# Central Queensland Coal Project

## Appendix 15 - ESCP Typical Drawings

## Supplementary Environmental Impact Statement

All information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

**Refer to Erosion Sediment Control Plan**

## Work Area

The defined 'Work Area' is limited to areas as nominated design drawings, with the widths and alignments been defined through the information provided by the Client. All erosion and sediment controls are to be constructed, operated and maintained within the Work Area.

## Key Management Practices

### Soil Management (IECA Book 2, Appendix C)

Earthworks should be undertaken when the soil moisture content can maintain the soil properties. Earthwork on dry soil can cause excessive dust and soil structure decline. Saturated soils are more likely to slump and or disperse potentially causing excessive sediment loads and soil structure decline. Where topsoil is required to be stripped and stockpiled prior to construction, the topsoil should be managed appropriately to maintain its existing properties.

### Soil Testing (IECA Book 2, Appendix C9)

Physical and chemical soil testing provides additional information on the characteristics of the soils within the Work Area. Testing related to erosion characteristics include; Soil texture, Cation Exchange Capacity (CEC), Exchangeable Sodium Percentage (ESP), exchangeable cations, pH and Electrical Conductivity (EC), and Emerson Dispersion. As required, testing should be conducted to obtain additional information on the characteristics of the soils within the Work Area.

Limited specific soil information and testing requires conservative estimates for soil erodibility to be used. The use of conservative values to determine soil erodibility potentially increases the level of erosion and sediment control required.

Testing and analysis of topsoil to define and optimise the parameters for rehabilitation (i.e. nutrient status) should be undertaken prior to rehabilitation. CDM Smith note the specification and the scope of works related to rehabilitation is nominated by others.

### Principles of Erosion and Sediment Control (IECA Book 1, Section 2)

Avoiding erosion and minimising the potential for erosion is considered the most effective way of ensuring environmental objectives are achieved. Reducing or avoiding erosion can be achieved through the application of multiple techniques, often with one technique supplementing another. Example techniques include:

- Scheduling and Staging of clearing, earthworks and rehabilitation;
- Minimising disturbance; and
- Increase and or maintain ground cover in high erosion risk areas.

#### *Recommended Management Actions*

- Wherever possible schedule work in high erosion risk areas in low erosion risk periods of the year (refer to Table 5);
- Restrict the disturbance created by the construction works to the minimum practical area;
- Disturbance or exposure of subsurface or highly erodible layers should be avoided wherever possible; and
- Provide temporary ground cover during construction by applying mulch, rock mulch, gravel or soil binder to achieve at least 60% ground cover. This is of particular importance in Work Areas where sediment controls cannot be successfully incorporated into the works.

### Drainage Control (IECA Book 1, Section 2)

Up- slope 'clean' water must, wherever possible, be diverted around the disturbed or active Work Areas. Clean Water Flow Diversion Banks (generally constructed of topsoil stripped from the work area, and where required are provided with effective erosion protection) are to be constructed on the up-slope side of the Works Area as nominated on the ESC drawings. Dirty water drainage, as nominated on the ESC drawings is to be constructed to ensure that sediment-laden runoff from disturbed or active Work Areas is appropriately directed into the nominated sediment control or sediment trap.

## Design Assumptions

### Erosion Hazard Assessment (IECA Book 2 Appendix E)

Soil loss estimation was conducted using the Revised Universal Soil Loss Equation (RUSLE). The RUSLE equation is defined as; A = R.K.L.S.C.P

Where:

A = Annual soil loss due to erosion (tonnes/hectare/year)
R = 4786
- constant calculated rainfall erosivity factor site

K = Variable based on soil type
- assumed for soils

LS = 0.30 to 0.96
- variable calculated value based on length and slope

C = 1
- based on no ground cover

P = 1.3
- default for construction phase

### Seasonal Erosion Risk Rating and Rehabilitation Requirements (IECA Book 1, Section 4.4)

Recommended timeframes for land clearing, prior to construction works commencing are presented in Table 1. Table 5 has been reproduced from IECA Guidelines.
The specification for rehabilitation are nominated within the rehabilitation plan or engineering specifications. Monitoring and maintenance of ground cover should be considered as part of the rehabilitation program.

**Table 1**: Erosion Risk, Timing of Works and Rehabilitation

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Erosion Risk | H | H | M | M | VL | VL | VL | VL | VL | VL | M | H |
| Maximum Land clearing ahead of work (weeks) | 4 | 4 | 6 | 6 | 8 | 8 | 8 | 8 | 8 | 8 | 6 | 4 |

Key: H= High, M= Moderate, L= low, VL= Very Low

#### *Recommended Management Actions*

- Develop the clearing schedule based on recommendations as presented in Table 1.

### Drainage Design Standard (IECA Book 1, Section 4.3)

The anticipated timeframe of the construction works is estimated to be less than 12 months. A drainage design standard of a 1 in 2 year ARI is applicable to the design of temporary drainage works associated with the works.

### Sediment Control Standard (IECA Book 1, Section 4.5)

The sediment control standard adopted is presented in Table 2. Areas which have a minimum requirement of a Type 3 device (based on the size of the area), where potentially high erosion rate are likely to be experienced will require additional ground cover to prevent erosion or alternately a Type 2 sediment control device to be installed and maintained.

**Table 2**: Sediment Control Standard

| Area Limit (m²) | Sediment Control Standard for Soil loss rate limit (t/ha/yr) | | |
|---|---|---|---|
| | Type 1 | Type 2 | Type 3 |
| 250 | N/A | N/A | All Cases |
| 1000 | N/A | N/A | All Cases |
| 2500 | N/A | >75 | 75 |
| >2500 | >150 | 150 | 75 |

The following notes relate to potential reductions in the Sediment Control Standard i.e. sediment controls that may be considered if the works proceed during low risk periods of the year (as noted in Table 1), and or if ground cover is maintained e.g. mulch, rock mulch or soil binder. Ongoing assessment with regard to integrity of groundcover is required with regard to selection of sediment controls.

1. If works commence and are completed in accordance with Table 1 within a Low or Very Low Erosion risk period of the year, or at least 60% ground cover can be maintained throughout works during other parts of the year, some Type 2 devices can be potentially be downgraded to Type 3 devices.
2. Excavated sediment traps cannot be used in unstable soils due to the high probability of tunnel erosion and sediment trap failure.
3. Emerson Dispersion testing (a simple in-field dispersion test) must be completed on the subsoil (0.30-1.0m) in a location where an Excavated Sediment Trap is proposed. If the Emerson class is 4 or less, the soil is likely to be too unstable and an alternative, above ground device must be used.

## Construction Assumptions

Assumptions have been made in regard to construction processes. During construction works, if the assumptions are identified or envisaged to be erroneous or inconsistent with the actual construction processes or site conditions, the ESC controls may require updating to reflect the additional or actual conditions experienced on site.

- Earthworks e.g. cut or fill batter slopes will be constructed to allow all ESC devices to remain within the defined Work Area;
- Works will be staged to minimise the time of exposure of soils, particularly works associated with drainage paths and or waterways.
- Works will not commence in high risk areas if a forecast rainfall event that is likely to produce more than approximately 25 mm is forecast, unless erosion and sediment controls can be effectively established prior to the event.
- Soil within the Work Area will be assessed for dispersion potential and treated with Gypsum (if required).

### Methodology and installation sequence for construction works

1. Assess timing of works with respect to Table 1.
2. Refer to the approved ESC drawing for the indicative location of location Drainage, Erosion and Sediment Controls.
3. Refer to Typical Details and technical notes for nominated Drainage, Erosion and Sediment Controls.
4. Clear and grub vegetation for processing into mulch and utilise as required.
5. Strip and relocate the topsoil to construct a 'Clean Water' Flow Diversion Bank on the up-slope as detailed on the approved ESC drawing or stockpile and provide adequate controls.
6. Exposed sections of the 'Clean Water' Flow Diversion Bank that will experience medium to high concentrations and velocities of clean water may require scour protection. Scour protection may include:

Medium protection, place a layer of coarse mulch (approximately 150mm mm in thickness) on the up-slope side of the 'Clean Water' Flow Diversion Bank. The layer of mulch is to extend approximately 300mm up the newly



Revisions

| No: | BY | DATE | DESCRIPTION | CHECKED |
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| | BG | 07/03/16 | | |

DESIGNED | CHECKED MM | APPROVED MM | DATE 31/03/16 | CPESC NO: 7718

Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13 | Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
STANDARD TECHNICAL NOTES

Status: FOR INFORMATION | CDM Smith DWG No.: ESCP-TYP-001 | REV: 0

a. constructed face of the bank and 300mm on the up-slope existing ground surface;
b. Medium to High protection, install erosion control blanket (ECB) or geotextile fabric (approximate roll width 1.2m) to the up-slope surface of the 'Clean Water' Flow Diversion Bank. The lining is to extend approximately 500mm up the newly constructed face of the bank and remainder of roll to cover the up-slope existing ground surface. The lining is to be pinned as per the manufactures recommendations to maintain contact with the soil.

7. Construct Catch Drains or Topsoil Diversion Banks on the down-gradient side of the works to retain water within the disturbed limits.
8. Install Cross Banks and sediment traps as soon as practicable or if rain is forecast within 24 hours during ground surface treatment operations.
9. Where significant quantities of subsoil are cut from the work area, the material is to be stockpiled in a dedicated area with appropriate erosion and sediment controls.
10. Install all erosion control measures (e.g. soil binder, mulch, gravel, or rock mulch) within the disturbed areas as soon as practicable, or if rain is forecast within 24 hours.
11. Control traffic on all areas where soil binder has been used for erosion control to prevent damage to the surface.
12. Waterway crossings (bed level crossings and or pipe culverts) if any are to be installed as required for access.
13. Clearing, grubbing and earthworks associated with drainage paths e.g. gully crossings area are to be delayed as long as is practicable and be minimised where possible.
14. Rehabilitation is recommended to commence as soon as practical with drainage paths e.g. gully crossings areas rehabilitated as a priority.

## Operation, Monitoring and Maintenance

1. Monitoring of erosion and sediment controls should be conducted at intervals no greater than seven (7) days apart.
2. Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.
3. Inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of erosion and sediment controls and adjoining drainage. General inspection considerations include:
   a. inlet and discharge areas for damage or excessive scour;
   b. channel banks directing runoff to the sediment trap for damage from overtopping flows;
   c. excessive sedimentation e.g.. more than 30% of original sediment trap volume.
   d. integrity of temporary ground cover.
4. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.
5. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.



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STANDARD TECHNICAL NOTES

Status: FOR INFORMATION | CDM Smith DWG No. ESCP-TYP-001 | REV: 2

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## CHUTES: Key Principles

Used for conveying concentrated flows/water down steep slopes.
Critical parameters are;

- the slope of the chute, effecting the flow velocity;
- lining type and or rock size;
- flow entry conditions into the chute; and
- reducing the energy at the base or outlet of the chute.

Operational issues include poor inflow or incorrect construction causing scour around the chute.

## Diversion Drains: Key Principles

Diversion Drains are used to convey clean or dirty water to the nominated point of discharge as specified in the plan.

In areas where water is trapped up-slope of the site, clean water diversion drains are used to convey the flow across the site. Examples include minor drainage paths, grade reversals across a slope and other areas where it is impractical to divert water around the site.

### Construction

Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Materials

1. Where rock is specified:
    a. Installed without damaging geotextile lining (install protective layer of gravel/aggregate or sand if required).
    b. Specific gravity of 2.5 (desired).
    c. Hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size;
    d. The largest rock size should be no larger than 1.5 times the nominal rock size.
    e. Installed to achieve a relatively consistent graded and stabilised surface.
    f. Small rock need to fill the voids between the larger rocks.
2. Geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum 'bidim' A34 or equivalent.
3. Coir or Jute Matting, refer to supplier for product specifications. Typical claimed values for Coir mat: 400 gsm- 2.7m/sec, 700 gsm- 3.3m/sec, 900 gsm 4.8 m/sec

### Installation

1. Remove all unsuitable material (i.e. dispersive soils or large rocks) from the area and replace with stable material to achieve the correct drain dimensions.
2. If subsoil is defined or suspected to be dispersive material, a layer of non-dispersive or ameliorated material is to be provided under the nominated channel lining.
3. Ensure the drain has a smooth surface and appropriate entry and exit flow conditions.
4. Where rock is specified allow for the required thickness of the rock when excavating.
5. Subgrade material is to be compacted to minimise water seepage.
6. Geotextile or jute mat lined chutes; compact and smooth the subgrade to achieve the correct drain dimensions.
7. Rock lined chutes: avoid over compacting the subgrade to a condition that would prevent the rock lining from adequately bedding into the subgrade.
8. On fill slopes, ensure that the soil is adequately compacted for a width of at least one metre each side of the chute to minimise the risk of soil erosion. Where required protect the soil with suitable scour protection measures such as turf or erosion control mats.
9. Geo textile fabrics, Coir or Jute linings:
    a. extend "side wings" a minimum of 300mm from the upper edges of the channel;
    b. trench (key in) geotextile fabric "wings" in to a depth of 200mm, with excavated material returned to the trench and compacted prevent movement of the liner;
    c. overlap side laps edges (if required) a minimum of 300 mm.
    d. flow direction overlaps (if required) a minimum 300mm.
    e. fixed to the drain surface using the appropriate pins/staples to ensure contact between the liner and channel surface are to be pinned to the subgrade at regular intervals.
10. Chutes: Geotextile Liner
    a. extend "side wings" a minimum of 300mm from the upper edges of the channel;
    b. extend and "up-slope wing" a minimum of 300mm from the top of the chute and trench (key in) geotextile fabric in to a depth of 200mm, with excavated material returned to the trench and compacted prevent movement of the liner;
11. Chutes: Install an appropriate outlet structure (energy dissipater) at the base of the chute.
12. Chutes: Ensure water leaving the chute and the outlet structure will flow freely without causing undesirable ponding or scour.
13. Diversion Drains must be constructed to dissipate concentrated flows, without causing scour.
14. Appropriately stabilise all disturbed areas immediately after construction.

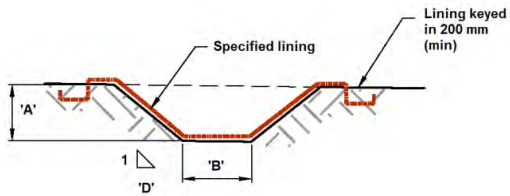
## Operation, Monitoring and Maintenance

Inspect weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the drainage structure. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Embankments for excessive settlement, slumping or piping.
2. Inlet and discharge areas for damage or excessive scour.
3. Damage to the chute lining, including surface cracking.
4. Scour adjacent the drainage structure.
5. Where required restore the drainage structure to its original configuration unless an amended layout is required.




## Decommissioning

1. When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised or when permanent drainage has been constructed, the chute or drain may be decommissioned. General considerations include:
    a. Removal and disposal of all materials including rock and lining materials;
    b. Diversion of water around the decommissioned area to discharge in a non-erosive manner while the chute area is reinstated;
    c. disturbed areas associated with the chute are to be reinstated and rehabilitated to conform with the adjoining land features, e.g. compaction, slope, vegetation;
    d. decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the chute.

CONSTRUCTION TABLE - CHUTES AND DRAINS

| TYPE | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Description | Diversion drain | Diversion drain | Chute | Chute | Chute | Chute |
| Typical application | Drainage of minor flows across the site | Drainage of moderate flows across the site | Drainage of minor flows down steep slopes | Drainage of minor flows down steep slopes | Drainage of moderate flows down steep slopes | Drainage of minor flows down very steep slopes |
| Lining type | Open weave Coconut, Coir or Jute fibre mat | Open weave Coconut, Coir or Jute fibre mat | Open weave Coconut, Coir or Jute fibre mat | Open weave Coconut, Coir or Jute fibre mat | TRM or heavy duty Coir | TRM or heavy duty Coir |
| Maximum slope (%) | 5 | 5 | 25 | 25 | 25 | 40 |
| Maximum slope ratio (V:H) | 1:20 | 1:20 | 1:4 | 1:4 | 1:4 | 1:2.5 |
| Maximum discharge rate ($m^3/s$) | 0.25 | 0.5 | 0.25 | 0.5 | 0.75 | 0.75 |
| Min. velocity rating of lining ($m^2/s$)* | 2 | 2.5 | 2.9 | 3.25 | 4.6 | 4.7 |
| Drain depth 'A' (m) | 0.3 | 0.35 | 0.3 | 0.3 | 0.3 | 0.3 |
| Drain base width 'B' | 0.6 | 0.6 | 1.5 | 2.2 | 1 | 2.2 |
| Maximum side slope 'D' (H:V) | 2:1 | 2:1 | 2:1 | 2:1 | 2:1 | 2:1 |

Data source: Catchments & Creeks (2010) Chutes Design Fact sheets.

NOTE: Channel lining must not be placed directly on dispersive soils. Refer IECA factsheet 'Erosion Control Mats', "Special Requirements" for best practice installation procedure.

***Refer to supplier for product specifications. Typical claimed values for Coir mat: 400 gsm- 2.7m/sec, 700 gsm- 3.3m/sec, 900 gsm 4.8 m/sec**

| Revisions | | | | | | | | | |
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Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13 | Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS LINED DRAINS AND CHUTES

Status: FOR INFORMATION | CDM Smith DWG No.: ESCP-TYP-101 | REV: 0

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Cross banks are drainage control devices that reduce erosion by limiting the slope length of an area and preventing excessive runoff velocities. Cross banks assist or limit concentrated flow paths that lead to rill and gully formation.

Cross banks are installed to direct runoff in a controlled manner to structures to include; sediment traps, drains, chute or outlet structure.

Where required or observed though onsite monitoring, Cross Banks may need to be lined to prevent scour of the invert of the drain section.

## Construction

Construct the Cross Bank in accordance with the approved plans i.e. location, while observing site conditions with respect to the recommended maximum slope lengths up-slope of the control as detailed in Table 1 and Table 2.

The recommended spacing of Cross Banks may need to be reduced from those specified on the approved plans or those note in Table 1 and Table 2 if the soils are considered to be highly susceptible to erosion and or if intense rainfall events are envisaged.

**Table 1 Recommended maximum slope length up-slope of a Cross Bank on non-vegetated slopes on low to moderately erodible soil.**

| | | Batter Slope | Cross Bank (non-vegetated slopes) | |
|---|---|---|---|---|
| Vertical | Horizontal | Percentage | Horizontal Spacing (m) | Vertical Spacing (m) |
| 1 | 100 | 1.0% | 80 | 0.9 |
| | 75 | 1.3% | 70 | 1.0 |
| | 50 | 2.0% | 60 | 1.2 |
| | 40 | 2.5% | 55 | 1.3 |
| | 35 | 2.9% | 50 | 1.4 |
| | 30 | 3.3% | 45 | 1.5 |
| | 25 | 4.0% | 40 | 1.6 |
| | 20 | 5.0% | 35 | 1.8 |
| | 15 | 6.7% | 30 | 2.2 |
| | 10 | 10.0% | 25 | 2.5 |
| | 5 | 20.0% | 15 | 3.2 |
| | 4 | 25.0% | 13 | 3.5 |
| | 3 | 33.3% | 10 | 3.5 |
| | 2.5 | 40.0% | 9 | 3.5 |
| | 2 | 50.0% | 6 | 3 |

**Table 2 Recommended maximum slope length up-slope of a Cross Bank on vegetated slopes on low to moderately erodible soil.**

| | | Batter Slope | Cross Bank (Vegetated Slopes) | |
|---|---|---|---|---|
| Vertical | Horizontal | Percentage | Horizontal Spacing (m) | Vertical Spacing (m) |
| 1 | Less than 10% | | No spacing specified | |
| | 10 | 10.0% | 120 | 12 |
| | 8 | 12.5% | 100 | 12 |
| | 6.5 | 15.4% | 80 | 12 |
| | 5 | 20.0% | 55 | 11 |
| | 4 | 25.0% | 40 | 10 |
| | 3 | 33.3% | 30 | 9 |
| | 2.5 | 40.0% | 30 | 9 |
| | 2 | 50.0% | 25 | 7 |

## Materials

Cross banks are to be constructed using suitable material i.e. clean, non-dispersive soil free of woody vegetation and roots, rocks or other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Seek additional advice regarding material suitably if required.

## Installation

1. Inspect the proposed alignment of the cross bank and adjust as required to ensure the invert (back or drain section) of the Cross Bank of will be free draining and have a cross-fall between 2-5%.
2. If required, remove surface vegetation, roots, stumps, and other debris. Do not use debris to construct the bank.
3. Ensure soil to be used is at an appropriate moisture content to ensure adequate compaction. Wet or condition the soil as required.
4. Excavate the up-slope drain and push excavated material to form the down slope berm.
5. Compact the placed soil in lifts or use an alternative method to ensure adequate compaction and a smooth bank surface.
6. If the area is suspected or known to include problematic materials, (e.g. unstable soils), soil testing and soil amelioration should be completed as required. Alternatively the cross bank area can be covered with a minimum of 100mm of stable, non-dispersive soil.
7. If required, construct a trafficable section with dimensions of the bank adjusted to accommodate the wheelbase of expected traffic. The bank height in the trafficable section is required to be maintained.
8. Provide free draining, smooth flow conditions in the invert (back or drain section) of the cross bank towards the receiving sediment trap, drain or outlet.
9. Ensure the cross bank drains to a stable outlet, and does not discharge to an unstable fill slope. Install a suitable splash pad and/or chute immediately down-slope of the cross bank to control discharges and or soil erosion.
10. Seek clarification if any aspect of the construction of the sediment trap is in question.

## Operation, Monitoring and Maintenance

Inspect regularly, particularly after rainfall events producing runoff to assess the ongoing integrity and functionality.

Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

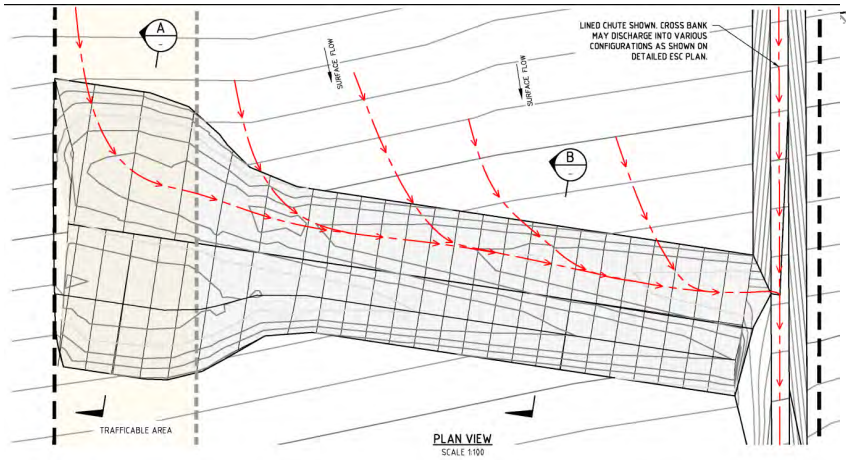
General inspection considerations include:

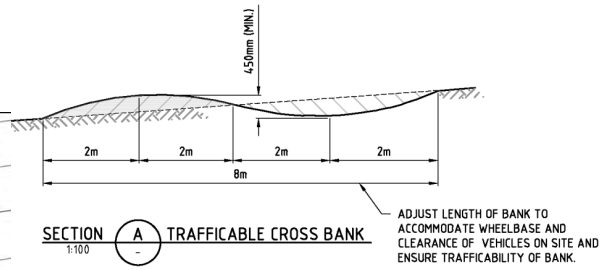
1. Damage from vehicles or livestock.
2. Slumping on banks or excessive sour of the invert or base on the drain section.
3. Damage or scouring from overtopping flows.
4. Discharge areas for damage or excessive scour.
5. Excessive sedimentation to be removed appropriately. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

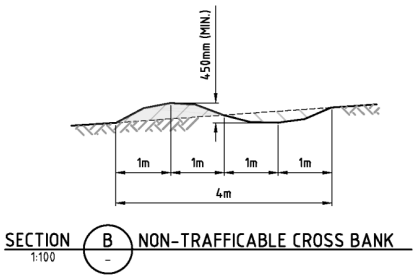
## Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the cross bank may be decommissioned. General considerations include:

1. Disturbed areas associated with the cross bank are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
2. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment control.

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Scale: NOT TO SCALE

Client: Central Queensland Coal

Designer: CDM Smith

Project Number BES150189.13 | Client DWG No. Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS CROSS BANKS

Status: FOR INFORMATION | CDM Smith DWG No. ESCP -TYP-102 | REV: 0

All information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Sediment Basins are generally used as the final sediment control measure at the end of dedicated drainage channels within a catchment area greater than 0.25ha.

Appropriately designed, constructed and operated Sediment Basins are classed as a Type 1 sediment trap. Sediment Basins are downgraded to a Type 2 sediment trap if inappropriately operated or maintained.

Sediment collection is achieved through gravity induced sedimentation. Under some circumstances sedimentation can be improved with the use of flocculants to achieve the required discharge criteria.

Type F (Fine) and Type D (Dispersive) are considered as wet basins with the treated water to be dewatered through a controlled discharged as soon as the discharge criteria i.e. suitable water quality is achieved. As soon as conditions allow the basin must be maintained in either a dry-bed condition or with a water level no greater than the top of the design sediment storage zone.

Sediment basins are normally designed for a 5-day cycle i.e. rainfall event producing runoff into the basin, water treatment and dewatering of the basin within a maximum 5-day period.

## Construction

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications). An assessment of the 'as constructed' Sediment Basin is to be conducted by suitably qualified person/s.

### Materials

Sediment Basins are to be constructed using suitable material i.e. clean (non-dispersive) soil. Soil is to be free of woody vegetation and roots, rocks or other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2 (1) should only be used upon recommendation from geotechnical specialist with the basin to be lined with as applicable. Seek additional advice regarding material suitably if required.

### Installation

1. Delay clearing the up-slope pond area until the Sediment Basin is formed and is able to act as a suitable sediment trap.
2. Install required temporary sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.
3. The footprint of the embankment must be cleared of unsuitable material i.e. topsoil, unsuitable soil, vegetation material (trees, stumps, roots, dead timber), with large voids to be filled and compacted.
4. Clearing the main pond area is to be delayed until the embankment is completed.
5. Topsoil is to be appropriately stockpiled for rehabilitation as necessary.
6. Excavate a cut-off trench along the centre-line of the earth embankments 600mm deep with side slopes no steeper than 1:1 (H:V).
7. The base of cut off trench is to be wide enough to allow adequate compaction and be free from loose or unsuitable material.
8. Backfill and compact with select earth/soil fill to the required compaction and moisture specification.
9. Key in main embankment to prepared footprint surface using scarification.
10. Construct the main embankment with select earth/soil fill in continuous 150 to 250mm layers and compact to the required compaction and moisture specification.
11. Unless otherwise specified on the approved plans, compact the soil at approximately 1% to 2% of optimum and to 95% modified or 100% standard compaction recognising the optimum moisture content.
12. All loose uncompacted earth-fill material on the upstream and downstream batter must be removed prior to spreading of topsoil.
13. Stabilise associated exposed earth embankments immediately after construction through appropriate compaction, topsoil vegetation and/or erosion control matting.
14. Construct the spillway section to the specified flow rates or dimensions.
15. Where specified line the spillway with geotextile fabric (heavy-duty, needle-punched, non-woven filter cloth, minimum 'bidim' A24 or equivalent).
    a. Extend into the upstream base of pond and adequately secure.
    b. Overlap side laps edges a minimum of 300 mm.
    c. Flow direction overlaps (if required) to be key in by burying 300mm the up slope edge and re-compacting.
    d. Pinned overlaps at 1m spacing.
    e. Ensure fabric is not damaged during placement of rock. If required repair as necessary overlapping 300mm and securely pinning.
16. Where rock is specified:
    a. Install without damaging geotextile lining (install protective layer of gravel/aggregate or sand if required).
    b. Specific gravity of 2.5 (desired).
    c. To be hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size.
    d. The largest rock size should be no larger than 1.5 times the nominal rock size.
    e. Installed to achieve a relatively consistent graded and stabilised surface.
    f. Small rock needs to fill the voids between the larger rock.
    g. The final discharge area must be stabilised to ensure controlled discharge flows and prevent scouring.
17. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
18. Install a sediment storage level marker post within sediment storage zone.
19. Install (if specified), internal settling pond baffles below, the elevation of the emergency spillway crest.
20. Install (as required) access points for operation and maintenance e.g. desilting access and stabilised dewatering points.
21. Potential safety and or environmental risks should be assessed for the construction and operational stages and managed appropriately. e.g. barrier fencing or internal side slope to allow egress of wildlife or fauna as necessary.
22. Seek clarification if any aspect of the construction of the sediment trap is in question.

## Operation, Monitoring and Maintenance

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Outflow or downstream water quality, 'clarity'.
2. Embankments for excessive settlement, slumping or piping.
3. Inlet and discharge areas for damage or excessive scour.
4. Diversion banks and drainage directing runoff to the sediment trap for damage from overtopping flows.
5. Excessive sedimentation shall be removed appropriately i.e. greater than the original sediment volume.
6. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:

1. Use of an appropriate flocculants that will be effective for the soil types in the area.
2. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
3. Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.

## Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the sediment trap may be decommissioned.

General considerations include:

1. Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.

| Revisions | | | | | | | | | |
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Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13 | Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS SEDIMENT BASIN

Status: FOR INFORMATION | CDM Smith DWG No.: ESCP -TYP-301 | REV: 0

## Summary of design requirements

Table 1 provides a summary of the recommended design requirements.

### Table 1 – Summary of sediment basin design requirements

| Parameter | Type F & D basins |
|---|---|
| Soil characteristic | Type F: More than 33% of soil finer than 0.02mm.<br>Type D: More than 10% of soil dispersive, or where turbidity control is essential. |
| Settling pond sizing, surface area (As), or settling volume (Vs) | Vs = 10 R(Y%, 5-day) Cv A |
| Length to width ratio | L:W of 3:1 is highly desirable |
| Minimum depth of settling zone | 0.6m |
| Sediment storage volume | 50% of settling volume |
| Use of inlet chamber | Desirable if length to width ratio is less than 3:1, or if inflow is concentrated with high flow velocity. |
| Internal baffles | Desirable if length to width ratio is less than 3:1 |
| Use of outlet chamber | Use depends on type of outlet system adopted |
| Control inflow conditions | Used to control erosion at inlets and, where practicable, ensure the inflow pipe invert is above the spillway crest elevation. |
| Pre-treatment pond | Used to reduce the cost and frequency of de-silting operations. |
| Primary outlet | Ensure choice of outlet system is compatible with basin type. |
| Emergency spillway minimum design capacity | Less and 3 month design life: capacity of 1 in 10 year ARI.<br>3 to 12 months design life: capacity of 1 in 20 year ARI. Greater than 12 months design life: capacity of 1 in 50 yr ARI. |
| Elevation from top of riser pipe outlet to spillway crest | N/A |
| Freeboard from maximum pond water level to top of virgin soil bank | 150mm (min) |
| Freeboard from maximum pond water level to top of fill embankment | 300mm (min) |
| Minimum freeboard along spillway chute | 300mm (min) |
| Minimum embankment crest width | 2.5m |
| Maximum gradient of access ramp | 6:1 |
| Chemical flocculation | Type F: As required to satisfy water quality objectives.<br>Type D: Essential |



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Scale: NOT TO SCALE

Client: Central Queensland Coal

Designer: CDM Smith

Project Number BES150189.13 | Client DWG No. Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS SEDIMENT BASIN

Status: FOR INFORMATION | CDM Smith DWG No. ESCP -TYP-301 | REV: 2

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Rock Filter Dams (RFD) are generally used at the end of minor table drains and drainage channels with a catchment area less than 0.25ha.

A RFD is a rock embankment generally constructed from large uniform-sized rocks, with a filter medium placed on the upstream face.
The filter medium is generally:

- one or more layers of geotextile filter cloth; and/or
- a layer of smaller aggregate.

Appropriately designed, constructed and operated RFDs are classed as a Type 2 sediment trap. A RFD is to be downgraded to a Type 3 if inappropriately operated or maintained.

Sediment collection is achieved through gravity induced sedimentation in the up-slope ponded area and filtration through the filter medium. Under some circumstances sedimentation can be improved with the use of flocculants to achieve the required discharge criteria.

Other considerations include:

- Stable inflow conditions are required to avoid re-suspension of existing sediments.
- The downstream face of the rock embankment acts as a spillway.
- The discharge area must be stabilised to ensure controlled discharge flows and prevent scouring.
- Partial sediment blockage is required to achieve optimum filtration properties.
- An excavated sediment pit immediately upstream may reduce the risk of sediment blockage of the filter medium and in turn reduce maintenance.
- Access must be provided for maintenance.

Where specified the RFD is required to be keyed in a minimum of 200 mm into the bed and the adjacent earth banks (if any) to prevent water tunnelling under or around RFD.

## Construction

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Materials

Primary core rock and Spillway Rock: well graded, hard, angular, erosion resistant rock; mean size as specified in the approved plan, but not less than 225mm, or greater than 350mm.
Aggregate filter (if specified): 15 to 25mm clean aggregate.
Geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum 'bidim' A34 or equivalent.

### Installation

1. Delay clearing the up- slope pond area until the RFD is formed and is able to act as a suitable sediment trap.
2. If earth abutments are specified, excavate a cut-off trench along the centre-line of the RFD and into the adjoining earth embankments 600mm deep with side slopes no steeper than 1:1 (H:V).
    a. The base of cut off trench is to be wide enough to allow adequate compaction and be free from loose or unsuitable material.
    b. Backfill and compact with select earth/soil fill to the required compaction and moisture specification.
3. Clear the area where the RFD is to be constructed of debris and sharp rocks that may puncture the geotextile, and install a geotextile fabric base sheet.
    a. Cover the foundation area and cut-off trench (if cut off trench specified) with heavy-duty filter fabric.
    b. Overlap side laps edges a minimum of 300 mm.
    c. Flow direction overlaps (if required) 600mm.
    d. Ensure fabric is not damaged during placement of rock. If required repair as necessary overlapping 300mm and securely pinning.
4. If earth abutments are specified construct to ensure:
    a. well compacted, erosion resistant soil ,free of vegetation and roots; and
    b. up-slope fill batters slopes are a minimum 2:1 (H:V) or flatter;
    c. downstream face of earth abutments are a minimum 3:1 (H:V) or flatter;
    d. overfill earth abutments 150mm to allow for settlement.
5. Place the RFD core rock to ensure:
    a. upstream face is 2:1 (H:V) or flatter;
    b. the downstream face is 3:1 (H:V) or flatter; and
    c. smaller rocks are worked into the voids of the larger rocks.
6. Construct the spillway of the RFD section using the specified armour rock to ensure.
    a. a minimum depth within the spillway section of 300mm;
    b. the spillway weir crest is level across its full width;
    c. the downstream slope of the rock spillway is a maximum of 3:1 (H:V);
    d. the thickness of armour rock protection is a minimum of 500mm, or twice the nominal rock size, whichever is the greater.
    e. the spillway extends downstream past the toe of the formed embankment until stable conditions are reached, or a distance equal to the height of the dam, whichever is the greater;
    f. the upper or outer edges of the spillway are left flush with the surrounding ground.
7. If specified install the filter medium (aggregate and/or geotextile filter fabric) on the upstream face of the RFD.
    a. extend the fabric over the crest of the rock filter dam into the spillway chute;
    b. if the sediment trap is anticipated to be in place for greater than two (2) months, it is recommended the placement of sacrificial layers of fabric on the upstream face to allow a layer to be removed if the fabric becomes completely blocked with sediment.
8. The discharge area is to be stabilised as necessary and discharge water to be directed off the site in a manner that will not cause erosion.
9. Clear the settling pond area of woody vegetation and organic matter to the dimensions specified within the plans.
10. If specified excavate the upstream settling pond and/or sediment storage pit in nominated on the approved plans.
    a. excavated pits typically have side slopes of 2:1 (H:V) or flatter unless steeper slopes are known to be stable.
11. Stabilise any associated earth embankments immediately after construction through appropriate compaction, vegetation and/or erosion control matting.
12. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
13. Install (as required) access points for operation and maintenance e.g. desilting access.
14. Potential safety and or environmental risks should be assessed for construction or operation stage and managed appropriately. e.g. barrier fencing or internal side slope to allow egress of wildlife or fauna as necessary.
15. Seek clarification if any aspect of the construction of the sediment trap is in question.

## Operation, Monitoring and Maintenance

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Outflow or downstream water quality, 'clarity'.
2. Embankments for excessive settlement, slumping or piping .
3. Inlet and discharge areas for damage or excessive scour.
4. Diversion banks and drainage directing runoff to the sediment trap for damage from overtopping flows.
5. Excessive sedimentation shall be removed appropriately i.e. greater than 10% of original sediment volume.
6. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

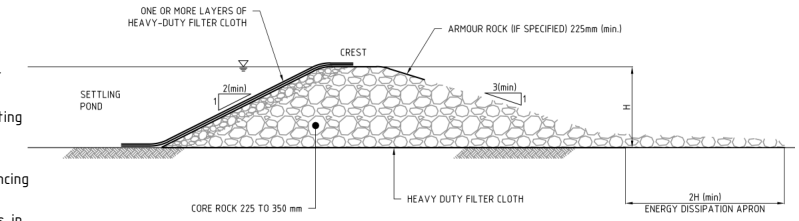
Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:

1. Use of an appropriate flocculants that will be effective for the soil types in the area.
2. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
3. Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.

## Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilized, the sediment trap may be decommissioned. General considerations include:

1. Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.




TYPICAL SECTION OF ROCK FILTER DAM WITH WITH GEOTEXTILE FILTER

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Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13 | Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS ROCK FILTER DAMS

Status: FOR INFORMATION | CDM Smith DWG No.: ESCP -TYP-302 | REV: 0

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Sediment Fences are used to manage sheet flow i.e. water flowing uniformly down a low to medium slope gradient. Sediment Fences are not recommended in areas of concentrated flow e.g. drainage channels or chutes.

**Sediment Fences** are relatively effective in trapping or retaining sand and silt size particles, however are limited in capturing clay sized particles that increase the colour and turbidity of water passing through the fence.

Sediment collection utilizing Sediment Fences is achieved through gravity induced sedimentation as a result of water temporarily being ponded or retained on the up-slope side of the sediment fence. The surface area of the up-slope ponded area created during the construction and positioning of the sediment fence and or returns is critical towards maximizing sediment collection i.e. the greater ponded surface area, the greater potential for sediment collection. Filtration of water through the fabric provides limited or secondary sediment collection.

**Filter Fences**, although constructed similarly to a Sediment Fences are not consider an acceptable replacement for sediment fences unless constructed directly down-slope of earth stockpiles. Filter Fences are used to manage coarse grained runoff from stockpiles and rely on filtration as the primary treatment mechanism.

**Note**: specific considerations related to the construction of filter fences are noted in italics i.e. *"Filter Fence: italics"*. Filter Fences are not recommended in areas of concentrated flow. Appropriately constructed and maintained Sediment Fences are classed as a Type 3 sediment control, however are to be downgraded if inappropriately maintained.

## Construction

Construct the Sediment Fence in accordance with the approved plans i.e. for location, extent, and required type of fabric (if specified) and the observed site condition with respect to the recommended maximum slope lengths up-slope of the sediment fence as detailed in Table 1. *"Filter Fence: Table 1 not applicable, Filter Fence only to be used directly down-slope of earth stockpiles"*.

**Table 1 Recommended maximum slope length up-slope of a Sediment Fence on non-vegetated slopes on low to moderately erodible soil.**

| | | Batter Slope | Sediment Fence | |
|---|---|---|---|---|
| Vertical | Horizontal | Percentage | Horizontal Spacing (m) | Vertical Spacing (m) |
| 1 | 100 | 1.0% | 60 | 0.6 |
| | 75 | 1.3% | 60 | 0.8 |
| | 50 | 2.0% | 60 | 1.2 |
| | 40 | 2.5% | 55 | 1.3 |
| | 35 | 2.9% | 50 | 1.4 |
| | 30 | 3.3% | 45 | 1.5 |
| | 25 | 4.0% | 40 | 1.6 |
| | 20 | 5.0% | 35 | 1.8 |
| | 15 | 6.7% | 30 | 2.2 |
| | 10 | 10.0% | 25 | 2.5 |
| | 5 | 20.0% | 15 | 3.2 |
| | 4 | 25.0% | 12 | 3.5 |
| | 3 | 33.3% | 10 | 3.5 |
| | 2.5 | 40.0% | 9 | 3.5 |
| | 2 | 50.0% | 6 | 3 |

## Materials

Sediment fence fabric can be manufactured from polypropylene, polyamide, nylon, polyester, or polyethylene woven or non-woven fabric, and a minimum of 700mm in width and a minimum unit weight of 140GSM.

Fabric is to contain ultraviolet inhibitors and stabilisers to provide a minimum of 6 months of useable construction life.

If specified, fabric reinforcement wire or steel support mesh, minimum 14-gauge (approx. 2.0 mm) with a maximum mesh spacing of 200mm.

Support posts/stakes:

- 1500mm² (e.g. 30mm x 50 mm) (min) hardwood,
- 2500mm² (e.g. 30mm x 50 mm) (min) softwood, or
- 1.5kg/m (min) steel star pickets suitable for attaching fabric.

*"Filter Fence: Geotextile fabric: non-woven filter cloth (minimum 'bidim' A34 or the equivalent)."*

## Installation

1. Delay clearing or placing erodible material up- slope area until the sediment fence is constructed and is able to act as a suitable sediment control.
2. The fence is to be located:
    a. within the property boundaries;
    b. along a line of constant elevation or contour where possible;
    c. a minimum of 2m from the toe of any fill batters or earthworks to prevent damage to the fence.
3. Install returns within the fence at a maximum of:
    a. 20m intervals if the fence is installed along the contour;
    b. 5 to 10m maximum spacing (dependant on slope) if the fence is installed at an angle to the contour.
4. The returns can be constructed using:
    a. V-shaped section extending at least 1.5m up-slope; or
    b. sandbag or rock/aggregate check dam a minimum 1/3 and maximum 1/2 fence height, and extending at least 1.5m up-slope.
5. Extreme ends of the fence are to be turned up-slope at least 1.5m or as necessary to minimise water bypassing around the fence.
6. Avoid concentration of flow along the fence and or discharge of water around the ends of the fence.
7. Protect existing trees and root systems and do not utilise vegetation to support fabric.
8. Unless otherwise directed or nominated on the approved plans, excavate a 200mm wide by 200mm deep anchor trench along the proposed fence alignment and place the excavated material on the up-slope side of the trench.
9. On the lower side of the anchor trench secure the support posts into the ground at the following spacing:
    a. no greater than 2m *"Filter Fence: 1.5m"*.
    b. no greater than 3m if supported by a top support wire or weir mesh backing *"Filter Fence: 2m"*.
10. Securely attach the support wire (or mesh where specified) to the up-slope side of the support posts. Support mesh to extend a minimum of 200mm into the anchor trench.
11. Fabric (and mesh where specified) is to be attached to the up-slope side of the support posts.
12. Join ends of fabric by overlapping to the next support post.
13. Securely attach the fabric to the support posts, maximum fixing spacing of 150mm.
14. Securely attach the fabric to the support wire/mesh (where specified) at a maximum fixing spacing of 1m.
15. The completed fence is to be a minimum of 450mm, but no greater than 700mm high from the finished up-slope surface. If a spill-though weir is installed ensure the crest of the weir is a minimum of 300mm above the finished up-slope surface.
16. Backfill and compact the anchor trench to firmly secure the entire length of the fabric (and mesh where specified) and ensure up-slope water will not undercut, undermine, flow under the fence.
17. If conditions do not allow for the excavation of an anchor trench a continuous layer of sand or aggregate may be used to anchor the fabric firmly on the ground.
18. Seek clarification if any aspect of the construction of the sediment trap is in question.

Additional requirements for the installation of a spill-through weir. *"Filter Fence: No spill-through weirs required"*.

1. Construct the weir crest:
    a. lower than the ground level at ends of the fence;
    b. a minimum of 300mm high from the finished up-slope surface.
2. Securely attached a horizontal cross member (weir) to the support posts positioned on either side of the weir.
3. Cut the fabric down the side of each support post and fold the fabric over the cross member and appropriately secure the fabric.
4. Install a suitable splash pad and/or chute immediately down-slope of the spill-through weir to control discharges passing over the weir and soil erosion below the spill-through weir.

## Operation, Monitoring and Maintenance

Inspect sediment fences weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the sediment control.

Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Undercutting, undermining, flow under the fence.
2. Damage from overtopping flows.
3. Discharge areas for damage or excessive scour.
4. Excessive sedimentation to be removed appropriately i.e. greater than the 1/3 of the height of the sediment fence. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

## Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the sediment control may be decommissioned. General considerations include:

1. Water or sediment within the sediment control should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment control are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment control.

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CPESC NO: 7718

Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number BES150189.13 | Client DWG No. Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS SEDIMENT FENCE – FILTER FENCE

Status: FOR INFORMATION | CDM Smith DWG No. ESCP-TYP-303a | REV: 0

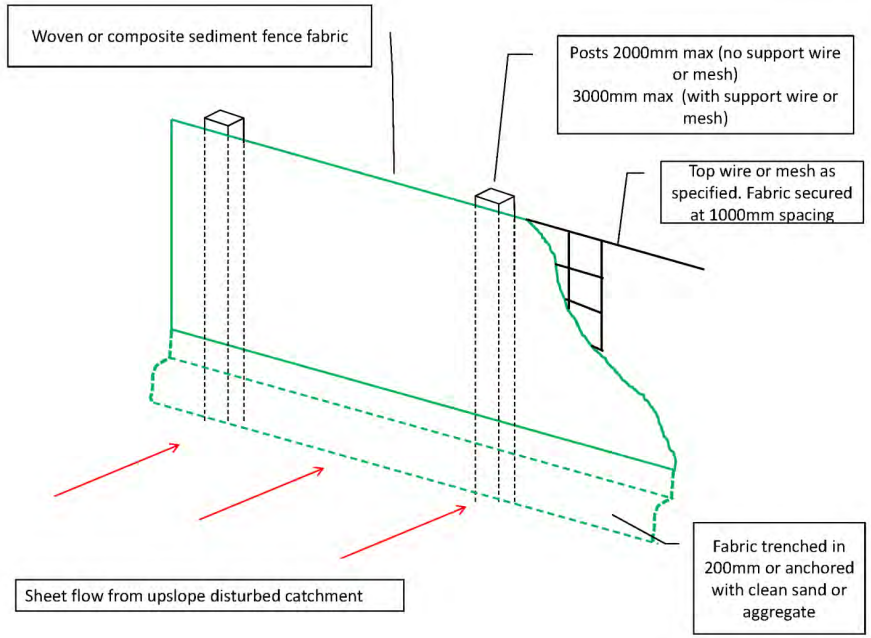


Figure 1: General layout of sediment fence construction

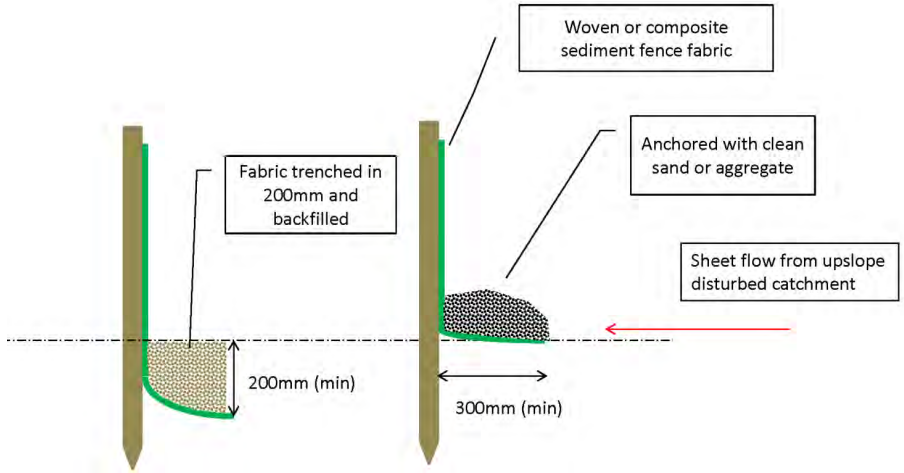


Figure 2 Options for anchoring bottom of sediment and filter fence

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Scale: NOT TO SCALE

Client: Central Queensland Coal

Designer: CDM Smith

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|---|---|---|
| Project Number BES150189.13 | Client DWG No. Appendix C | |
| TITLE: EROSION AND SEDIMENT CONTROL PLAN<br>TYPICAL DETAILS SEDIMENT FENCE – FILTER FENCE | | |
| Status: FOR INFORMATION | CDM Smith DWG No. ESCP-TYP-303b | REV: 2 |

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Excavated Sediment Traps (EST) are generally used as a sediment control measure at the end of dedicated drainage channels.

Appropriately designed, constructed and operated EST are classed as a Type 2 sediment trap when a Rock Filter Dam (RFD) outlet is incorporated into the device. ESTs utilized other situations are classed as to a Type 3 sediment trap.

Sediment collection is achieved through gravity induced sedimentation. Under some circumstances sedimentation can be improved with the use of flocculants to achieve the required discharge criteria. ESTs provide limited control of fine sediment unless the settling area has a substantial surface area. ESTs should not be used constructed in dispersive soils.

Stable inflow conditions are required to avoid re-suspension of existing sediments. In addition, the discharge area of the sediment trap must be stabilized to ensure controlled discharge flows and prevent scouring.

## Construction

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Materials

Where specified as having have a RFD outlet:

1. rock and the spillway rock should be well graded, hard, angular, erosion resistant rock; mean size as specified in the approved plan, but not less than 225mm, or greater than 350mm.
2. Geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum 'bidim' A34 or equivalent.

Other areas requiring erosion protection can utilise geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum 'bidim' A24 or equivalent.

### Installation

1. Delay clearing the up-slope pond area until the EST is formed and is able to act as a suitable sediment trap.
2. Where possible, the sediment trap is to be constructed with an internal side slopes of 2:1 (H:V) or flatter.
3. Where excavation area is limited, or the overall dimensions of the trap are too small for the practical use of 2:1 (H:V) internal side slopes the sediment trap may be constructed 1:1 (H:V) internal side slopes.
4. Where the excavation area is suspected or known to include problematic materials, (e.g. large voids or unstable soils), soil testing, soil amelioration or relocation of the sediment trap should be undertaken.
5. Where specified on the approved plan, the inlet area and discharge area or RFD outlet are to be stabilised with geotextile fabric and hard angular durable rock where specified.
6. Placement and or stockpiling of excavated material is to be managed not to create an erosion or pollution hazard.
7. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
8. Potential safety and or environmental risks should be assessed for the construction and operational stages and managed appropriately. e.g. barrier fencing or internal side slope to allow egress of wildlife or fauna as necessary.
9. Seek clarification if any aspect of the construction of the sediment trap is in question.

## Operation, Monitoring and Maintenance

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Outflow or downstream water quality, 'clarity'.
2. Embankments for excessive settlement, slumping or piping.
3. Inlet and discharge areas for damage or excessive scour.
4. Diversion banks and drainage directing runoff to the sediment trap for damage from overtopping flows.
5. Excessive sedimentation be removed appropriately i.e. greater than 30% of original sediment volume.
6. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

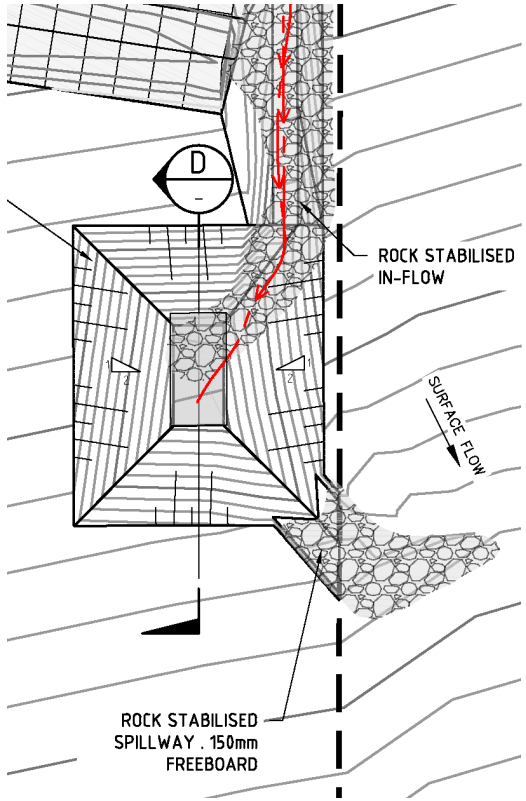
Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:

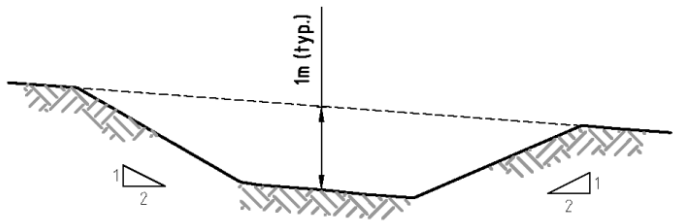
1. Use of an appropriate flocculants that will be effective for the soil types in the area.
2. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
3. Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.

## Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilized, the sediment trap may be decommissioned. General considerations include:

1. Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.




SECTION D EXCAVATED SEDIMENT TRAP
1:100



| Revisions | | | | | | | | |
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Scale: NOT TO SCALE

Client: Central QueenslandCoal

Designer: CDM Smith

Project Number BE3150189.13 | Client DWG No. Appendix L

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS EXCAVATED SEDIMENT TRAP

Status: FOR INFORMATION | CDM Smith DWG No. ESCP-TYP-305 | REV: 0

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

## Key Principles

Mulch Filter Berms are a similar sediment control to sediment fence and i.e. used to manage sheet flow, water flowing uniformly down a low to medium slope gradient.

Mulch Berms are not recommended in areas of concentrated flow e.g. drainage channels or chutes.

Appropriately designed, constructed Mulch Berms are classed as a Type 2 sediment control. Mulch Berms are relatively effective in trapping or retaining sand and silt size particles, however are limited in capturing clay sized particles that increase the colour and turbidity of water passing through the berm.

Sediment collection utilising Mulch Berms is achieved through gravity induced sedimentation as a result of water temporarily being ponded or retained on the up-slope side of the berm.

The surface area of the up-slope ponded area (created during the construction and positioning of the berm and or returns) is critical towards maximizing sediment collection i.e. the greater ponded surface area, the greater potential for sediment collection.

Filtration of water through the berm provides limited or secondary sediment collection.

### Construction

Construct the Mulch Berm in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Materials

1. Mulch to be processed using onsite material, which contains woody vegetation, and is free of weed seeds.
2. Mulch to be processed using a tub grinder or similar process that fractures the vegetation to a fibrous product. Wood chipping is not acceptable.
3. Mulch to be 90% by mass of fibrous, woody material with a maximum size of 150mm
4. Mulch should comply with the requirements of AS4454.
5. Maximum soluble salt concentration of 5dS/m.
6. Moisture content of 30 to 50% prior to application.

### Installation

1. When selecting the location of a mulch filter berm, to the maximum degree practical, ensure the berm is located:
    a. Totally within the approved area of disturbance;
    b. Along the contour of the slope;
    c. At least 1m, ideally 3m, from the toe of a fill embankment;
    d. Away from areas of concentrated flow.
2. Ensure flows are not concentrated along the length of the berm.
3. If the berm is installed diagonally across a slope, and concentration of flow is unavoidable, install regular 'returns' at a 90°angle to reduce the potential velocity of flow along the berm.
4. Ensure water flows through the berm and is not discharged around the end of the berm.
5. Ensure the berm has been placed such that ponding up-slope of the berm is maximised.
6. Ensure both ends of the berm are adequately turned up the slope to prevent flow bypassing prior to water passing over the berm.

## Operation, Monitoring and Maintenance

Inspect weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Undercutting, undermining, flow under the berm or washouts.
2. Damage from overtopping flows.
3. Discharge areas for damage or excessive scour.
4. Excessive sedimentation to be removed appropriately i.e. greater than 100mm or the 1/3 of the height of the berm. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.
6. Where required restore the structure to its original configuration unless an amended layout is required.

## Decommissioning (if required)

1. When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the mulch berm may be decommissioned. General considerations include:
    a. Disturbed areas associated with the berm are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. slope and or vegetation.
    b. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas

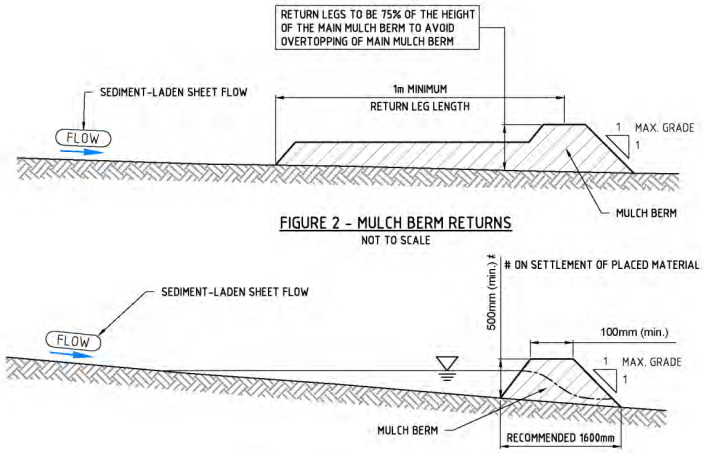


FIGURE 2 - MULCH BERM RETURNS
NOT TO SCALE

FIGURE 1 - PLACEMENT OF MULCH BERM

Table 1 provides the recommended maximum spacing of mulch filter berms down long slopes.

**Table 1 – Recommended maximum spacing of mulch filter berms down slopes**

| Land slope (H:V) | Bank slope (%) | Maximum spacing (m) |
|---|---|---|
| flatter than 50:1 | flatter than 2% | 30m |
| 20:1 | 5% | 25m |
| 10:1 | 10% | 15m |
| 5:1 | 20% | 8m |
| steeper than 4:1 | steeper than 25% | not recommended |

Table 2 provides the recommended minimum bank heights for mulch filter berms. The base width of berms should be at least twice its formation height.

**Table 2 Recommended dimensions of mulch filter berms**

| Conditions | Land slope perpendicular to bank | |
|---|---|---|
| | Less than 5% | Greater than 5% |
| Minimum bank height at time of formation | 750mm | 1000mm |
| Minimum bank height after natural settlement and organic breakdown | 500mm | 500mm |
| Top width of bank (min) | 100mm | 100mm |
| Base width (min) | 1600mm | 1600mm |
| Side slope (max) | 1:1 (H:V) | 1:1 (H:V) |

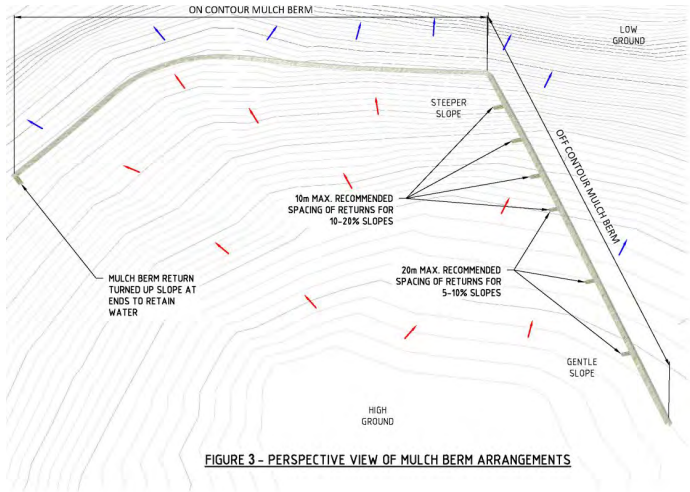


FIGURE 3 - PERSPECTIVE VIEW OF MULCH BERM ARRANGEMENTS

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Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13

Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS MULCH FILTER BERMS

Status: FOR INFORMATION

CDM Smith DWG No.: ESCP -TYP-306

REV: 0

Information sourced from Catchments and Creeks (2010) information sheets IECA Best Practice Erosion and Sediment Control (2008)

The Waterway, Gully or Culvert Crossing Area 'the Crossing Area' is defined as the area with the banks of the natural drainage feature.

## Key Principles

Avoiding erosion and minimising the potential for erosion are considered the most effective ways of ensuring environmental objectives are achieved during works. Reducing or avoiding erosion can be achieved through the application of multiple techniques, often with one technique implemented to complement another. Examples techniques include:

- Scheduling works in low erosion risk periods;
- Staging the works to minimise disturbance;
- Minimise erosion of exposed surfaces by increasing and or maintaining ground cover;
- Control the movement of water;
- Minimise movement of sediment or sediment laden waters; and
- Rehabilitate disturbed areas as soon as possible.

### Construction

Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Installation and General Notes

1. Wherever possible schedule work in high erosion risk areas in low erosion risk periods of the year (refer to Table 1);
2. Wherever possible schedule works during periods of no flow;
3. Stage and or restrict the construction works to the minimum practical area;
4. Disturbance or exposure of subsurface or highly erodible layers should be avoided wherever possible;
5. Provide temporary ground cover during construction by applying mulch, rock mulch, gravel or soil binder:
6. Soil binder should be suitable for in-stream application;
7. Excavated material or erodible material is not to be stockpiled within the Crossing Area.
8. Divert up-slope stormwater (from the side banks) around the disturbed work area
9. Provide adequate passage of upstream flows through the work area using diversion bunds/ barriers or pipes/ channels;
10. Provide adequate passage for aquatic fauna as required;
11. Avoid contamination of upstream flows wherever possible;
12. Sediment control devices should be positioned so that they are not damaged or washed away in a reasonably foreseeable stream flow event;
13. Where required, a bed level crossing should be installed, disturbing only the area that is required for the bed level crossing;
14. Earthworks batters to establish entry and exit points and or a bed level crossing may require erosion protection through the use of hard, durable rock;
15. Access tracks into the work area should be sheeted with clean aggregate for the full extent of the Crossing Area, excluding the bed level crossing, aggregate is to be angular d50 0.075m to 0.15m unless specified otherwise;
16. Work within the Crossing Area should not commence or is to be protected if significant rainfall is forecast within the scheduled period of works;
17. Removal and disposal of water, sediment is to be undertaken in a manner that will not create an erosion or pollution hazard.
18. Construct or rehabilitate as per the nominated engineering specification or rehabilitation plan as soon as possible.
19. Waterway crossing works should be managed in accordance with the relevant codes and approvals e.g. Code for self-assessable development, Temporary waterway barrier works, DAFF 2013. Code no: WWBW02

### Construction

Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

### Materials

1. Geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum 'bidim' A24 or equivalent.
2. Where rock is specified:
   a. Installed without damaging geotextile lining.
   b. Specific gravity of 2.5 (desired).
   c. Hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size;
   d. The largest rock size should be no larger than 1.5 times the nominal rock size.
   e. Installed to achieve a relatively consistent graded and stabilised surface.

**TABLE 1**

| IECA Table 4.4.5 Erosion Risk Based on average monthly rainfall erosivity | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Yearly R-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | H | M | M | VL | VL | VL | VL | VL | VL | M | H | |
| Monthly R Factor | 1286 | 1334 | 899 | 215 | 19.1 | 4.8 | 0.0 | 0.0 | 9.6 | 52.6 | 244 | 722 | 2329 |
| Key: H= High, M= Moderate, L= low, VL= Very Low | | | | | | | | | | | | | |

   f. Small rock needs to fill the voids between the larger rocks.

### Installation

1. Refer to associated drawings for additional details. .
2. Appropriately stabilise all disturbed areas immediately after construction.

## Operation, Monitoring and Maintenance

Inspect weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the temporary crossing. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to stream flow or rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:

1. Damage to the temporary crossing, including rocked surfaces.
2. Integrity of structure to pass anticipated flows i.e. blocked culverts.
3. Trafficable (rocked) sections for excessive sediment build up
4. Embankments and batters for erosion scouring, slumping.
5. Associated erosion and sediment controls.
6. Where required restore the structure to its original configuration unless an amended layout is required.

## Decommissioning

General considerations include:

1. Removal and disposal of all materials including rock and lining materials;
2. Disturbed areas to be reinstated and rehabilitated to conform with the adjoining land features, e.g. compaction, slope, vegetation;
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining area

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Client: Central QueenslandCoal

Designer: CDM Smith

Project Number: BES150189.13

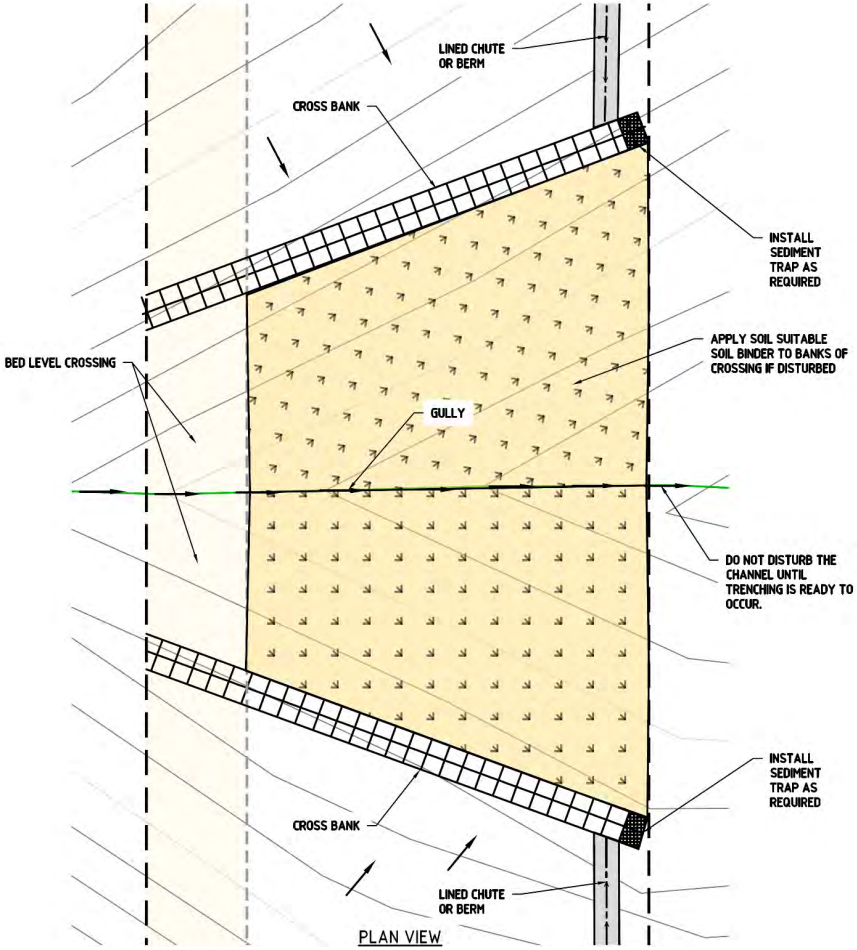
Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS WATERWAY CROSSING

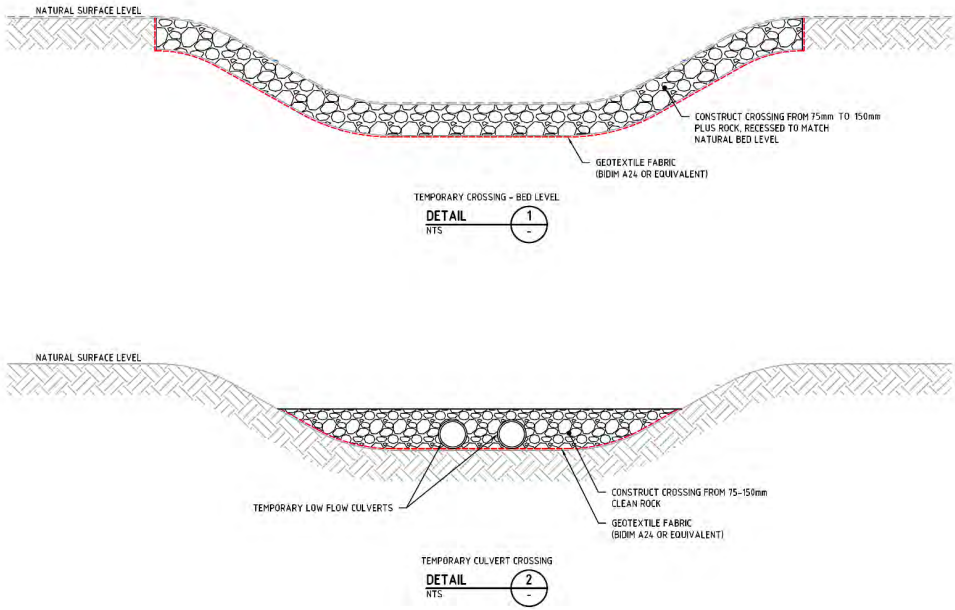
Status: FOR INFORMATION

CDM Smith DWG No.: ESCP-TYP-402a

REV: 0




Plan View of Gully Crossing




Gully Crossing Temporary Crossing Cross Sections

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Client: Central Queensland Coal

Designer: CDM Smith

Project Number: BES150189.13

Client DWG No.: Appendix C

TITLE: EROSION AND SEDIMENT CONTROL PLAN
TYPICAL DETAILS WATERWAY CROSSING

Status: FOR INFORMATION

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