Appendix 13.17-A Standard Best Management Practices (BMPs)

TELKWA COAL
LIMITED

Topsoiling

Erosion Control:
Exposed Surface Protection – Vegetated

BMP1

Description and Purpose

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

Applications

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

Advantages

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

Limitations

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

Construction

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

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

Topsoiling

Erosion Control:
Exposed Surface Protection – Vegetated

BMP1

Construction Considerations

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

Inspection and Maintenance

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

Similar Measures

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

Seeding

Erosion Control:
Exposed Surface Protection – Vegetated

BMP2

Description and Purpose

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

Applications

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

Advantages

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

Limitations

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

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

Construction

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

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

Construction Considerations

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

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

Inspection and Maintenance

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

Similar Measures

- Hydraulic seeding and mulching
- Sodding

Design Considerations

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

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

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

Mulching

Erosion Control:
Exposed Surface Protection – Vegetated

BMP3

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

Mulching

Erosion Control:
Exposed Surface Protection – Vegetated

BMP3

Construction Considerations

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

- Install mulches as per manufacturer or supplier recommendations
- Mulches may be crimped into the ground using a disk or tracking method to prevent movement by blowing wind or water
- 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
    - Should be tested for pH prior to use; may require a soil amendment to prevent acidity from inhibiting vegetation growth
  - 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
  - Pine needles may inhibit growth of other vegetation
- 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 (1:2 year 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)

Hydroseeding-Hydromulching

Erosion Control:
Exposed Surface Protection – Vegetated

BMP4

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 re-vegetation by any other method would be very difficult or unsafe; frequent re-seeding 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 erosion control prior to establishment of permanent 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

Hydroseeding-Hydromulching

Erosion Control:
Exposed Surface Protection – Vegetated

BMP4

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

- 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 re-vegetating 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)
- dyes in the mulch can be used for control of the coverage of the mulch; also important in inspection
- 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)

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP5

Description and Purpose

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

Applications

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

Advantages

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

Limitations

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

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP5

Construction

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

- Grade the slope or channel to final design grade
- Place filter (underlay) layer on prepared slope; filter layer can consist of non-woven geotextile underlay and/or well graded granular material dependent on hydraulic conditions
- Place riprap layer
- The following riprap sizes may be used as a guide to specifying gradation and mass:

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

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

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

Non-Woven Geotextile Filter Fabric Specifications and Physical Properties

Specified Parameter	**Riprap Nominal Diameter**	
	500 mm and Smaller	**Greater than 500 mm**
Grab Strength	650 N	875 N
Elongation (Failure)	50%	50%
Puncture Strength	275 N	550 N
Burst Strength	2.1 MPa	2.7 MPa
Trapezoidal Tear	250 N	350 N
Minimum Fabric Overlap to be 300 mm		

Source: Alberta Transportation Bridge Specification (2001)

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP5

Construction Considerations

- Riprap should be placed in a uniform thickness across the channel so as not to constrict channel width
- Blasted rock is preferred (if available)
- Riprap layer should be 1.5 to 2 times the thickness of the largest rocks used, 1.5 to 3 times the thickness of the d_{50} material, and not less than 300 mm in thickness
- On channel banks, the riprap blanket should be keyed in to a depth equal to the anticipated scour depth; alternatively, a self-launching apron of extra rock can be provided

Inspection and Maintenance

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

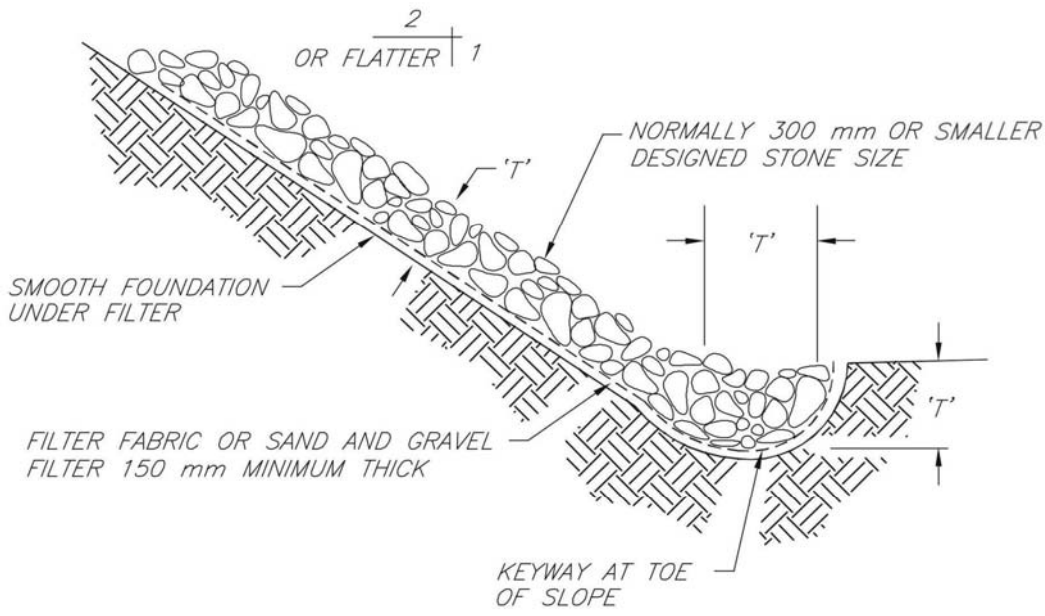
Similar Measures

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

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP5



TYPICAL SECTION

NOTE:

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

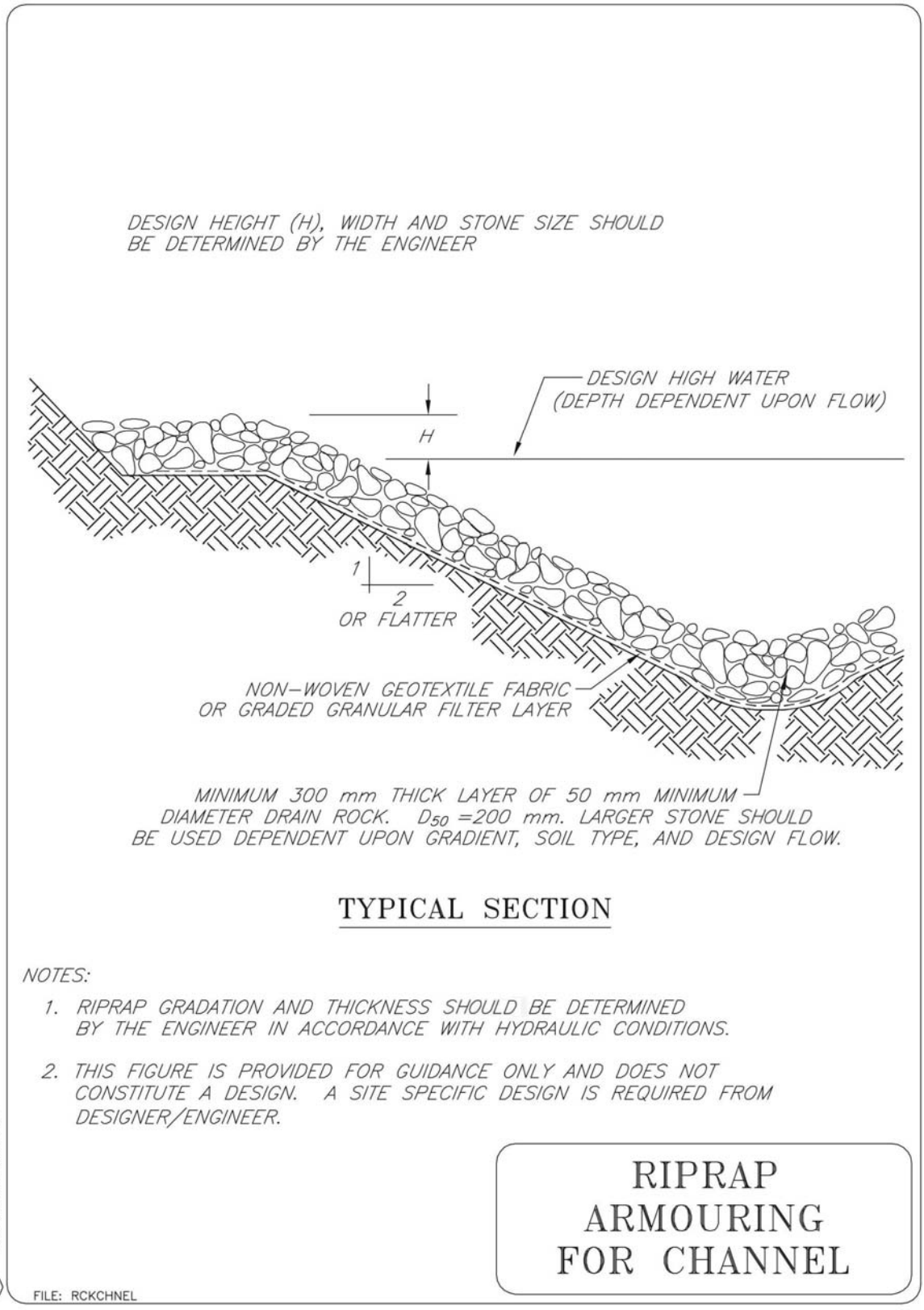
RIPRAP ARMOURING FOR SLOPE

FILE: RIPRAP

Riprap Armouring

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP5



Aggregate Cover

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP6

Description and Purpose

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

Applications

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

Advantages

- Easily constructed and implemented

Limitations

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

Aggregate Cover

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP6

Construction

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

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

Construction Considerations

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

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

Inspection and Maintenance

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

Similar Measures

- Subdrain systems

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP7

Description and Purpose

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

Applications

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

Advantages

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

Limitations

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

Implementation

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

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

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP7

Construction Considerations

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

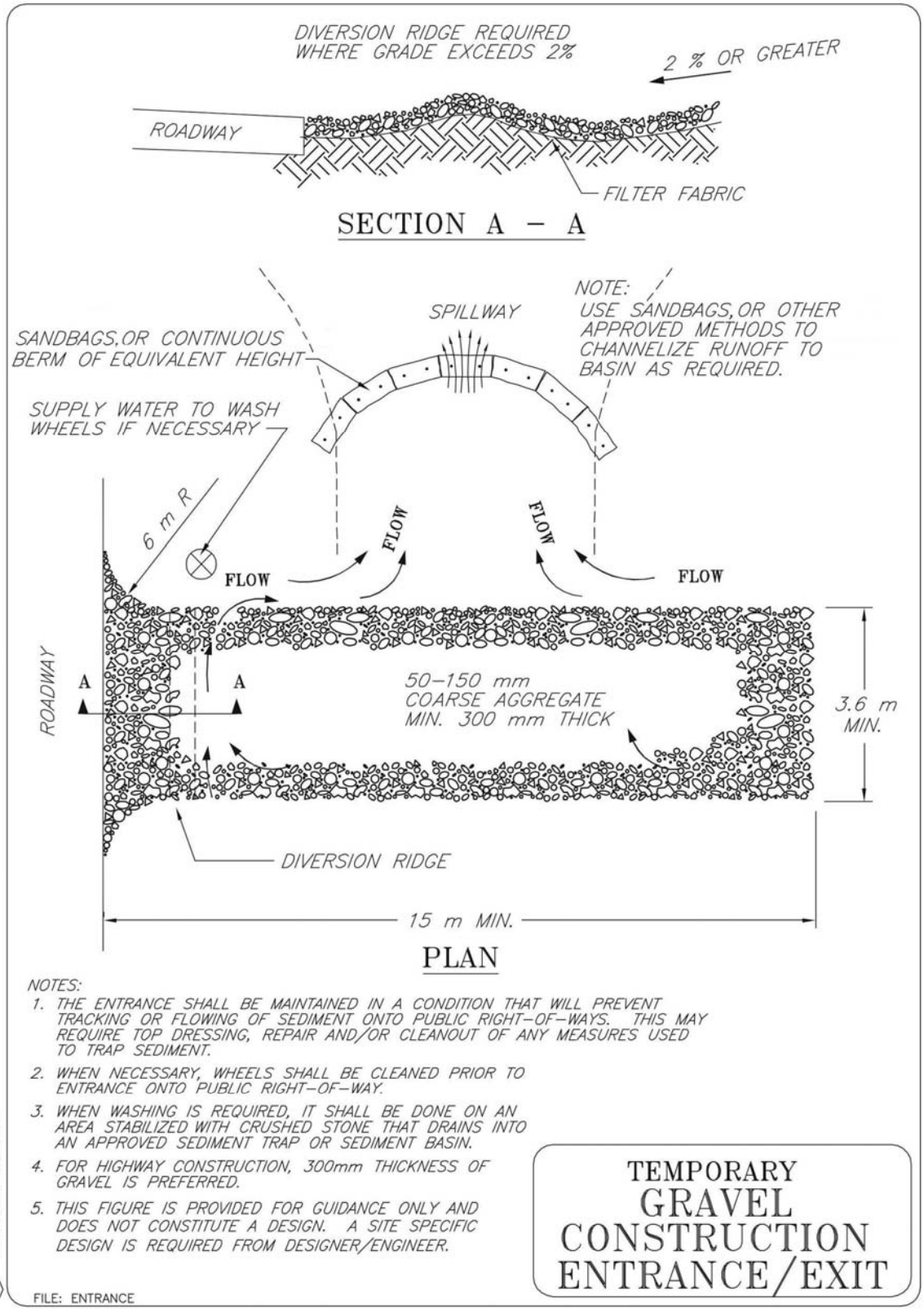
Inspection and Maintenance

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

Stabilized Worksite Entrance

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP7



NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT–OF–WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT–OF–WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.
4. FOR HIGHWAY CONSTRUCTION, 300mm THICKNESS OF GRAVEL IS PREFERRED.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT

FILE: ENTRANCE

Rolled Erosion Control Products (RECP)

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8

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

- 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^2 minimum (0.5 m spacing) for slopes steeper than 2H:1V and 1/m² (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: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

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

  - Backfill and compact soil over RECP in check slot
- Anchor terminal ends of RECP in a minimum 0.15 m deep and 0.15 m wide trench
  - Use a double row of staggered anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
  - Backfill and compact soil over RECP in trench

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 (e.g. TxDoT – Hydraulic and Erosion Control Laboratory or equivalent laboratory) 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/repaired, 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)

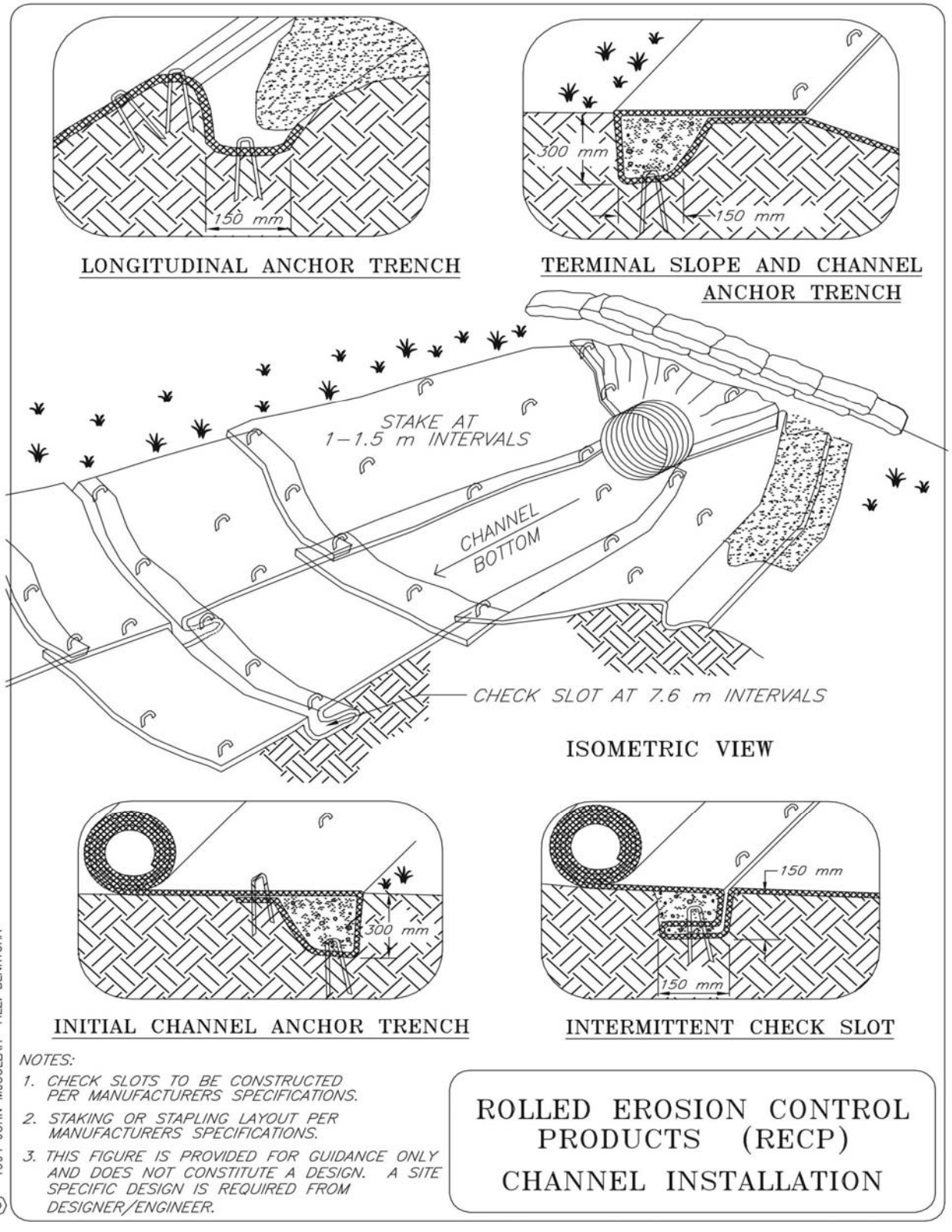
Design Considerations

- 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.

Rolled Erosion Control Products (RECP)

Erosion Control:
Exposed Surface Protection – Non-Vegetated

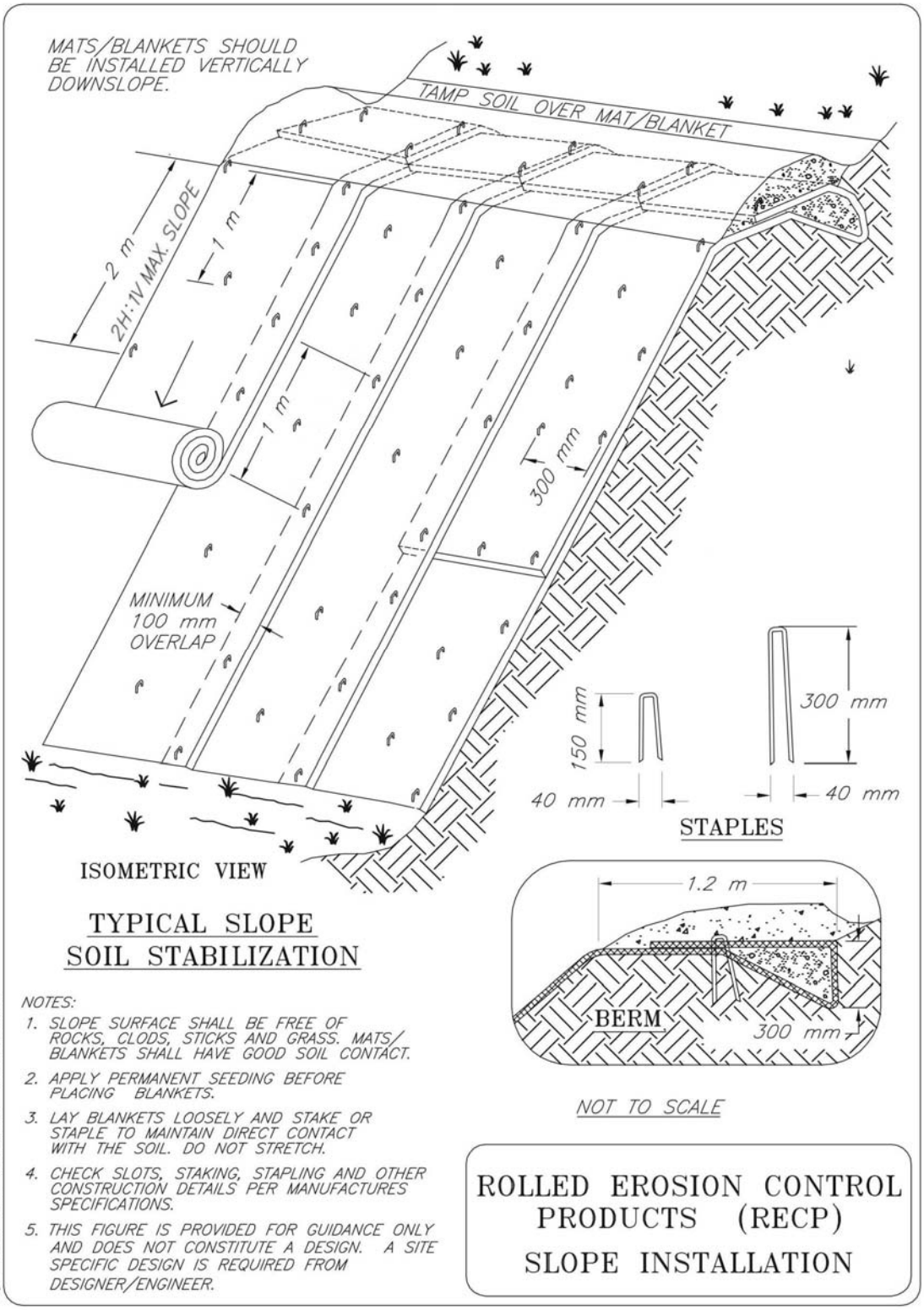
BMP8



Rolled Erosion Control Products (RECP)

Erosion Control:
Exposed Surface Protection – Non-Vegetated

BMP8



Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP9

Description and Purpose

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

Applications

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

Advantages

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

Limitations

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

Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP9

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

Construction

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

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

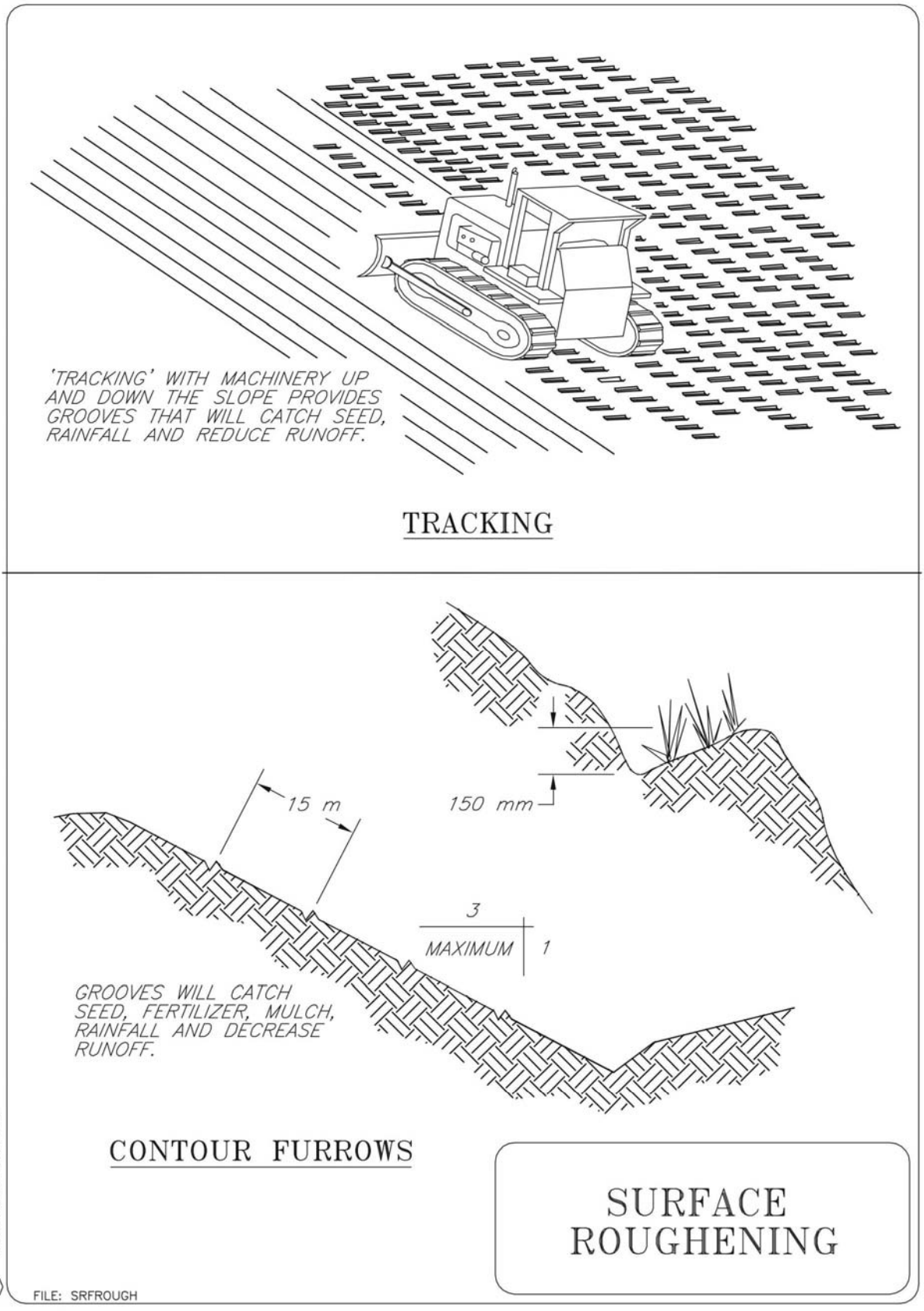
Construction Considerations

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

Slope Texturing / Grading

Erosion Control:
Runoff Control

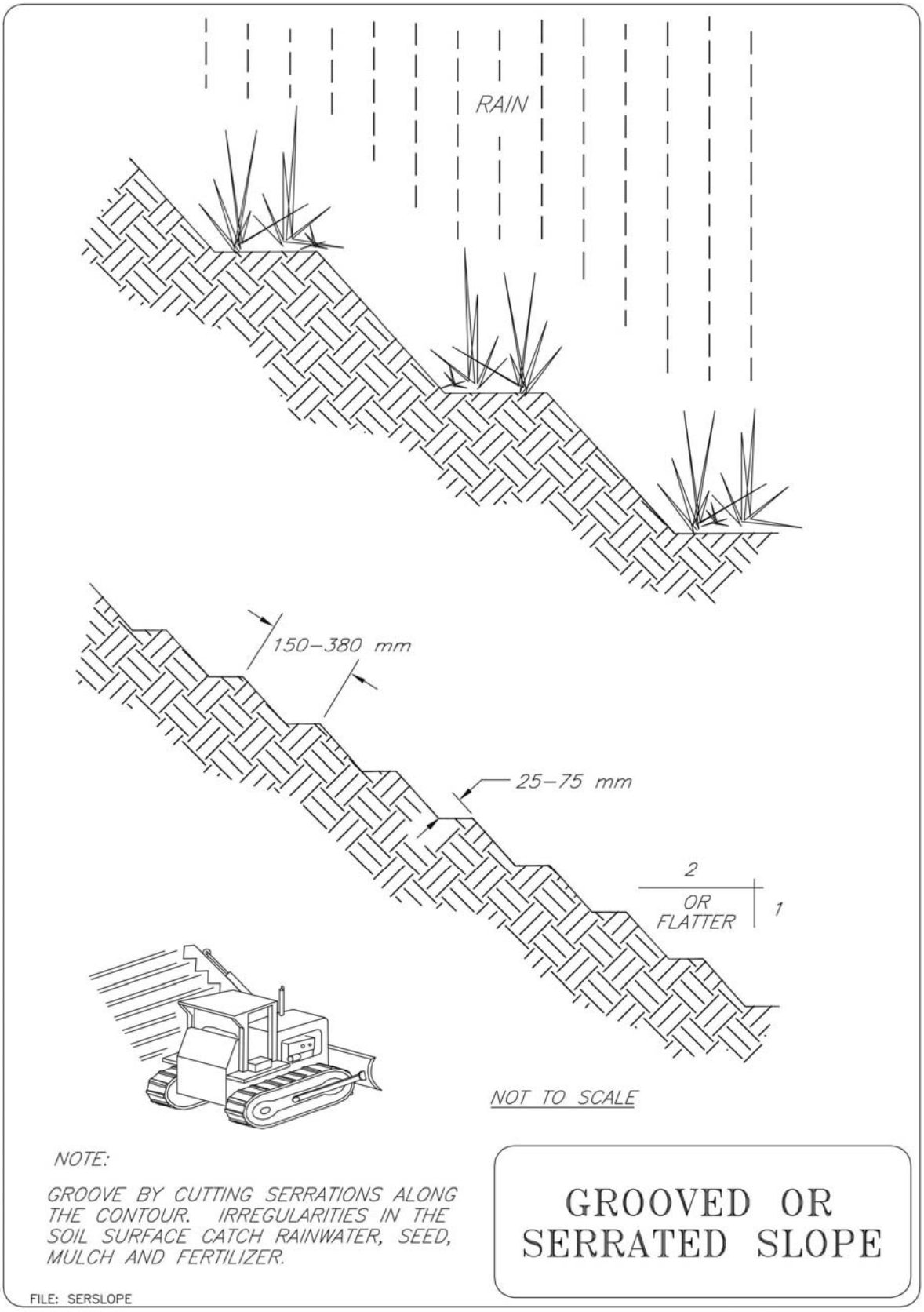
BMP9



Slope Texturing / Grading

Erosion Control:
Runoff Control

BMP9



Groundwater Control

Erosion Control:
Runoff Control

BMP10

Description and Purpose

- Drains that intercept and collect subsurface flow and divert it from slope, thus lowering the groundwater table to minimize piping erosion, reduce seepage flow on slopes and increase slope stability
- 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 professional engineer
- Can be expensive to install
- Plugging of drainage outlet can cause build-up of pore pressure; the drain outlet must be protected to ensure a free-draining condition

Construction

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

- 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

- Slopes with high water tables are susceptible to seepage and unstable excavation slopes; trench protection measures (i.e. trench box) may be required
- Carry out work as soon as possible to mitigate seepage damage, soil loss and deterioration of unstable slopes
- Excavate and install drains to the grade and spacings as designed by the geotechnical engineer
- Protect the drain outlet with sturdy pipe to ensure free draining condition

Inspection and Maintenance

- Drains installed below grade will require manholes 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

Fibre Rolls and Wattles

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP11

Description and Purpose

- Straw rolls consist of bundled straw or natural fibre, wrapped in photo-degradable open-weave plastic netting, and staked into the soil along slope contours as a grade break to reduce erosion potential
- Wattles consist of bundled live fascines, staked 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 and encouraging ponding and sediment deposition
- Live stakes can be installed to anchor the fibre rolls and wattles to provide deep root vegetation with potential favourable moisture retention provided by the fibre roll
- Fibre rolls and wattles 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)
- 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 lines 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 breaks to assist in revegetation and stabilization of banks
- Can be used in conjunction with live staking as bioengineering measure

Advantages

- Function as a grade break measure to lower sheet and rill erosion potential
- Can be used on slopes too steep for silt fences
- 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, but fibre rolls also 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
- 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: The following method is provided for guidance only. A site-specific design by a qualified designer is required.)

- Prepare slope face and remove large rocks or other deleterious materials
- Excavate small trenches approximately one-half roll diameter deep and 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 slopes having trenches spaced closer together
- Place fibre rolls into trench, ensuring continuous contact with 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 1.2 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

Construction Considerations

- Use live stakes instead 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
- On steep slopes, anchors may be required on the downslope side of the fibre roll

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 erosion control measures should be considered for rilling areas damaged by runoff

Similar Measures

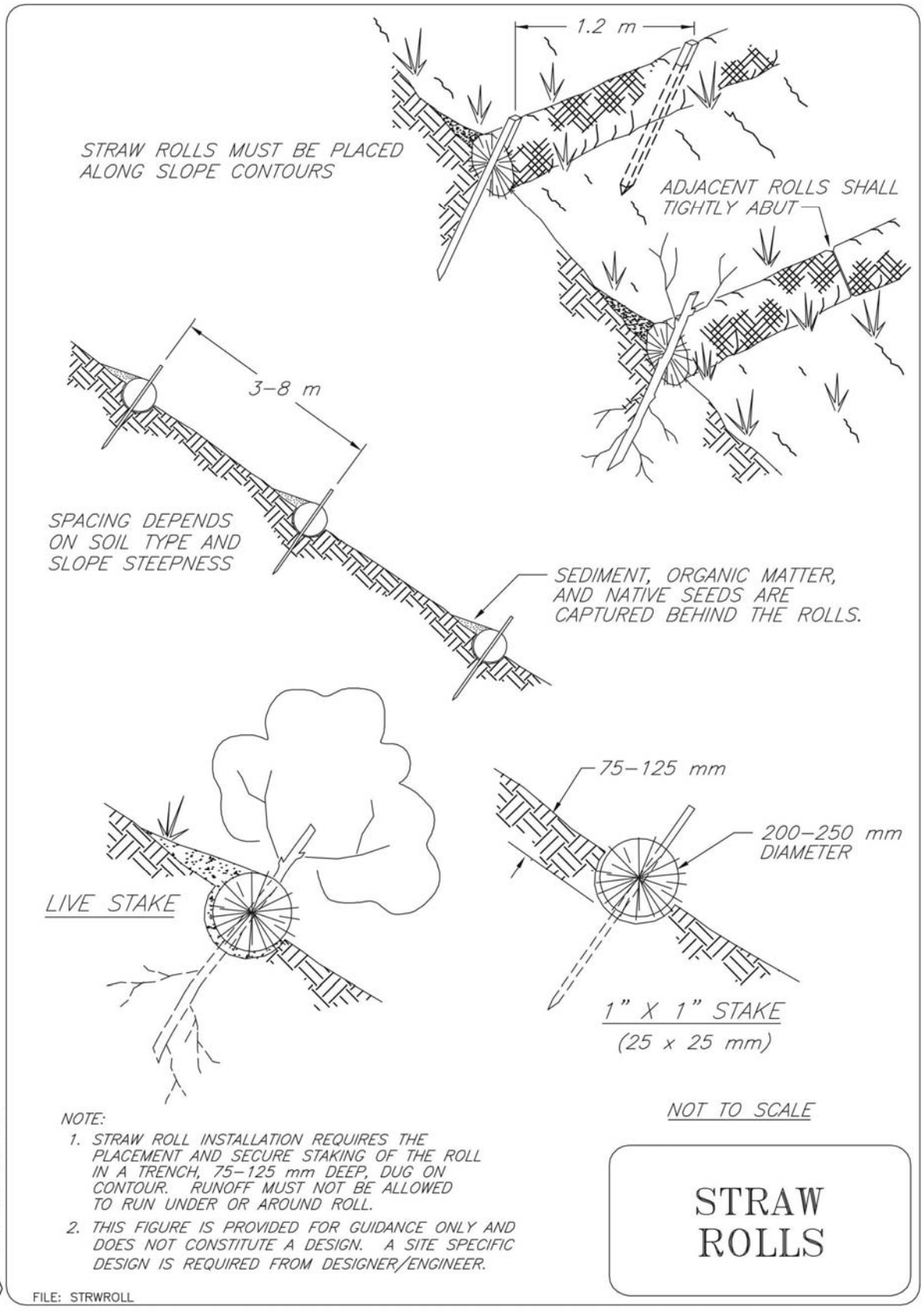
- Synthetic permeable barriers

Fibre Rolls and Wattles

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP11

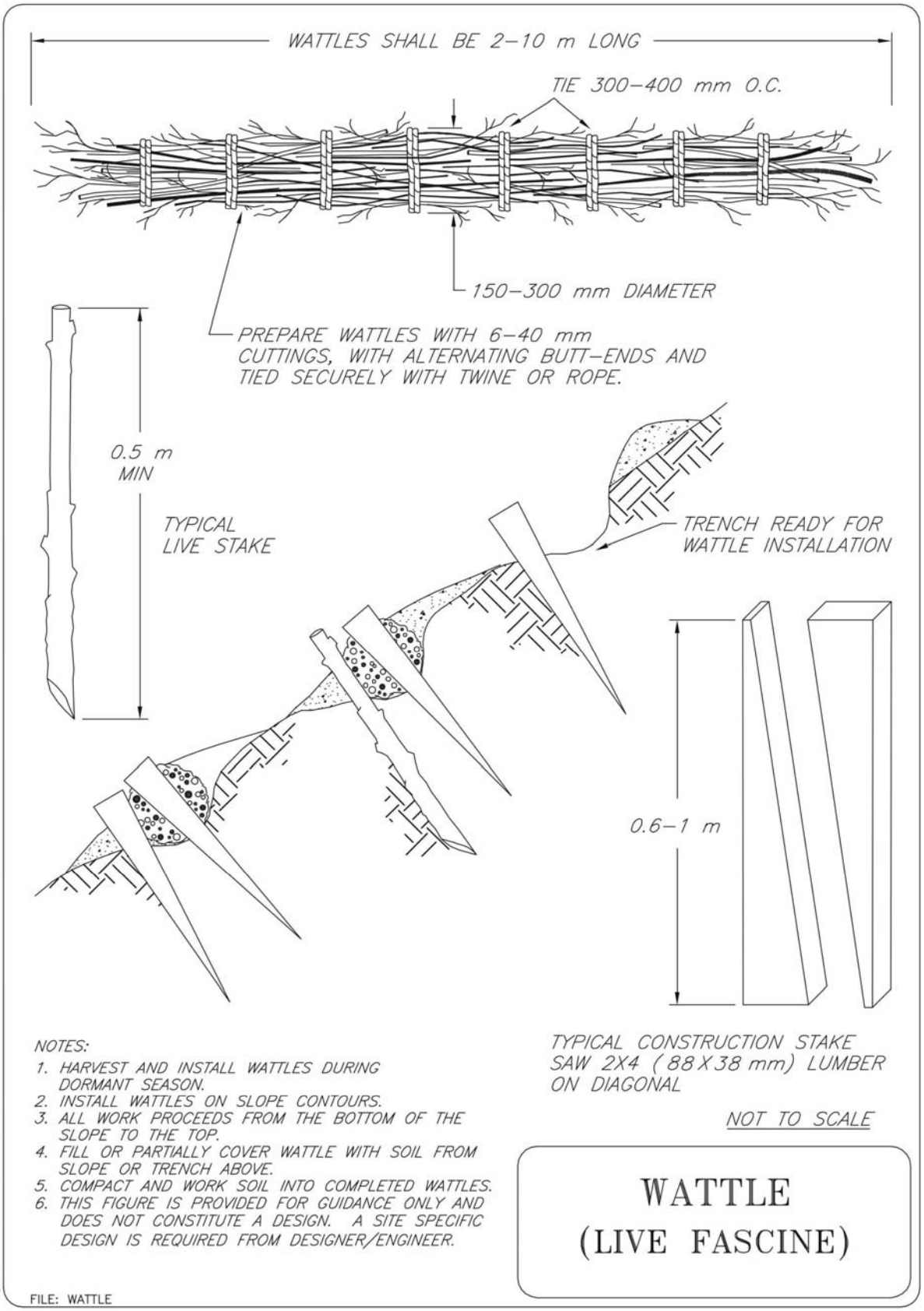


Fibre Rolls and Wattles

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP11



Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12

Description and Purpose

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

Applications

- Temporary or permanent measure
- Reduces long steep grade to intervals of gentle grades between structures
- Reduces flow velocities to decrease erosion potential caused by runoff
- Sediment laden runoff is retained behind structure allowing sediment to settle out
- May be used in channels that drain 4 ha or less (2ha or less for straw bales)
- May be used in steep channels where runoff velocity is less than 1.5 m/s (limited to 0.3 m/s for straw bales)

Advantages

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

Limitations

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

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12

Construction (Rock Check Dam)

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

- Excavate a trench key a minimum of 0.15 m in depth at the rock check structure location
- Place non-woven geotextile fabric over footprint area of rock check structure
- Construct structure by machine or hand
- Structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of structures should be less than 0.8 m in height to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 3H:1V (minimum)
- Upstream slope of the check dam should be 2H:1V (minimum)

Construction Considerations (Rock Check Dam)

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

Construction (Sandbag Check Dam)

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

- Place sandbags by hand at check structure location with geometry similar to that shown for the rock check dam
- Check structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of check structures should be less than 0.8 m to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 2.5H:1V (minimum)
- Upstream slope of the check dam should be 1.5H:1V (minimum)

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12

Construction Considerations (Sandbag Check Dam)

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

Construction (Straw Bale Check Dam)

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

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

Construction Considerations (Straw Bale Check Dam)

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

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12

Construction (Log Check Dam)

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

- Embed ends of logs at least 0.5 m into channel or ditch bed
- Ensure there are minimal gaps between logs
- Install horizontal cross brace at top of the downstream side of structure to connect logs together providing integral support
- Structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- To avoid impounding large volumes of runoff, check structures should be less than 0.5 m in height above the base of the ditch.

Construction Considerations (Log Check Dam)

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

Inspection and Maintenance

- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged materials immediately or consider a more robust structure

Similar Measures

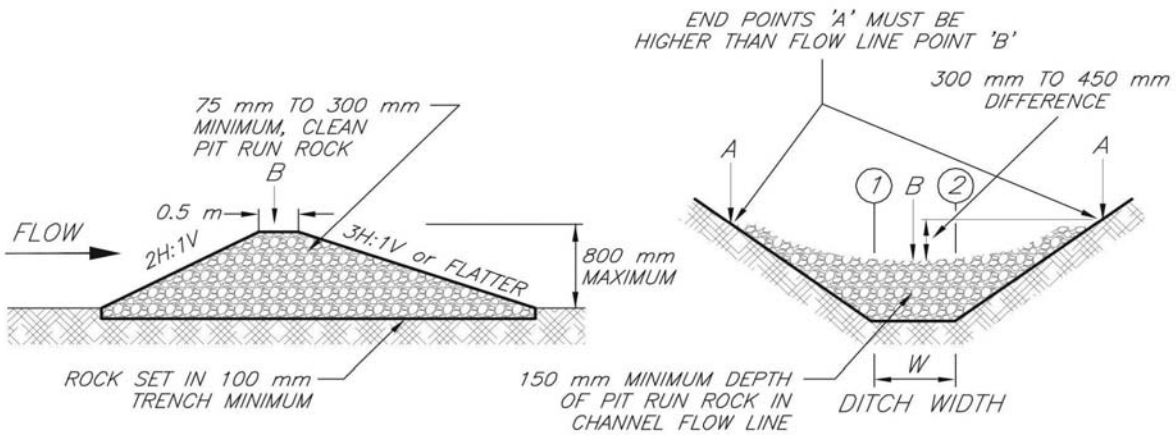
- Synthetic permeable barrier

Check Dams

Erosion Control: ***Runoff Control***

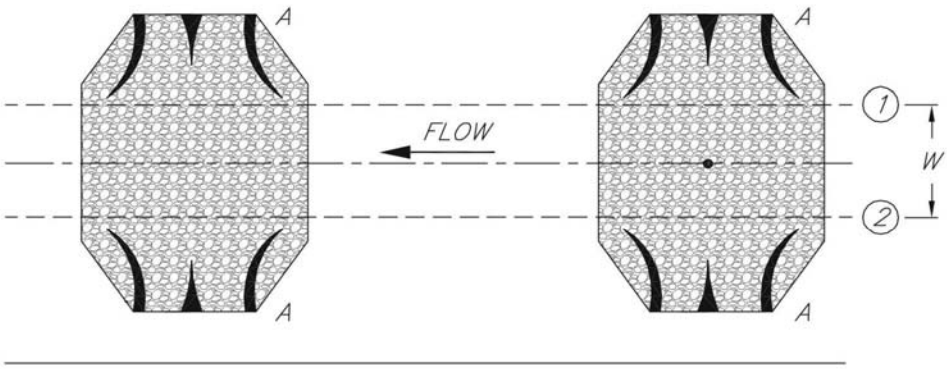
Sediment Control: ***Settling***

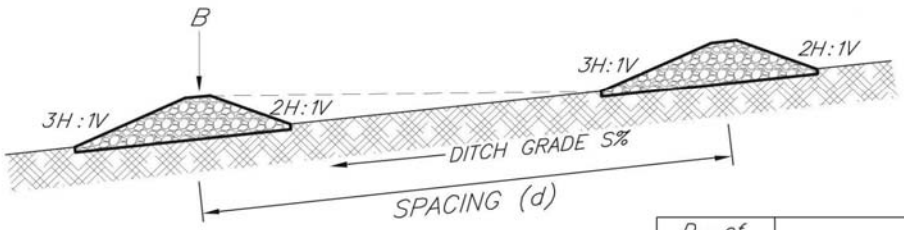
BMP12



SIDE VIEW

FRONT VIEW





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

SUGGESTED ROCK DIAMETER AND OVERFLOW DEPTHS

NOTES:

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

NOT TO SCALE

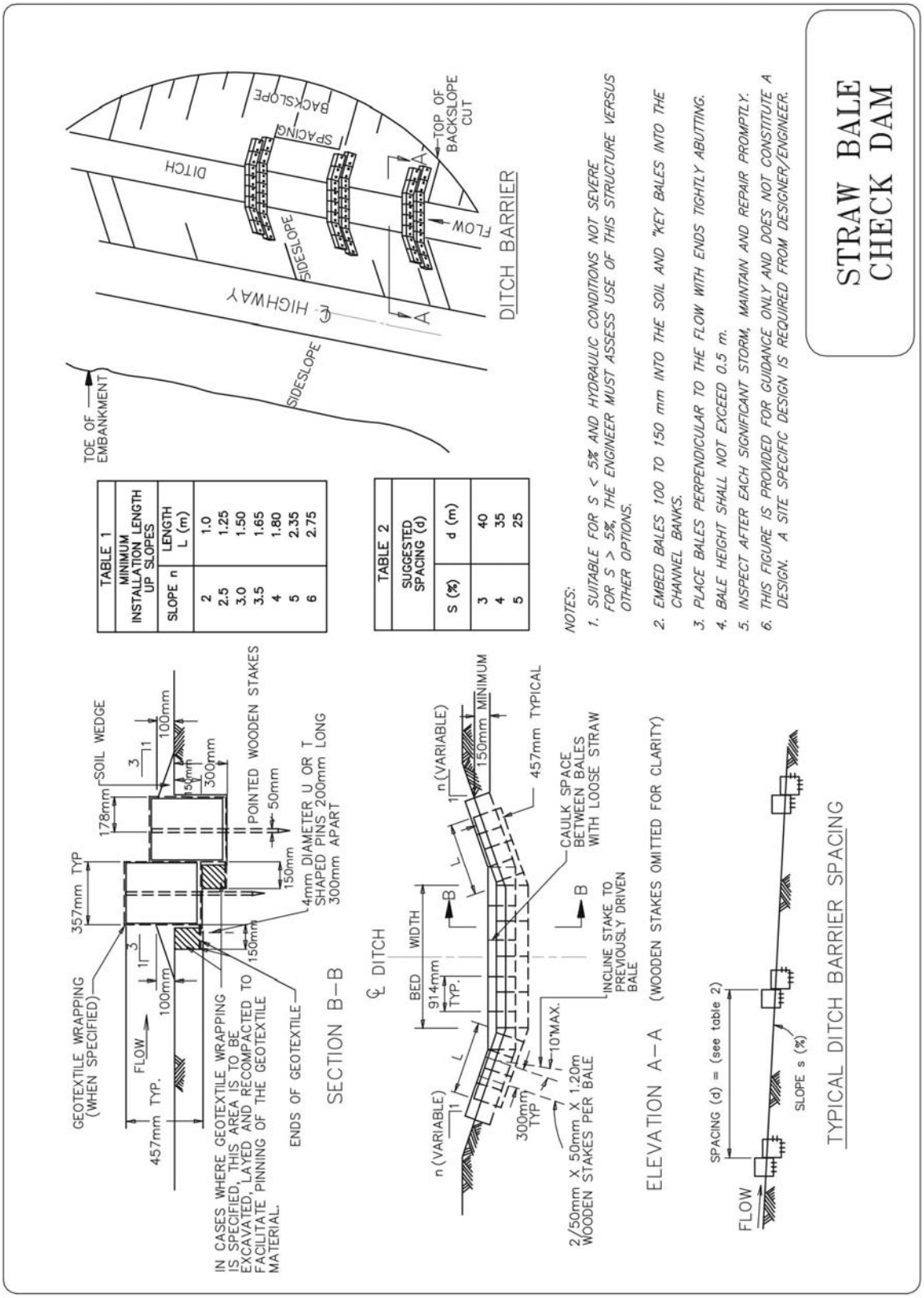
ROCK CHECK DAM

Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12

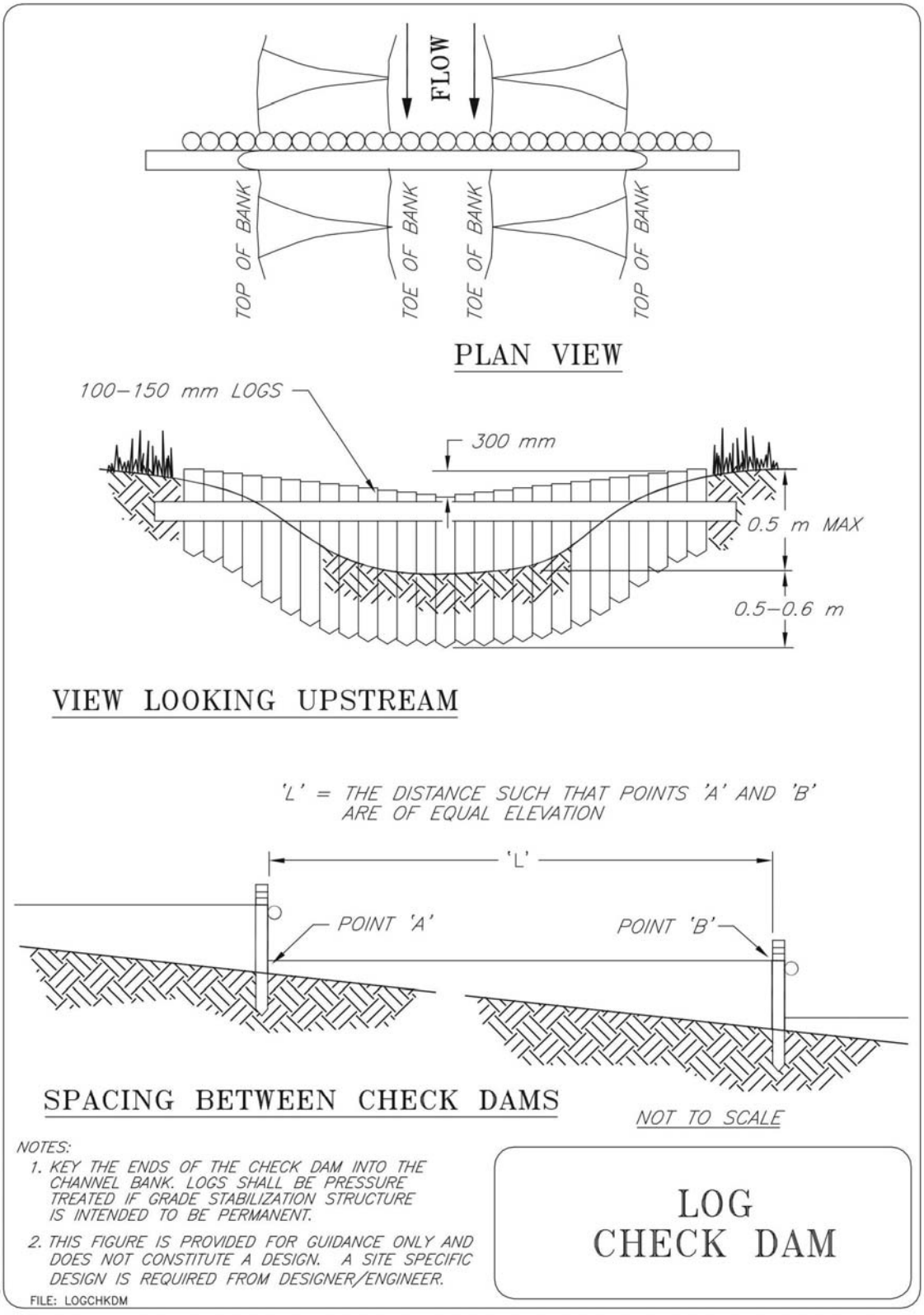


Check Dams

Erosion Control: ***Runoff Control***

Sediment Control: ***Settling***

BMP12



Diversion Ditch

Erosion Control:
Runoff Control

BMP13

Description and Purpose

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

Applications

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

Limitations

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

Construction

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

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

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

Construction Considerations

- Channel should be graded towards nearest outfall or drainage pipe

Inspection and Maintenance

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

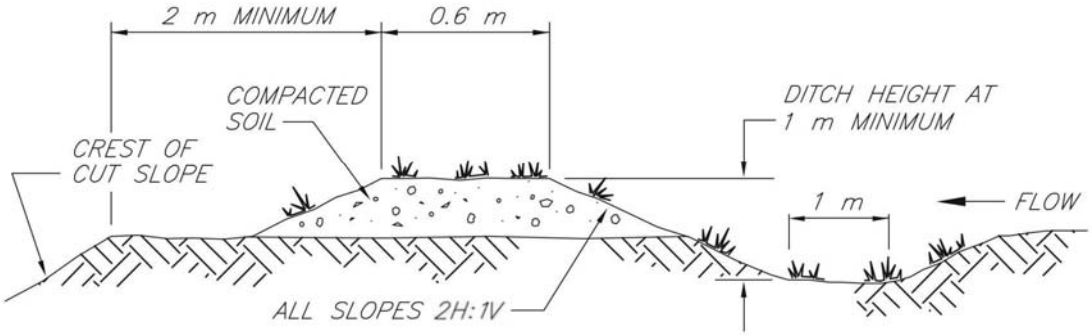
Similar Measures

- Berms
- Barriers

Diversion Ditch

Erosion Control:
Runoff Control

BMP13



TYPICAL DIVERSION DITCH

NOTES:

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

DIVERSION DITCH

FILE: TEMPDIKE

Energy Dissipators

Erosion Control:
Runoff Control

BMP14

Description

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

Applications

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

Advantages

- Reduces flow energy in a relatively small area

Limitations

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

Construction

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

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

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

Construction Considerations

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

Inspection and Maintenance

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

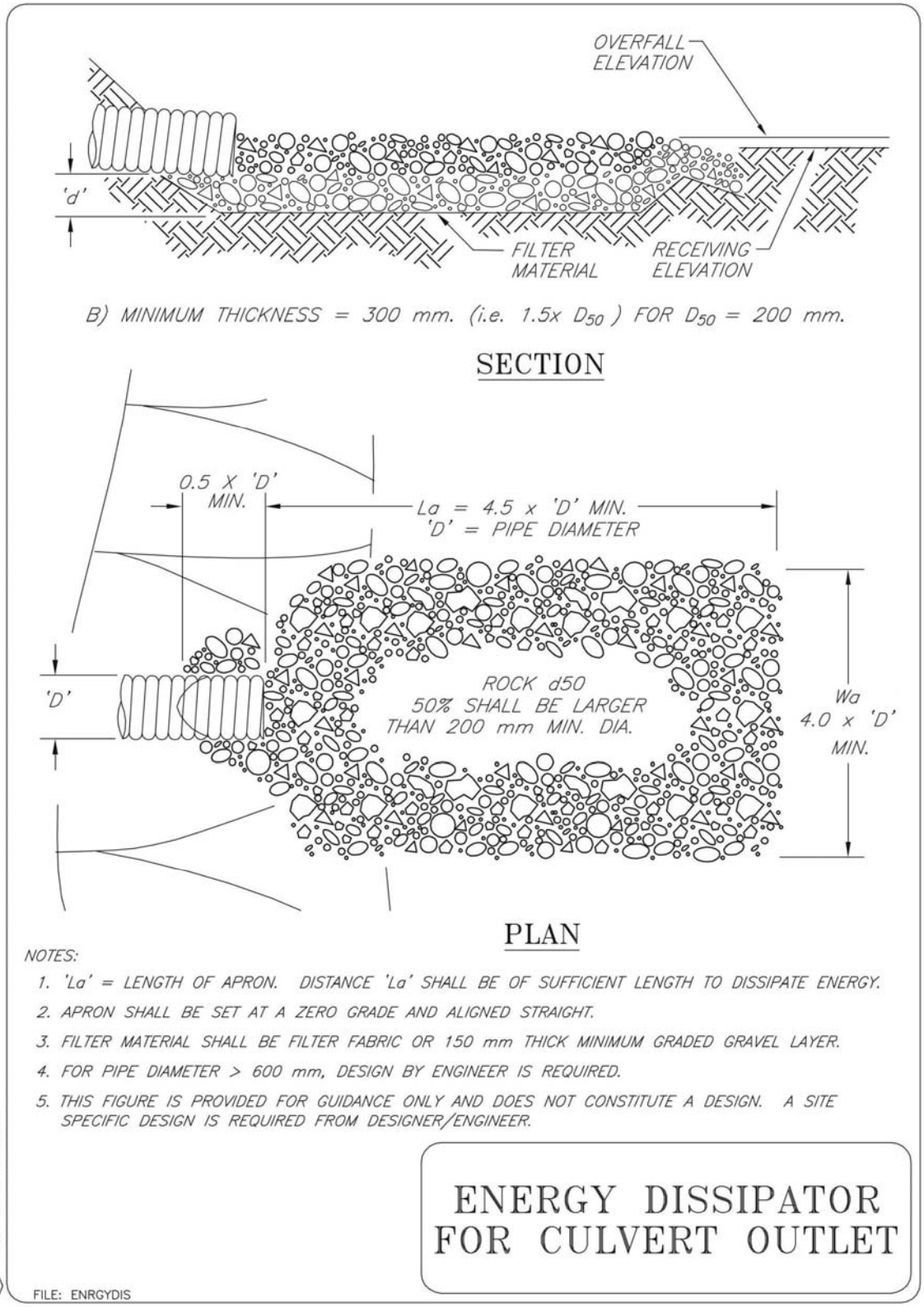
Similar Measures

- Gabion mattresses

Energy Dissipators

Erosion Control:
Runoff Control

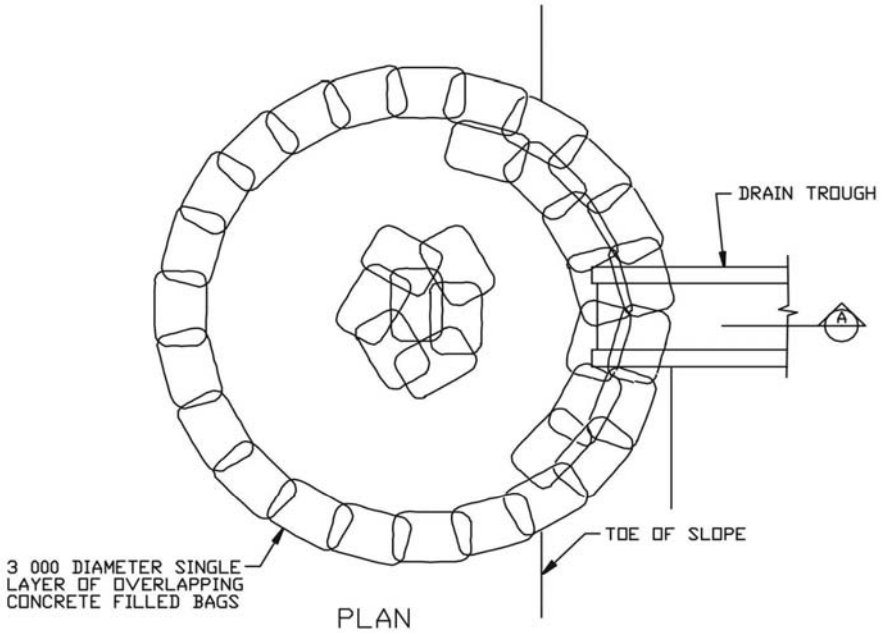
BMP14



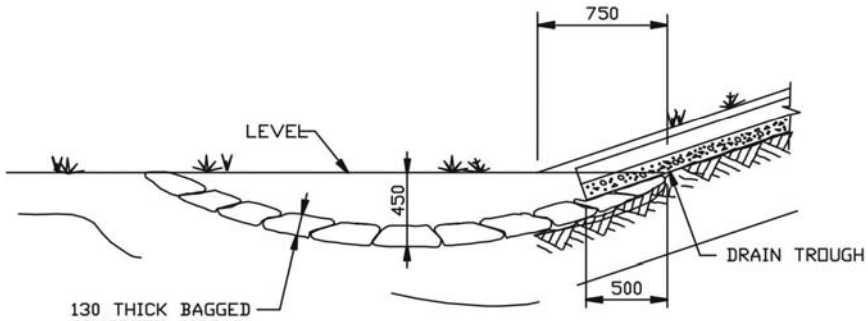
Energy Dissipators

Erosion Control:
Runoff Control

BMP14



PLAN



A SECTION

GENERAL NOTES

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

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

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

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

Silt Fence

Sediment Control: Settling

BMP15

Description and Purpose

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

Applications

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

Advantages

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

Limitations

- **Successful performance is highly dependent on proper installation**; silt fence is commonly installed incorrectly and failures can cause erosion
- Applicable for sheet flow, normally cannot handle concentrated channel flow volumes
- May fail under high runoff events or due to damage caused during sediment removal
- Limited to locations suitable for temporary ponding of sediment laden runoff
- Low permeability silt fences may not be strong enough to support weight of water retained behind it and may require reinforcement (i.e. wire mesh and stronger support posts)
- Sediment build up needs to be removed at 1/2 height and on a regular basis
- Has a useable life of approximately one year, depending on maintenance and sediment requirement

Silt Fence

Sediment Control: Settling

BMP15

Construction

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

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

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

Construction Considerations

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

  - Maximum flow path length above silt fence should be no greater than 30 m
  - Maximum slope gradient above the silt fence should be no greater than 2H:1V
- Fence should be placed on the contour to produce proper ponding
- Fence should be placed far enough away from the toe of slope to provide an adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of the fence should be angled upslope to collect runoff
- Fence should not extend more than 0.6 m above grade
- Posts can be wood or metal, depending on design and ground conditions
- Posts should be placed on the downstream side of the fence
- Posts should be driven at least 0.6 m into the ground
- Posts should not be spaced greater than 2 m apart
- Wire mesh or snow fencing may be placed between the posts and the filter fabric to provide additional strength and support reinforcement
- Filter fabric should be cut from a continuous roll to avoid joints. If joints are necessary, filter fabric should be wrapped around the fence post with a minimum overlap of 0.2 m, and staples should be used to attach the fabric to the post
- Fence (and wire mesh or snow fence, if used) should be attached to the posts with heavy duty staples, tie wires, or hog rings
- Fence (and wire mesh or snow fence, if used) should be dug into a trench at least 0.30 m deep to prevent undercutting of fence by runoff
- Trench backfill should be compacted
- Long runs of silt fence are more prone to failure than short runs
  - The maximum length of each section of silt fence should be 40 m
  - Silt fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours allowing an escape path for ponded water (minimizes overtopping of silt fence structure)

Inspection and Maintenance

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

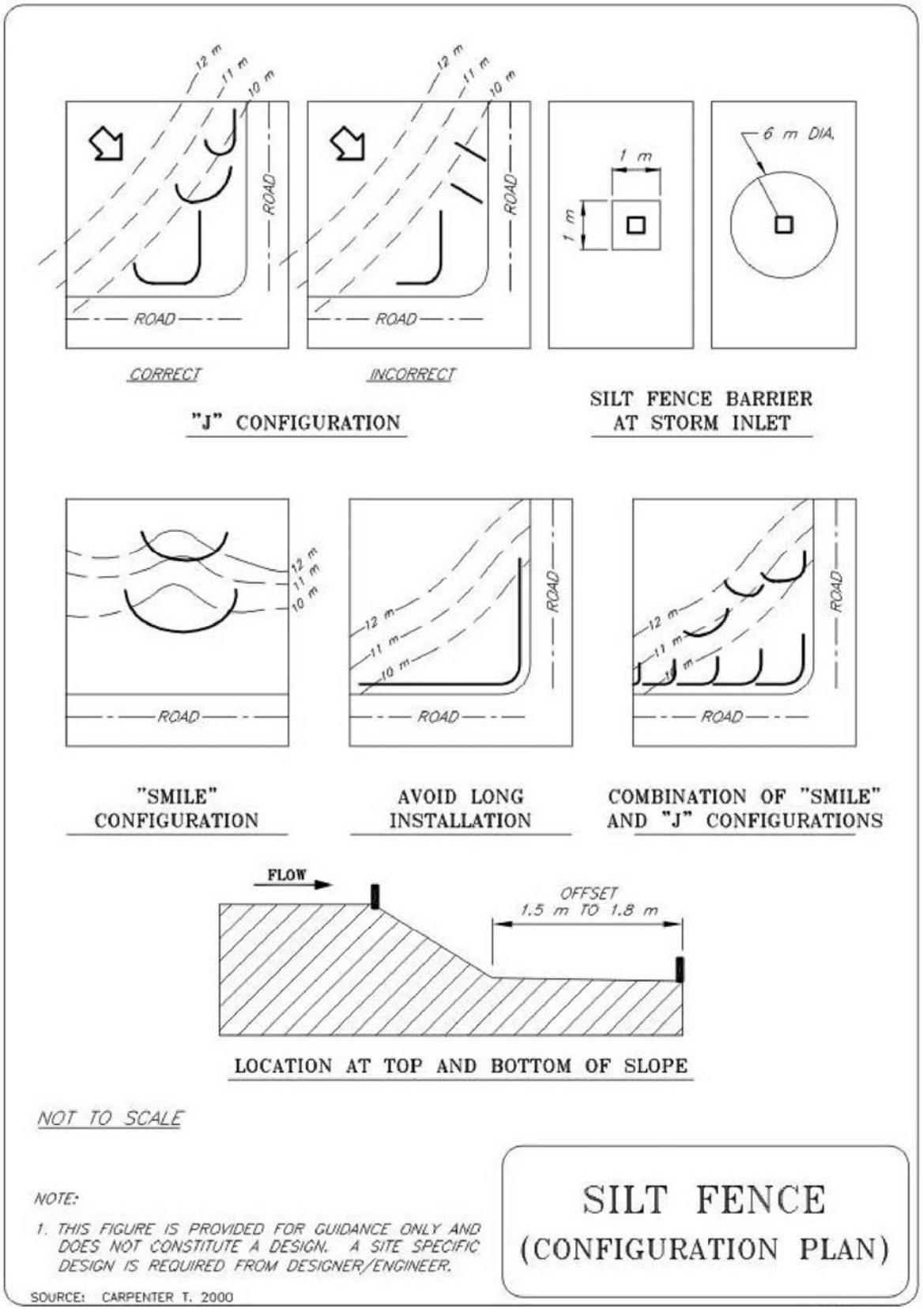
Similar Measures

- Check Dams
- Permeable synthetic barriers

Silt Fence

Sediment Control:
Settling

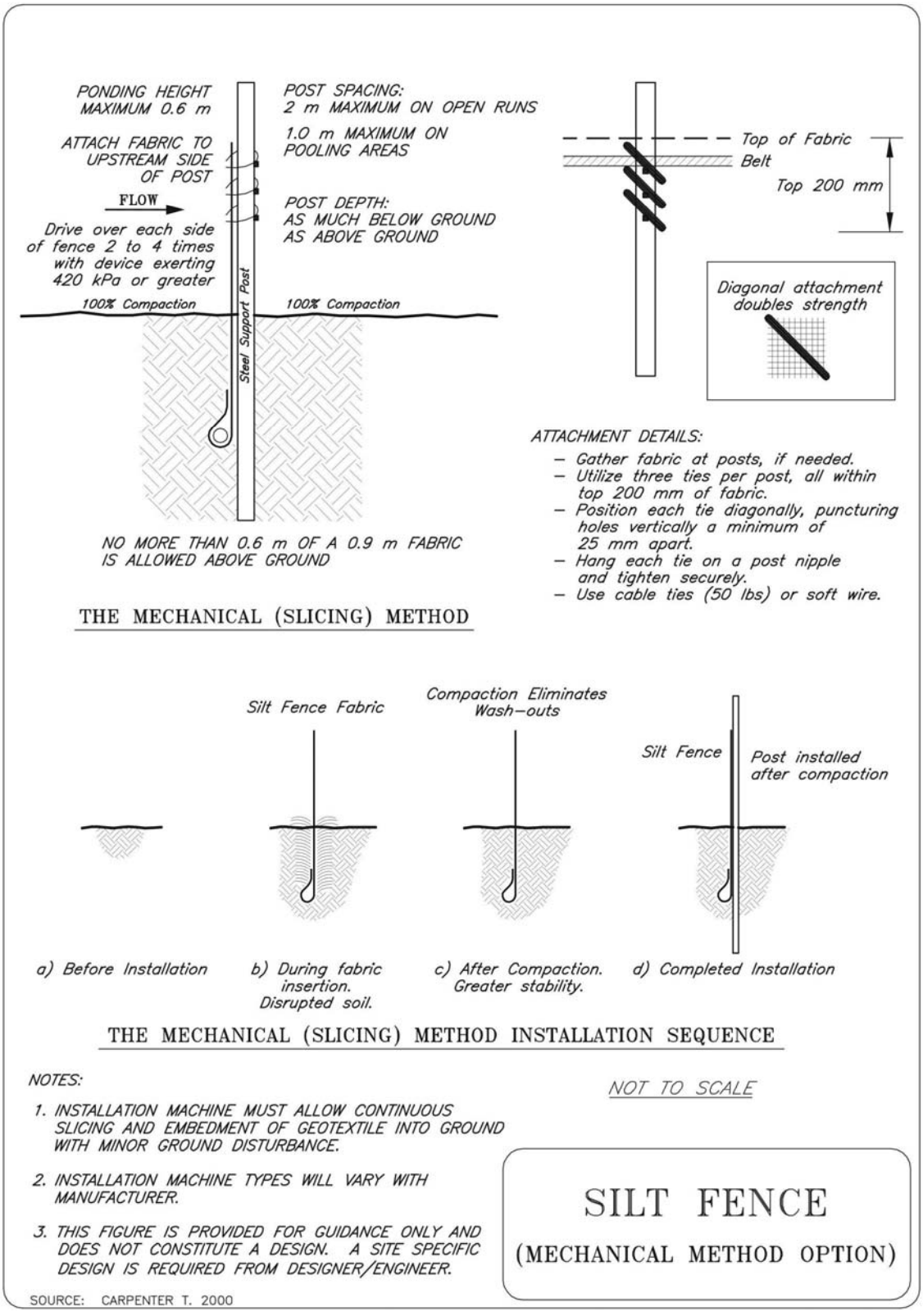
BMP15



Silt Fence

Sediment Control: Settling

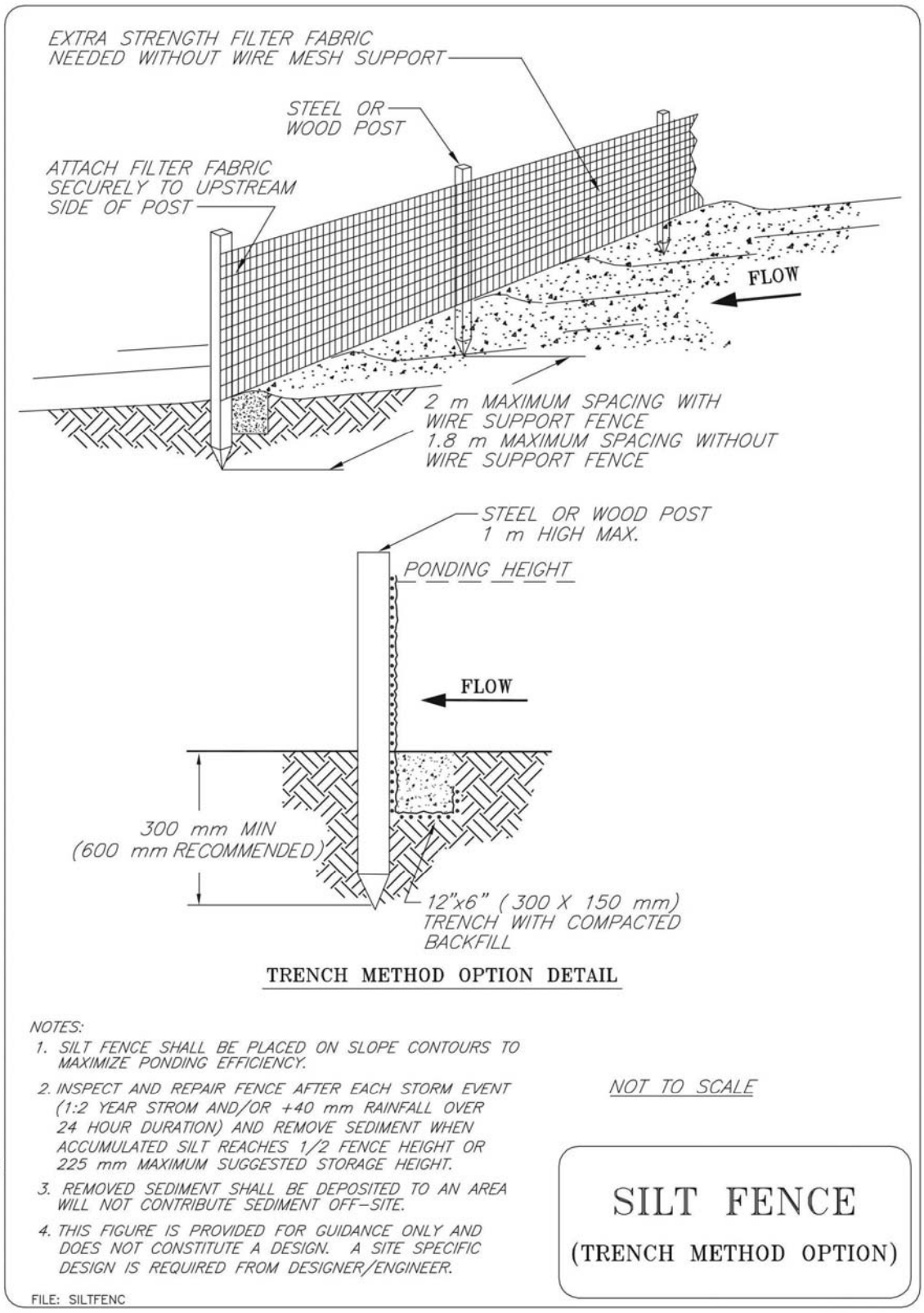
BMP15



Silt Fence

Sediment Control:
Settling

BMP15



Brush or Rock Berm

Sediment Control:
Settling

BMP16

Description and Purpose

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

Applications

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

Advantages

- May be equally effective as silt fences

Limitations

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

Construction

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

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

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

Construction Considerations

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

Inspection and Maintenance

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

Similar Measures

- Berms/barriers
- Check dams
- Permeable synthetic barriers

Brush or Rock Berm

Sediment Control:
Settling

BMP16

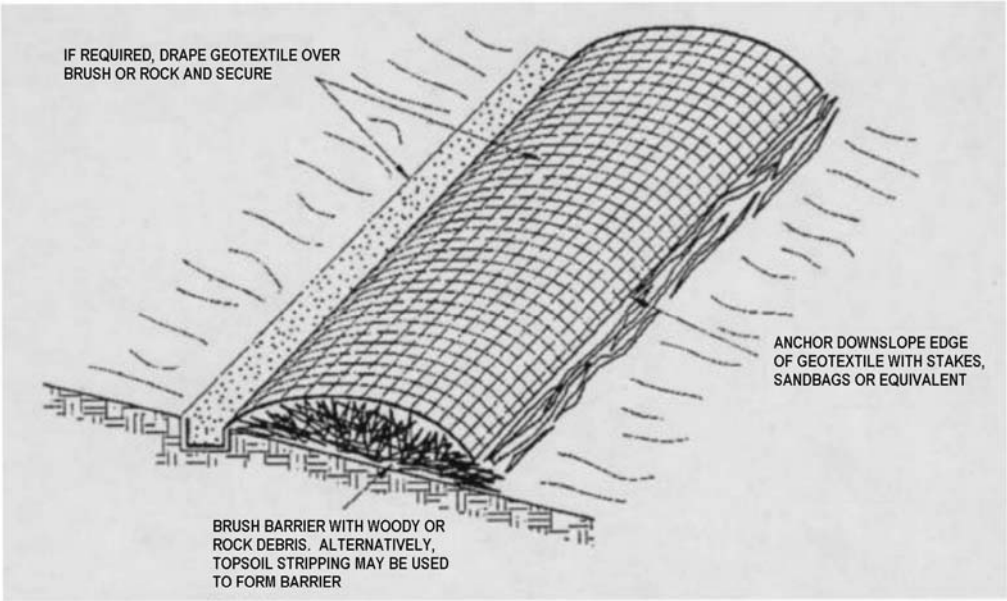
Design Considerations

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

Brush or Rock Berm

Sediment Control:
Settling

BMP16



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

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17

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:

  - Block and Gravel Sediment Barrier – Option 1
  - Block and Gravel Curb Inlet Sediment Barrier – Option 2
  - Sand Bag Curb Inlet Sediment Barrier – Option 1
  - Sand Bag Curb and Gutter Sediment Barrier – Option 2
  - Silt Fence Sediment Barrier

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 or less
- Used in open areas subjected to sheet flow and concentrated flows less than 0.014 m^3/s
- Block and gravel bag barriers are applicable when sheet flows or concentrated flows exceed 0.014 m^3/s 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 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 may be required for high flow situations

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17

Construction

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

- 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 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 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 three-quarters full to allow sand bag to be 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 the inlet
- For drainage areas larger than 0.4 ha 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

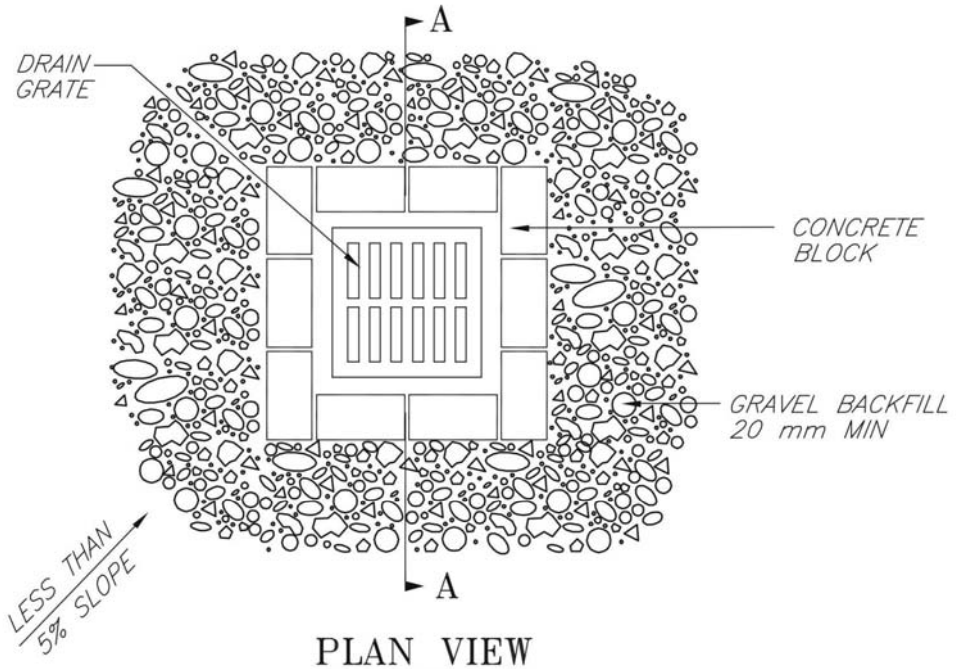
Inspection and Maintenance

- 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

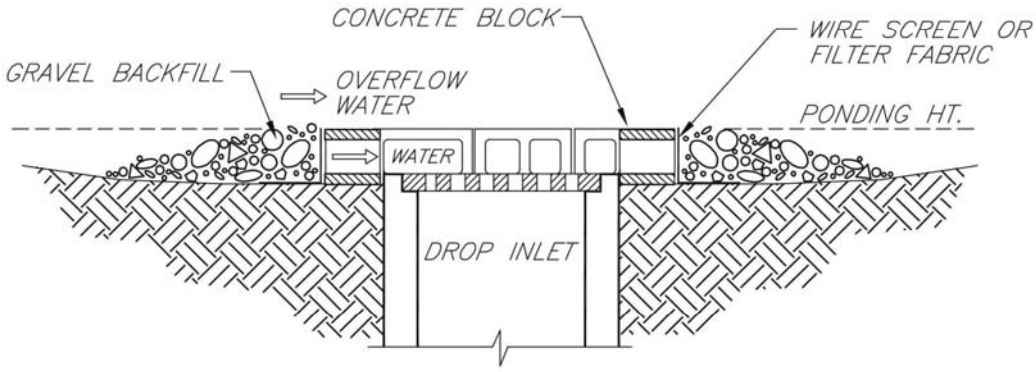
Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17



PLAN VIEW



SECTION A – A

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.

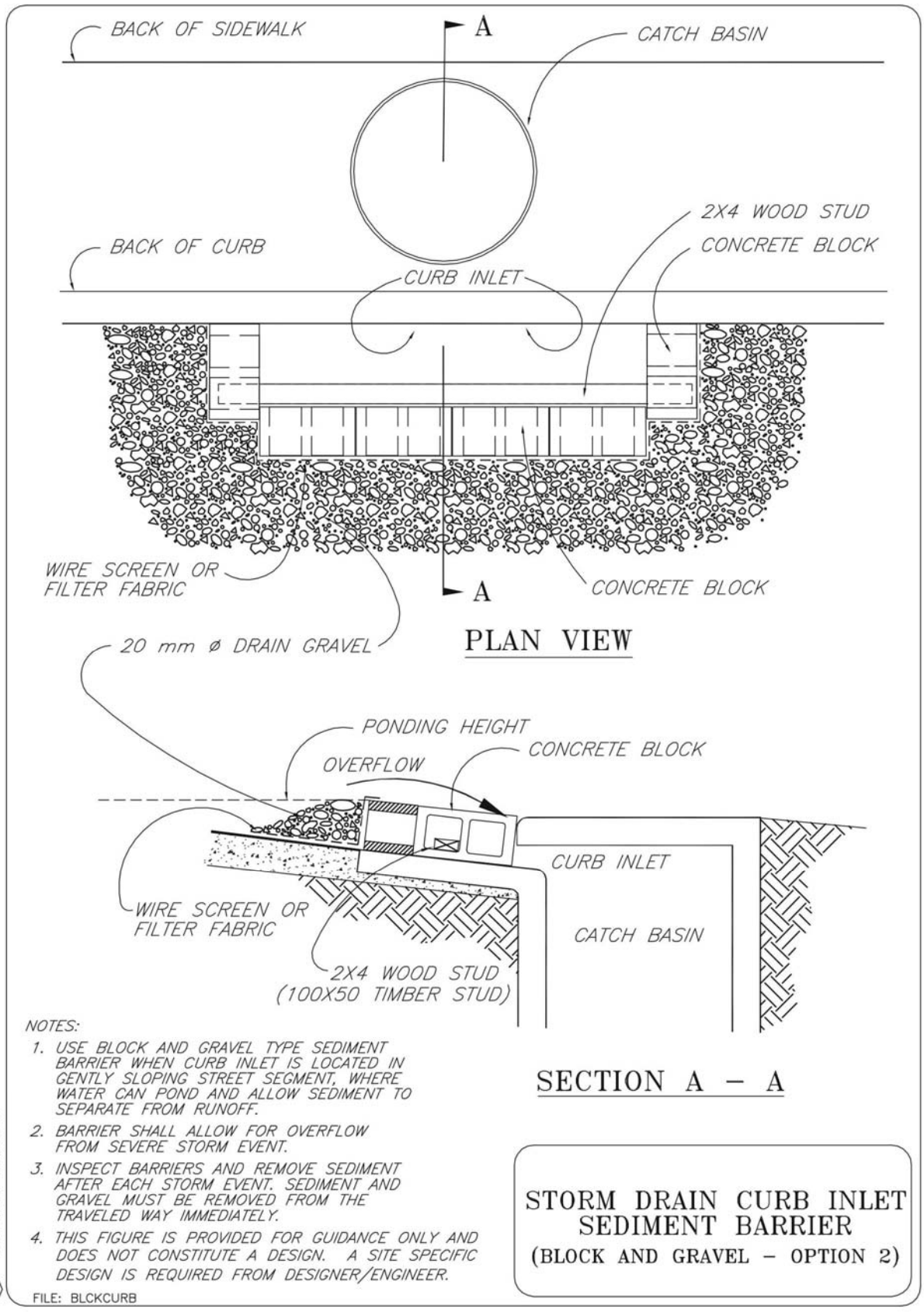
STORM DRAIN DROP INLET SEDIMENT BARRIER
(BLOCK AND GRAVEL – OPTION 1)

FILE: BGSEDBAR

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17



NOTES:

1. USE BLOCK AND GRAVEL TYPE SEDIMENT BARRIER WHEN CURB INLET IS LOCATED IN GENTLY SLOPING STREET SEGMENT, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. BARRIER SHALL ALLOW FOR OVERFLOW FROM SEVERE STORM EVENT.
3. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

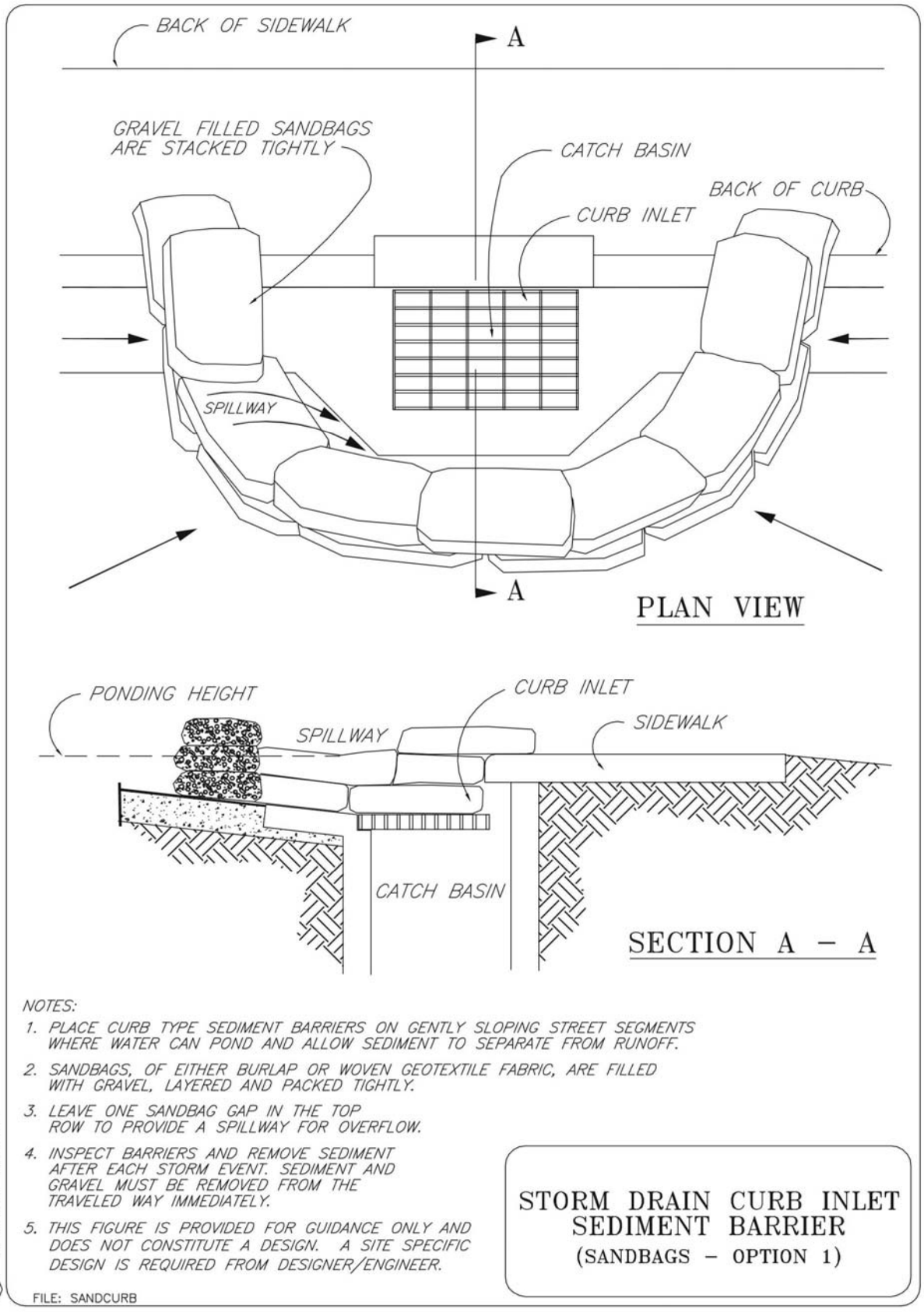
FILE: BLCKCURB

STORM DRAIN CURB INLET
SEDIMENT BARRIER
(BLOCK AND GRAVEL – OPTION 2)

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17



NOTES:

1. PLACE CURB TYPE SEDIMENT BARRIERS ON GENTLY SLOPING STREET SEGMENTS WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. SANDBAGS, OF EITHER BURLAP OR WOVEN GEOTEXTILE FABRIC, ARE FILLED WITH GRAVEL, LAYERED AND PACKED TIGHTLY.
3. LEAVE ONE SANDBAG GAP IN THE TOP ROW TO PROVIDE A SPILLWAY FOR OVERFLOW.
4. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

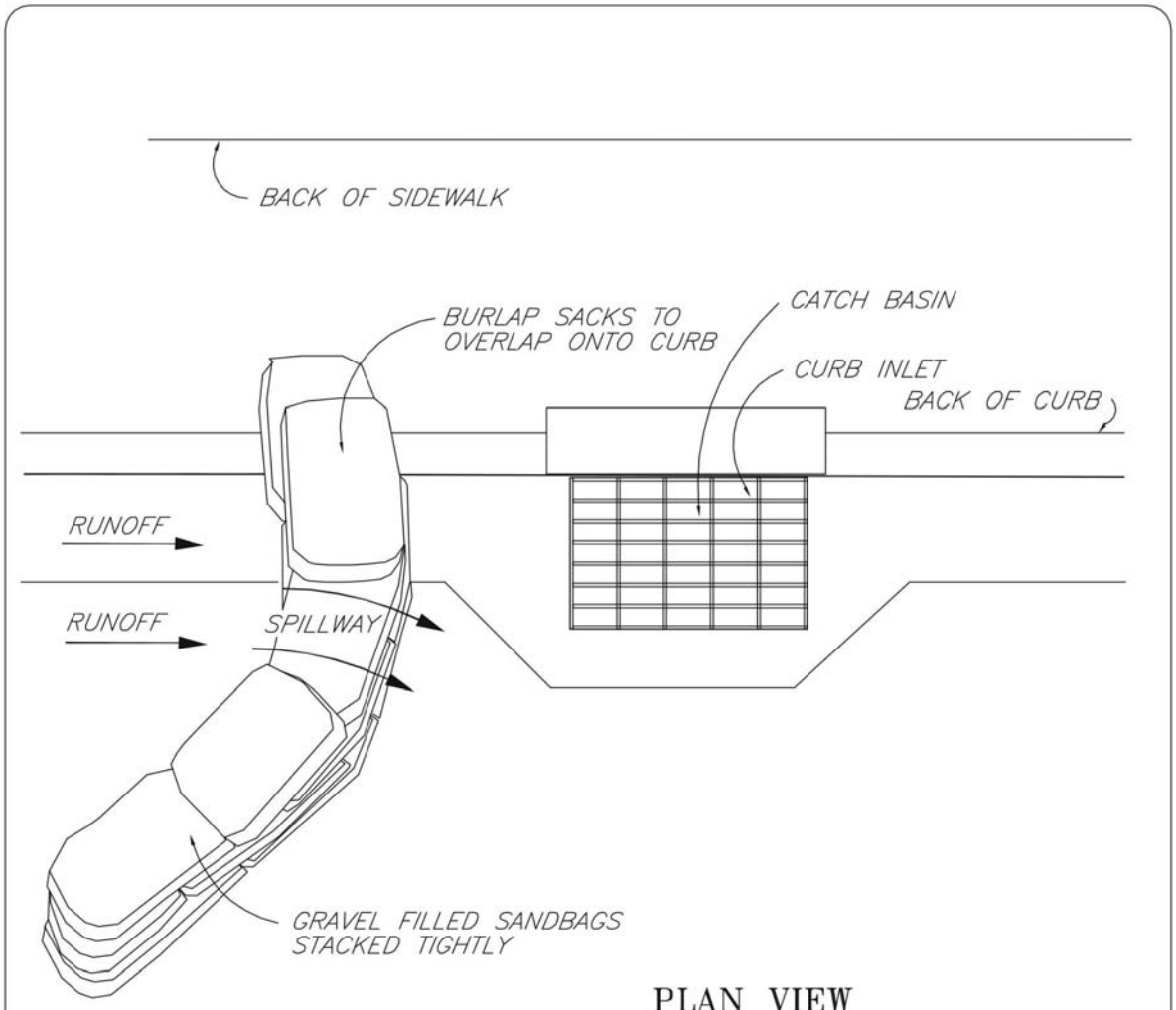
STORM DRAIN CURB INLET SEDIMENT BARRIER
(SANDBAGS – OPTION 1)

FILE: SANDCURB

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17



PLAN VIEW

NOTES:

1. PLACE CURB TYPE SEDIMENT BARRIERS ON GENTLY SLOPING STREET SEGMENTS, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. SANDBAGS OF EITHER BURLAP OR WOVEN 'GEOTEXTILE' FABRIC, ARE FILLED WITH GRAVEL, LAYERED AND PACKED TIGHTLY.
3. LEAVE A ONE SANDBAG GAP IN THE TOP ROW TO PROVIDE A SPILLWAY FOR OVERFLOW.
4. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
5. DESIGN CENTRE SPILLWAY LOWER THAN OUTSIDE EDGE TO MINIMIZE FLOW OUTFLANGING.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

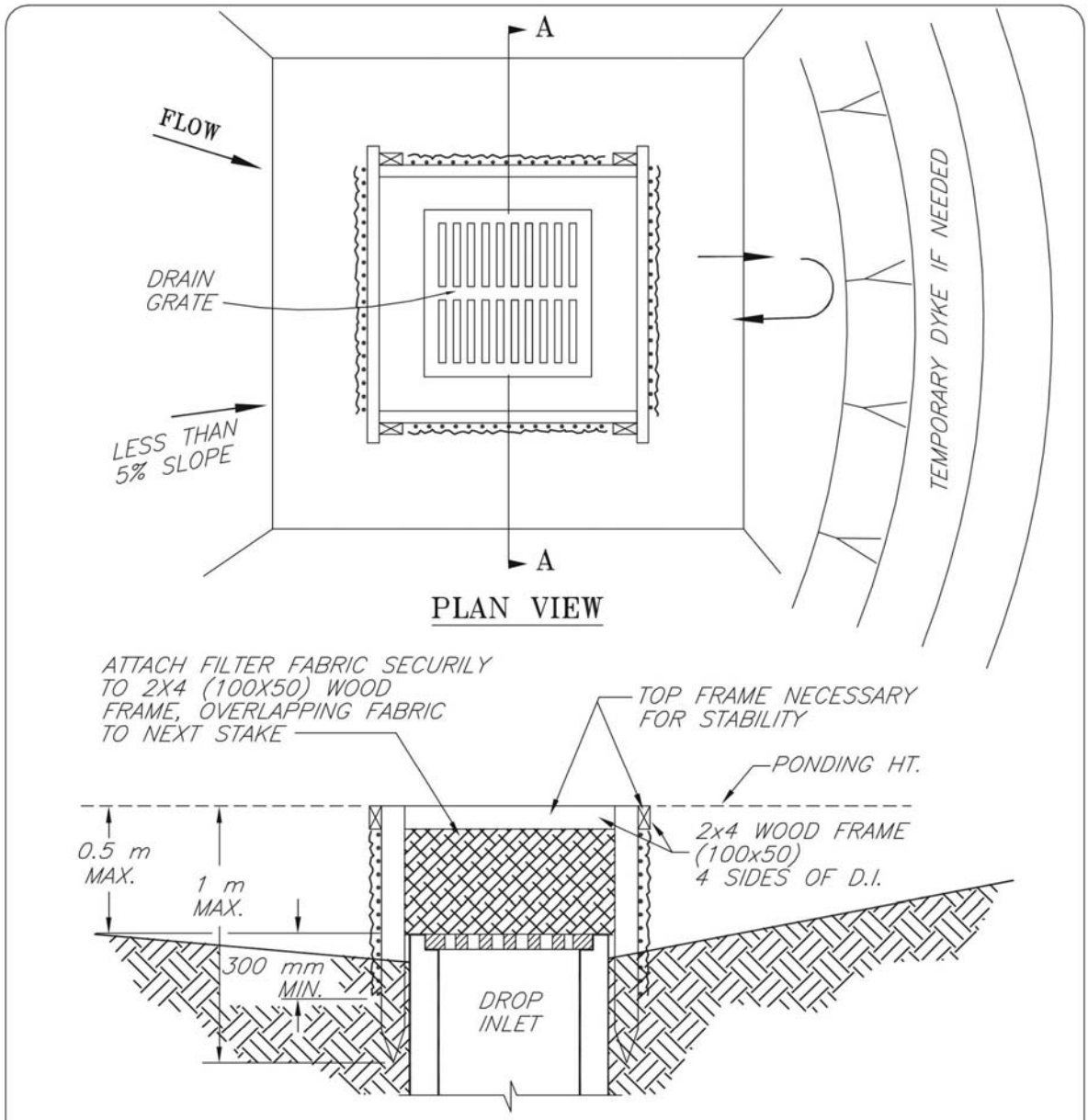
STORM DRAIN INLET
CURB AND GUTTER
SEDIMENT BARRIER
(SANDBAGS – OPTION 2)

FILE: CURBGTTR

Drain Inlet Sediment Barrier

Sediment Control:
Settling

BMP17



PLAN VIEW

SECTION A–A

NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. USE 2"X4" (100X50mm) WOOD OR EQUIVALENT METAL STAKES, 1 m MINIMUM LENGTH.
3. INSTALL 2"X4" (100X50mm) WOOD TOP FRAME TO INSURE STABILITY.
4. THE TOP OF THE FRAME (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BY–PASSING THE INLET. A TEMPORARY DYKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

FILE: SILTFDIB

NOT TO SCALE

STORM DRAIN DROP INLET SEDIMENT BARRIER
(SILT FENCE – OPTION)

Sediment Traps and Basins

Sediment Control:
Settling

BMP18

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 m²
  - Trap (Type II) for pond area $\leq$500 m²

Applications

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

Advantages

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

Limitations

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

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

Construction

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

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

Sediment Traps and Basins

Sediment Control:
Settling

BMP18

Construction Considerations

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

Inspection and Maintenance

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

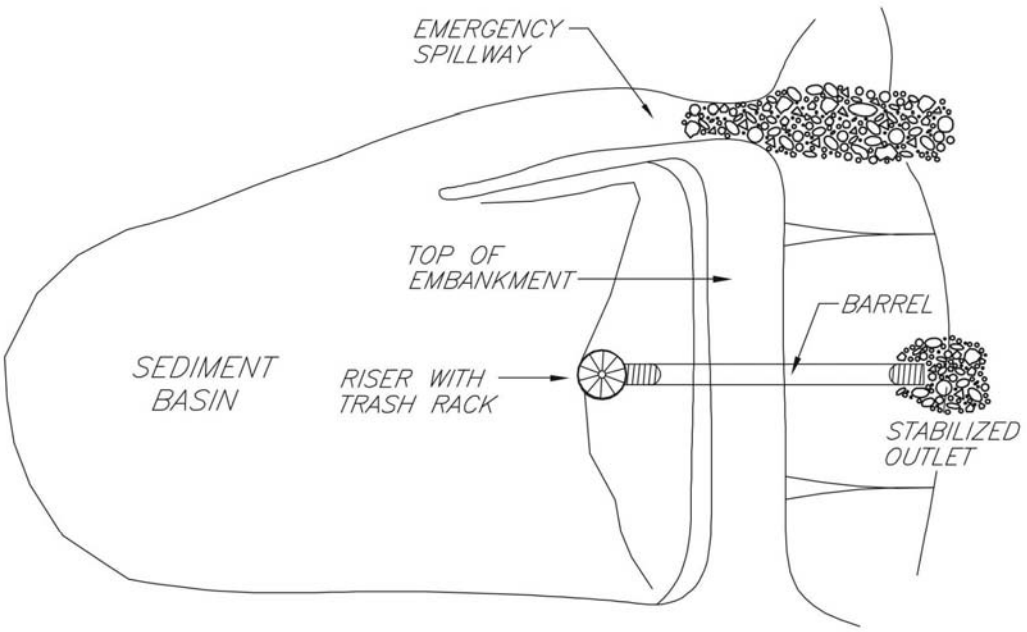
Design Considerations

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

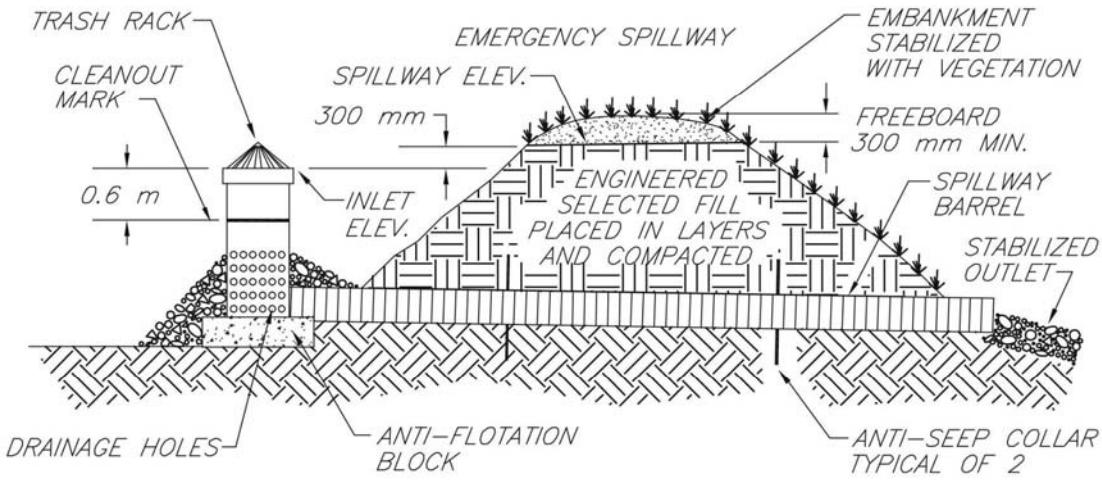
Sediment Traps and Basins

Sediment Control:
Settling

BMP18



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_e) OF BASIN), REFER TO NEXT PAGE.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

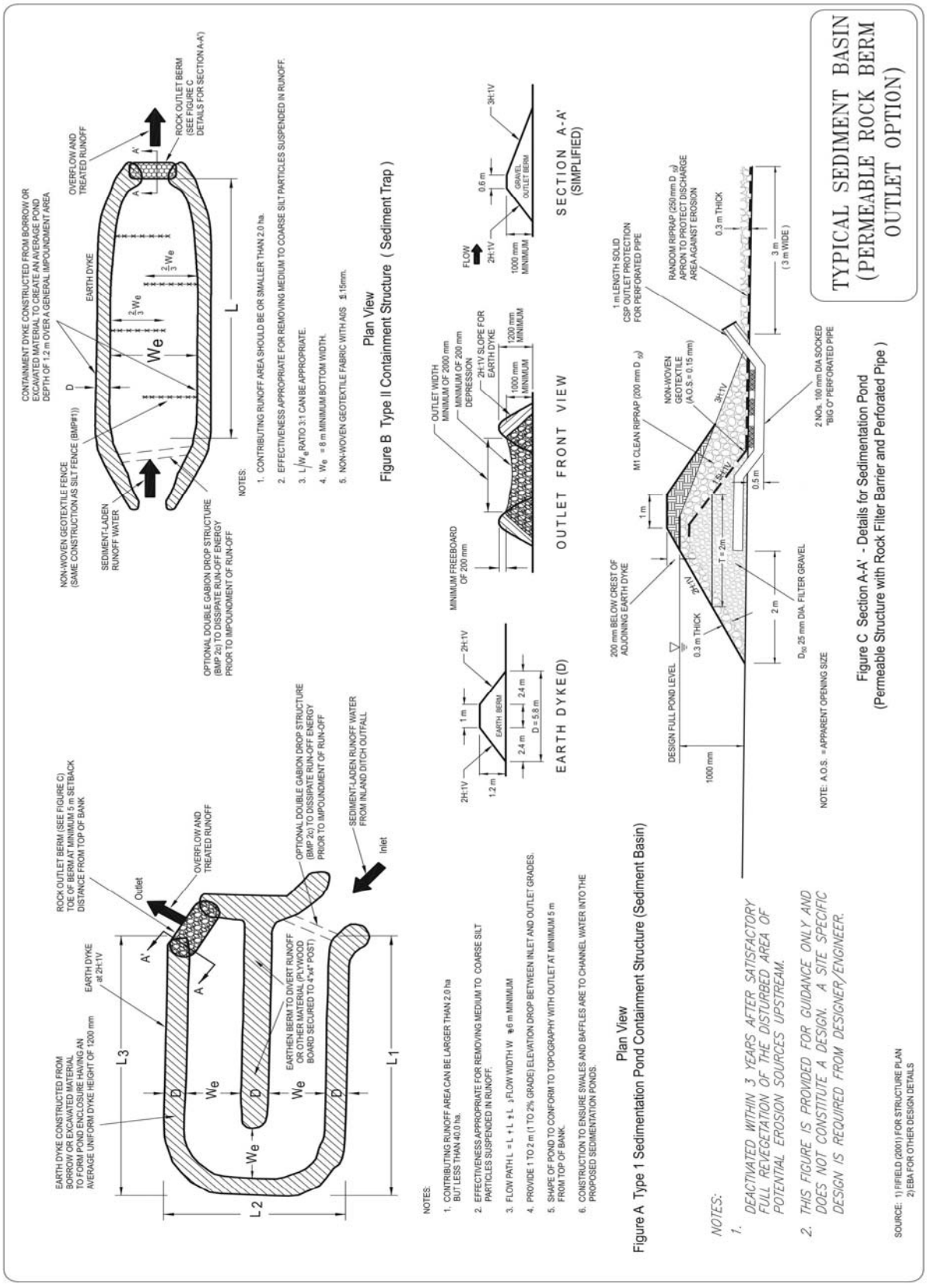
FILE: SEDBASIN

TYPICAL SEDIMENT BASIN (RISER OUTLET OPTION)

Sediment Traps and Basins

Sediment Control:
Settling

BMP18



Pumped Silt Control Systems

Sediment Control:
Filtration

BMP19

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

Pumped Silt Control Systems

Sediment Control:
Filtration

BMP19

Implementation

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

- 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

Implementation 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

Pumped Silt Control Systems

Sediment Control:
Filtration

BMP19