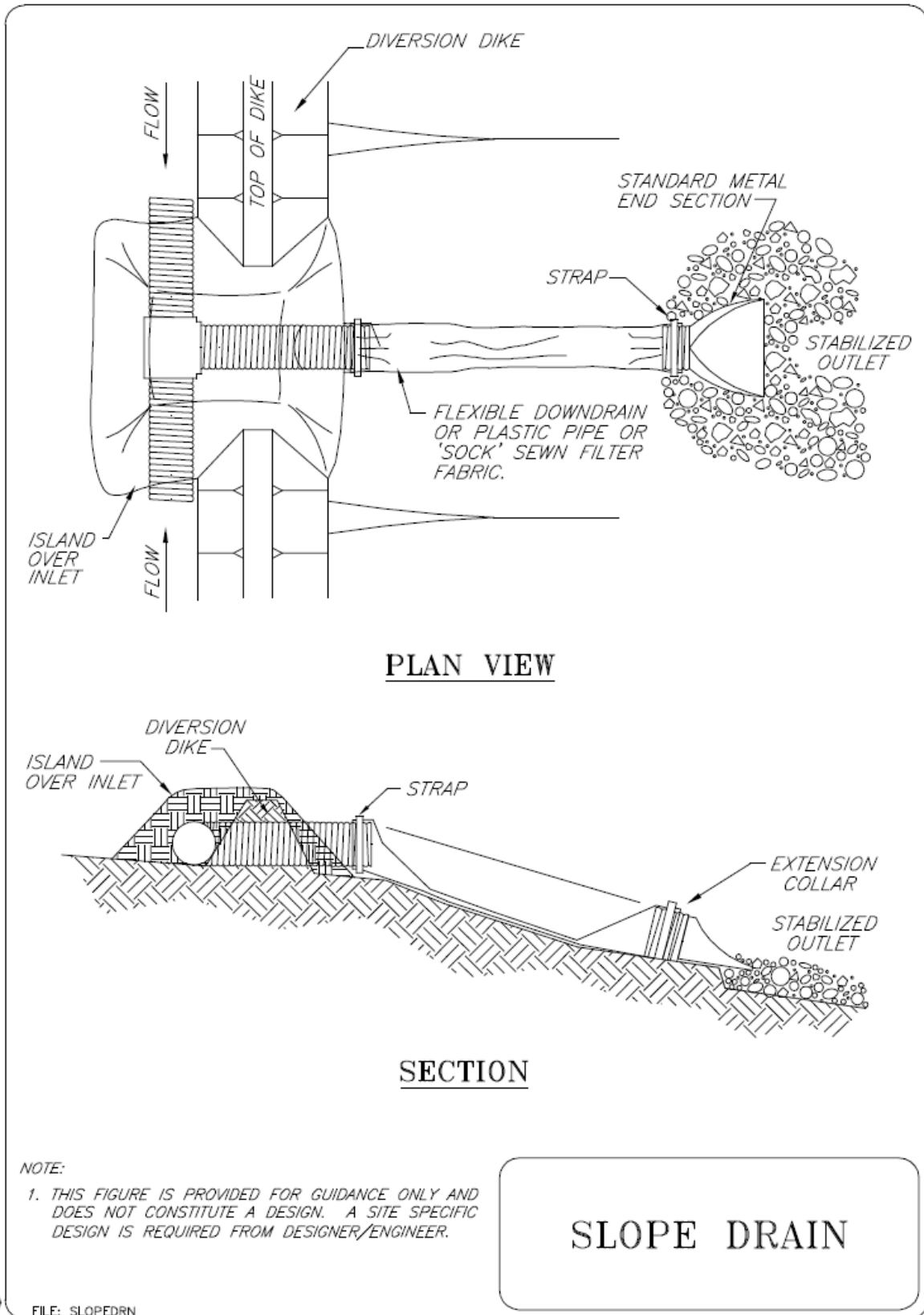
- Use coiled drain pipe for low flows only
- If constructing inflow apron at crest of slope out of sandbags, only fill each sandbag  $\frac{3}{4}$  full, this will allow sandbag to be flexible enough to mould around drain pipe and remain in continuous contact with the ground
- Several slope drains may be required if upslope drainage areas are too large for one drain pipe

### **Inspection and Maintenance**

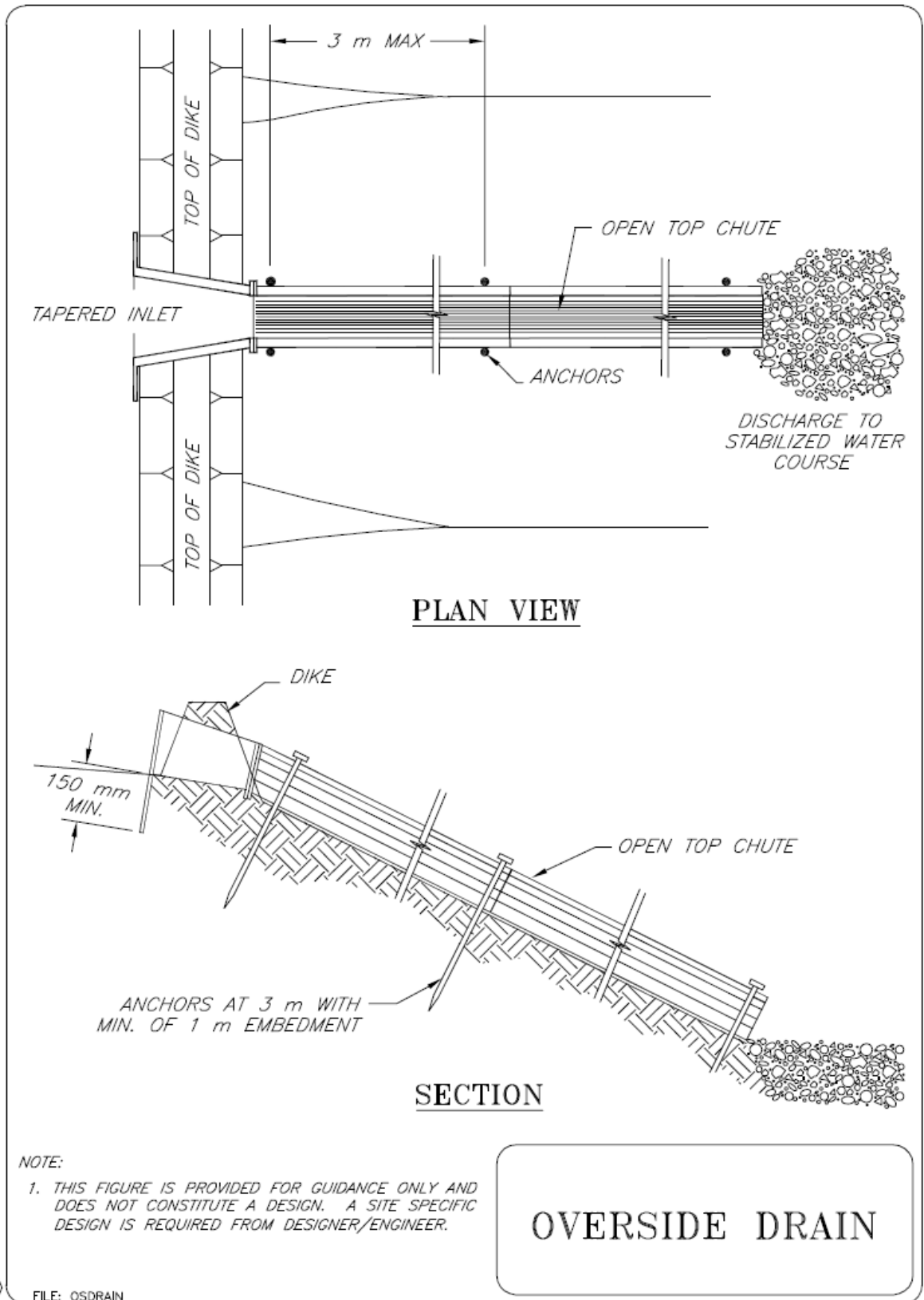
- Inspect slope drains at least once per week, or after significant storm events (1:2 year storm and/or 40 mm precipitation in 24 hours)
- Repair any damaged section of pipe immediately
- If evidence exists of pipe movement, install additional anchor stakes to secure and anchor at zones of movement
- Remove sediment from upslope inflow apron area after each storm event otherwise either downslope sediment transport will occur or cause the drainpipe to be plugged which could result in overtopping of inflow apron structure and sheet flow over slope face.

### **Similar Measures**

- Rock lined channel
- Permanent Pipe (slope drains)
  - Corrugated steel pipe (CSP) downdrain (AT Drawing No. CB-6 2.4 M17)
  - Half-round corrugated steel (1/2 CSP) downslope drain (AT Drawing No. CB-6 2.4 M4) for low flow areas such as bridge head slopes



Source: Alberta Transportation BMP #19a / Slope Drain / Typical Section



Source: Alberta Transportation BMP# 19b / Overside Drain / Typical Section



**Description and Purpose**

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

**Applications**

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

**Limitations**

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

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

- Use backhoe to form ditch a minimum offset distance of 2 m between crest of highway slope and top of offtake ditch sideslope, thus providing a dyke width of 1 m
  - Place and compact excavated soil to form a dyke between crest of highway slope and offtake ditch channel to provide adequate depth (1 m) of the offtake ditch
  - The consequence of failure on this dyke will determine the level of compaction effort required
  - Sideslopes of ditch should not be steeper than 2H:1V (depending upon material type)
  - Depth of ditch (from base of ditch to top of embankment) should be a minimum of 1 m in depth; width of ditch should be 1 m minimum
  - Ditch grade should be graded a minimum of 1% to promote positive drainage and outfall

**Construction Considerations**

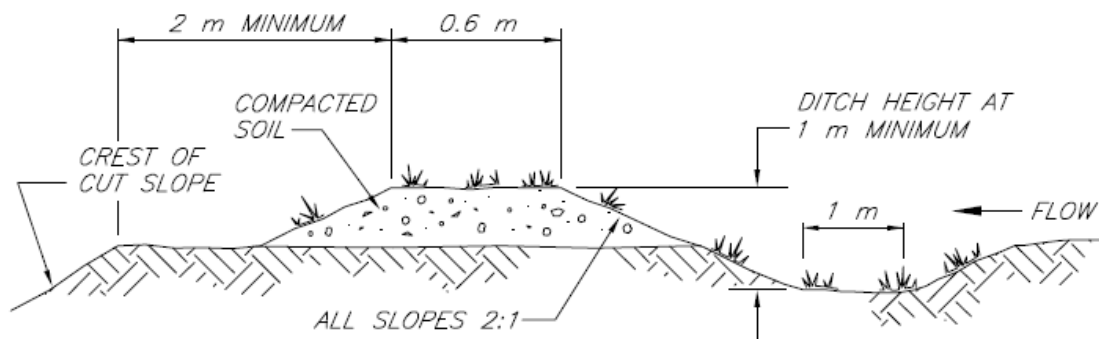
- Channel should be graded towards nearest outfall (draw) or drainage pipe

**Inspection and Maintenance**

- 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



**TYPICAL OFFTAKE DITCH**

**NOTES:**

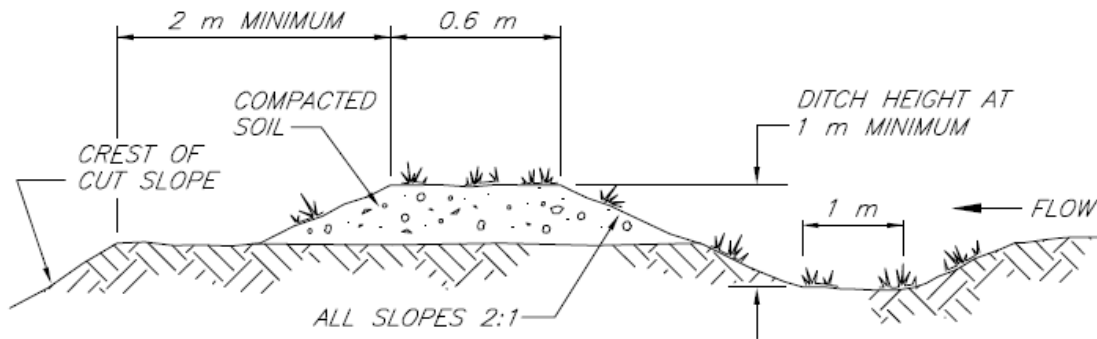
1. THE DITCH BEHIND THE DYKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
2. THE DYKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
3. FOR SENSITIVE HIGH RISK AREAS, THE DITCH SHALL BE STABILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND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

**OFFTAKE DITCH  
(INTERCEPT DITCH)**

From: Salix-Applied Earthcare -- EROSION DRAW 3.0  
1996 JOHN McCULLAH



FILE: TEMPOIKE



**TYPICAL OFFTAKE DITCH**

**NOTES:**

1. THE DITCH BEHIND THE DYKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
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**OFFTAKE DITCH  
(INTERCEPT DITCH)**

From: Salix-Applied Earthcare -- EROSION DRAW 3.0  
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FILE: TEMPOIKE

Source : Alberta Transportation BMP #21 / Typical Section

**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**

- Temporary or 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 and in sedimentation ponds to provide higher sedimentation duration of runoff impoundment

**Advantages**

- Promotes development of organic mat
- Dense leaves and large diameter plant stalks increases channel roughness and reduces 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 as success of plant growth is dependent on various unknown site parameters (i.e. moisture, soil, terrain, weather, seeding conditions, etc.)
- Revegetated areas are susceptible to erosion until vegetation develops; and should be used in conjunction with hydroseeding and/or mulching
- Plants may be damaged by wildlife
- Potential for low success rate
- Few precedents as this measure is generally not used on AT construction projects

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

- **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 0.05 m (5 cm) below a leaf bud
  - All side shutes should be trimmed to within 0.05 m 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**

- 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 0.025 m (25 mm)
- Place brush layer approximately 0.1 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**

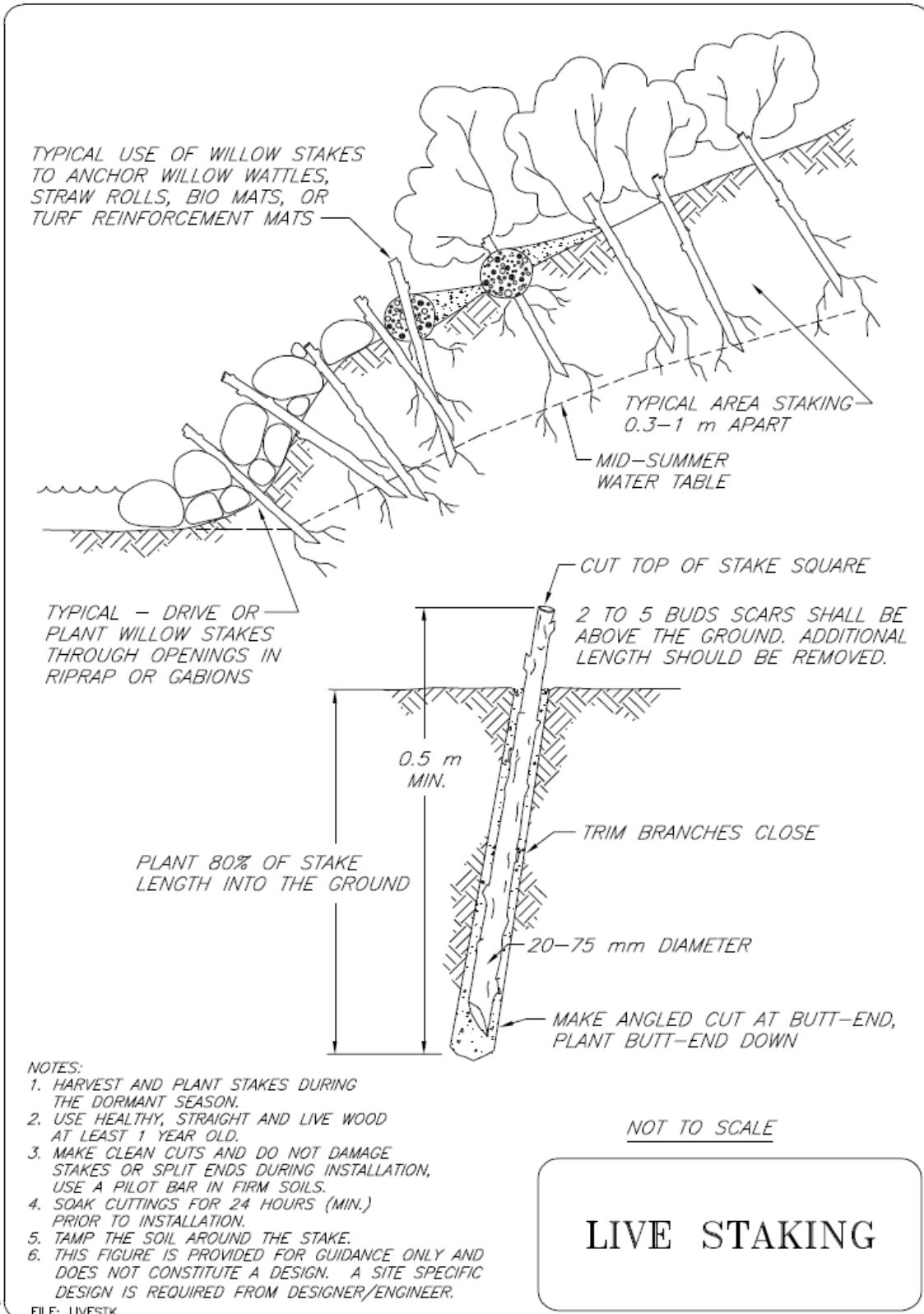
- Successful installation requires the use of freshly cut branches or stakes
  - Storage time of cut branches/stakes on-site prior to installation should be kept to as short a time period as possible
- Successful growth dependant on soil moisture and rainfall conditions
- Consultation with agrologist,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

**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 stormwater control measures should be considered for severe rilling areas damaged by runoff
- Watering plants is required for first one to two months after planting

**Similar Measures**

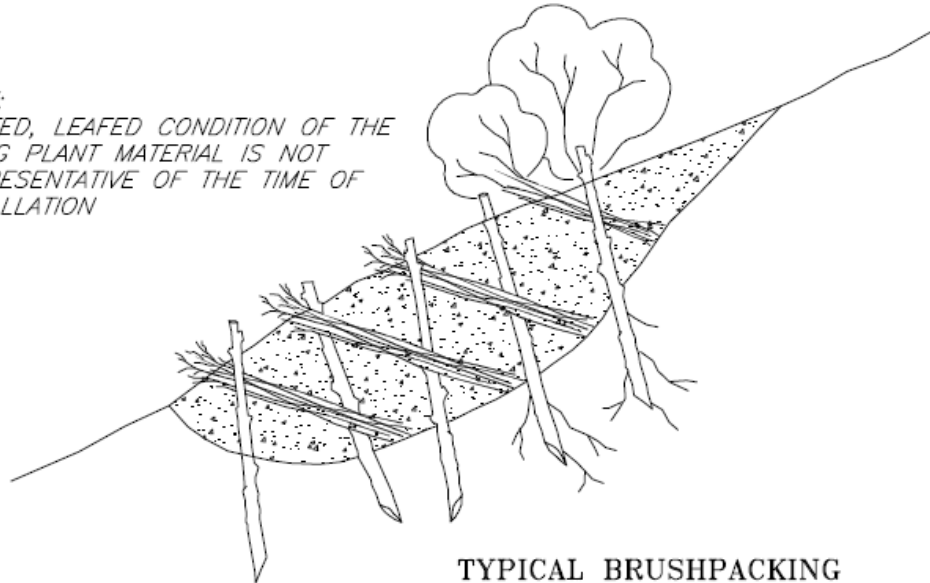
- Seeding
- Mulching
- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)



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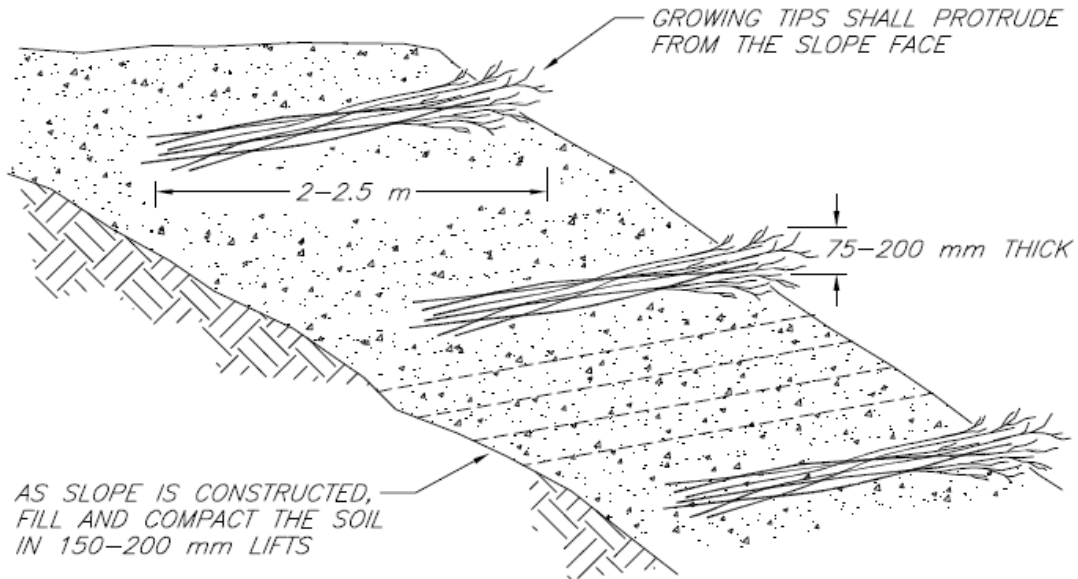
Source: Alberta Transportation BMP #27a / Live Staking / typical Section

*NOTE:  
ROOTED, LEAFED CONDITION OF THE  
LIVING PLANT MATERIAL IS NOT  
REPRESENTATIVE OF THE TIME OF  
INSTALLATION*



**TYPICAL BRUSHPACKING**

*COVER BRUSHLAYER IMMEDIATELY WITH  
150 mm OF FILL SOIL, WATER AND  
COMPACT ACCORDING TO SPECIFICATIONS*



*GROWING TIPS SHALL PROTRUDE  
FROM THE SLOPE FACE*

*2-2.5 m*

*75-200 mm THICK*

*AS SLOPE IS CONSTRUCTED,  
FILL AND COMPACT THE SOIL  
IN 150-200 mm LIFTS*

**TYPICAL BRUSHLAYERING  
WITH SLOPE CONSTRUCTION**

*NOTE:*

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

FILE: BRSHLAYR

**BRUSHLAYERING**

From: Salix-Applied Earthcare - EROSION DRAW 3.0  
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Source: Alberta Transportation BMP #27b / Brush-layering / Typical Section

### **Description and Purpose**

- Straw roll consists of bundled straw (or natural fibre) wrapped in photo-degradable openweave plastic netting staked into the soil along slope contours as a grade break to reduce erosion potential
- Wattles consist of bundled live fascine to stake into the soil along slope contours
- Fibre rolls are installed across slope contours as a grade break to reduce erosion potential by reducing overland flow velocities
- Normally live stake can be installed to anchor the Fibre Rolls and Wattles to provide deep root vegetation with potential favourable moisture retention provided by Fibre Roll
- Fibre rolls and wattles also capture sediment, organic matter, and seeds carried by runoff

### **Applications**

- Temporary measure
- 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)
- May be used on slopes and channel banks with adequate sunlight, moisture, and wind protection to support vegetation
- May be used along long slopes as a grade break to shorten slope length between line of fibre rolls at different contour elevations
- May be used as grade breaks, where slopes transition from flatter to steep gradients
- May be used on lake shores as wave break to assist in revegetation and stabilization of banks
- Can be used in conjunction with live staking as bioengineering measure

### **Advantages**

- Grade break measure to lower sheet and rill erosion potential
- Can be used on slopes too steep for silt fences or straw bale sediment barriers
- In time, plastic netting will degrade due to the sunlight and straw will degrade and be incorporated into the soil
- Primary purpose is erosion control, however fibre rolls do provide some sediment control

### **Limitations**

- Designed for low sheet flow velocities
- Designed for short slopes with a maximum gradient of 1H:1V
- May be labour intensive to install
- Few precedents as this measure is generally not used on AT construction projects
- Straw rolls have short 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** (*Note: For guidance only. A site specific design is required from the designer/engineer*)

- Prepare slope face and remove large rocks or other deleterious materials
- Excavate small trenches a minimum of 0.15 m deep and 0.15 m wide across the width of the slope, perpendicular to slope direction, starting at the toe of the slope and working upwards towards crest of slope
- Space trenches a maximum of 3 to 8 m apart along the slope incline, with steeper slopeshaving trenches spaced closer together
- Place fibre rolls into trench ensuring continuous contact between fibre roll and soil surface
- Butt-joint adjacent fibre roll segments tightly against one another
- Use a metal bar to make pilot hole through middle of the fibre roll a minimum 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 stake may be used as alternate anchor
- • Place soil excavated from trench on upslope side of fibre roll and compact to minimize
- undermining of fibre roll by runoff



- Seed the soil along the upslope and downslope sides of the fibre roll to promote vegetation growth

**Construction Considerations**

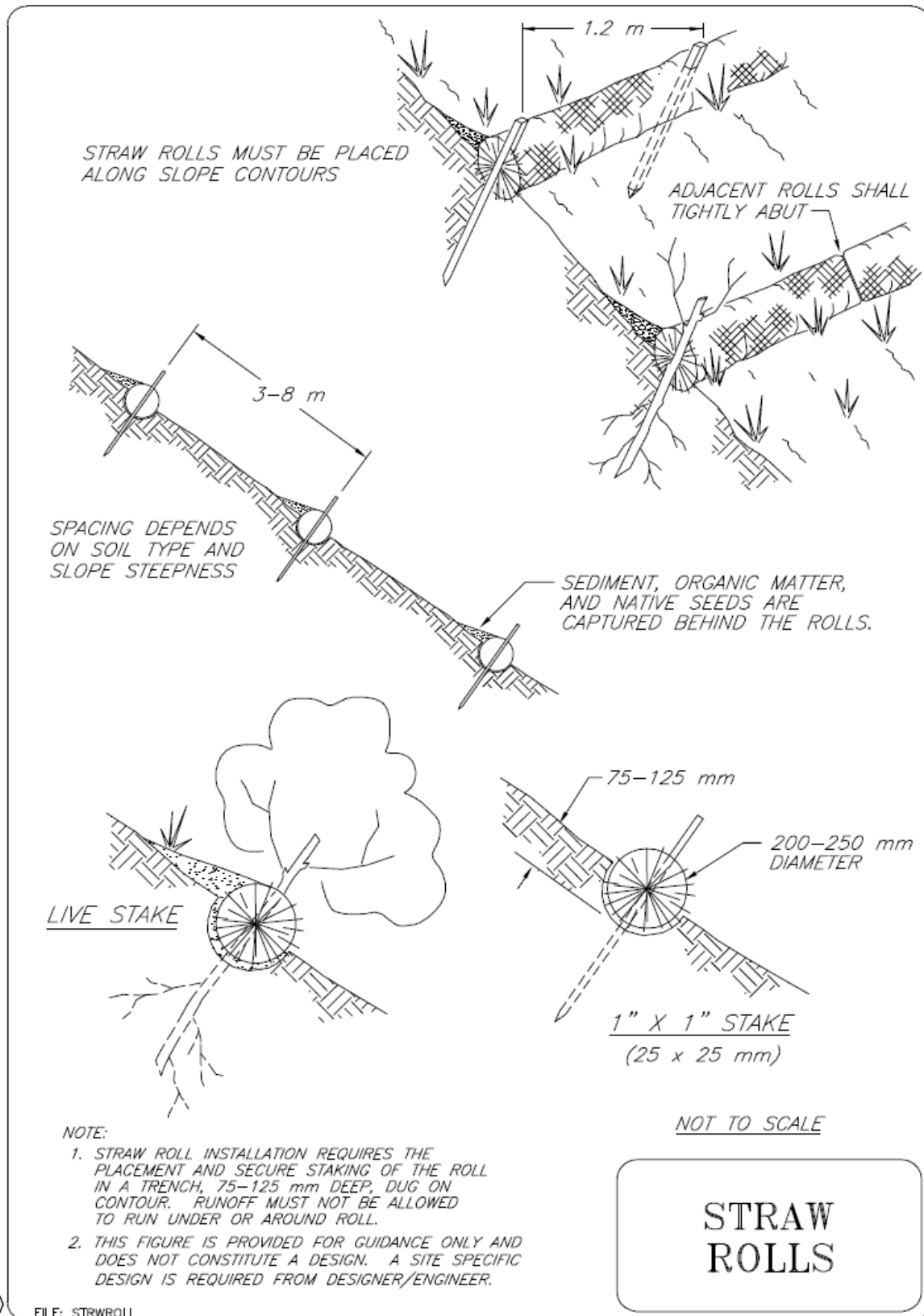
- Use live stakes in place of wooden stakes
- If the slope soil is loose and uncompacted, excavate trench to a minimum depth of 2/3 of the diameter of the fibre roll
- For steep slopes, additional anchors placed on the downslope side of the fibre roll may be required

**Inspection and Maintenance**

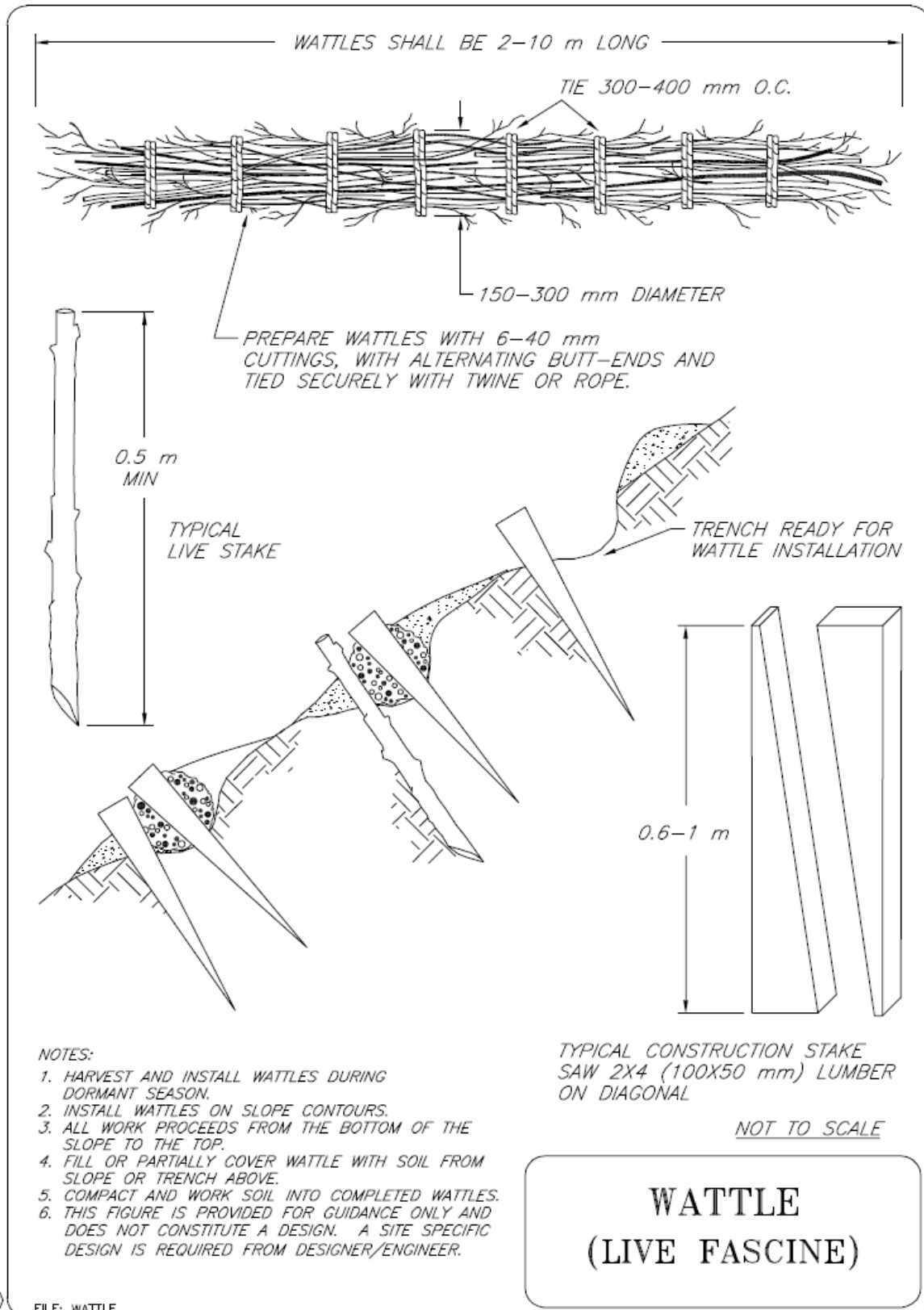
- Inspect structures at biweekly intervals or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rutting should be repaired immediately
- Additional stormwater control measures should be considered for rilling areas damaged by runoff

**Similar Measures**

Synthetic permeable barriers



Source: Alberta Transportation BMP #28a / Straw Roll / Typical Section



Source: Alberta Transportation BMP #28b / Wattle (Live Fascine) / Typical Section

**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 allowing sediment to settle out as water filters through fabric
- Decreases flow velocity in channels with low to moderate flows (< 0.03 m<sup>3</sup>/s)
- Entraps and minimizes coarse sediment from sheet flow or overland flow from entering waterbodies
- Perimeter control for sediment transport and deposition

**Applications**

- Temporary measure
- Used at bottom of cut or fill slopes to collect sediment laden runoff
- Used in swales or ditches with low flow velocity and flow less than 0.03 m<sup>3</sup>/s
- Used along streams (or channels) banks
- Used around stockpiles
- Midslope grade-break (using "J-hook" or "smile" pattern to effect ponding, filtering and sedimentation)

**Advantages**

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

**Limitations**

- Applicable for sheet flow, normally cannot handle concentrated channel flow volumes
- May fail under high runoff events
- Limit to locations suitable for temporary ponding of sediment laden runoff
- Not to be used in swales or ditches with flow greater than 0.03 m<sup>3</sup>/s
- 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 post)
- Sediment build up needs to be removed at 1/2 height and on a regular basis
- Damage to fence may occur during sediment removal
- Useable life of approximately one year dependent on maintenance and sediment requirement

**Construction** (*Note: For guidance only. A site specific design is required from designer/engineer*)

- Two methods of installation are commonly used
  - Trench method
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent)
- Trench Method
  - Select location of silt fence (usually along contours)
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Excavate trench approximately 0.15 m deep by 0.15 m wide for entire length of fence along upstream side of posts
  - Attach the wire mesh or snow fencing, if used as reinforcement to fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts
  - Backfill and compact soil in trench, being careful not to damage fence
- Mechanical Installation Method
  - Select location of silt fence (usually along contours)
  - Use mechanical installation machine to embed the fabric a minimum of 0.15 m into the ground. One mechanical installation method is by slicing (with special equipment) the geotextile fabric to embed into the ground without excavation and backfill. Minor disturbance of ground if affected and only tamping of ground is required for compaction.
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Attach the wire mesh or snow fencing, if used as reinforcement to silt fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts

**Construction Considerations**

- Site Selection
  - Size of drainage area should be no greater than 0.1 ha per 30 m length of silt fence
  - Maximum flow path length above silt fence should be no greater than 30 m
  - Maximum slope gradient above the silt fence should be no greater than 2H:1V
  - For use in swales, gradient should be less than 2% and drainage area less than 0.8 ha
- Fence should be placed on contour to produce proper ponding
- Fence should be placed far enough away from toe of slope to provide adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of fence should be angled upslope to collect runoff
- Fence should not extend more than 0.6 m above grade
- Posts can be wood or metal material dependent on design and ground conditions
- Posts should be placed on downstream side of fence
- Posts should be driven at least 0.3 m (preferable 0.6 m) into the ground
- Posts should not be spaced greater than 2 m apart
- Wire mesh or standard snow fencing may be placed between the posts and 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, the wrapping of fabric around the fence post and a minimum overlap of 0.2 m with staples should be used to attach the fabric to the post)
- Fence (and wire mesh or snow fence, if used) should be attached to posts with heavy duty staples, tie wires, or hog rings
- Fence (and wire mesh or snow fence, if used) should be dug into a trench at least 0.15 m deep to prevent undercutting of fence by runoff
- Trench backfill should be compacted
- Long runs of silt fence are more prone to failure than short runs
  - Maximum length of each section of silt fence should be 40 m
  - Silt fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours allowing an escape path for ponded water (minimizes overtopping of silt fence structure)

**Inspection and Maintenance**

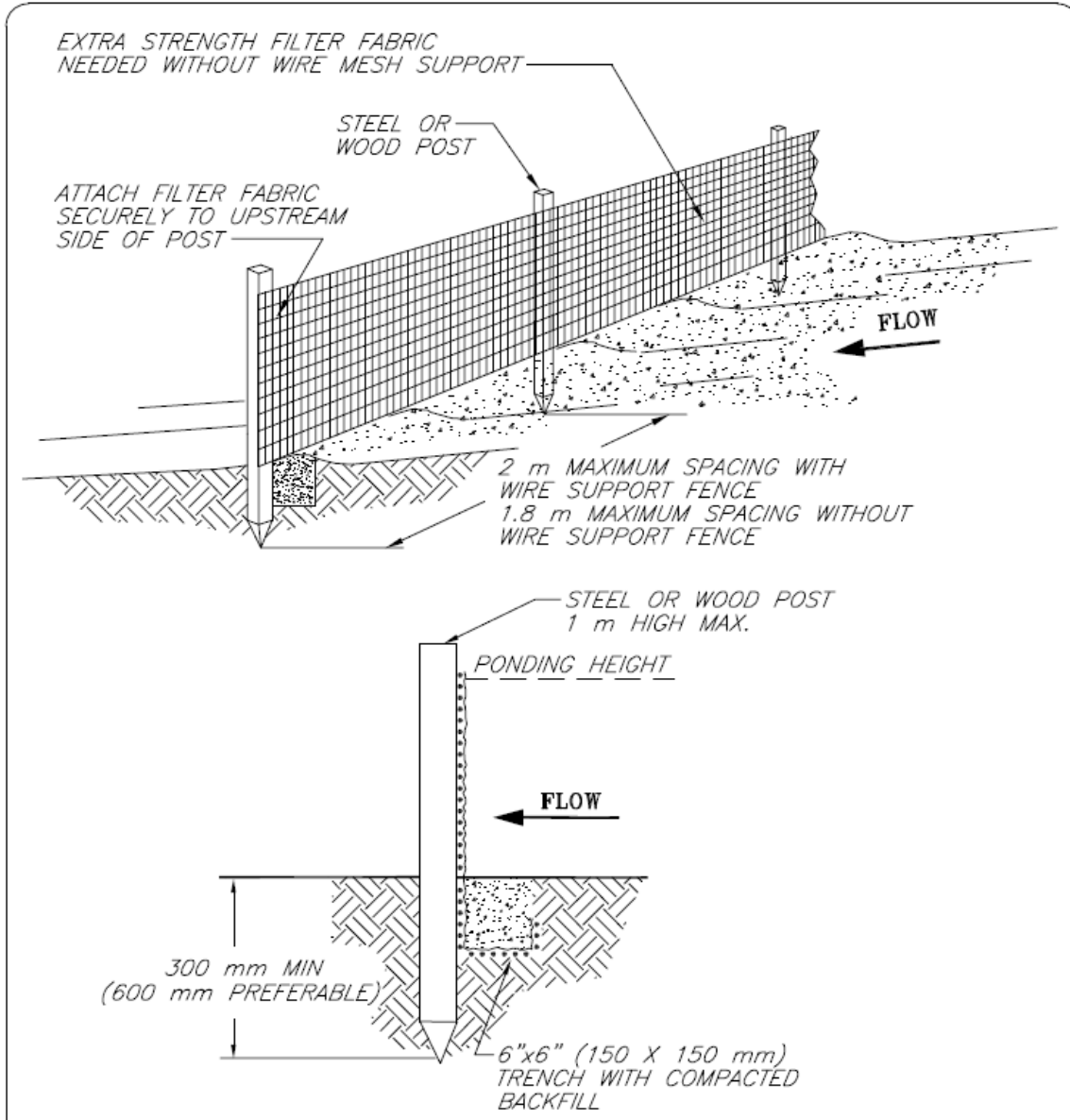
- Inspections should occur twice per week and after significant storm events (1:2 year storm event and/or +40 mm rainfall over 24 hours duration)
- Repair undercut fences and repair or replace split, torn, slumping or weathered fabric immediately
- Sediment build up should be removed once it accumulates to a depth of 0.2 m or at ½ height of fence
- Remove fence after vegetation is established
- Deactivate fabric by cutting-off top portion of fabric above ground; bottom trenched-in portion of fence fabric can be left in-ground thus minimizing ground disturbance

**Similar Measures**

- Straw Bales
- Rock Barrier
- Check Dams
- Permeable/Synthetic Barriers

**Design Considerations**

- For a silt fence system to work as a whole, the following factors should be considered:
  - quantity – adequate number and frequency of fence for efficient ponding and sedimentation
  - installation – workmanship
  - compaction – backfill and trenching of fabric
  - support – posts adequately embedded and of strong material and close spacings
  - attachment – secure fabric to post
- Install silt fences in a 'J' hook or 'smile' configuration to allow efficient ponding and sedimentation as well as escape route for excess runoff along the ends
  - Minimizes overtopping of structure



**TRENCH METHOD OPTION DETAIL**

**NOTES:**

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT (1:2 YEAR STROM AND/OR +40 mm RAINFALL OVER 24 HOUR DURATION) AND REMOVE SEDIMENT WHEN ACCUMULATED SILT REACHES 1/2 FENCE HEIGHT OR 225 mm MAXIMUM SUGGESTED STORAGE HEIGHT.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA WILL NOT CONTRIBUTE SEDIMENT OFF-SITE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

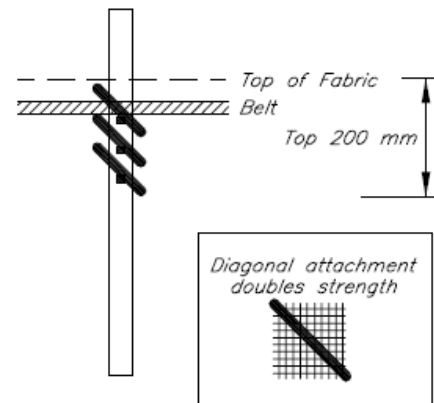
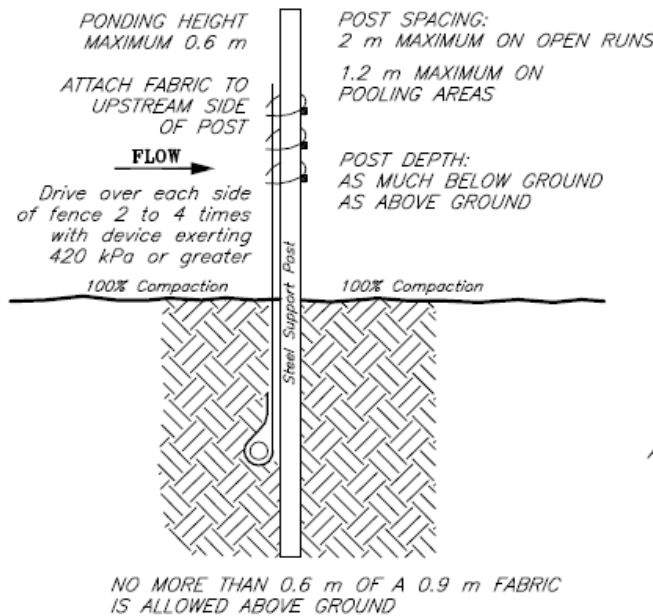
*NOT TO SCALE*

**SILT FENCE**  
**(TRENCH METHOD OPTION)**

© 1994 JOHN McCULLAH  
From: Salix-Applied Earthcare - EROSION DRAW 3.0

FILE: SILTFENC

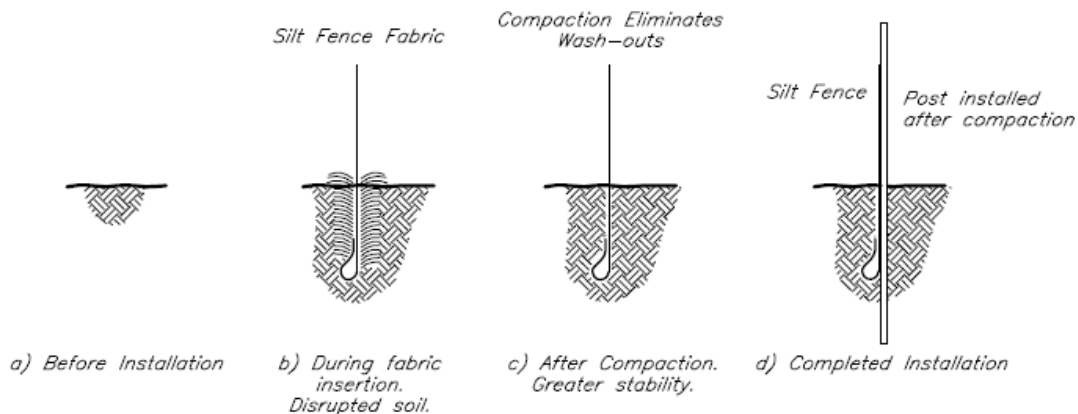
Source: Alberta Transportation BMP #1 / Typical Section / Picture 1 of 3



**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.

**THE MECHANICAL (SLICING) METHOD**



**THE MECHANICAL (SLICING) METHOD INSTALLATION SEQUENCE**

**NOTES:**

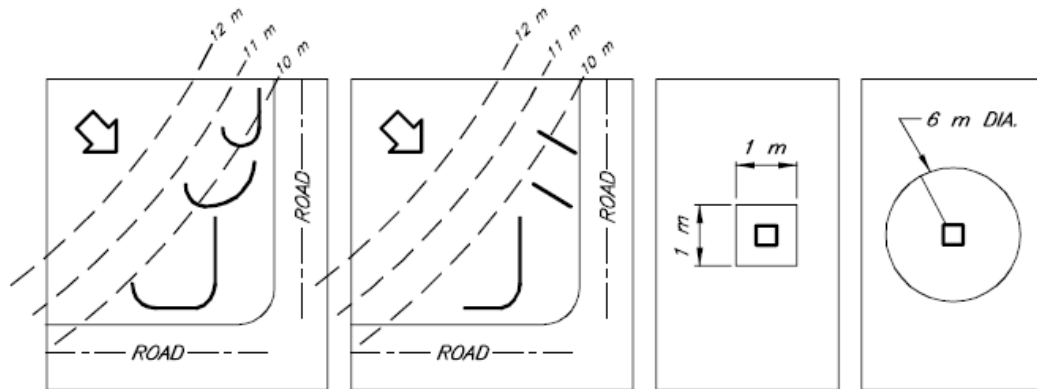
1. INSTALLATION MACHINE MUST ALLOW CONTINUOUS SLICING AND EMBEDMENT OF GEOTEXTILE INTO GROUND WITH MINOR GROUND DISTURBANCE.
2. INSTALLATION MACHINE TYPES WILL VARY WITH MANUFACTURER.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM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

NOT TO SCALE

**SILT FENCE**  
**(MECHANICAL METHOD OPTION)**

SOURCE: CARPENTER T. 2000

Source: Alberta Transportation BMP #1 / Typical Section / Picture 2 of 3

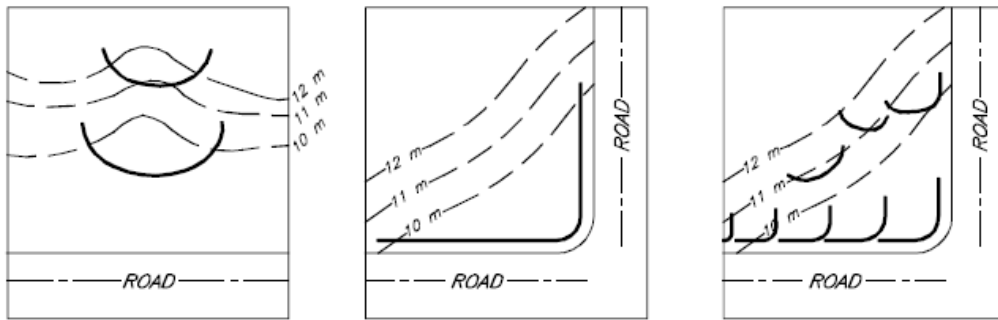


*CORRECT*

*INCORRECT*

**"J" CONFIGURATION**

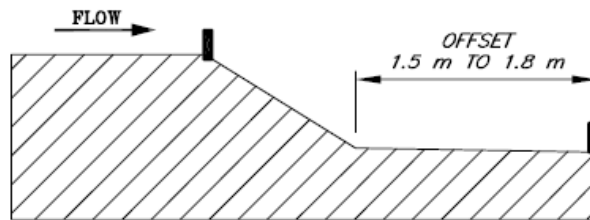
**SILT FENCE BARRIER AT STORM INLET**



**"SMILE" CONFIGURATION**

**AVOID LONG INSTALLATION**

**COMBINATION OF "SMILE" AND "J" CONFIGURATIONS**



**LOCATION AT TOP AND BOTTOM OF SLOPE**

*NOT TO SCALE*

**NOTE:**

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

SOURCE: CARPENTER T. 2000

**SILT FENCE  
(CONFIGURATION PLAN)**

Source: Alberta Transportation BMP #1 / Typical Section / Picture 3 of 3



**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: For guidance only. A site specific design is required from designer/engineer.)*

- 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**

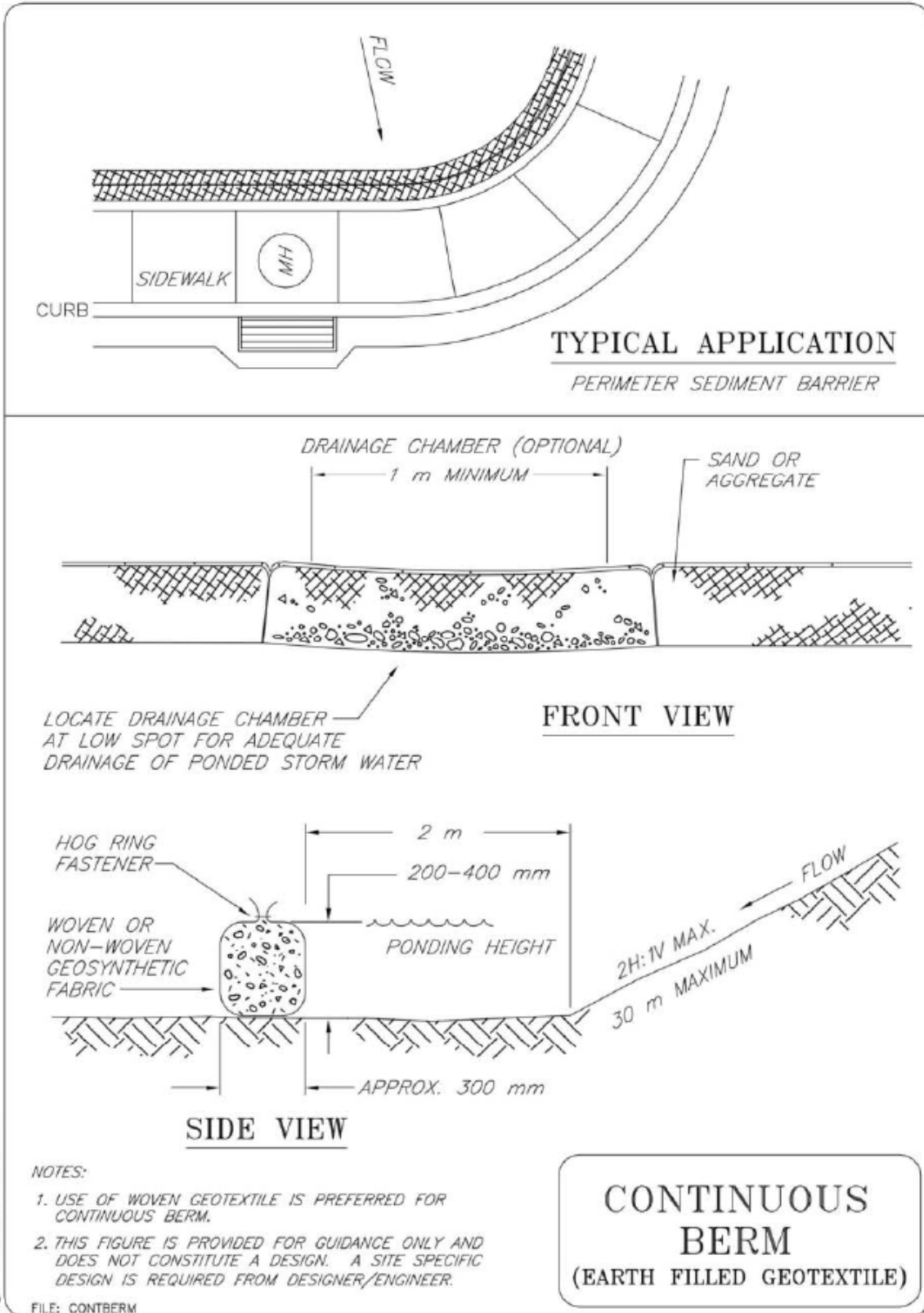
- Berm constructed of sand, aggregate, or other pervious soil encased in geotextile fabric
- Maximum berm height is approximately 0.4 m
- Higher permeability fill materials should be used in 'drainage chambers' in low areas

**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



**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  $\geq 500 \text{ m}^2$
  - Trap (Type II) for pond area  $\leq 500 \text{ m}^2$

**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: For guidance only. A site specific design is required from designer/engineer)*

- 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

### **Construction Considerations**

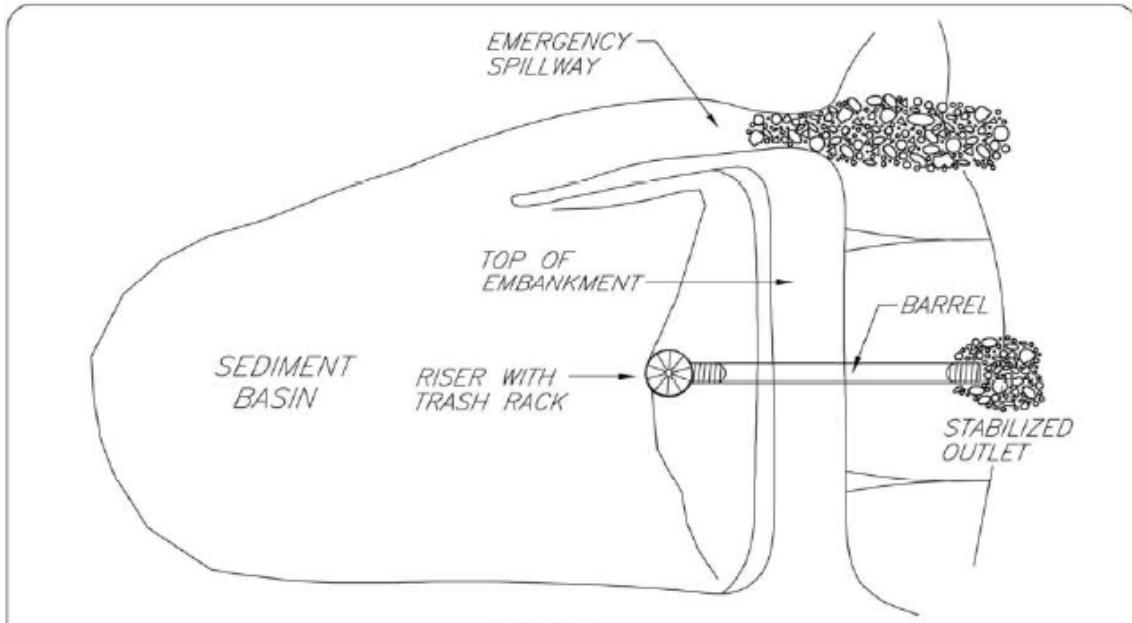
- It is preferable to strip to mineral soil only along the footprint area required for dyke construction; the pond floor centre area can be left cleared but unstripped
- The pond can be constructed by excavating, constructing embankments, or a combination of the two methods
- Baffles should be provided 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**

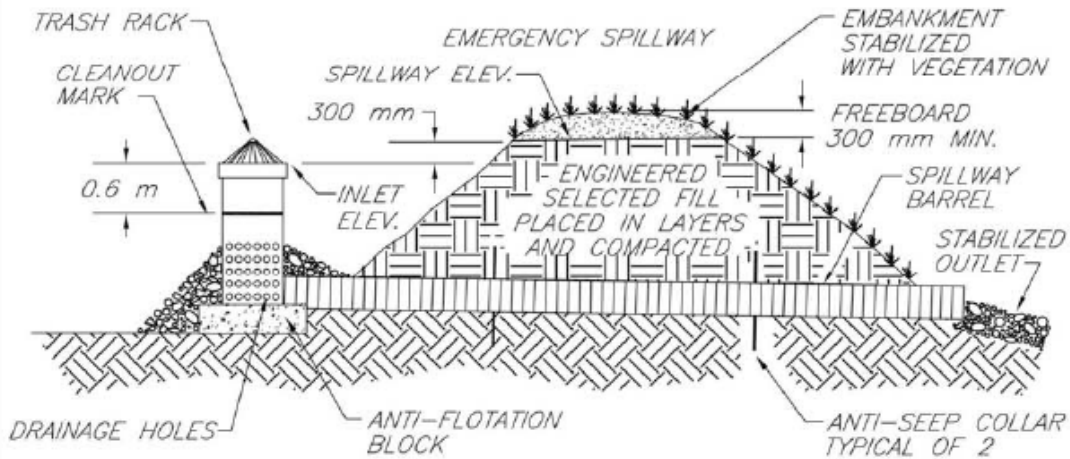
- Regular inspection is required to identify seepage, structural soundness, outlet damage or obstruction and amount of sediment accumulation
- Inspections should be performed weekly and after significant storm events (1:2 yr storm and/or 40 mm rainfall in 24 hours)
- Sediment should be removed upon reaching 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)



**PLAN**



**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<sub>0</sub>) 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)**

From: Solix-Applied Earthcare - EROSION DRAW 3.0  
1994 JO-IN McCULLAH



FILE: SEDBASIN

Source: Ontario BMP 35-5



**Description and Purpose**

- Temporary devices constructed to minimize the amount of sediment entering a storm drain by ponding sediment laden runoff at the inlet
- Storm Drain Inlet protection can consist of the following measures:
  - a) Block and Gravel Sediment Barrier – Option 1
  - b) Block and Gravel Curb Inlet Sediment Barrier – Option 2
  - c) Sand Bag Curb Inlet Sediment Barrier – Option 1
  - d) Sand Bag Curb and Gutter Sediment Barrier – Option 2
  - e) Straw Bale / Gravel Sediment Barrier - Option
  - f) Silt Fence Sediment Barrier - Option

**Applications**

- Temporary measure
- Used where storm drains are operational prior to establishing vegetation on disturbed drainage areas
- Can be effective where drainage enters municipal sewers or watercourses
- Used for small, nearly level (less than 5% grade) drainage areas
- Used as curb inlet barriers in gently sloping ditches and gutters
- Used where drainage area is 0.4 ha (1 ac) or less
- Used in open areas subjected to sheet flow and concentrated flows less than 0.014 m<sup>3</sup>/s (0.5 cfs)
- Block and gravel bag barriers are applicable when sheet flows or concentrated flows exceed 0.014 m<sup>3</sup>/s (0.5 cfs) and is necessary to allow for overtopping to prevent flooding
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected and overflow capacity is required

**Advantages**

- Easy to install and remove
- Sand bags may be reusable

**Limitations**

- Ponding around inlet may result in excessive local flooding
- Use only when ponding will not encroach into vehicular traffic, onto erodible surfaces and slopes or beyond the limits of the construction site
- Frequent removal of sediment required for high flow situations

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

- Place inlet sediment barrier around entrance to drain/pipe. The option appropriate for use is dependent on site conditions.
- Silt fence barrier can be used for soil surfaces
- Gravel or aggregate filled sand bags should be used for asphalt or concrete surfaces
- Aggregate filled sand bags
  - Place sand bags stacked one or two bags high around inlet
- Gravel barriers
  - Place concrete blocks stacked one or two blocks high, with cavities of blocks aligned with direction of flow, around inlet
  - Wrap 13 mm (1/2 inch) wire mesh around concrete blocks
  - Place 25 mm to 38 mm diameter rock around block and wire mesh assembly ensuring
- rock extends down from top of blocks to asphalt or concrete surfacing
- Gravel filter curb inlet
  - Place concrete blocks stacked one or two blocks high around inlet, with cavities of blocks aligned with direction of flow, forming a 'U' shape
  - Wrap 13 mm (1/2 inch) diameter wire mesh around concrete blocks
  - Place 25 mm to 38 mm diameter rock around block and wire mesh assembly ensuring rock extends down from top of blocks to asphalt or concrete surfacing

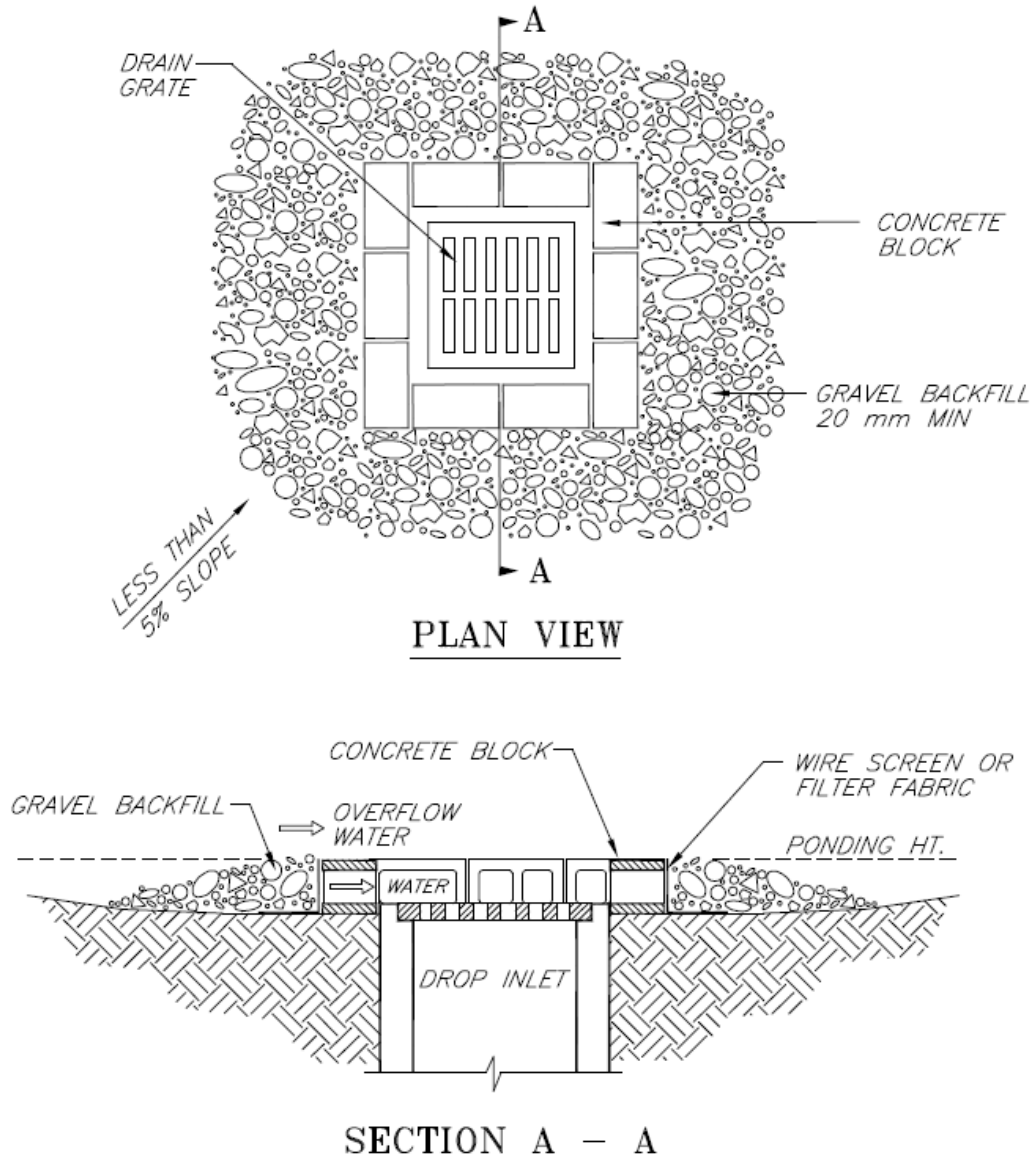
**Construction Considerations**

- Gravel or aggregate filled sand bags should be used for asphalt or concrete surfaces
- Aggregate filled sand bags
  - Sand bags should be filled with pea gravel, drain rock, or other free draining material
  - Gravel or aggregate filled sand bags should be filled only  $\frac{3}{4}$  full to allow sand bag to be flexible to mould to contours, maintaining continuous contact with surface
- flexible to mould to contours, maintaining continuous contact with surface
  - Barrier should be placed at least 0.1 m from inlet to be protected
  - Several layers of sand bags should be overlapped and tightly packed against one another
  - A one sand bag wide gap should be left in the lowest point of the upper layer to act as an emergency spillway
- Gravel filter inlet berm and gravel filter curb inlet
  - Slope gravel towards inlet at a maximum slope of 2H:1V
  - Maintain at least 0.3 m spacing between toe of gravel and inlet to minimize gravel entering inlet
  - 25 mm wire mesh may be placed over inlet to prevent gravel from entering inlet
- For drainage areas larger than 0.4 ha (1 ac) runoff should be directed towards a sediment retention device designed for larger flows before allowing water to reach inlet protection structure
- Use aggregate sand bags filled with 25 mm diameter rock in place of concrete blocks for gravel filter inlet berm or gravel filter curb inlet

**Inspection and Maintenance**

- Inspect barriers at least once a week and before and after each significant rainfall event (1:2 year storm and/or 40 mm in a 24 hour period)
- Remove sediment build up after each storm event
- Sediment and gravel should not be allowed to accumulate on roads
- Replace gravel if it becomes clogged with sediment
- Remove all inlet protection devices when inlet protection is no longer required





**NOTES:**

1. STORM DRAIN DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%).
2. EXCAVATE A BASIN OF SUFFICIENT SIZE ADJACENT TO THE STORM DRAIN DROP INLET.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. A TEMPORARY DYKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

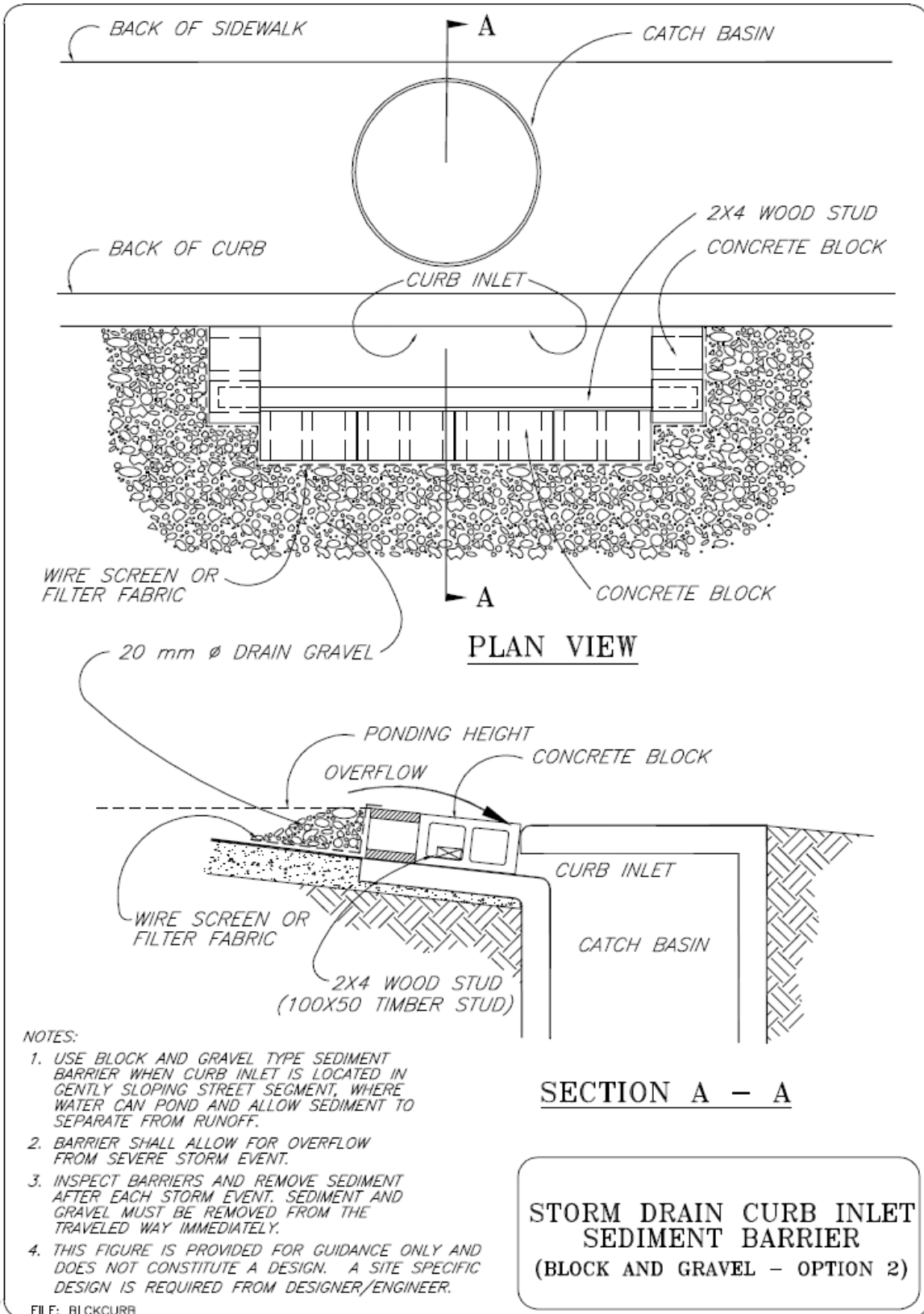
**STORM DRAIN DROP INLET  
SEDIMENT BARRIER  
(BLOCK AND GRAVEL - OPTION 1)**

From: Salix—Applied Earthcare - EROSION DRAW 3.0  
1994 JOHN McCULLAH



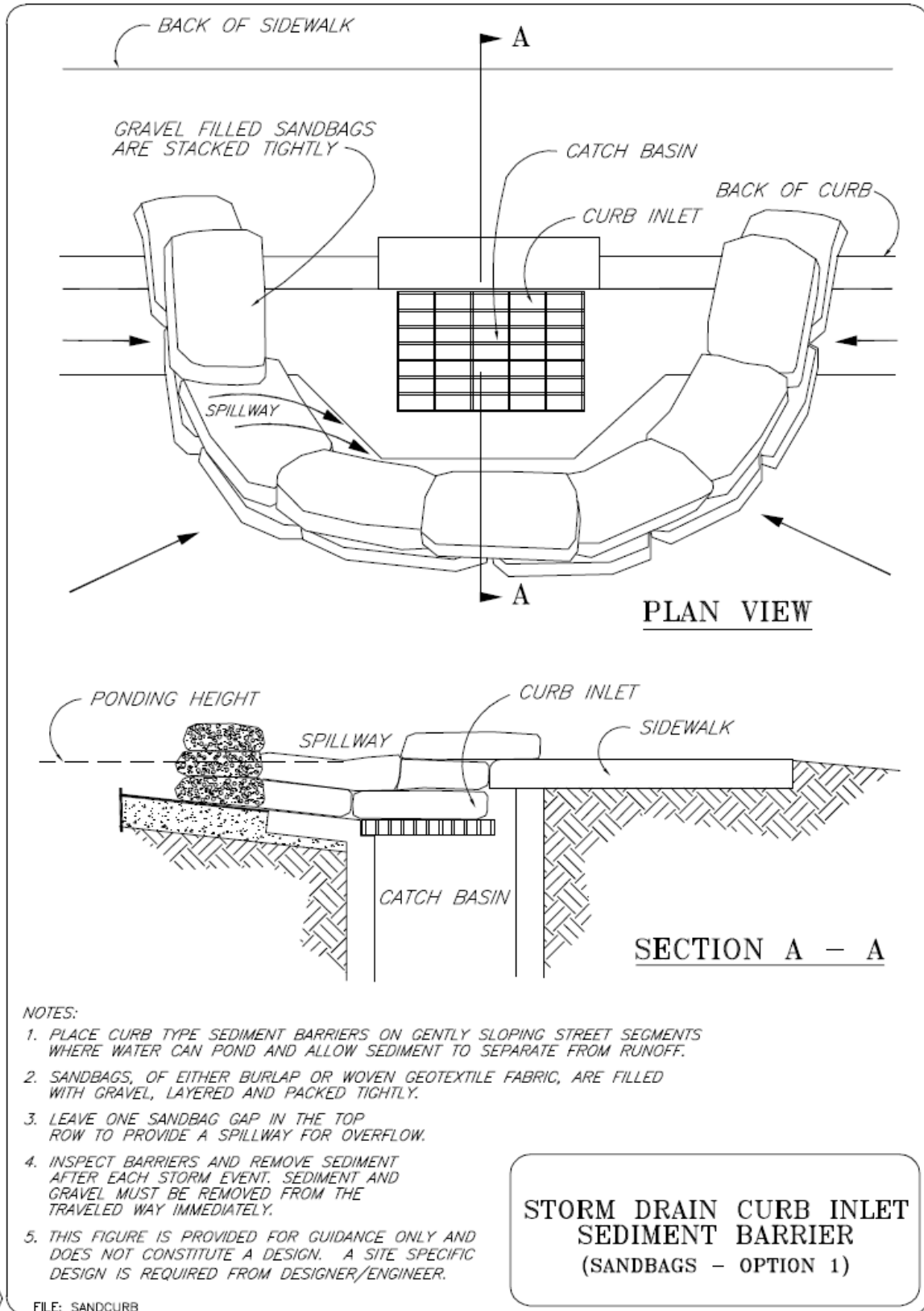
FILE: BGSEDBAR

Source: Alberta Transportation BMP #6a / Typical Section

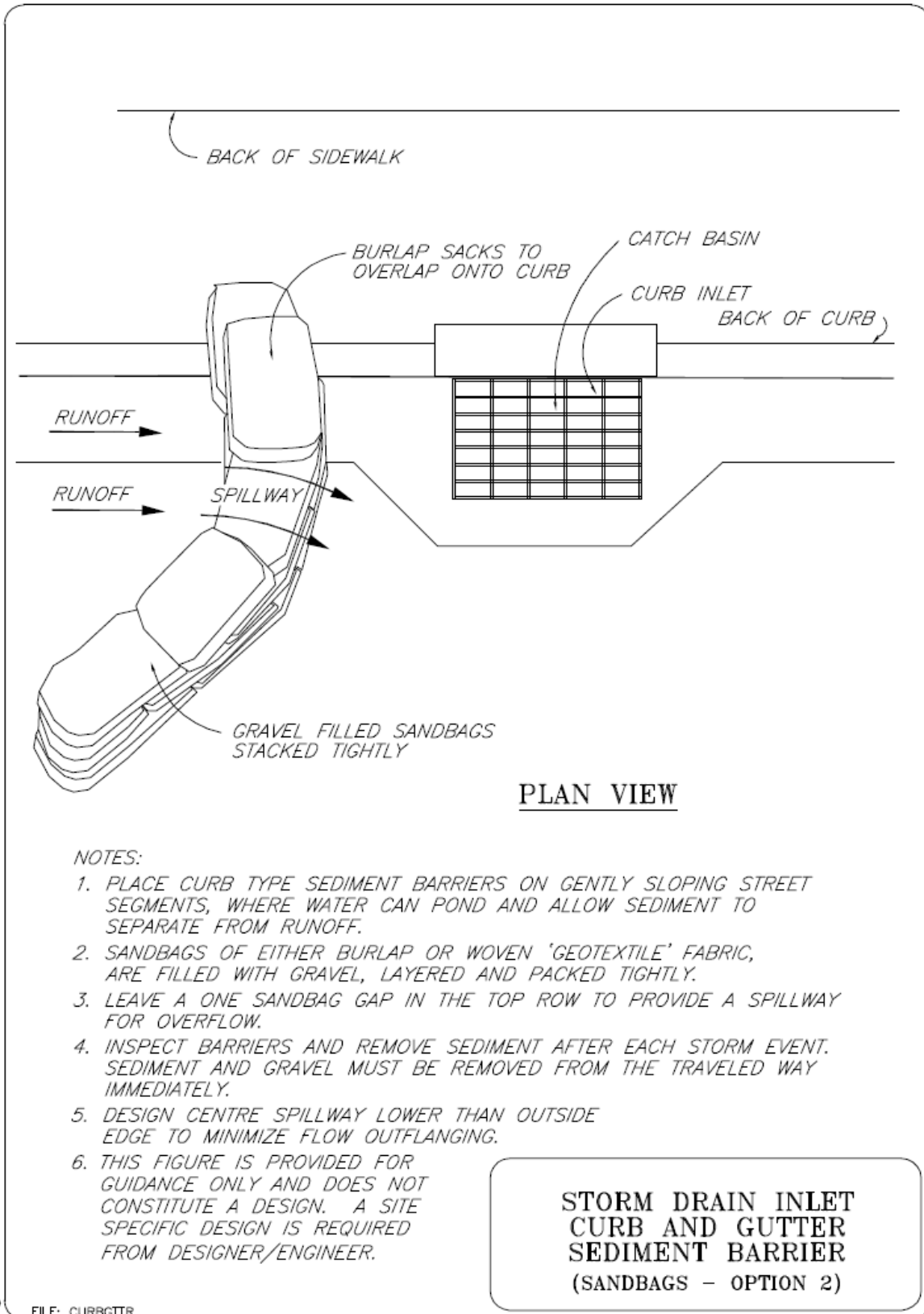


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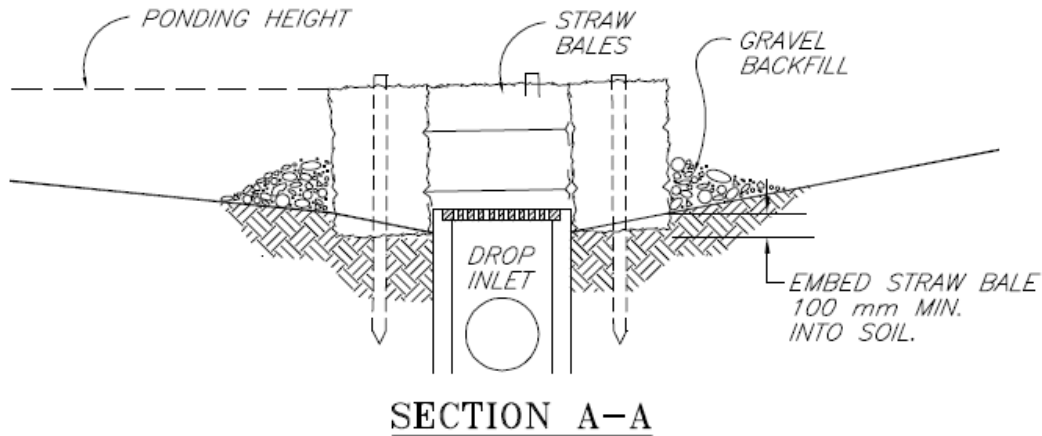
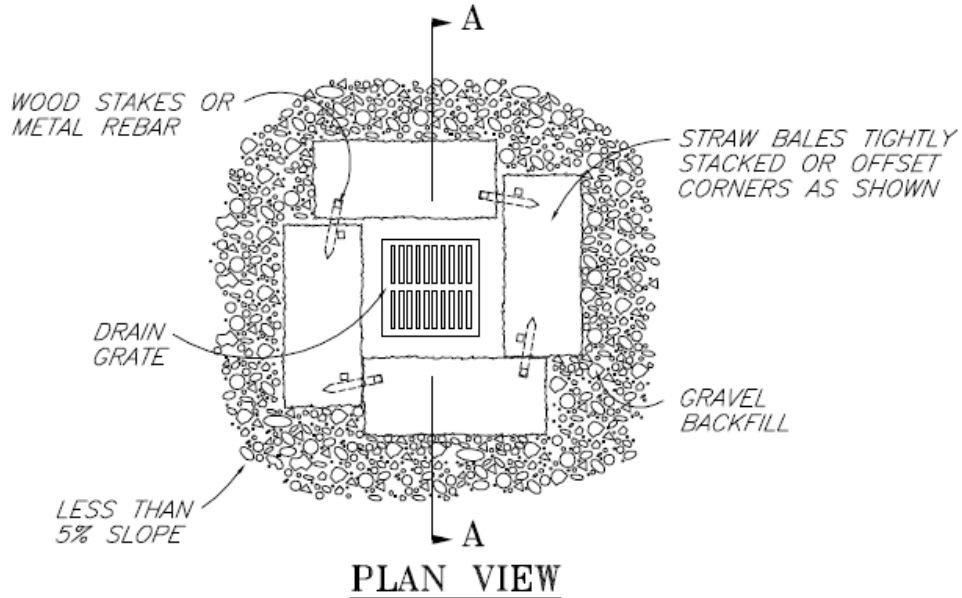
Source: Alberta Transportation BMP #6b / Typical Section



Source: Alberta Transportation BMP 6c / Typical Section



Source: Alberta Transportation BMP #6d / Typical Section



**NOTES:**

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. EMBED THE BALES 100 mm INTO THE SOIL AND OFFSET CORNERS OR PLACE BALES WITH ENDS TIGHTLY ABUTING. GRAVEL BACKFILL WILL PREVENT EROSION OR FLOW AROUND THE BALES.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. EXCAVATION OF A BASIN ADJACENT TO THE DROP INLET OR A TEMPORARY DIKE ON THE DOWNSLOPE OF THE STRUCTURE MAY BE NECESSARY.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

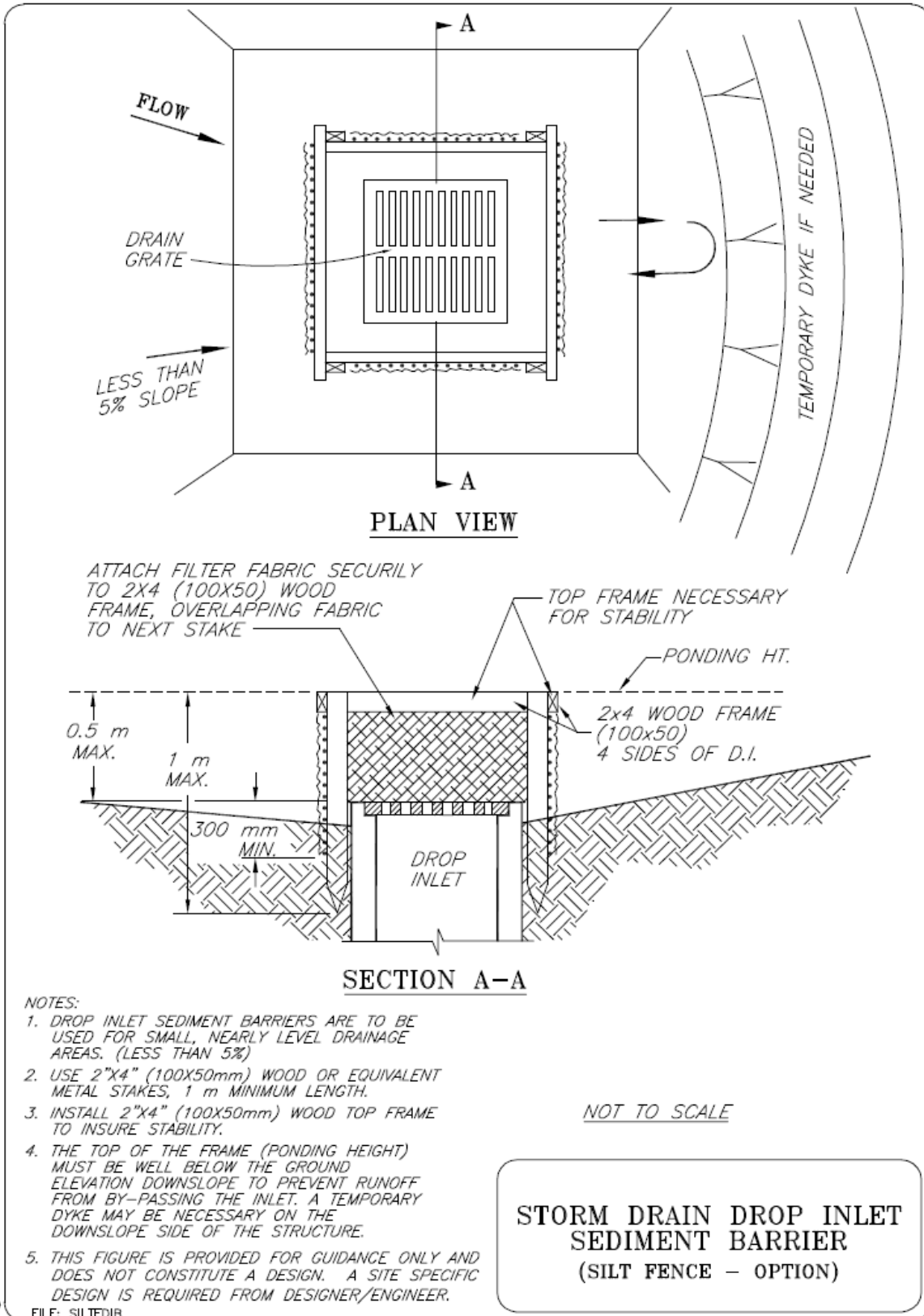
**STORM DRAIN DROP INLET  
SEDIMENT BARRIER  
(STRAW BALE / GRAVEL - OPTION)**

From: Salix-Applied Earthcare - EROSION DRAW 3.0  
1994 JOHN McCULLAH



FILE: STRWGRVB

Source: Alberta Transportation BMP #6e / Typical Section



Source: Alberta Transportation BMP #6f / Typical Section

**Description and Purpose**

- A geotextile barrier installed in a slowly flowing, or quiescent, river, lake, or wetland to contain suspended sediment produced by construction
- In shallow water the curtain may be mounted on posts driven into the bed. In deeper systems the curtain may be suspended from ropes supported by floats (and suitably anchored).

**Applications**

- For use in a slowly flowing river, lake or wetland
- Where there are fine sediments that have long settling times

**Limitations**

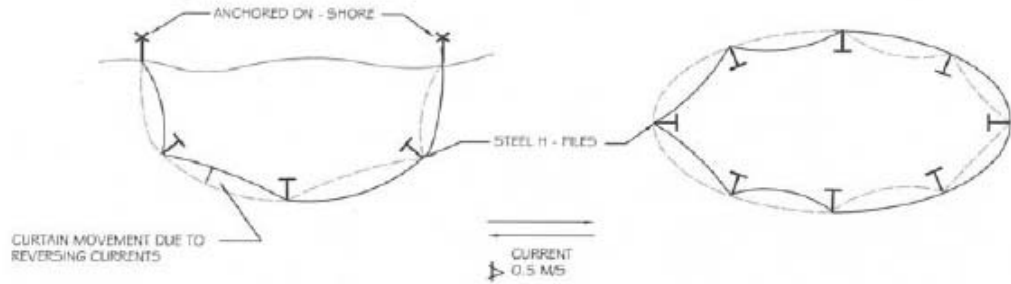
- Not feasible in higher currents (greater than 0.5 m/s)
- Not feasible in higher or breaking wave conditions
- Not feasible in the presence of ice

**Construction Considerations**

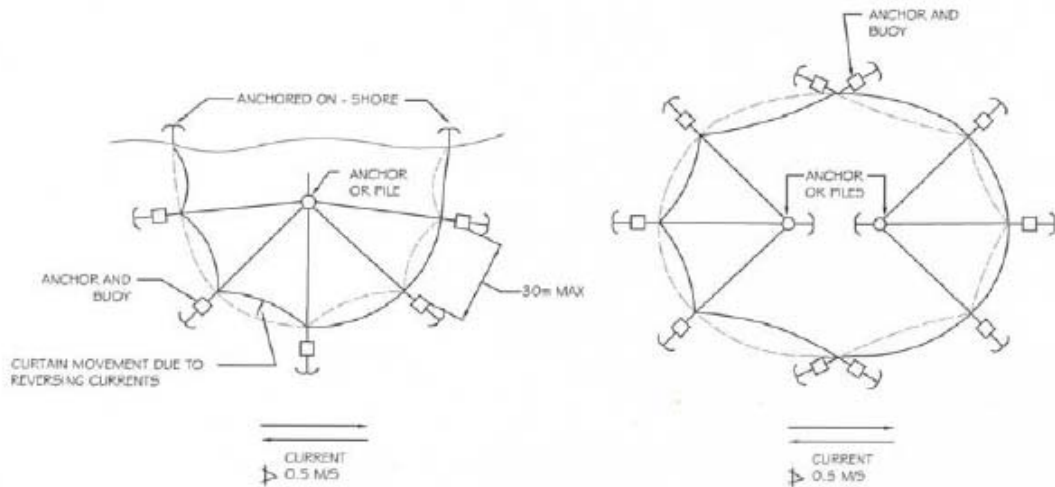
- The curtain should be installed according to manufacturer's and/or MIT/ESRA specifications
- The curtain should not be removed until all construction activity has been completed and all suspended sediment has settled

**Inspection and Maintenance**

Turbidity curtains are vulnerable to damage from wind, waves, currents, ice and boats, and should therefore be monitored regularly (and especially after storm events) to ensure that the curtain is functioning satisfactorily



(A) WITH PILES



(B) WITH MARINE ANCHORS

**TYPICAL SILT CURTAIN  
DEPLOYMENT  
CONFIGURATIONS**

Source: Ontario BMP 32-2



### **Description and Purpose**

- 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

### **Applications**

- Temporary measure
- Can be used in high risk areas to supplement performance of containment pond systems
- An example area would be where containment pond space is limited on construction site and appropriate sized containment pond cannot be constructed adjacent to high risk areas
- Useful for additional extraction of sediment dewatering sumps, sediment ponds, or other retention facilities with accumulations of sediment laden runoff

### **Advantages**

- Filter bag is lightweight and portable
- Simple cleanup and disposal
- Sediment is captured within filter bag for removal from site

### **Limitations**

- May be expensive: extra costs are associated with cost of filter bags and costs of pumping out retention facilities
- Power supply for pumps may be required
- Useful for only short periods of time and small volumes of water
- Refer to manufacturers' product performance information
- Can only retain particle sizes larger than the Apparent Opening Size (AOS) of the filter fabric bag
- Generally for available non-woven filtration geotextile, AOS values of 0.15 mm range or lower can be realistically manufactured. It is important to require manufacturer to provide performance specification and physical properties of the bags. The designer and supplier of the filter bag should choose the fabric and AOS based on the anticipated gradation of the sediments.
- Generally only suitable for use as an emergency measure for highly sensitive sites

### **Construction** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

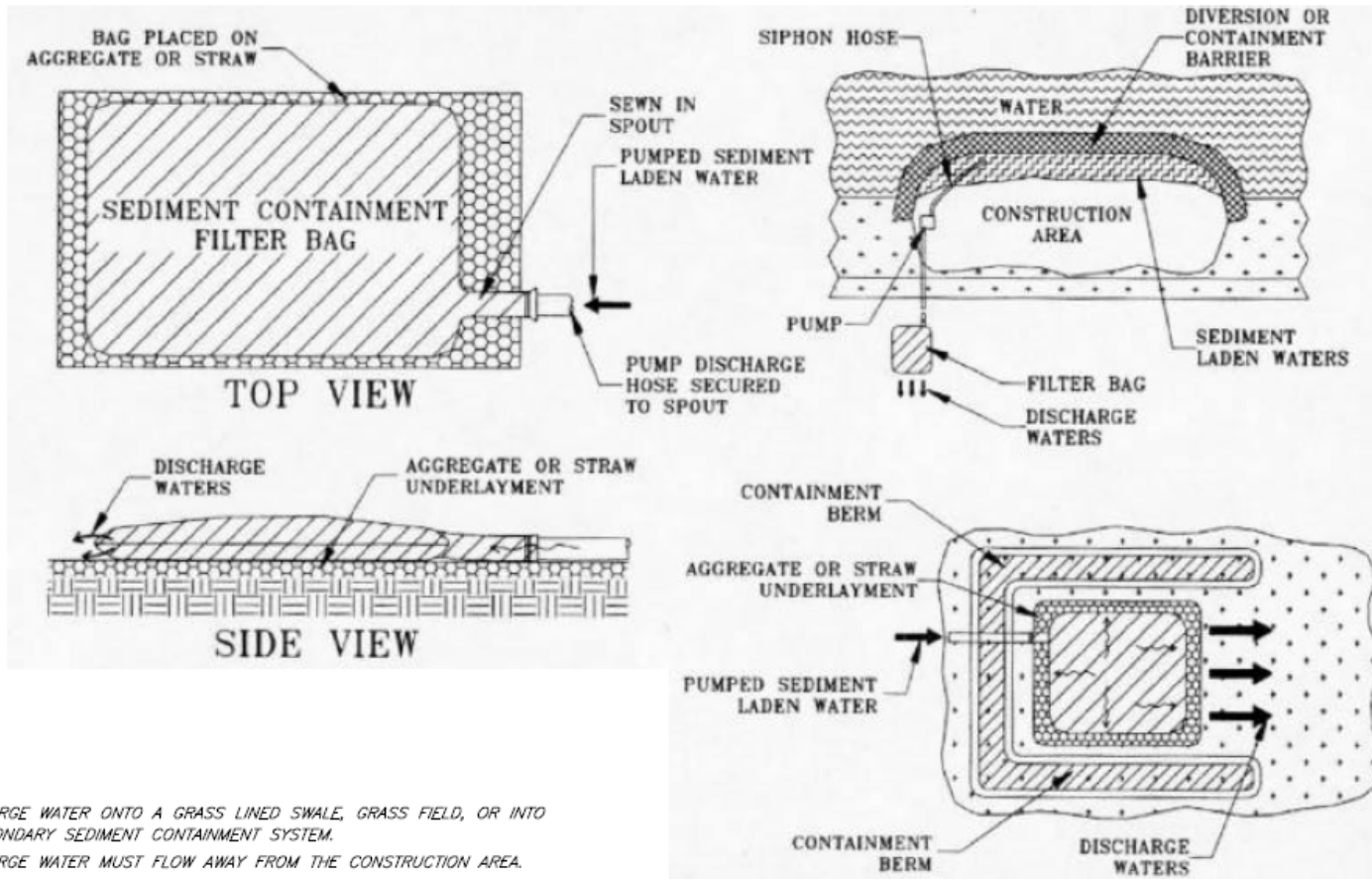
- Place filter bag on free-draining base (such as gravel pad or straw pile) on a slight slope, with opening to silt bag facing upslope
- Attach hose to opening of filter bag, and ensure a tight seal to prevent discharge of sediment laden runoff outside of bag
- Attach hose to pump and insert extraction hose into retention facility to be dewatered
- Turn on pump and remove sediment laden water until the filter bag is full of sediment
- Disengage pump once the filter bag is full, tightly close the filter bag opening to prevent spilling of sediment and remove the bag
- Repeat the process (using new filter bags) until the retention facility is dewatered to acceptable levels

### **Construction Considerations**

- Full filter bags can be removed from site or buried in designated locations on-site
- Care should be taken to ensure filter bag is not overfilled, which may cause it to tear and spill sediment
- Care should be taken when transporting full filter bags to prevent tearing

### **Inspection and Maintenance**

- Inspect all hoses and connections before and during pumping operations to • minimize leaks



**NOTES:**

1. DISCHARGE WATER ONTO A GRASS LINED SWALE, GRASS FIELD, OR INTO A SECONDARY SEDIMENT CONTAINMENT SYSTEM.
2. DISCHARGE WATER MUST FLOW AWAY FROM THE CONSTRUCTION AREA.
3. SEDIMENT CAPTURED BY THE FILTER BAG MUST BE REMOVED AND STABILIZED.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

SOURCE: FIFIELD 2001

**PUMPED SILT CONTROL SYSTEM**

Source: Alberta Transportation BMP #31 / Typical Section

**Description and Purpose**

- A temporary dam constructed of earth, sheet piling or other material to enclose a work area and permit the removal of water
- Portable fabric cofferdams may be considered for use in Ontario
- To isolate equipment, materials and operations

**Applications**

- Work areas that encroach into a watercourse, lake, or wetland
- Areas where the coffer dam will not hinder passage of fish and brats

**Advantages**

- Permits work to be carried out in the dry
- Allows boat and fish passage
- Does not unduly affect flow in the stream

**Limitations**

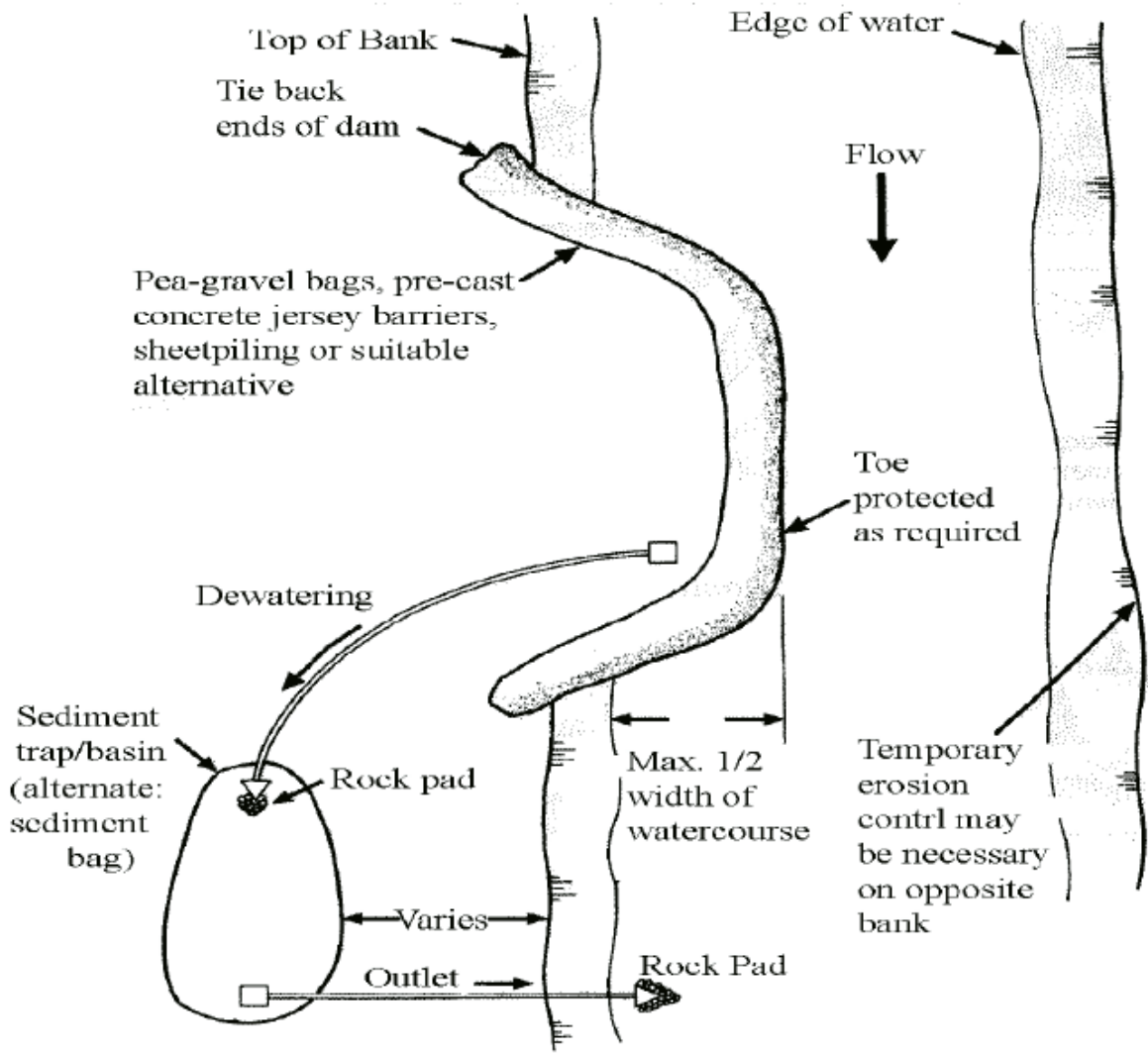
- In areas of shallow flow depth (less than 1.5 m)
- Constant pumping may be required to keep work area dewatered

**Construction** (Note: *For guidance only. A site specific design is required from designer/engineer*)

- Encroachment into watercourse should be minimized
- Cofferdam should not cause unacceptable sewer and flow velocities in the watercourse
- Height of the dam should provide protection for a 10 year event, if possible (height of dam to be less than 1.5 m)
- All debris and accumulated sediment must be cleared away before removal of the coffer dam
- Operations within the work area must be capable of withstanding inundation without risk to life and equipment damage

**Inspection and Maintenance**

- Dams should be inspected regularly and immediately repaired if required. A through inspection should be conducted following flood events
- Water removed from work area may be silty and should be discharged to a vegetated area at least 30 m from the watercourse, or pumped through a filter bag
- The weather forecast should be monitored to anticipate the occurrence of high flow events. Work operations should be adjusted to accumulate possible overtopping of the coffer dams



Source: Greater Golden Horseshoe Conservation Authorities

**BMP 25 Seeding**

**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: For guidance only. A site specific design is required from designer/engineer.)*

- 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
- Fertilizer should then be applied after seeding

**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 for all mixes should be 25 kg/ha minimum
- Fall rye may be added at 5 kg/ha 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

#### **Similar Measures**

- Hydraulic seeding and mulching
- Sodding

#### **Design Considerations**

- Seed application rate of 25 kg/ha may be used
- If fall rye is to be added, it should have an application rate of 5 kg/ha
- When using a seed drill or brilliant seeder, grasses and legumes should not be planted deeper than 1 cm
- Bacterial inoculants must be used when seeding with legumes
- Fertilizer, in lieu of a soil test, should be applied as per the supplier's recommendations or:
  - it should be applied at a rate of 50 to 75 kg of nitrogen/ha, depending upon site conditions
  - fertilizer use should be carefully controlled as this may increase nutrient loading to receiving streams if runoff is not controlled properly
- 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
- Seeding should not occur after the 50% frost probability date for the site
- 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.

**Description and Purpose**

- Application of organic material or other normally biodegradable substances as a protection layer to the soil surface to:
  - minimize raindrop/runoff erosion and conserve a desirable soil moisture property for plant growth; and
  - promote seed germination and plant growth
- Mulches conserve soil moisture, reduce runoff velocities and surface erosion, control weeds, help establish plant cover, and protect seeds from predators, raindrop impact, and wind/water erosion

**Applications**

- Can be used to provide temporary and permanent erosion control
- Can be used as an organic cover or growth medium for seeds where topsoil is not readily available
- May be used with or without seeding in areas that are rough graded or final graded
- May be applied in conjunction with seeding to promote plant growth
- May comprise organic mulches (such as straw, wood fibres, peat moss, wood chips, pine needles, compost) or chemical mulches (such as vinyl compounds, asphalt, rubber, or other water-mixed substances)
- Chemical mulches may be used to bind other mulches in a hydroseeding/hydromulching application

**Advantages**

- Relatively cheap method of promoting plant growth and slope protection

**Limitations**

- Application of mulch may be difficult on steep slopes
- May require spray-on method to apply mulch with tackifier to provide adhesion to steep slopes

**Installation**

- Prepare soil surface by removing large rocks or other deleterious materials
- Apply topsoil and seed, if required, subject to topsoil availability
- Apply mulch as per supplier's recommendations
- Certain mulches may require additional anchoring to minimize loss of mulch due to wind or water erosion

**Construction Considerations** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

- Install mulches as per manufacturer or supplier recommendations
- Organic Mulches
  - Straw
    - Refers to stalks or stems of small grain (primarily wheat) after drying and threshing
    - Straw should be free of weeds
    - Loose straw is very susceptible to movement by blowing wind and water runoff and should be anchored either with chemical tackifier or some form of netting
    - When properly secured to surface, straw is highly suitable for promoting good grass cover quickly, however, it may be a fire hazard in dry conditions
  - Raw Wood Fibre
    - Mixture of cellulose fibres a minimum of 4 mm in length extracted from wood
    - Wood fibres usually require a soil binder and should not be used as erosion control during periods of hot dry weather in the summer or for late fall seeding unless it is used in conjunction with another suitable mulch as it is prone to removal by blowing wind or water runoff
    - Wood fibre is primarily used in hydroseeding-hydromulching operations where it is applied as part of a slurry and when used in conjunction with a tackifier, it is well suited for tacking straw mulch on steep slopes

- Peat Moss
  - Comprises partly decomposed mosses and organic matter under conditions of excessive moisture
  - Usually available in dried and compressed bundles
  - Should be free of coarse material
  - Useful soil conditioner to improve organic content of soil promoting plant growth
  - Highly susceptible to removal by blowing wind and water runoff if dry and spread on top of soil
- Wood Chips
  - By-products of timber processing comprised of small, thin pieces of wood
  - Decompose slowly
  - Suitable for placing around individual plants (shrubs and trees) and for areas that will not be closely mowed
  - Highly resistant to removal by blowing wind and water runoff
- Bark Chips (Shredded Bark)
  - By-products of timber processing comprised of small, thin pieces of tree bark
  - Suitable for areas that will not be closely mowed
  - Have good moisture retention properties and are resistant to removal by blowing wind and water runoff
- Pine Needles
  - Comprise needles from coniferous trees (pine, spruce)
  - Needles should be air dried and free of coarse material
  - Decompose slowly
  - Suitable for use with plants that require acidic soils
  - Resistant to removal by blowing wind and water runoff
- Compost (Straw Manure)
  - Comprised of organic residues and straw that have undergone biological decomposition until stable
  - Should be well shredded, free from coarse material, and not wet
  - Has good moisture retention properties and is suitable as a soil conditioner promoting plant growth
  - Relatively resistant to removal by blowing wind and water runoff if not dried out completely
- Chemical Mulches
  - Comprised of acrylic co-polymers, vinyl compounds, asphalt, rubber, or other substances mixed with water
  - Usually used in hydroseeding-hydromulching applications
  - Should be applied in accordance with supplier's recommendations

#### **Inspection and Maintenance**

- Inspect mulched areas at least once per year or after significant storm events (1:2year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rilling should be regraded if necessary and recovered with mulch immediately
- Additional stormwater control measures should be considered for areas of severe rilling erosion damaged by runoff
- Small bare spots may need to be reseeding and recovered with mulch

#### **Similar Measures**

- Topsoiling
- Hydraulic seeding and mulching (hydroseeding, hydromulching)
- Rolled erosion control products (RECP)



**Description and Purpose**

- The spraying-on of a slurry to a slope or channel surface to provide a layer of seed and growth bedding medium
- The slurry consists of seed, fertilizer, mulch, tackifiers, and water which are mixed together in a tank
- Enables quick re-vegetation of very steep or rocky/gravelly slopes where revegetation by any other method would be very difficult or unsafe; frequent reseeding and special mix design may be required
- When sprayed on the soil, the slurry forms a continuous blanket with seeds and protects the soil from wind and water erosion and raindrop impact by aggregating (or adhering) them in place
- The slurry conserves moisture, reduces soil moisture evaporation, and decreases soil surface crusting due to evaporation/drying of soil

**Applications**

- Can be used to provide temporary and permanent erosion control prior to establishment of vegetation
- Slurry is held in suspension through consistent agitation and is sprayed onto disturbed areas using high pressure pumps
- Can be used for spray-on seeding covering large areas efficiently after placement of topsoil
- May be used to provide soil stabilization for seeding disturbed soil areas
- Can also be used with higher efficiency and large area coverage with Advantages over conventional methods (broadcast seeders, drill seeders)
- Can be used in areas where little topsoil is available

**Advantages**

- Relatively cheap and efficient spraying method of seeding and promoting plant growth as well as erosion protection
- Allows spray-on re-vegetation of steep slopes where conventional re-vegetation methods are very difficult
- Minimizes effort required to re-vegetate disturbed areas as hydroseeding/hydromulching usually only requires one spray-on operation in comparison with planting and farrow method
- Relatively efficient operation with high coverage rates
- Provides dust control and protection from wind erosion

**Limitations**

- Site must be accessible to hydroseeding/hydromulching equipment
  - Usually mounted on trucks
  - Maximum hose range of approximately 150 m
- May require subsequent spraying to reseed bare spots or areas with low growth

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

- Prepare soil surface by removing large rocks or other deleterious materials
- Apply topsoil if available
- Spray on hydroseed-hydromulch as per supplier's recommendations

**Construction Considerations**

- Seed
  - 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
- Hydraulic Mulches
  - Cellulose
  - Comprised of recycled paper from newspapers, magazines, or other paper sources
  - Rapid method for applying seed, fertilizer, mulch, and water in almost any disturbed areas
  - Usually installed without tackifier in slurry
  - Short fibre lengths and lack of tackifier limits erosion control effectiveness and does little to moderate moisture content and temperature within the soil
  - Residual inks within the recycled paper may leach into soil, which may present a problem in environmentally sensitive areas
  - Longevity significantly shorter than for wood fibre mulches or bonded fibre matrices (BFM)
  - Cheaper than wood fibre mulches and BFM
  - Wood Fibre
  - Comprised of whole wood chips
  - Industry standard, provides quick and uniform method and medium for revegetating large areas quickly and economically
  - Longer fibre lengths than for cellulose mulches
  - Longer lasting and has better wet-dry characteristics than cellulose mulches
  - Provides limited erosion control even when sprayed on with tackifiers
  - Provides limited moderation of soil moisture content and temperature when applied at higher rates
  - Cheaper, but less effective than, BFM
  - More expensive, and more effective than, cellulose mulches
  - Bonded Fibre Matrices (BFM)
  - Slurry comprised of either cellulose mulch, wood fibre mulch, or a combination of the two
  - Mulches are bound together using chemical bond, mechanical bond, or a combination of the two
  - All fibres and binding agents are premixed by the manufacturer, ensuring uniformity and consistency throughout the application
  - Well suited for sites with existing desirable vegetation and where worker safety and minimal ground disturbance are desired
  - Degree of protection is similar to that obtained from rolled erosion control products (RECP)
  - Quicker installation than for RECP
  - Chemically bonded BFM may require a 'set-up' or curing/drying period
  - Application must be limited to periods where there is no threat of rain during curing period
  - Mechanically bonded BFM have no curing time and are effective immediately after application
  - Application on dry soils is not recommended
  - More expensive, and more effective, than cellulose and wood fibre mulches
- Tackifiers
  - May include vinyl compounds, asphalt, rubber, or other water-mixed substances

**Inspection and Maintenance**

- Inspect hydroseeded-hydromulched areas at least once per year after initial
- application or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by runoff may need to be repaired and protected
- Small bare spots may need to be reseeded

**Similar Measures**

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

**Description and Purpose**

- The spraying-on of a slurry to a slope or channel surface to provide a layer of seed and growth bedding medium
- The slurry consists of seed, fertilizer, mulch, tackifiers, and water which are mixed together in a tank
- Enables quick re-vegetation of very steep or rocky/gravelly slopes where revegetation by any other method would be very difficult or unsafe; frequent reseeded and special mix design may be required
- When sprayed on the soil, the slurry forms a continuous blanket with seeds and protects the soil from wind and water erosion and raindrop impact by aggregating (or adhering) them in place
- The slurry conserves moisture, reduces soil moisture evaporation, and decreases soil surface crusting due to evaporation/drying of soil

**Applications**

- Can be used to provide temporary and permanent erosion control prior to establishment of vegetation
- Slurry is held in suspension through consistent agitation and is sprayed onto disturbed areas using high pressure pumps
- Can be used for spray-on seeding covering large areas efficiently after placement of topsoil
- May be used to provide soil stabilization for seeding disturbed soil areas
- Can also be used with higher efficiency and large area coverage with Advantages over conventional methods (broadcast seeders, drill seeders)
- Can be used in areas where little topsoil is available

**Advantages**

- Relatively cheap and efficient spraying method of seeding and promoting plant growth as well as erosion protection
- Allows spray-on re-vegetation of steep slopes where conventional re-vegetation methods are very difficult
- Minimizes effort required to re-vegetate disturbed areas as hydroseeding/hydromulching usually only requires one spray-on operation in comparison with planting and farrow method
- Relatively efficient operation with high coverage rates
- Provides dust control and protection from wind erosion

**Limitations**

- Site must be accessible to hydroseeding/hydromulching equipment
  - Usually mounted on trucks
  - Maximum hose range of approximately 150 m
- May require subsequent spraying to reseed bare spots or areas with low growth

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

- Prepare soil surface by removing large rocks or other deleterious materials
- Apply topsoil if available
- Spray on hydroseed-hydromulch as per supplier's recommendations

**Construction Considerations**

- Seed
  - 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
- Hydraulic Mulches
  - Cellulose
  - Comprised of recycled paper from newspapers, magazines, or other paper sources
  - Rapid method for applying seed, fertilizer, mulch, and water in almost any disturbed areas
  - Usually installed without tackifier in slurry
  - Short fibre lengths and lack of tackifier limits erosion control effectiveness and does little to moderate moisture content and temperature within the soil
  - Residual inks within the recycled paper may leach into soil, which may present a problem in environmentally sensitive areas
  - Longevity significantly shorter than for wood fibre mulches or bonded fibre matrices (BFM)
  - Cheaper than wood fibre mulches and BFM
  - Wood Fibre
  - Comprised of whole wood chips
  - Industry standard, provides quick and uniform method and medium for revegetating large areas quickly and economically
  - Longer fibre lengths than for cellulose mulches
  - Longer lasting and has better wet-dry characteristics than cellulose mulches
  - Provides limited erosion control even when sprayed on with tackifiers
  - Provides limited moderation of soil moisture content and temperature when applied at higher rates
  - Cheaper, but less effective than, BFM
  - More expensive, and more effective than, cellulose mulches
  - Bonded Fibre Matrices (BFM)
  - Slurry comprised of either cellulose mulch, wood fibre mulch, or a combination of the two
  - Mulches are bound together using chemical bond, mechanical bond, or a combination of the two
  - All fibres and binding agents are premixed by the manufacturer, ensuring uniformity and consistency throughout the application
  - Well suited for sites with existing desirable vegetation and where worker safety and minimal ground disturbance are desired
  - Degree of protection is similar to that obtained from rolled erosion control products (RECP)
  - Quicker installation than for RECP
  - Chemically bonded BFM may require a 'set-up' or curing/drying period
  - Application must be limited to periods where there is no threat of rain during curing period
  - Mechanically bonded BFM have no curing time and are effective immediately after application
  - Application on dry soils is not recommended
  - More expensive, and more effective, than cellulose and wood fibre mulches
- Tackifiers
  - May include vinyl compounds, asphalt, rubber, or other water-mixed substances

### **Inspection and Maintenance**

- Inspect hydroseeded-hydromulched areas at least once per year after initial
- application or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by runoff may need to be repaired and protected
- Small bare spots may need to be reseeded

### **Similar Measures**

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

**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
- Placing and grading topsoil can be time consuming and expensive
- Dry topsoil may be removed by blowing wind
- Topsoil may not be readily available in some areas

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

- 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

**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

**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)

**Description and Purpose**

- Chemical substances that are sprayed onto disturbed soils to effect a change of soil properties, generally by aggregating finer soil particles
- Aggregated finer soil particles are less susceptible to erosion and reduce erosion potential of exposed slopes

**Applications**

- Temporary measure
- May be used in place of, or in conjunction with, mulch materials to act as both a soil stabilizer and mulch binding agent
- May be used for exposed soils not subject to traffic during the temporary establishment of a seedbed
- May be used to provide temporary erosion protection before revegetation is started
- May be used in areas where success of vegetation as a soil stabilizer is very difficult
- Primarily used on dry, highly permeable soils or in soils already in place which are subjected to sheet flow rather than concentrated flows
- May be used in wind erosion prone areas as temporary protection

**Advantages**

- Chemical stabilizers increase cohesion of soil surface which helps development of permanent vegetative cover by reducing erosion and reducing evaporation of soil moisture
- Efficiently sprayed over large areas of exposed soils

**Limitations**

- Site must be accessible to hydroseeding-hydromulching equipment
  - Usually mounted on trucks
  - Maximum hose range of approximately 150 m
- May require additional specialized equipment not commonly used during construction activities
- Increased longevity if chemical stabilizer application rate is increased, however, increased application rates may prevent seeds from germinating
- Crust-forming chemical stabilizers (such as bitumen) may crack during freeze-thaw cycles

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer.)*

- Prepare slope face and remove large rocks or other deleterious materials
- Place topsoil and seed (if required)
- Spray on chemical stabilization according to suppliers recommended application rate

**Construction Considerations**

Chemical Soil Stabilizers

- Alginate - Paste-like emulsion or granulate produced from sea algae and consisting largely of natural carbohydrates with associated minerals added
- Aquatain - Water dispersible, non-toxic
- Asphalt Sprays - Available as an asphalt emulsion or as a liquid asphalt
- Bitumen - Thick-flowing undilutable emulsion or a cold emulsion, 50% dilutable with water
- DCA – 70 - Water dispersible, non-toxic, non-phytotoxic
- Hydrosilicates Methylcellulose - Gel-like elastic film in a powder form or as a water based emulsion
- Plastic Emulsion - Usually a liquid which can be diluted with water producing a thin film to cover the soil surface
- Polyvinyl Alcohol - An emulsion with water

<b>Soil Tackifiers (Chemical Stabilization)</b> <i>Sediment Control</i>	<b>BMP 29</b>
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**Inspection and Maintenance**

- Inspect treated areas at biweekly intervals or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Additional stormwater control measures should be considered for severe rilling areas damaged by runoff
- Period of effectiveness lasts from a few weeks to a few months, depending on application rate
  - Repetitive application will prolong effectiveness

**Similar Measures**

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

**Description and Purpose**

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

**Applications**

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

**Advantages**

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

**Limitations**

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

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer).*

- It is highly important to preserve an established vegetative buffer as freshly planted vegetation generally require substantial growth periods before they are as effective as established riparian zones
- Wherever possible, retain as much existing vegetation as possible between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize sediment transport off of the construction site into the sensitive zones
- Define and delineate riparian zones to be preserved in Environmental Construction Operations Plan (ECO Plan) prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field (with construction fencing, survey flagging, or other highly visible measure) so all personnel involved with construction operations can identify areas to be preserved

**Construction Considerations**

- Riparian zones must be fenced off immediately to minimize trespassing and to ensure effectiveness of riparian zone is maintained
- Do not allow equipment to enter areas not necessary to construction

**Inspection and Maintenance**

- Maintain fences protecting riparian zones from trespassing



**Description and Purpose**

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

**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
- Must be used in conjunction with non-woven geotextile fabric underlay for areas of high groundwater seepage exits
- In most situations, subsurface drains are designed in conjunction with gravel blankets.

**Advantages**

- Easily constructed and implemented

**Limitations**

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

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

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

**Construction Considerations**

- Aggregate must be placed evenly over slope
- On slopes of highly erodible materials (silt and sand) gravel blanket thickness should be 0.4 m minimum 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 (Designation 6 Class 125 AT Specifications) to 0.4 m thickness

**Metric Sieve Size (mm) Percent Passing**

125,000	100
50,000	5-100
25,000	38-100
16,000	32-85
5,000	20-65

<b>Gravel Blanket <i>Sediment Control</i></b>	<b>BMP 31</b>
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315  
80

6-30  
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

**Description and Purpose**

- Scheduling the sequence and timing arrangement of construction activities (1) 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 (2) to limit the portion of land disturbance (construction) compatible with the efficient rate of construction of erosion control measures achievable
- Incorporating erosion and sedimentation control concerns during the scheduling phase will minimize the amount and duration of bare soil exposure to erosion elements and ensure erosion and sedimentation control measures are implemented at an appropriate time
- Scheduling may be designed during planning stages by the contractor and altered during construction to suit actual conditions encountered

**Applications**

- Temporary measure

**Advantages**

- Ensures erosion and sedimentation control issues are identified during the planning stage by the Contractor
- May be used to minimize bare soil exposure and erosion hazard with careful planning and utilization of equipment in construction projects

**Limitations**

- May be more costly as erosion control measures (such as topsoiling and seeding) have to be implemented immediately after completion of each phase or a short section of construction

**Construction**

- Incorporate a schedule with erosion protection perspective to form part of the overall construction plan
- Determine sequencing and timetable for the start and end of each item, such as clearing, grubbing, stripping, etc.
- Incorporate installation of appropriate erosion and/or sediment control measures in construction schedule
- Allow sufficient time before rainfall begins to install erosion and/or sediment control measures
- Whenever possible, schedule work to minimize extent of site disturbance 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

**Inspection and Maintenance**

- Routinely verify that construction activities and the installation of erosion and sediment control measures is progressing in accordance with schedule – If progress deviates from schedule, take corrective action
- When changes to the project schedule are unavoidable, alter the schedule as soon as practicable to maintain control of erosion

**BMP 33 Groundwater Control****Description and Purpose**

- Drains that intercept and collect subsurface groundwater and divert it from slope, thus
- lowering groundwater table to minimize piping erosion reducing seepage flow on slopes and increase slope stability

- Relief drains (perforated finger-drains or French drains) to mitigate high groundwater table to minimize piping erosion

**Applications**

- Permanent measure
- Used on cutslopes where groundwater seepage exits on slope face

**Limitations**

- Must be designed by a geotechnical engineer
- Can be expensive to install
- Plugging of drainage outlet can be detrimental to cause build-up of pore pressure; it is mandatory to protect the outlet area to ensure free draining condition

**Construction** *(Note: For guidance only. A site specific design is required from designer/engineer)*

- Excavate trench at subsurface drain location
- Install drain pipe
- Backfill with clean, coarse drainage gravel and/or non-woven geotextile fabric to provide filtration separation with adjacent soils

**Construction Considerations**

- When signs of seepage and unstable excavation slope are encountered at excavations, it is advisable to install trench protection measures for safety (i.e. trench box)
- Carry out work as soon as possible to mitigate seepage damage, soil loss and deterioration of unstable slope
- Excavate and install drains to the grade and spacings according to design and recommendations made by the geotechnical engineer
- Protect outlet of drainage with sturdy pipe to ensure free draining condition

**Inspection and Maintenance**

- Drains installed below grade will require manhole at frequent intervals (100 m maximum) to facilitate inspection and maintenance
- Flushing and maintenance clean out of drains can be carried out through manhole locations