Appendix 5

Soil and Water Management Plan

vgt
Environmental
Compliance
Solutions
PO Box 2335 Greenhills NSW 2323
P (02) 4028 6412 F (02) 4028 6413 E mail@vgt.com.au
www.vgt.com.au ABN 79 103 636 353

Hodgson Quarry Products Pty Ltd

Soil and Water Management Plan
Frazer Park Quarry

June 2016

Prepared by:

VGT Pty Ltd

in conjunction with:

Hodgson Quarry Products Pty Ltd

Hodgson Quarry Products Pty Ltd

Soil and Water Management Plan
Frazer Park Quarry

June 2016

Prepared by:	
VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335 Greenhills NSW 2323	ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

Report Date:	27/06/2016	
Report Number:	2806_FP_SWMP_2016_R4	
Copy Number:		
Report Authorised by:	Martin Hodgson	27/06/2016
	Tara O'Brien	27/06/2016
Collation Checked by:	Sinead Kelly	27/06/2016

Revision Table

Date	Details
4/04/2016	2806_FP_SWMP_2016_R0 First Draft for internal comment
30/05/2016	2806_FP_SWMP_2016_R1 Amendments after first review
16/06/2016	2806_FP_SWMP_2016_R2 Final revision
20/06/2016	2806_FP_SWMP_2016_R3 Figures 3 and 5 updated
27/06/2016	2806_FP_SWMP_2016_R4 Updated fuel storage text

Disclaimer

Table of Contents

Figures

Appendices

List of Tables

List of Photographic Plates

List of Graphs

Section 1. Executive Summary

This document has been prepared to supplement the Environmental Impact Statement accompanying the Development Application to develop a recycling operation within the Frazer Park Quarry.

The water management of the site has been developed to comply with Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries. Erosion and sediment controls for the proposed development are discussed in this document as well as impacts and their management, monitoring and performance criteria and responses.

Clean water is currently effectively diverted around the disturbed area via diversion bunds and the natural ridgeline setting. Dirty water is collected in the disturbed area into one of several sediment dams to allow for settling to occur. Retained water is reused on site for dust suppression and material processing. Surplus water is then treated further to obtain the specified water quality parameters if required prior to release.

Sediment basins are designed for a 90th percentile, 5 day rainfall event whilst catch drains and diversions are designed for a 10 year Average Recurrence Interval. Spillways have been designed for a 1 in 100 year ARI storm event. Dams will only be discharged when quality limits are met.

A water balance model has been developed to ascertain the water usage requirements of the development and the impact on the surrounding environment. In summary the site will have sufficient water to meet its needs without the need for potable water through reuse and recycling of the retained surface water. During average yearly rainfall conditions, the current sediment dams will not overtop.

A risk assessment was undertaken and management procedures developed. This included the development of performance criteria, trigger levels and actions to be taken when required.

The operator will undertake a regular monitoring and maintenance program to ensure water management goals are met. The results of all monitoring will be recorded and reported to the EPA on an annual basis and Lake Macquarie City Council on a 6 monthly basis as required by the consent conditions. It is envisaged that the development consent conditions, should the project be approved, will require annual reporting to the Secretary on the performance of the site.

Section 2. Introduction

2.1. History of Operations

Hodgson Quarry Products Pty Ltd (HQP) currently operates Frazer Park sand and gravel quarry on the Pacific Highway, Frazer Park.

The site is described as Lots 1 and 2 DP 549905 and Portion 465 in the Parish of Wallarah. The quarry is located on the Pacific Highway at Frazer Park, near Catherine Hill Bay as presented in *Figure One.* The site is bounded by the Pacific Highway to the west, and Munmorah State Recreation area to the south.

This Soil and Water Management Plan has been developed to accompany a Development Application to operate a recycling operation.

2.2. NSW Planning and Environment Requirements

The Secretary's Environmental Assessment Requirements (SEAR's) for the preparation of the Environmental Impact Statement included requirements for soils and water management to be addressed as stated below.

SEARs Requirement	Where addressed in this report
Description of the water demands and a breakdown of water supplies including any water licensing requirements;	*Section 7*
A detailed water balance;	Section 7.4
Description of the measures to minimise water use;	*Section 7*
Description of the construction erosion and sediment controls;	Section 6 & Section 8
A description of the surface and stormwater management system, including on site detention, and measures to treat or reuse water;	Section 6 & Section 8
An assessment of potential surface and groundwater impacts associated with the development, including impacts to flooding, groundwater dependent ecosystems, and potentially affected groundwater users;	Section 8
Details of impact mitigation, management and monitoring measures	Section 8, Section 9, Section 10 and Section 11

2.3. Objectives

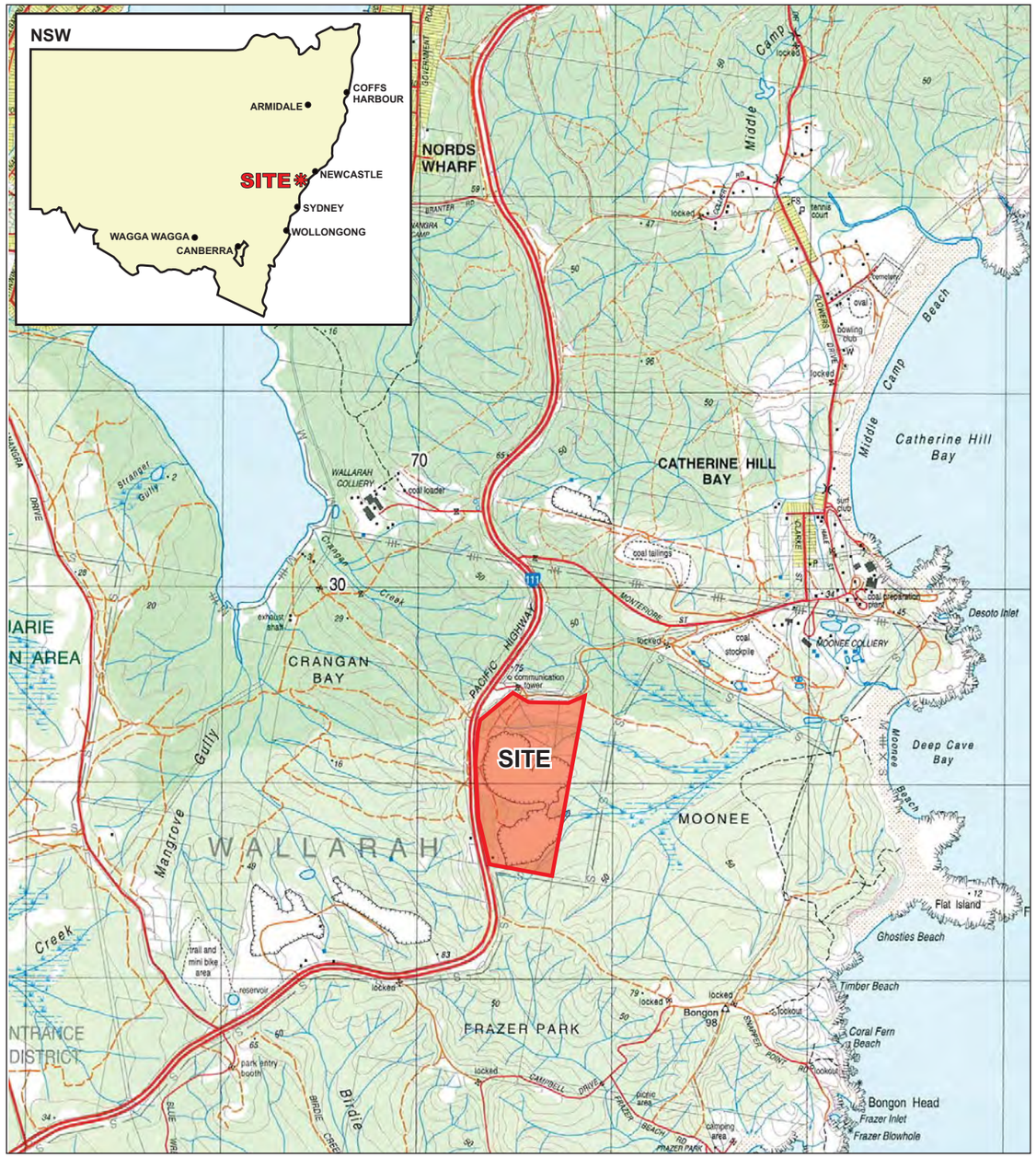
The principle objectives of the Soil and Water Management Plan (SWMP) are set out below.

- To minimise erosion and sedimentation from all active and rehabilitated areas, thereby minimising sediment egress into surrounding surface waters.
- To ensure the segregation of ‘dirty’ water from ‘clean’ water and maximise the retention time of ‘dirty’ water such that any discharge from the project site meets the relevant water-quality limits, including limits contained in the relevant guidelines and any limits imposed by specific project approvals. ‘Dirty’ water is defined as surface runoff from disturbed catchments. ‘Clean’ water is defined as surface runoff from catchments that are undisturbed by project- related activities and rehabilitated catchments.
- Reduce and manage the potential for contaminated water from the recycling operations to impact off site.
- Ensure sufficient settlement time is provided prior to discharge or employ other means such as flocculants to ensure the water meets the objectives identified in the point above.
- To monitor the effectiveness of surface water and sediment controls and to ensure all relevant surface water quality criteria are met.
- To determine a water balance for the site based on current and projected usage as well as the water remaining in the final landform.
- Develop a set of performance criteria and appropriate actions based on a risk assessment of the site.

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Locality Plan	***Location:***	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	nearmap - Image Date 29/08/2015 & 1:25,000 Topographical Series Catherine Hill Bay Sheet	***Our Ref:***	2806_FP_SWMP_2016_C001_V0_F1.cdr
Figure:	ONE	***Council:***	Lake Macquarie City Council	***Survey:***	N/A	***Plan By:***	JD
Sheet:	1 of 1	***Tenures:***	Environment Protection Licence 1246	***Projection:***	N/A	***Project Manager:***	TO
Version/Date:	V0 27/04/2016	***Client:***	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

N

vgt Environmental Compliance Solutions



Approx Scale: 0 0.5 1km

Approx Scale: 0 150m

Legend

Site

Manager Hodgson Quarry Products Pty Ltd: Martin Hodgson

Signed: Martin R. Hodgson

Date: 27/05/2016

Reviewed By VGT: Lisa Thomson

Signed: Lisa Thomson

Date: 27/05/2016

Project Manager VGT: Tara O'Brien

Signed:

Date: 27/05/2016

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Site Layout
Figure:	TWO
Sheet:	1 of 1
Version/Date:	V0 06/06/2016

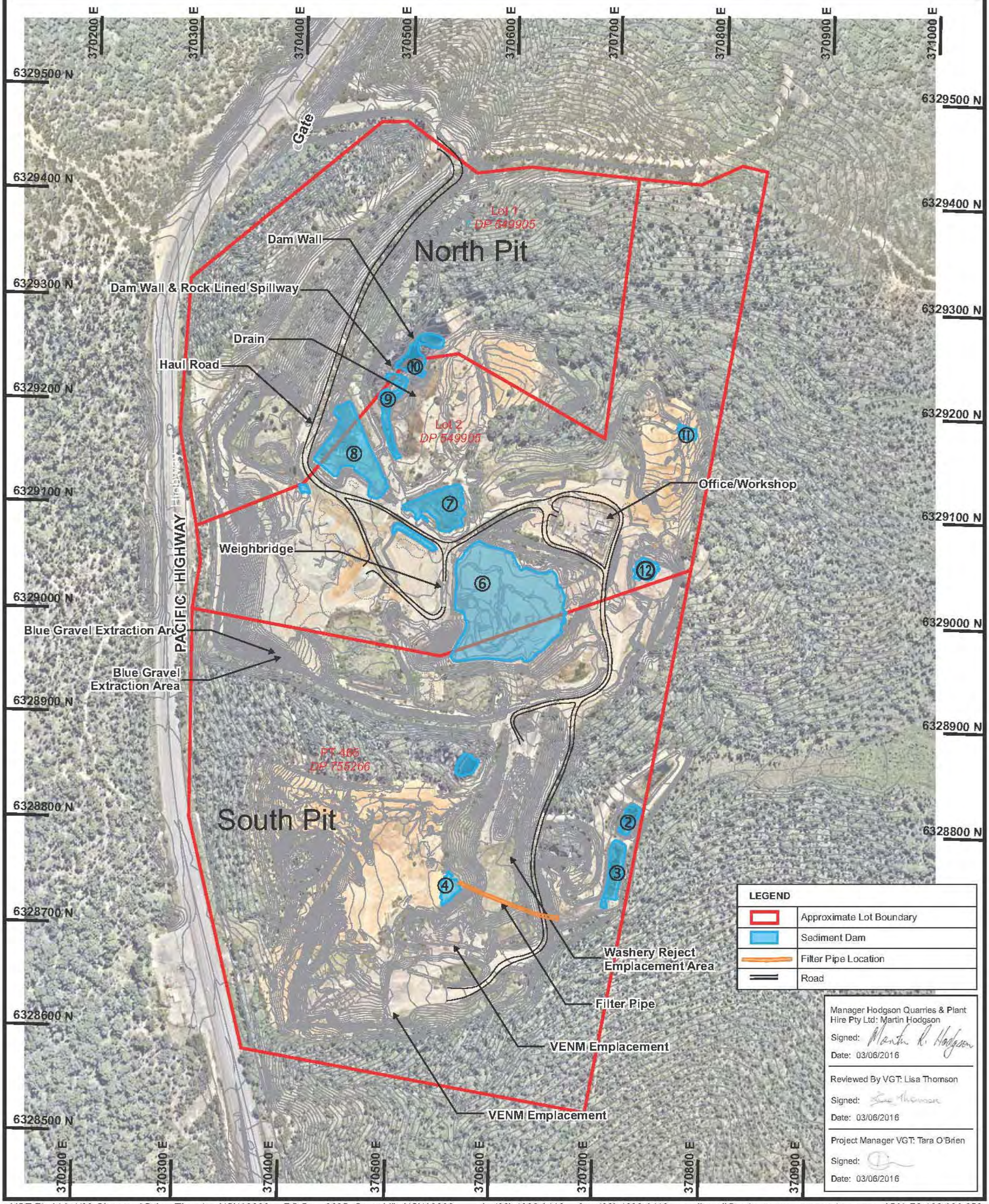
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

N

Scale: 0 250m

Location:	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	nearmap - Image Date 23/02/2016 and Hatch Survey	***Our Ref:***	2806_FP_SWMP_2016_C002_V0_F2.cdr
Council:	Lake Macquarie City Council	***Survey:***	2014	***Plan By:***	TO/JD
Tenures:	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Client:	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton



Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson
Signed: Martin R. Hodgson
Date: 03/06/2016

Reviewed By VGT: Lisa Thomson
Signed:
Date: 03/06/2016

Project Manager VGT: Tara O'Brien
Signed:
Date: 03/06/2016

VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

2.4. EPA Licence

The site holds an EPA licence (EPL1246) with the general condition that the licensee must comply with the protection of Environment operations Act 1997 (see ***Error! Reference source not found.***). In addition specific water quality limits are described below

Graph 1: EPL Licence Limits

POINT 1,2

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Oil and Grease	milligrams per litre				see below
pH	pH				6.5 - 8.5
Total suspended solids	milligrams per litre				40

Note: The oil and grease limit is 10 mg/L and none visible

Point 1 is defined as Settling Dam 10 and Point 2 is defined as Settling Dam 1 as shown in *Figure Three*.

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Existing Water Management
Figure:	THREE
Sheet:	1 of 1
Version/Date:	V1 20/06/2016

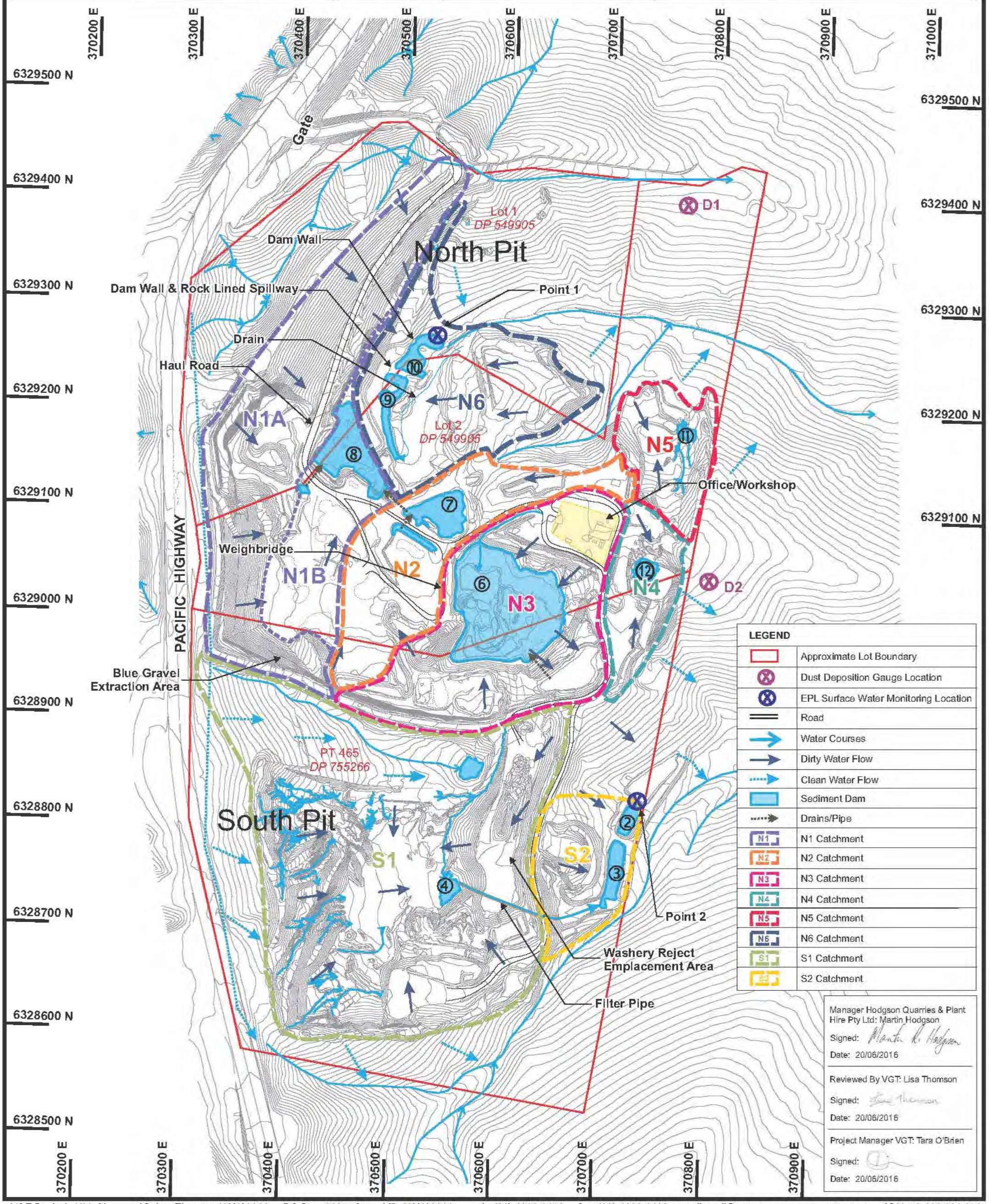
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

N

Scale: 0 250m

Location:	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Hatch Survey	***Our Ref:***	2806_FP_SWMP_2016_C003_V1_F3.cdr
Council:	Lake Macquarie City Council	***Survey:***	2014	***Plan By:***	TO/JD
Tenures:	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Client:	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton



Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson
Signed:
Date: 20/06/2016

Reviewed By VGT: Lisa Thomson
Signed:
Date: 20/06/2016

Project Manager VGT: Tara O'Brien
Signed:
Date: 20/06/2016

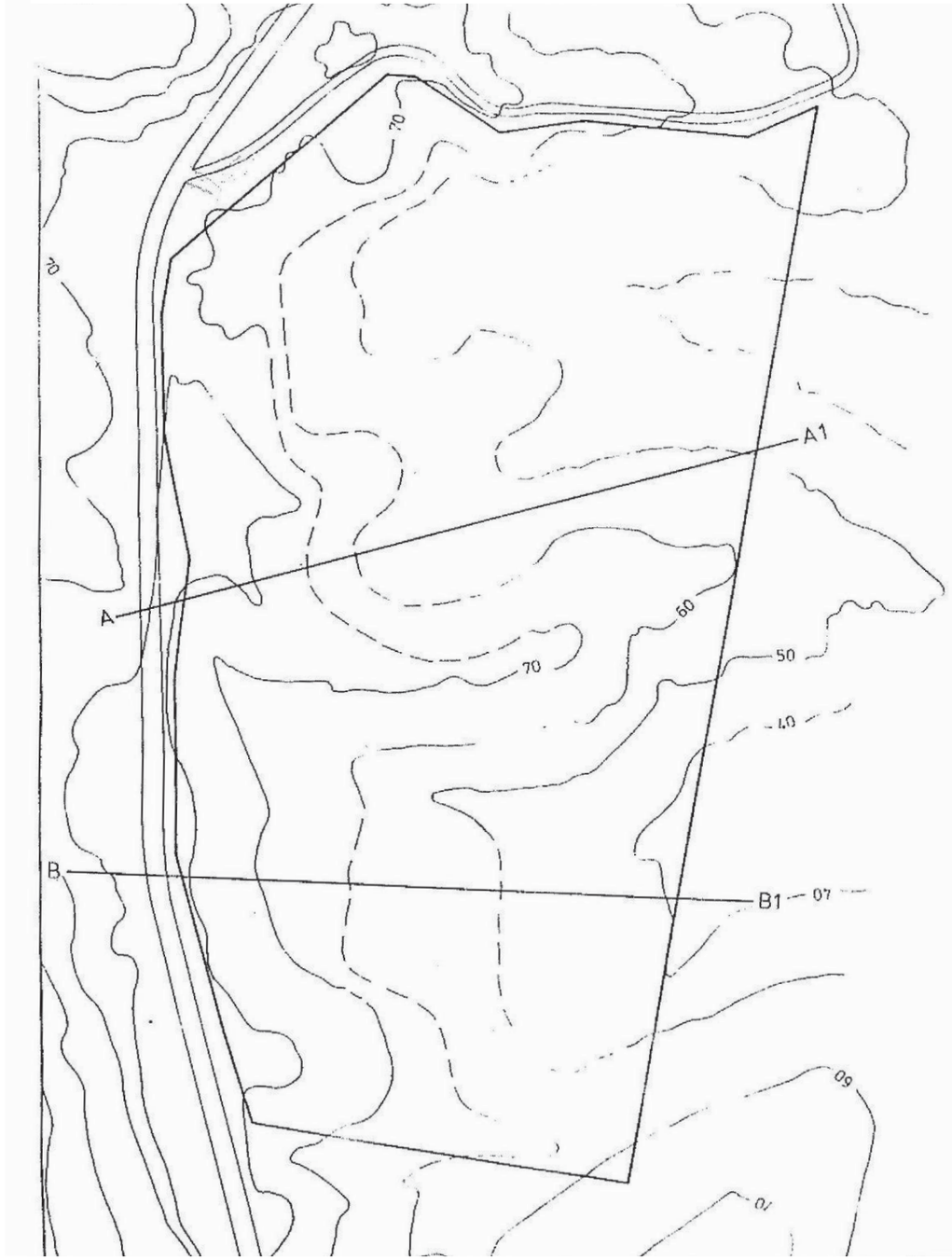
VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

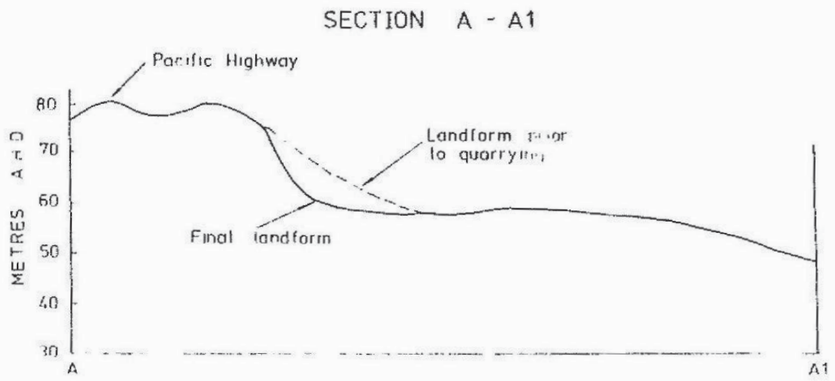
Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Final Landform	***Location:***	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Figure 17 Environmental Impact Statement Prepared by Resource Planning September 1982	***Our Ref:***	2806_FP_SWMP_2016_C004_V0_F4.cdr
Figure:	FOUR	***Council:***	Lake Macquarie City Council	***Survey:***	N/A	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 06/06/2016	***Client:***	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	10m	***Office:***	Thornton

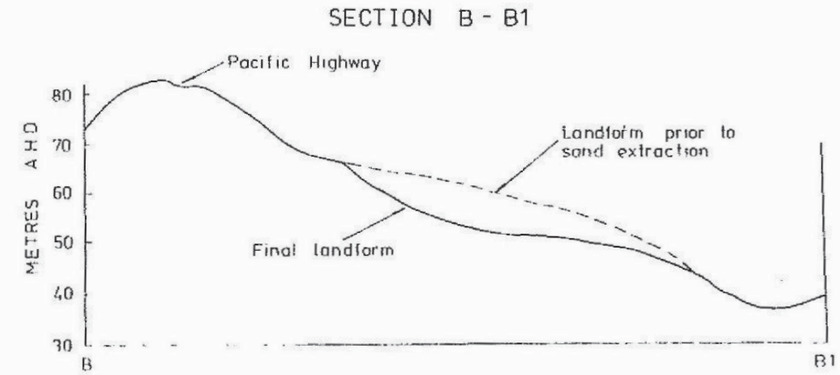
N

0 40 80 120 160 200m

vgt Environmental Compliance Solutions







KEY

70 Existing Contours (m)

Modified Contours (m)

FIGURE 17
FINAL LANDFORM

0 40 80 120 160 200
METRES

D.& J. CONSTRUCTIONS QUARRIES PTY LTD

Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson

Signed: Martin R. Hodgson

Date: 03/06/2016

Reviewed By VGT: Lisa Thomson

Signed: Lisa Thomson

Date: 03/06/2016

Project Manager VGT: Tara O'Brien

Signed:

Date: 03/06/2016

Section 3. Processing and Recycling Operations

In addition to extraction it is the proponent's intention to import cemiticious materials, slag and ash or blends of the same materials in order to blend with existing site road base materials to enhance the end product's quality. Concrete from demolition type activities will be brought onto site, crushed and blended with site materials in order to meet stringent Roads and Maritime Services specifications for road building material. 'Green' waste will also be imported and processed to provide a mulch material for blending and rehabilitation purposes.

All material received will be inspected and screened for foreign material which will be separated and placed in the appropriate storage bins for removal by a licensed waste contractor. Trucks found laden with hazardous waste will be rejected and removed from the site. Documentation and other relevant information will be requested by the waste provider as required by legislation.

Historically a pug mill was on site for a considerable period to undertake these recycling activities. Although the pug mill and associated silos (for storage of dry blending materials) were removed from the site early 2007, it is evidence that the proposed activities have previously in operation on the site. The past recycling activities have been accepted by the adjacent landowners and there has been negligible impact to the local environment.

Material imported for recycling purposes will be stockpiled on the hardstand areas of the quarry floor until required for processing. Processed material will also be stockpiled within the quarry floor. No recycled material will permanently remain on the site nor will it be used for rehabilitation.

Section 4. Site Characteristics

4.1. Topography

The land forms the southern portion of the Wallarah Peninsula, the main local features being the forested ridges, Lake Macquarie and the Pacific Ocean. Villages and towns are separated physically and visually by water and bush land.

Ridgelines which are common throughout the area are particularly prominent and make a major contribution to the visual environment.

The west of the site provides the highest elevation at approximately 80m AHD with the eastern most portions of the site lowering to approximately 40m AHD.

4.2. Site Amenities

There is a secure compound containing sheds and demountable buildings used for offices and amenities located in the north eastern portion of the site and are accessed via the haul road. The processing plant is located within the quarry floor. A weighbridge is also located centrally in the northern pit and will be integral to the processing operations.

Photographic Plate 1: Site Compound

4.3. Soil Types

Previous environmental investigations carried out on the site by Resource Planning Pty Ltd have identified two principle soil types; duplex profile soils on the gravel and podzols on the sand.

Soils on the gravel are acid (pH 5.5-6) and are rarely more than 40cm in depth. They comprise a surface organic sandy loam (0-20cm) underlain by B horizons comprising gravelly, sandy clay loams.

This material together with weathered gravel unsuitable for roadbase production is stripped from the working areas and currently stockpiled together at various locations around the quarry area.

Photographic Plate 2: Gravel deposit soil profile

The podzolic soils on the sand deposit consist of A horizons of organic-rich, clean fine to medium grained sand, underlain by sporadically bleached white, fine to medium grained sand to an average depth of 75cm. Beneath this depth the clay content increases, forming an iron-stained coating on individual sand grains in B horizons. This material appears to be uniform with depth. Minerals leached from the A horizons are redeposited in the upper part of the iron-stained B horizons, forming a hard 'pan'. The unit is acid throughout (pH5.5-6).

The A_1 and A_2 horizons comprising the organic rich, white sand have been stripped from the working area and stockpiled at various locations around the quarry.

Photographic Plate 3: Sand deposit soils

4.4. Geology

The Frazer Park Quarry is located in the Munmorah Conglomerate of Triassic age. In this area, it is predominately a conglomerate (hereafter referred to as gravel for ease of reporting) comprising well sorted pebbles 12.5 to 20mm in diameter with minor lenses of sandstone. Previous drilling has confirmed that the conglomerate reaches thicknesses of about 50m on the western margin reducing to 15m on the eastern margin**.**

On the western part of the holding the conglomerate comprises of up to 6m of 'brown' (weathered) conglomerate and 35-36m of 'blue' (unweathered) conglomerate.

In the southern portion of the holding, the conglomerate is lapped by recent Aeolian sand reaching a maximum thickness of about 15m.

Photographic Plate 4: Aeolian sand deposit.

Photographic Plate 5: Gravel deposit.

4.5. Surrounding Environments

The quarry is bounded by the Munmorah State Recreation Area (SRA), the Pacific Highway and coal mining activities represent a significant past land use. There exists an active quarry on the Pacific Highway to the south west of the site.

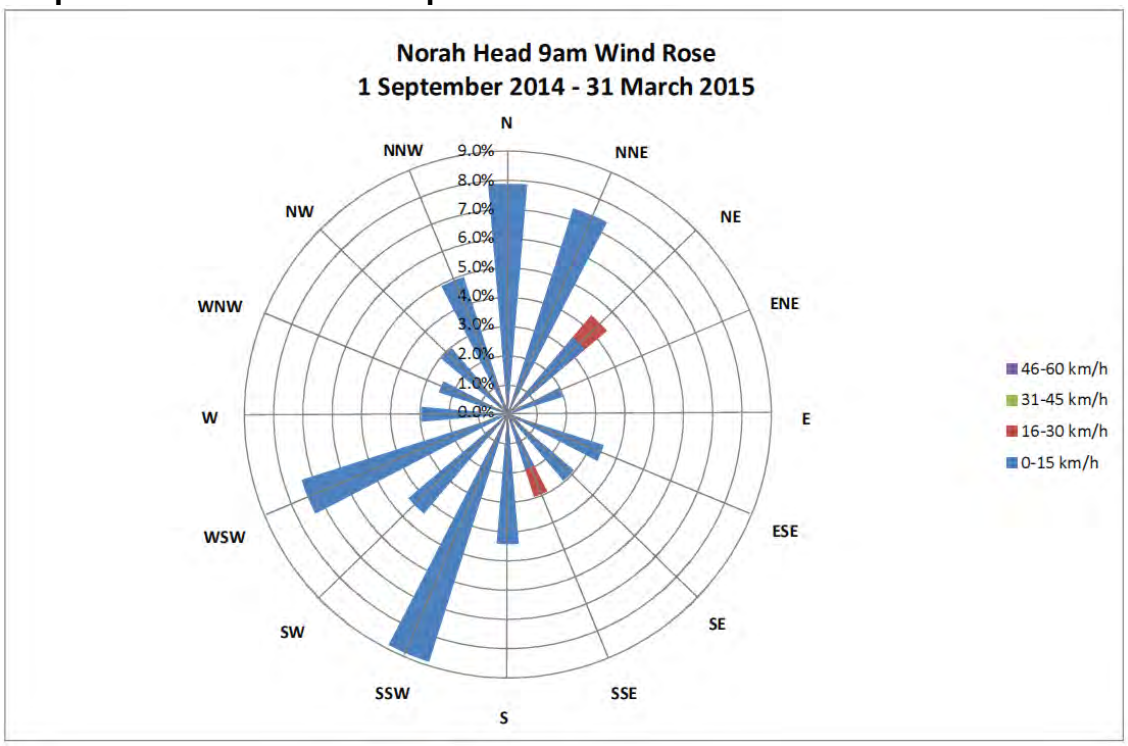
The development currently underway by Rose Corp in Catherine Hill Bay will introduce residential allotments within 1 kilometre of the quarry. Very little other development exists.

Photographic Plate 6: Frazer Park Quarry and residential development to the north east

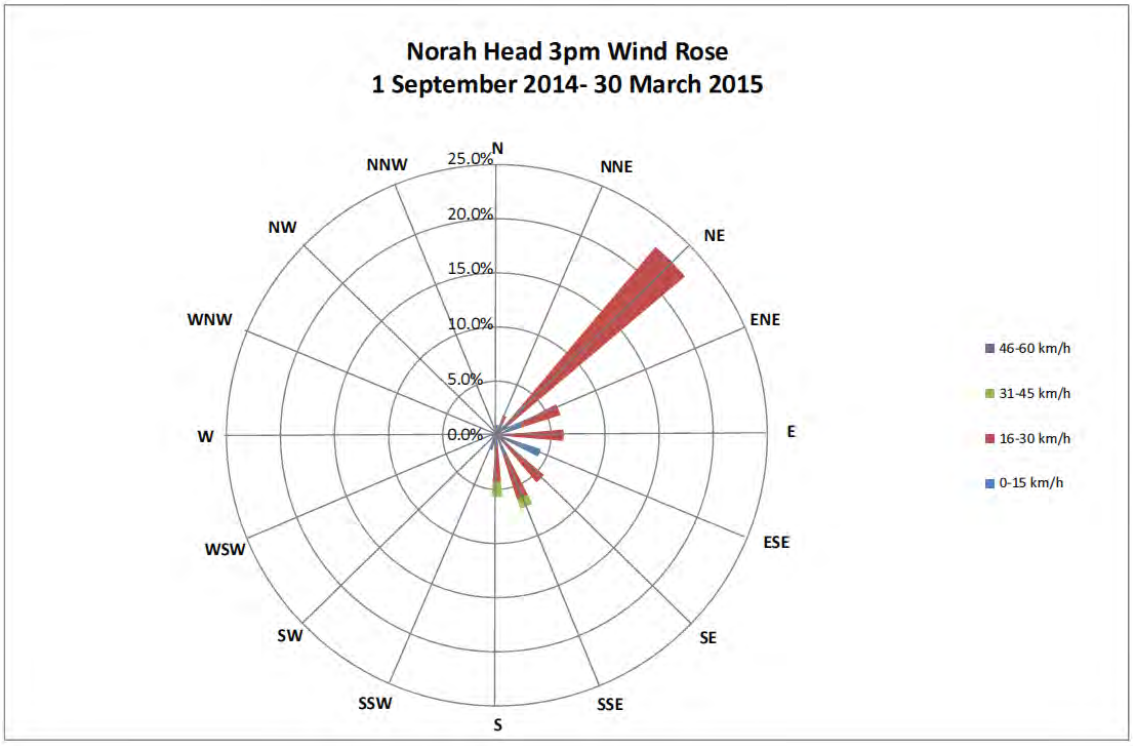
4.6. Climate Data

The climate at Frazer Park is typical of temperate coastal areas and is characterised by moderate temperatures throughout the year. Data from the Bureau of Meteorology states an average maximum temperature of 22ºC and minimum of 15ºC. The average annual rainfall is 1,230mm. Wind direction at 9am ranges predominately from the north to west and south with an average speed of 17.3km/hour. By afternoon the 3pm wind direction is either north easterly or south as on shore winds develop.

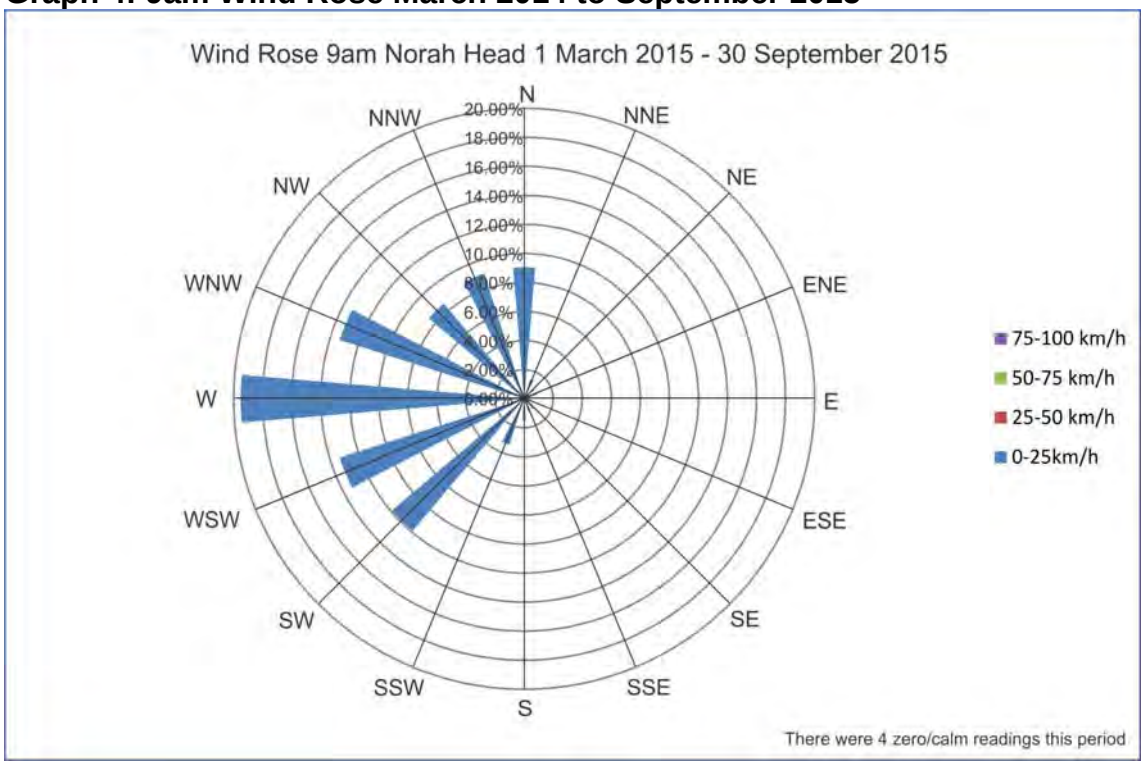
Graph 2: 9am Wind Rose September 2014 to March 2015



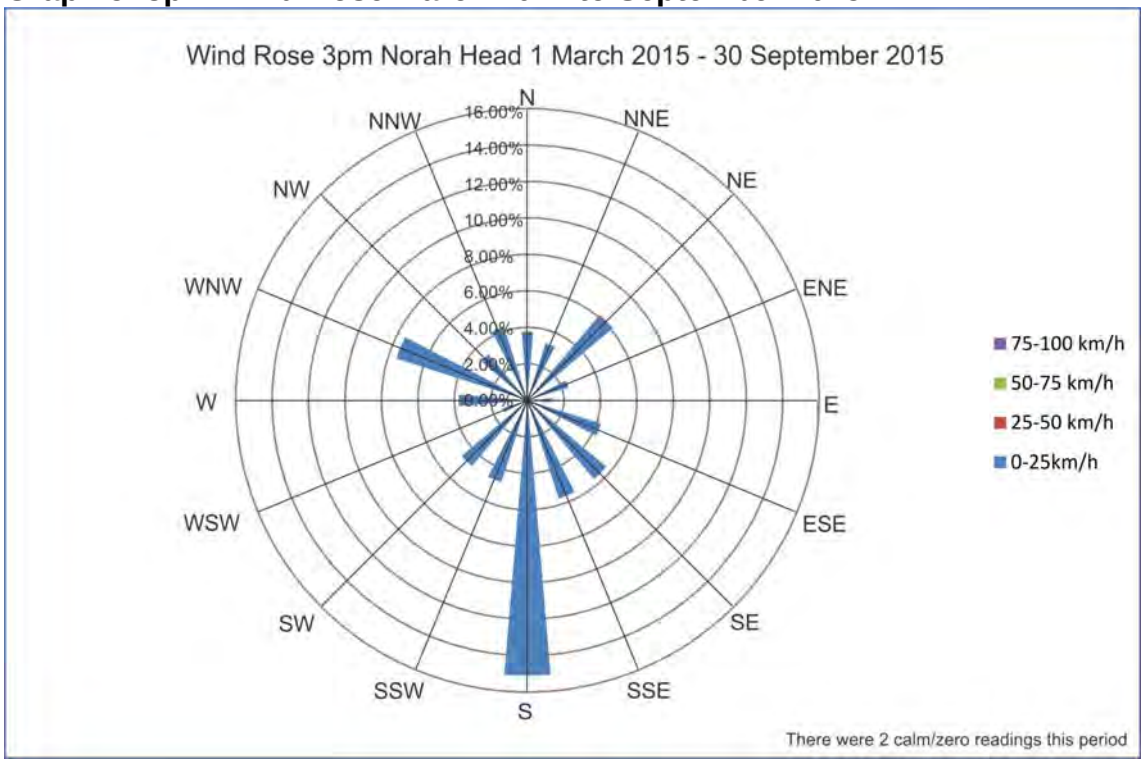
Graph 3: 3pm Wind Rose September 2014 to March 2015



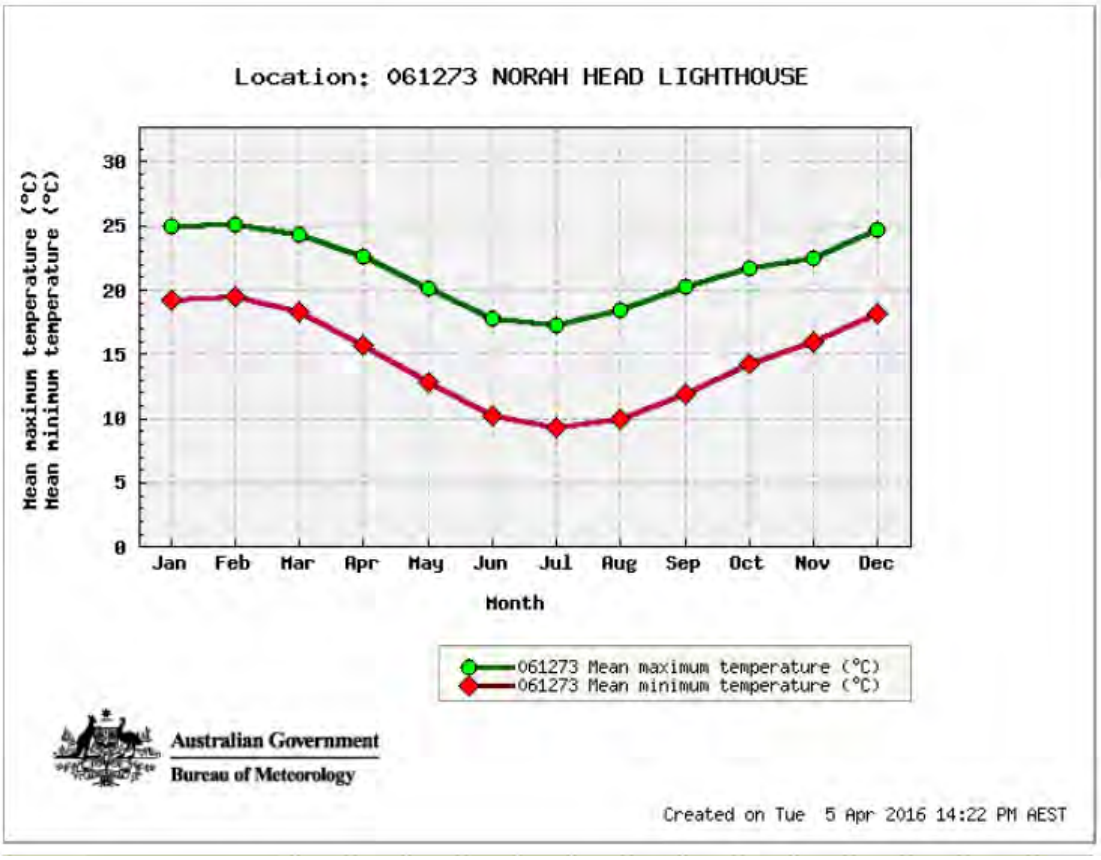
Graph 4: 9am Wind Rose March 2014 to September 2015



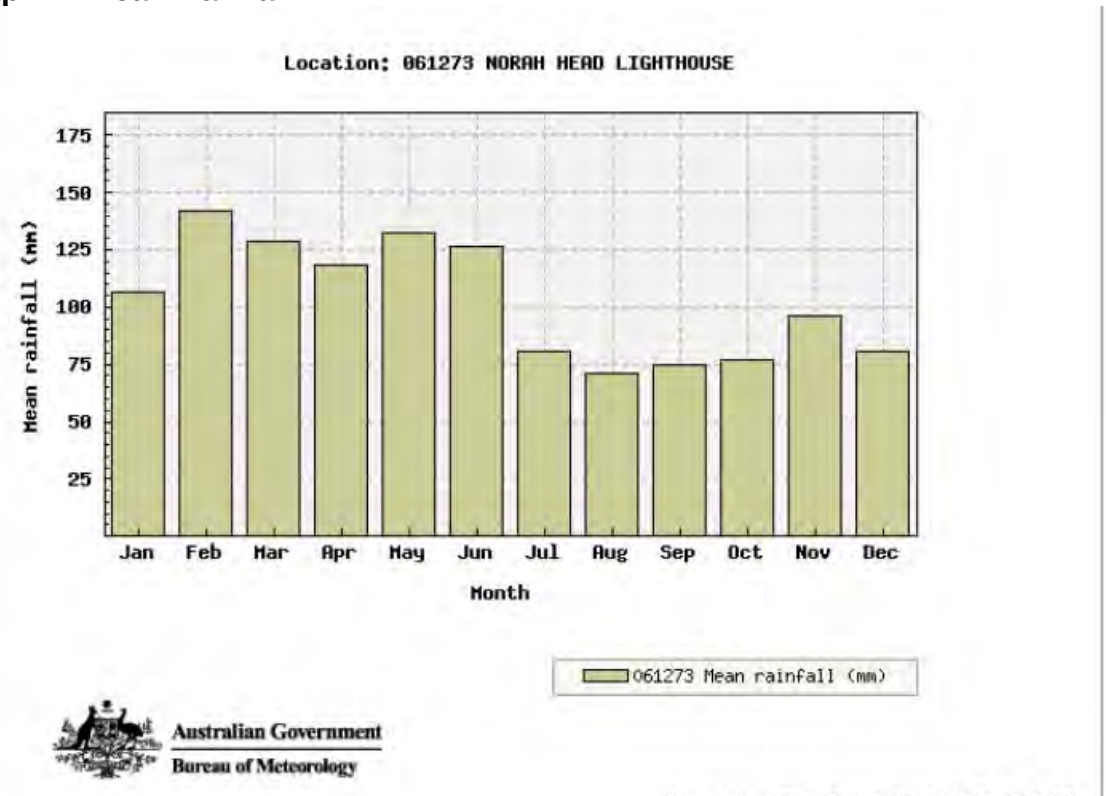
Graph 5: 3pm Wind Rose March 2014 to September 2015



Graph 6: Minimum and Maximum Temperatures



Graph 7: Mean Rainfall



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean rainfall (mm) for years 1969 to 2004	106.4	142.0	129.0	118.1	132.3	126.5	80.4	70.7	75.1	76.9	96.5	80.6	1230.5	35

Graph 8: Mean Evaporation

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean daily evaporation (mm) for years 1974 to 2016	6.9	6.2	5.0	3.8	2.7	2.5	2.6	3.6	4.7	5.6	6.3	7.2	4.8	42

Section 5. Existing Water Management

The site is managed with the aim of minimising ingress of clean water run-off into the excavation, so that sediment-laden water within the quarry is kept to a minimum. Surface water is collected within the excavated areas and directed to a number of sediment dams.

Should water from the sediment dams require discharge, testing is undertaken to ensure compliance with licence conditions.

5.1. Drainage Patterns

In general terms, the site is divided in two catchments, North Pit and South Pit. Within the North Pit there are six sub-catchments and within South Pit there are three sub-catchments (see *Figure Three*). The catchment of the operation is approximately 27.6Ha in total.

5.2. Clean Water Management

Clean water from the west bounded by the Pacific Highway and the slightly raised pit crest is directed around the site along natural drainage lines and eventually flows into wetlands and the Pacific Ocean to the east.

5.3. Dirty Water Management

5.3.1. North Pit Catchment One

Comprises the western most boundary of the quarry and extends from the north of the site to the southern boundary of the North Pit. It is further divided into 2 sub-catchments according to surface slopes. Surface water from this catchment drains via pipes under the entrance haul road to a sediment dam adjacent to the entrance haul road.

- North Pit Catchment One A (N1A) includes the active quarry to the west including the highwall areas and is approximately 3.98Ha in area. Average slopes are approximately 20% but some vertical faces are present. It drains via a pipe under the entrance haul road into Sediment Dam 8.
- North Pit Catchment One B (N1B) comprises the northern western floor of the quarry and is 3.43Ha in area with slopes around 3%. This catchment also drains to Sediment Dam 8 via the same pipe as N1A.

5.3.2. North Pit Catchment Two

Comprises the central area of the north pit processing area and the area to the north of the Office/Workshop compound. All surface water from this catchment drains into Sediment Dam 7. It covers an area of approximately 1.71Ha with slopes averaging 4%.

5.3.3. North Pit Catchment Three

This catchment includes the eastern most portion of the processing area and the Office/Workshop compound, Sediment Dams 5 (now removed) and 6. All surface water from this catchment drains into Sediment Dam 6 as Sediment Dam 5 has been breached in order to divert the water to Sediment Dam 6. It covers an area of approximately 3.57Ha with slopes averaging 7%.

5.3.4. North Pit Catchment Four

Comprises the south easternmost catchment in the North Pit and covers an area of 1.01Ha with slopes averaging 6%. Dirty water from this catchment drains into a sump within the catchment but due to the sandy soil the water dissipates into the ground and is not retained.

5.3.5. North Pit Catchment Five

This catchment is located in the north eastern most portion of the north pit and covers an area of 0.78Ha with slopes averaging 10%. It drains to a minor Sediment Dam (11) to the north. Similarly to North Pit Catchment Four, the sandy soil does not retain water and discharge of the dam is not required.

5.3.6. North Pit Catchment Six

Comprises the area north of the processing area and the final polishing dam prior to discharge into EPL Point 1. Recently the dam wall at the discharge point has been raised. This has increased the capacity of the dam and resulted the formation of one large dam from the previous Sediment Dams 9 and 10. It covers an area of 3.06Ha and slopes average 8%.

5.3.7. South Pit Catchment One

This catchment comprises the South Pit extraction area and covers an area of 9.37Ha. The majority of water drains to a centrally located pond, Sediment Dam 4 and thence drains via a filter pipe to the polishing ponds in east. A minor sediment dam in the north of the catchment collects clean surface water from undisturbed upper slopes and directs it to a small dam. When sufficient rainfall is received this dam overtops into Sediment Dam 4. Slopes within this catchment average 10%. The soils within this catchment are sandy and the majority of captured surface water is lost due to dissipation into the ground.

5.3.8. South Pit Catchment Two

This catchment comprises the final polishing ponds area prior to discharge from EPL Point 2. It covers an area of approximately 1.17Ha is generally well vegetated and has average slopes of 20%. Approximately 0.29Ha is disturbed but the majority of the catchment is clean water. Surface water collected in the catchment flows down slope into either Sediment Dam 2 or 3. The system is connected to South Pit Catchment One via a filter pipe beneath the emplaced coal waste in South Pit Catchment One which trickle feeds into Sediment Dam 3 and then Sediment Dam 2 via a pipe. The dams are well reeded to assist with flocculation of sediment with the final Sediment Dam 2 the discharge point.

5.4. Current Sediment Dam Capacities

5.4.1. Soil Constraints and Characteristics

In order to calculate required sediment dam capacities, it is necessary to consider soil characteristics, rainfall patterns and catchment areas. Certain assumptions have been made regarding the soil characteristics and are stated below. It should be noted that there are two distinctive soil types on the site with the north pit containing gravel and the south pit containing sand.

Table 1. Gravel Soil Type Constraints and Characteristics

Constraint/Opportunity	Value
Rainfall Erosivity	Moderate (R-factor= 2,950 from BOM IFD data)
Slope Gradients	Moderate to high (up to 20% on active faces)
Potential Erosion Hazard	High
Rainfall Zone	Zone 1
Soil Erodiblity	0.041 Moderate (on average)
Calculated Soil Loss	Averaging 370 tonnes/ha/yr depending on particular quarry slopes.
Soil Loss Class	From 1 to 6
Soil Texture Group	Type D (assumed)
Soil Hydrological Group	D
Runoff Coefficient	0.79 High
Peak Flow Runoff Coefficient	0.90 High

The soil erodibility factor has been determined from the Blue Book from the Doyalson Soil Landscape Map and has been assumed to be 0.041. The Soil Hydrological Group for the soil materials has been determined (Table C13 of the Blue Book- Doyalson) to be D, very high run-off potential. Water moves into and through these soils very slowly when thoroughly wetted. They shed run-off from most rainfall events.

Conservatively, sediment retention basins are designed using the Type D Soils calculations. This includes the sediment storage zone calculation using the estimated soil loss for the site over two months.

The likely soil loss is calculated with the Revised Universal Soil Loss Equation (RUSLE). The values of the other RUSLE factors are: P of 1.3, and the C is assumed to be 1.0 for bare soil.

Table 2. Sand Soil Type Constraints and Characteristics

Constraint/Opportunity	Value
Rainfall Erosivity	Moderate (R-factor= 2,950 from BOM IFD data)
Slope Gradients	Moderate to high (up to 20%)
Potential Erosion Hazard	High
Rainfall Zone	Zone 1
Soil Erodiblity	Moderate (on average)
Calculated Soil Loss	Averaging 490 tonnes/ha/yr depending on particular quarry slopes.
Soil Loss Class	From 2 to 6
Soil Texture Group	Type C (assumed)
Soil Hydrological Group	B
Runoff Coefficient	0.57 low to moderate
Peak Flow Runoff Coefficient	0.75 low to moderate

The soil erodibility factor has been determined from the Blue Book from the Doyalson Soil Landscape Map and has been assumed to be 0.041. The Soil Hydrological Group for the soil materials has been determined (Table C13 of the Blue Book- Doyalson) to be B, low to moderate run-off potential. Water moves into and through these soils at a moderate rate when thoroughly wetted. They shed run-off only infrequently.

Conservatively, sediment retention basins are designed using the Type D Soils calculations. This includes the sediment storage zone calculation using the estimated soil loss for the site over two months.

The likely soil loss is calculated with the Revised Universal Soil Loss Equation (RUSLE). The values of the other RUSLE factors are: P of 1.3, and the C is assumed to be 1.0 for bare soil.

5.4.2. Sediment Dam Volumes

The current estimated sediment dam volumes required as recommended from the Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries calculations for the design storm event of a 90th percentile, 5 day rainfall event for a standard receiving environment are shown below for a 5 day management period as well as 20 day management period. Full calculations can be found in *Appendix A*. The 20 day management period requires the dam capacities be 170% of the volume of the dam volume required for the 5 day management period.

Table 3. Calculated Required Dam Volumes

Dam Identification/ Catchment	Catchment Area (Ha)	Sediment Basin Storage (soil) volume (m^3)	Sediment Basin Storage (water) volume (m^3)	Dam Volume Required for 5 day management period (m^3)	Dam Volume Required for 20 day management period (170%) (m^3)
N1A (Dam 8)	3.98	696	1,956	2,652	4508
N1B (Dam 8)	3.43	61	1,685	1,746	2968
Total N1	**7.41**	**757**	**3,641**	**4,398**	7477
N2 (Dam 7)	1.71	154	840	884	1503
N3 (Dam 5 & 6)	3.57	245	1,754	1,900	3230
N4 (Dam 12)	1.01	134	358	381	648
N5 (Dam 11)	0.78	448	277	335	570
N6 (Dam 9 &10)	3.06	146	1,504	1,650	2805
S1 (Dam 4 & 4A)	9.37	922	3,322	4,244	7215
S2 (Dam 2, & 3)	1.17	39	415	454	772
Total S	**10.54**	**961**	**3,737**	**4,698**	7,987

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

The following table outlines the current estimated volume of water held by the sediment dams.

Table 4. Estimated Current Sediment Dam Volume of Water Held

Dam Identification	Dam Area (m^2)*	Estimated Depth (m)	Estimated Volume (m^3)
Dam 2	411	1.5	616
Dam 3	1,322	1.5	1,983
Dam 4A-	571	1.5	856
Dam 4	808	1.5	1,212
Dam 5	Currently dry, breached to fill Dam 6.		
Dam 6	11,549	2.5	28,873
Dam 7	1,789	1	1,789
Dam 8	1,661	1.5	2,492
Dam 9 & 10	7,312	2	14,624
Dam 11	Currently dry		
Dam 12	Currently dry		

*Dam areas are estimated from Nearmaps

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

The following table outlines the estimated maximum volume of the sediment dams and the current remaining capacity.

Table 5. Estimated Remaining Capacity of Sediment Dam

Dam Identification	Dam Area (m^2)	Estimated Maximum Depth (m)	Estimated Maximum Volume (m^3)	Remaining Capacity (m^3)	Dam Volume Required for a 20 management period (170%) (m^3)
Dam 2	411	2.5	1028	412	772
Dam 3	1322	2.5	3305	1322	
Dam 4A	571	3.0	1,713	857	7,215
Dam 4	10,489	6.5	68,178	66,966	
Dam 5	Currently dry, breached to fill Dam 6.			-	3,230
Dam 6	11549	4.5	51,970	23,097	
Dam 7	1789	2.0	3,578	1,789	1,503
Dam 8	4,503	3.0	13,509	11,017	7,477
Dam 9 & 10	9,496	4.0	37,984	23,360	2,805
Dam 11	240	1.5	360	360	570
Dam 12	661	1.5	992	992	648

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

As can be seen from the table above there is more than sufficient capacity in the current sediment dams for the design storm event with the exception of Dam 11. It is noted that due to the sandy soil in the Dam 11 catchment and the Dam itself that generally no water remains in the dam after 5 days due to dissipation through the soil.

5.4.3. Sediment Basin Design

The design of the sediment basins (Earth Basin-Wet) and other water management structures should be according to the Blue Book as shown in *Appendix B*. Some important features are noted below.

- The water depth of the sediment dam should be a minimum of 1,500mm.
- The sediment settling zone (water) should be a minimum depth of 600mm.
- There should be a minimum freeboard of 750mm over the crest of the spillway above the design capacity of the dam.
- The earth embankment surrounding the dam should be 3V:1H.
- The length to width ratio should be 3:1.
- All earthworks should be sufficiently vegetated or stabilised by other means to prevent failure of the dam or re-entrainment of sediment.

5.4.4. Sediment Dam Spillways

Spillway designs have been calculated for the dams directly into the downstream environment. The spillway sizing calculation for Dam 10 has been undertaken for the

immediate catchment (N6) only as this is main feeder for Dam 10 during storm events. Similarly the spillway for Dam 1 caters for the S2 catchment only. Spillways are not considered necessary for the other dams as discharge from these dams does not leave the site and potential sediment entrainment will be contained on site.

Using the Blue Book recommendation to design spillways for a 1 in 100 year ARI storm event the following recommendations are made. See *Appendix A* for full calculations.

The Dam 10 spillway should be constructed as shown in *Appendix B* from the Blue Book. The side slopes are to be at least 3H:1V with a channel base of 10%. The spillway should be trapezoidal in shape with a base width a minimum of 3 metres which should be lined with Light Performance TRM's and vegetated (or similar). This will ensure that the expected discharge flow rate of 2.10 cubic metres per second does not translate to an unsafe depth over the spillway.

The Dam 1 spillway should be constructed as shown in *Appendix B* from the Blue Book. The side slopes are to be at least 3H:1V with a channel base of 10%. The spillway should be trapezoidal in shape with a base width a minimum of 1.5 metres which should be lined with kikuyu of 50-150mm in height. This will ensure that the expected discharge flow rate of 1.31 cubic metres per second does not translate to an unsafe depth over the spillway.

Section 6. Proposed Water Management

6.1. Clean Water

No changes to the Clean Water system are proposed as shown in *Figure Three.*

6.2. Dirty Water

The majority of the quarry water management system will remain the same with the exception of the catchments that include the Processing Area, the Recycled Product hardstand area and the 'Tip and Sort' area. The changes to the system are discussed in detail below.

6.2.1. North Pit Catchment One

There will be no changes to the N1A catchment to the west. Catchment N1B will be slightly reduced in area to 1.76Ha due to the construction of the Recycled Product hardstand area and the access road to the tip and sort area which transect the catchment. Surface water collected from the east of the new exit loop road will be diverted to Sediment Dam 7.

6.2.2. North Pit Catchment Two

This catchment will increase in size to 2.11Has it will include the Recycled Product hardstand area. The floor of the pit will be reshaped to drain to the north from the east of the new haul loop road to be constructed for heavy vehicles. Surface water from the Recycled Product hardstand area will use the existing drains and road culverts to direct water to Sediment Dam 7.

The water from this catchment will still be considered dirty from sediment entrainment but is unlikely to contain other contaminants.

6.2.3. North Pit Catchment Three

Catchment N3 will decrease in area as surface water captures in the south western portion will be managed in the 'Tip and Sort' area. Water from this dam will continue to be utilised for dust suppression on the site.

6.2.4. Tip and Sort Area

The Tip and Sort area will be constructed to receive and sort waste products prior to processing. It will consist of a hardstand area where received material will be initially tipped off and inspected for contamination by hazardous or non-target materials. Target material will then be sorted into a series of concrete bays to await processing whist unwanted materials are stored on waste bins for removal off-site by a licenced contractor.. As there is the potential for contaminated material to be brought onto the site, the surface water from this catchment will be treated separately.

The surface water collected over this catchment will be diverted to a sump to be constructed on the eastern portion of the catchment. This will be achieved by forming a slightly sloped pad and drainage channels leading to the sump. A small berm (approximately 200mm in height) will surround the pad to ensure potentially contaminated surface water does not enter the surrounding catchments (see *Figure Seven* and *Figure Eight*) This catchment is estimated to cover an area of 0.4Ha and has slopes of 3%.

Water collected in this sump will be tested for pH, TSS and visible Oil and Grease prior to pumping out to Sediment Dam 7 and eventual discharge off site. If suspect material is on

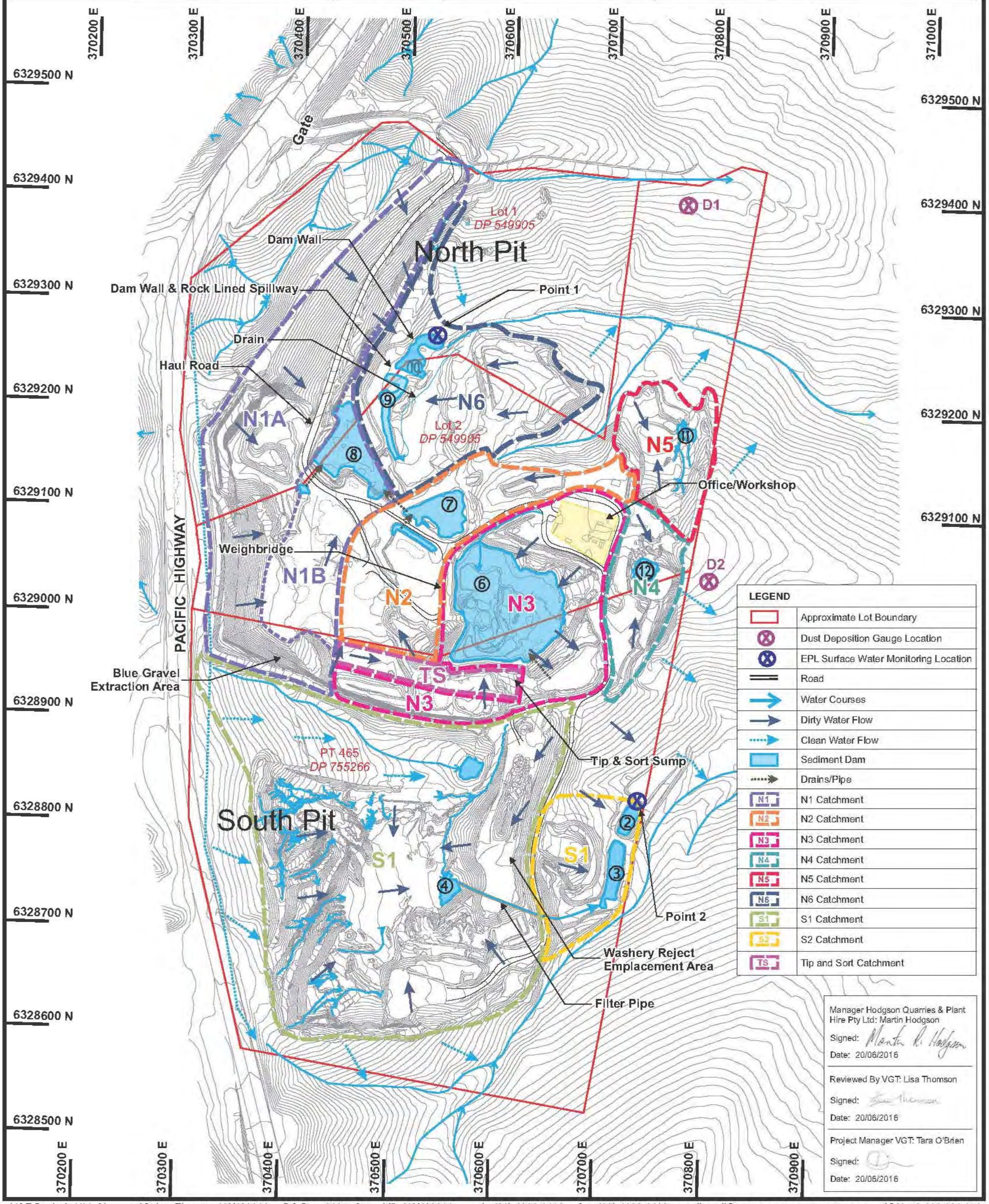
Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Proposed Water Management
Figure:	FIVE
Sheet:	1 of 1
Version/Date:	V1 20/06/2016

N

Scale: 0 250m

vgt Environmental Compliance Solutions

Location:	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Hatch Survey	***Our Ref:***	2806_FP_SWMP_2016_C005_V1_F5.cdr
Council:	Lake Macquarie City Council	***Survey:***	2014	***Plan By:***	TO/JD
Tenures:	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Client:	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton



Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson
Signed: Martin R. Hodgson
Date: 20/06/2016

Reviewed By VGT: Lisa Thomson
Signed:
Date: 20/06/2016

Project Manager VGT: Tara O'Brien
Signed:
Date: 20/06/2016

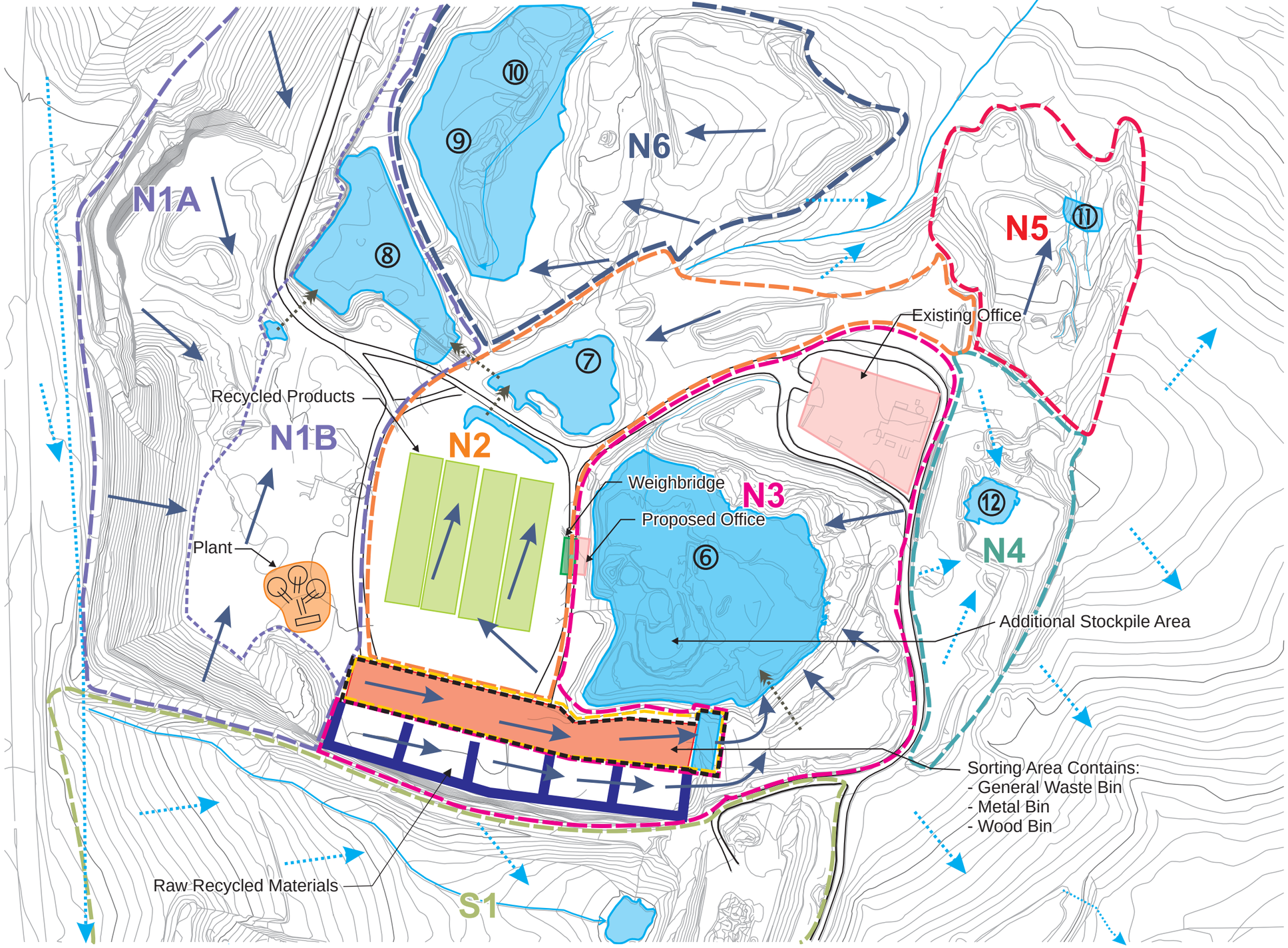
VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Proposed Water Management - Detail of North Pit	***Location:***	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Hatch Survey	***Our Ref:***	2806_FP_SWMP_2016_C006_V0_F6.cdr
Figure:	SIX	***Council:***	Lake Macquarie City Council	***Survey:***	2014	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 25/05/2016	***Client:***	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 10 20 30 40 50m

vgt Environmental Compliance Solutions



LEGEND

	Recycled Products Storage Area
	Raw Recycled Products Storage Area
	Tip and Pick Area
	Office
	Weighbridge
	Plant and Processing Area
	Conglomerate Stockpile
	Road
	Berm (Approx. 200mm in Height)
	Water Courses
	Dirty Water Flow
	Clean Water Flow
	Sediment Dam
	Drains/Pipe
N1	N1 Catchment
N2	N2 Catchment
N3	N3 Catchment
N4	N4 Catchment
N5	N5 Catchment
N6	N6 Catchment
S1	S1 Catchment
	Tip and Sort Sump Catchment

Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson
Signed: Martin R. Hodgson
Date: 03/06/2016

Reviewed By VGT: Lisa Thomson
Signed: Lisa Thomson
Date: 03/06/2016

Project Manager VGT: Tara O'Brien
Signed:
Date: 03/06/2016

VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Detail of Recycling Areas	***Location:***	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Hatch Survey	***Our Ref:***	2806_FP_SWMP_2016_C007_V0_F7.cdr
Figure:	SEVEN	***Council:***	Lake Macquarie City Council	***Survey:***	2014	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	Environment Protection Licence 1246	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 25/05/2016	***Client:***	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 5 10 15 20 25m

vgt Environmental Compliance Solutions

Large Vehicle Route

Berm to Divert Water Captured Over The Sorting Area

Small Vehicle Route

N1

N2

N3

⑥

Sorting Area- Contains Waste Bins
- General Waste Bin
- Metal Bin
- Wood Bin

TIP/SORT

R5

32m

R4

20m

R3

N3

R2

R1

Sediment Basin
Approx 24m (w) x 8m (l) x 1.5m (d)

Raw Recycled Materials Bays Constructed of Cement Blocks to Allow Water to Flow Through

S1

LEGEND

	Recycled Products Storage Area
	Raw Recycled Products Storage Area
	Tip and Pick Area
	Road
	Berm (Approx. 200mm in Height)
	Water Courses
	Dirty Water Flow
	Clean Water Flow
	Sediment Dam
N1	N1 Catchment
N2	N2 Catchment
N3	N3 Catchment
S1	S1 Catchment
TS	Tip and Sort Sump Catchment

Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson

Signed: Martin R. Hodgson

Date: 03/06/2016

Reviewed By VGT: Lisa Thomson

Signed: Lisa Thomson

Date: 03/06/2016

Project Manager VGT: Tara O'Brien

Signed:

Date: 03/06/2016

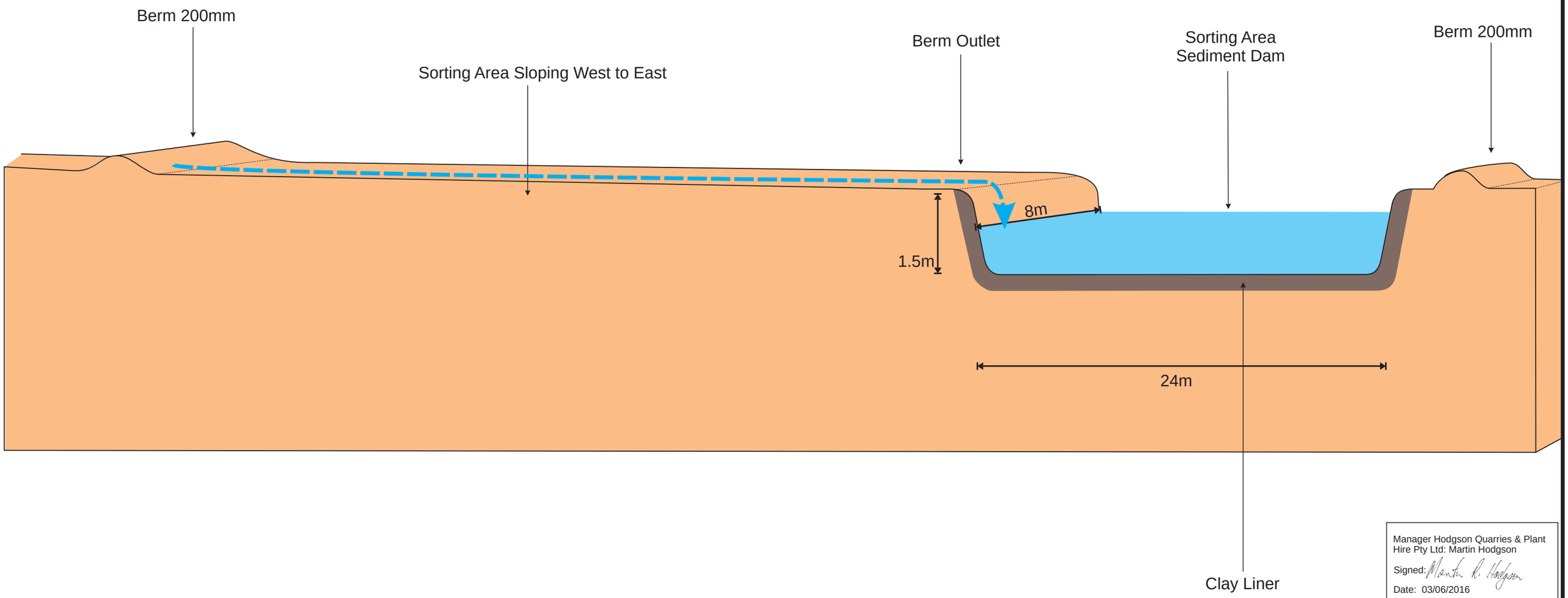
VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

Plan of:	Frazer Park Soil and Water Management Plan April 2016 - Cross Section of Tip and Sort Area	***Location:***	Frazer Park Quarry Lot 1 Pacific Highway, Frazer Park, NSW	***Source:***	Hatch	***Our Ref:***	2806_FP_SWMP_2016_C008_V0_F8.cdr
Figure:	EIGHT	***Council:***	Lake Macquarie City Council	***Survey:***	N/A	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	Environment Protection Licence 1246	***Projection:***	N/A	***Project Manager:***	TO
Version/Date:	V0 24/05/2016	***Client:***	Hodgson Quarries and Plant Hire Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

N

Not To Scale

vgt Environmental Compliance Solutions



Manager Hodgson Quarries & Plant Hire Pty Ltd: Martin Hodgson

Signed: Martin R Hodgson

Date: 03/06/2016

Reviewed By VGT: Lisa Thomson

Signed: Lisa Thomson

Date: 03/06/2016

Project Manager VGT: Tara O'Brien

Signed:

Date: 03/06/2016

the Tip and Sort Area and rainfall is expected, the material will be tarped to prevent rainfall infiltrating and potentially mobilising contaminants. If, despite these measures, it is suspected that other contaminants have entered the sump via contaminated waste brought onto the tip and sort area, the water will be tested for targeted analytes. Depending on the presence or concentrations of the analytes the sump water may be discharged (if there will be no environmental harm) or other disposal options considered such as pumping out and disposal to a licenced waste facility.

6.2.5. South Pit Catchment

There will be no changes to the south pit dirty water system.

6.3. Future Sediment Dam Capacity Requirements

The estimated future sediment dam volumes required as recommended from the Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries calculations for the design storm event of a 90th percentile, 5 day rainfall event for a standard receiving environment are shown below for a 5 day and a 20 day management period.

Table 6. Calculated Future Dam Capacities Required

Dam Identification/ Catchment	Catchment Area (Ha)	Sediment Basin Storage (soil) volume (m^3)	Sediment Basin Storage (water) volume (m^3)	Dam Volume Required for a 5 day management period (m^3)	Dam Volume for a 20 day management period (170%) (m^3)
N1A (Dam 8)	3.98	696	1,956	2,652	4,508
N1B (Dam 8)	1.76	31	865	896	1,523
Total N1	**5.74**	**727**	**2,821**	**3,548**	**6,031**
N2 (Dam 7)	2.11	54	1,037	1,091	1,855
N3 (Dam 5 & 6)	3.37	137	1,656	1,793	3,048
N4 (Dam 12)	1.01	134	358	381	648
N5 (Dam 11)	0.78	448	277	335	570
N6 (Dam 9 &10)	3.06	146	1,504	1,650	2,805
Tip and Sort Area	0.40	6	142	148	252
S1 (Dam 4 & 4A)	9.37	922	3,322	4,244	7,215
S2 (Dam 2, & 3)	1.17	39	415	454	772
Total S	**10.54**	**961**	**4,353**	**4,698**	**7,987**

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

The following table outlines the estimated maximum capacities of the sediment dams compared with the requirements of the future development.

Table 7. Estimated Maximum Sediment Dam Volumes

Dam Identification	Dam Area (m^2)*	Estimated Depth (m)	Estimated Maximum Volume (m^3)	Dam Volume Required for a 5 day management period (m^3)	Dam Volume for a 20 day management period (170%) (m^3)
Dam 2	411	2.5	1028	454	772
Dam 3	1,322	2.5	3305		
Dam 4A-	571	3.0	1,713	4,244	7,215
Dam 4	10,489	6.5	68,178		
Dam 5	Currently dry, breached to fill Dam 6.			1,793	3,048
Dam 6	11549	4.5	51,970		
Dam 7	1789	2.0	3,578	1,091	1,855
Dam 8	1,661	3.0	13,509	3,548	6,031
Dam 9 & 10	7,312	4.0	37,984	1,650	2,805
Dam 11	240	1.5	360	335	570
Dam 12	661	1.5	992	381	648
Tip and Sort Sump	192*	1.5	288	148	252

*Dam areas are estimated from Nearmaps.

#Tip and Sort Sump proposed dimensions are 8m x 24m x 1.5m.

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

As previously noted that due to the sandy soil in the Dam 11 catchment and the dam itself that generally no water remains in the dam after 5 days due to dissipation through the soil.

6.4. Diversion Drains

If new diversion drains are required they will be designed with a sufficient capacity to convey runoff from a 1 in 10 year storm. They will be trapezoidal in shape and have side batters of 1 in 3 to enable maintenance of the structures (see *Appendix B)*

Where steep grades are required which result in flow velocities that may cause scour, the drains shall be lined with appropriate scour protection, e.g. rock, jute mesh, rip rap etc.

6.5. Contaminated Water

The main source of potential water contamination, aside from sediment from the quarry, is hydrocarbons from fuels and oils used by the plant on the site. The risk of hydrocarbons entering the water system will be minimised by restricting all plant and vehicle repair and maintenance to the designated workshop area. Bunding has been constructed around the workshop area to contain any leaks or spills and divert clean water around the site.

Refuelling is restricted to within the designated area which contains a sump to collect any spilled fuel.

Any spill or leaks are dealt with as per the Spill and Leaks Procedure. Waste and contaminated material is removed off site by a licenced waste contractor. Visual inspections of the workshop area and refuelling area will be undertaken to ensure bunding and other controls are adequate. Within the quarry area and water management features, regular inspections will also assist in identifying potential risks to the environment.

As stated previously, water collected in the Tip and Sort sump will be tested prior to discharge for targeted analytes and either discharged through the normal water management system or other treatment or disposal options will be investigated.

6.6. Minimisation of Water Use

No potable water is connected to the site. Toilet facilities are provided by portable amenities that are serviced regularly by a contractor. The proponent currently endeavours to recycle as much dirty water on site as possible. Water collected in the Sediment Dams is used for dust suppression, rehabilitation works and for processing/crushing operations. The majority of surface water is returned to the downstream environment once it meets the EPL criteria and this will continue with the proposed operations.

6.7. Rehabilitation

As the site is progressively rehabilitated the rate of entrainment of sediment and erosion will decrease. Water management structures will remain in place until rehabilitation is complete but will transition from dirty water structures to clean water structures. This plan should be reviewed regularly to ensure proposed future operations are incorporated adequately.

Section 7. Water Demands

7.1. Water Licencing

The Water Management Act 2000 identifies basic landholder rights and when access licences are required. The harvestable water right is defined in terms of an equivalent dam capacity, the Maximum Harvestable Right Dam Capacity (MHRDC). Schedule 1 of the Water Management Regulation 2011 exempts certain classes of dam including those dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority to prevent the contamination of a water source. Therefore, as the on-site dams are used solely for the capture, containment and reticulation of drainage, consistent with best management practice to prevent impacts to the downstream environment they are not required to be licenced.

7.2. Current Water Demands

Water to supply the dust suppression is sourced from the onsite sediment dams. At present Dam 6 is the primary supply however any of the dams may be used if required.

Water is currently used on the site for dust suppression on stockpile areas and haul roads as well as dust suppression during crushing. On average, the water cart (10,000L capacity) is loaded 6 to 8 times a day for approximately 4 days per week for haul road and stockpile dust suppression. This equates to an average daily demand of 40,000L (40m^3) per day averaged over the year.

The crushing plant runs approximately 8 hours per day when operating for the abovementioned 4 days per week. It requires the water cart to refill approximately every 2 hours thus consuming 40,000L on a normal operating day. This equates to an estimate of 23,000L (23m^3) of water consumed per day averaged over the year.

Table 8. Current Daily Water Demands

Activity	Daily Usage (cubic metres)
Dust suppression on haul roads and stockpile areas	40
Dust suppression of crushing plant	23
Total	**63**

7.3. Predicted Water Demands

It is envisaged that the proposal will increase the demand for water. This will be due to the additional dust suppression measures required on the haul roads and stockpile areas as well as the dust suppression demands of the crushing plant. The crushing plant is expected to run for approximately 8 hours per day, averaging 5 days per week.

For site dust suppression, on average, the water cart (10,000L capacity) is expected to be loaded 8 times a day for approximately 5 days per week. This equates to an average daily demand of 80,000L (80m^3) per day averaged over the year.

The crushing plant, which will be used for both the extracted material and the recycled material is expected to operate approximately 8 hours per day 5 days per week. It

requires the water cart to refill approximately every 2 hours thus consuming 40,000L ($40m^3$) on a normal operating day.

Table 9. Predicted Daily Water Demands

Activity	Daily Usage (cubic metres)
Dust suppression on haul roads and stockpile areas	80
Dust suppression of crushing plant	40
Total	**120**

7.4. Water Balance

A detailed water balance for the future operations has been undertaken for the site. Due to the geology, topography and usage of the site the water balance has been divided into the North Pit and South Pit. Each catchment has been assessed for an average rainfall year, a wet year and a dry year. Data for rainfall is not available for the site and the Bureau of Meteorology historical monthly data for the Nora Head Lighthouse was used with the exception of the daily evaporation figures which were taken from the Williamtown RAAF base.

Usage rates of water on the site are described in *Section 7.3* above. The following is a list of assumptions made for the water balance.

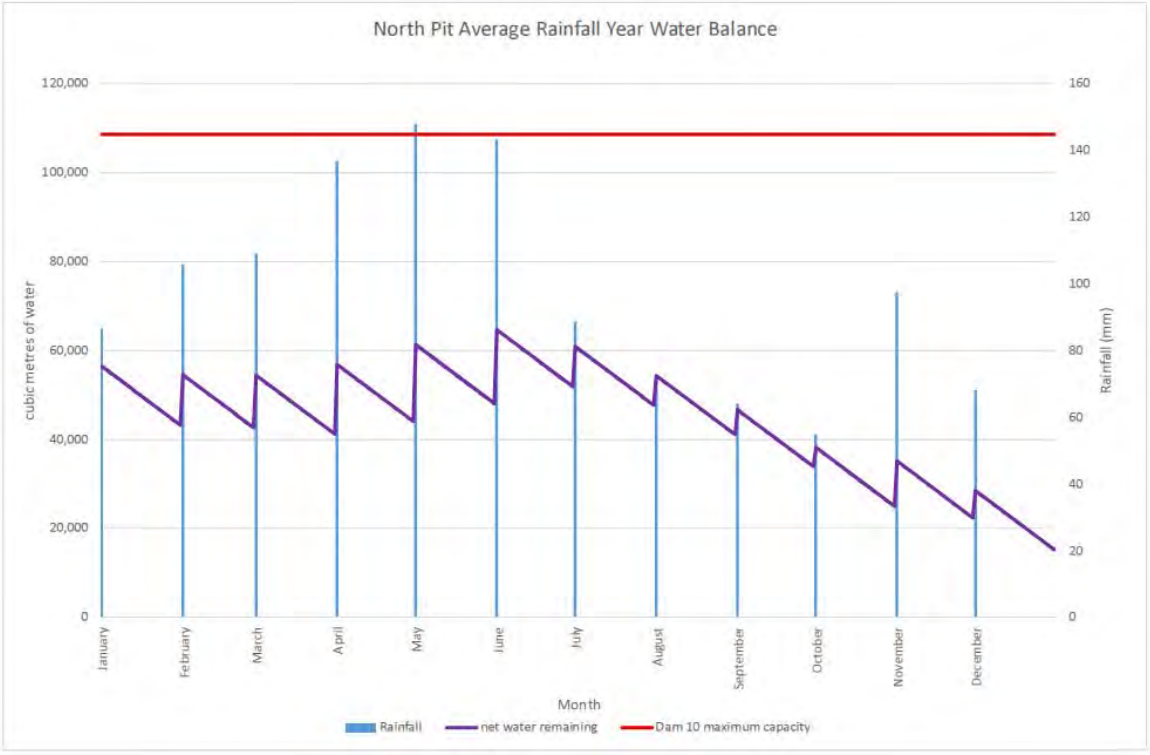
- Historical rainfall data from the Nora Head Lighthouse has been used for the years 1970 to 2003.
- The average annual rainfall is 1174mm according to BOM and the year 1970 where 1175mm of rainfall was received has been selected as representative of an average year.
- The wettest year and driest years were 1990 (1996mm) and 1980 (723mm) respectively.
- Since daily rainfall data is unavailable in the historical data, it has been assumed that the monthly rainfall is received in one storm event on the first of the month.
- It has been assumed that more than 20mm of rainfall must be received prior to runoff occurring.
- A runoff coefficient of 0.79 (from the blue book) has been used for the North Pit and South Pit (S2) which is predominately gravel and clay.
- A runoff coefficient of 0.57 (from the blue book) has been used for the South Pit (S1) catchment which consists of sandy material.
- The North Pit catchment is approximately 17.5Ha.
- The South pit has been divided into 2 sub catchments S1 is approximately 9.36Ha and S2 is approximately 1.17Ha.
- Maximum dam volumes before overtopping have been calculated from survey data and estimated dam depths.
- The affective area of evaporation has been assumed to be the current dam surface areas. The actual area will vary according to the dam volume but for this calculation vertical dam walls are assumed for ease of calculation.

- A pan evaporation factor of 0.75 for the water storage (to convert recorded pan evaporation to pond surface evaporation).
- Water usage only applies to the North Pit. The value is assumed to be constant throughout the year. In reality it may vary between drier months compared with wetter months.
- All dams in the North Pit area are assumed to feed into Dam 10 as a worst case scenario. This can be achieved by gravity feed or by pumping during normal water management activities. During extreme storm events internal dams in the catchment may overtop and will drain to Dam 10.
- Discharge from the North Pit is via Dam 10 and is assumed to be via pump 8 hours per day at 40,000L per hour.
- Discharge from the South Pit is from Dam 2 is assumed to flow at a rate of 500 cubic metres per day based on the dam volume and the time to empty the dam.
- Aside from incident rainfall, Dam 3 and thence Dam 2 receives water from Dam 4 via a filter pipe under the emplacement area. The flow rate for this pipe has been assumed to be 10L/min.
- A dissipation rate of 0.3m per day has been applied to Dam 4 due to the sandy soil.

7.4.1. North Pit Water Balance

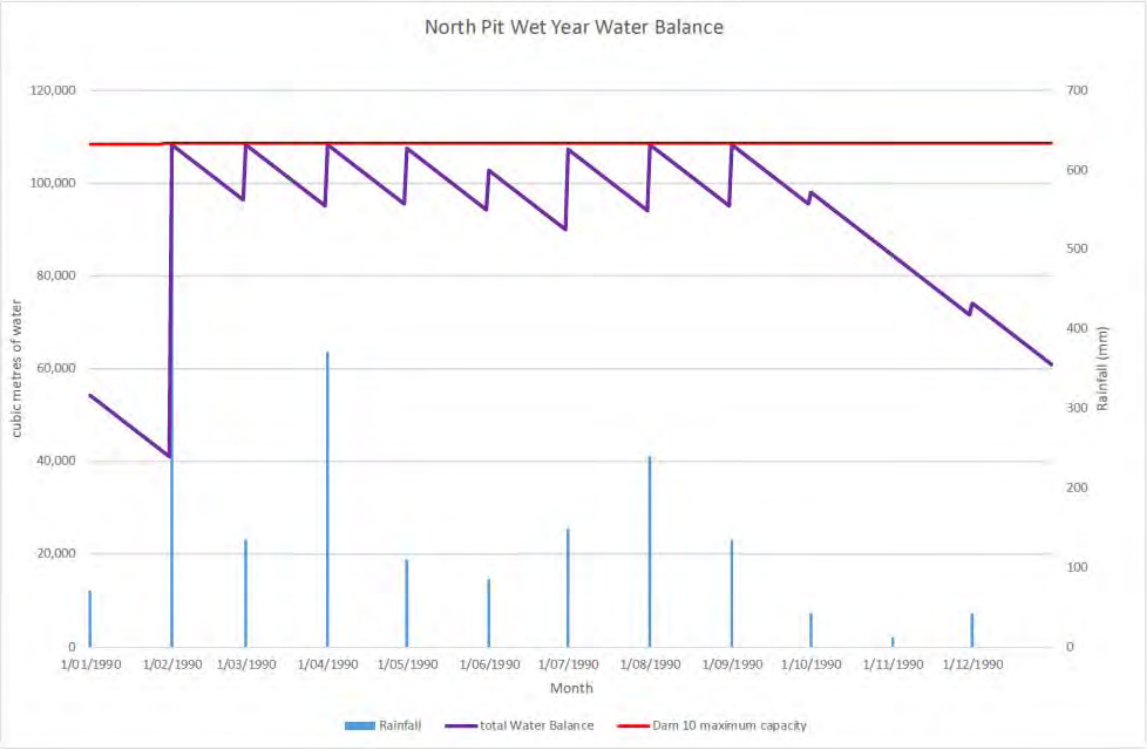
The North Pit water balance has been addressed separately from the South Pit as the recycling process will be undertaken in this catchment and this catchment supplies the water used on site for dust suppression and crushing. It will also include the dedicated sump for the Tip and Sort area.

Graph 9: North Pit Average Rainfall Year Water Balance



As can be seen from the graph above during an average rainfall year the pit will not spill from Dam 10. The pumping regime is able to maintain sufficient capacity for the design storm event at all times within a 20 day management period. This is acceptable according to the Blue Book which recommends that the average annual overflow frequency for a 90th percentile design storm event is 2-4 spills per year.

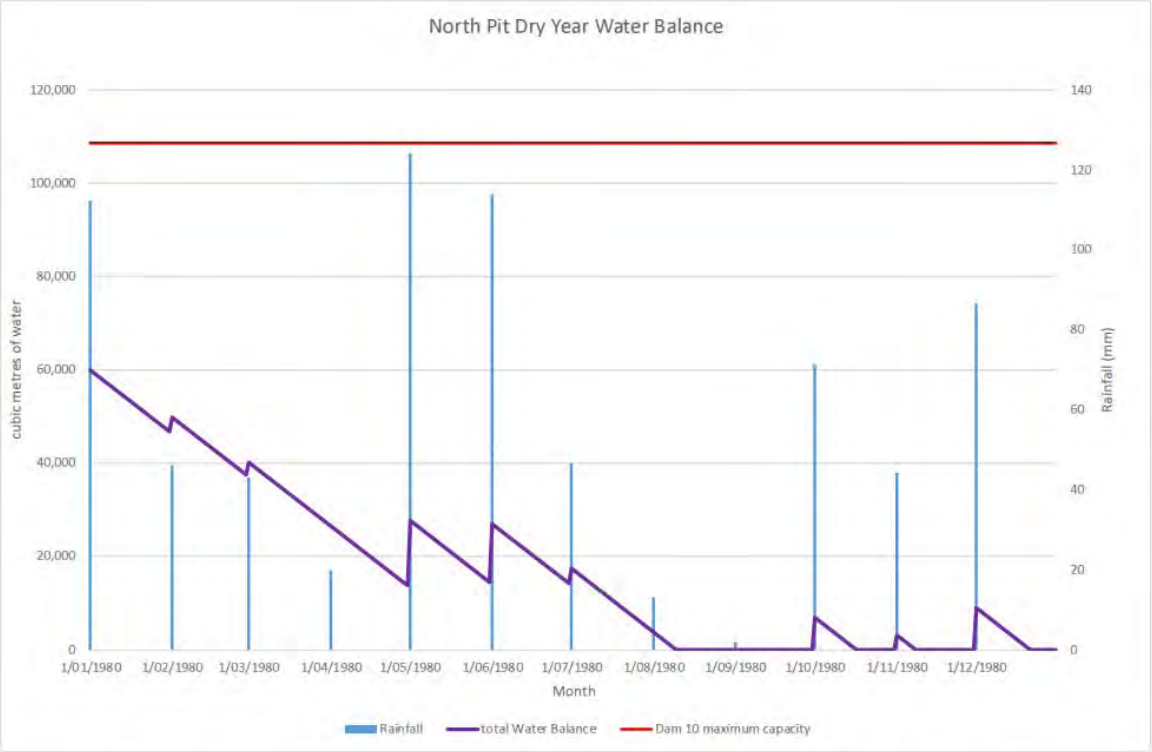
Graph 10: North Pit Wet Year Water Balance



During wet years it is expected that Dam 10 may overtop approximately 5 times. During these times the rainfall received is in excess of the design criteria of the Dams and overflows are expected. This is slightly outside the acceptable number of spills according to the Blue Book which recommends that the average annual overflow frequency for a 90th percentile design storm event is 2-4 spills per year.

It should be noted that during particularly wet periods, the required capacity of the dam may not be able to be maintained within the 20 day management period. The above model suggests that the required capacity of Dam 10 may take many months to achieve under the current pumping regime. Consideration could be given to altering the pumping regime to increase pumping hours i.e. 24 hours a day or the provision of additional pumps if the water is of sufficient quality to discharge.

Graph 11: North Pit Dry Year Water Balance

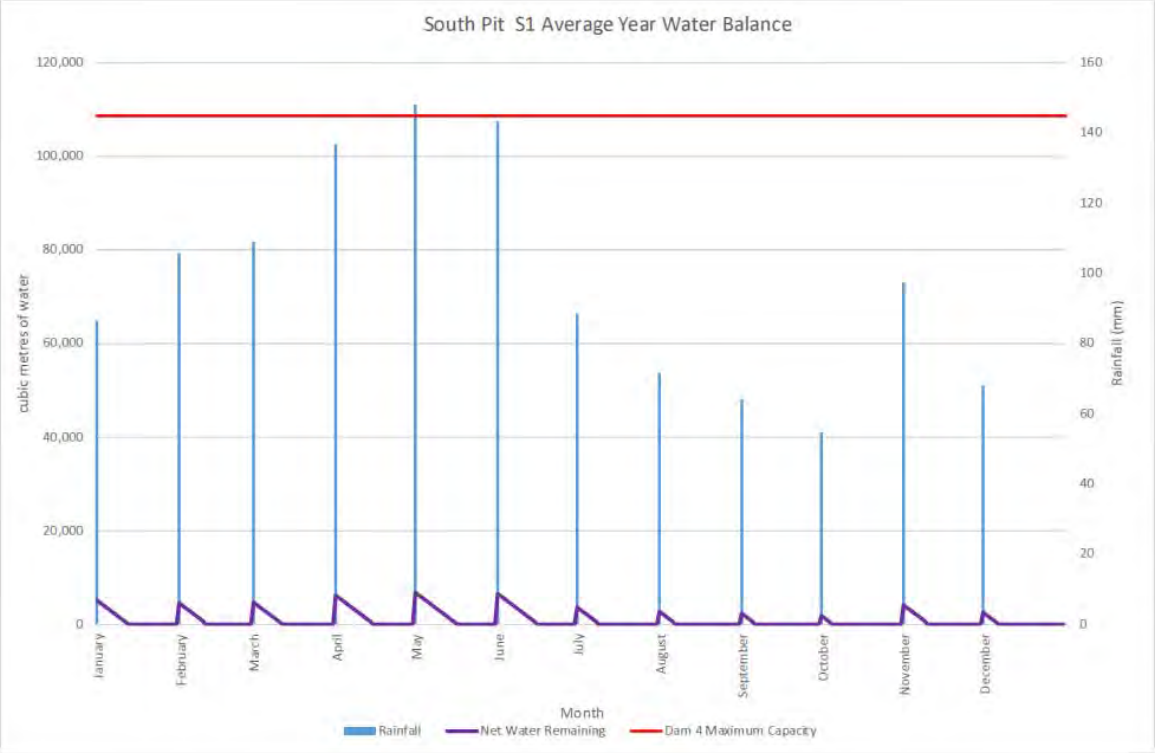


As can be seen from the graph above during a dry rainfall year the pit will not spill from Dam 10. The pumping regime is able to maintain sufficient capcity for the design storm event at all times within a 20 day management period. Water may not be discharged from the site if a dry period is expected in order to maintain sufficient supply for precessing and dust supression.

7.4.2. South Pit (S1) Water Balance

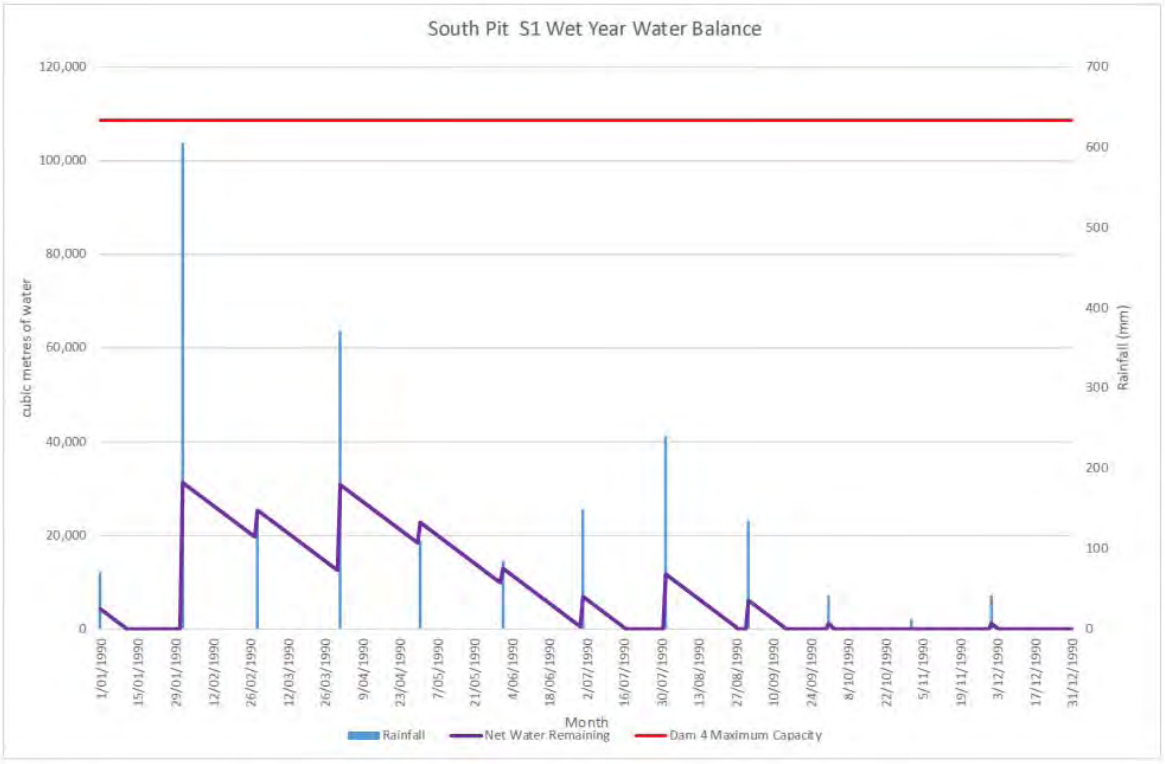
The South Pit (S1) water balance has been addressed separately. It essentially will be managed as it is now as it will not be involved in the recycling operation. Note, it feeds South Pit Dams 2 & 3 via a filter pipe under the emplacement area.

Graph 12: South Pit (S1) Average Rainfall Year Water Balance



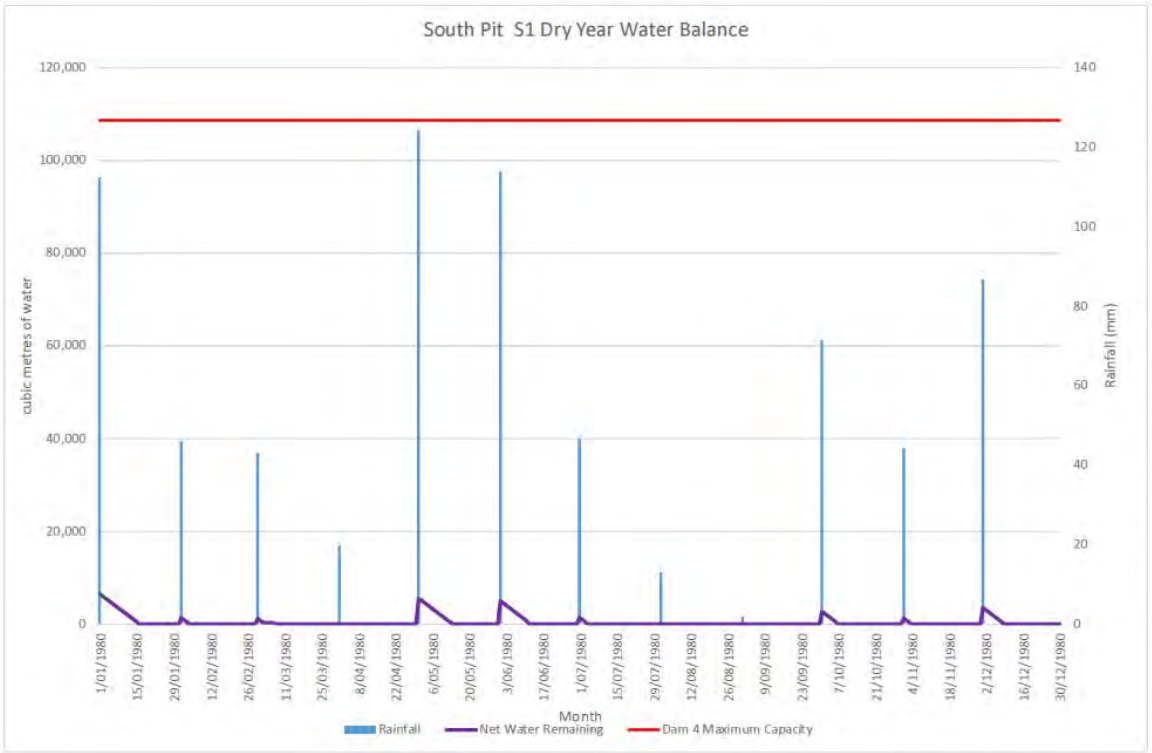
As can be seen from the graph above during an average rainfall year the pit will not spill from Dam 4. The discharge regime is able to maintain sufficient capcity for the design storm event at all times within a 20 day management period. This is acceptable according to the Blue Book which recommends that the average annual overflow frequency for a 90th percentile design storm event is 2-4 spills per year.

Graph 13: South Pit (S1) Wet Year Water Balance



Similarly to the average rainfall year the pit will not spill from Dam 4 in a wet year. The discharge regime is able to maintain sufficient capacity for the design storm event at all times within a 20 day management period.

Graph 14: South Pit (S1) Dry Year Water Balance

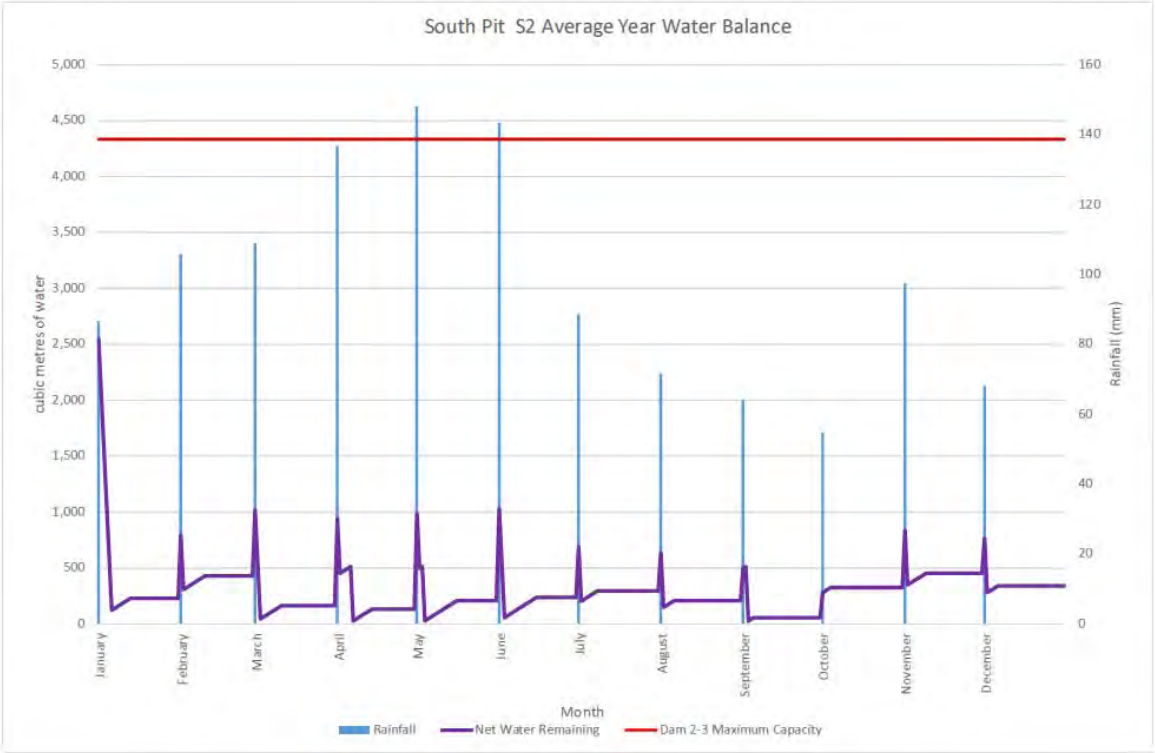


During a dry year the pit will not spill from Dam 4. The discharge regime is able to maintain sufficient capcity for the design storm event at all times within a 20 day management period.

7.4.3. South Pit (S2) Water Balance

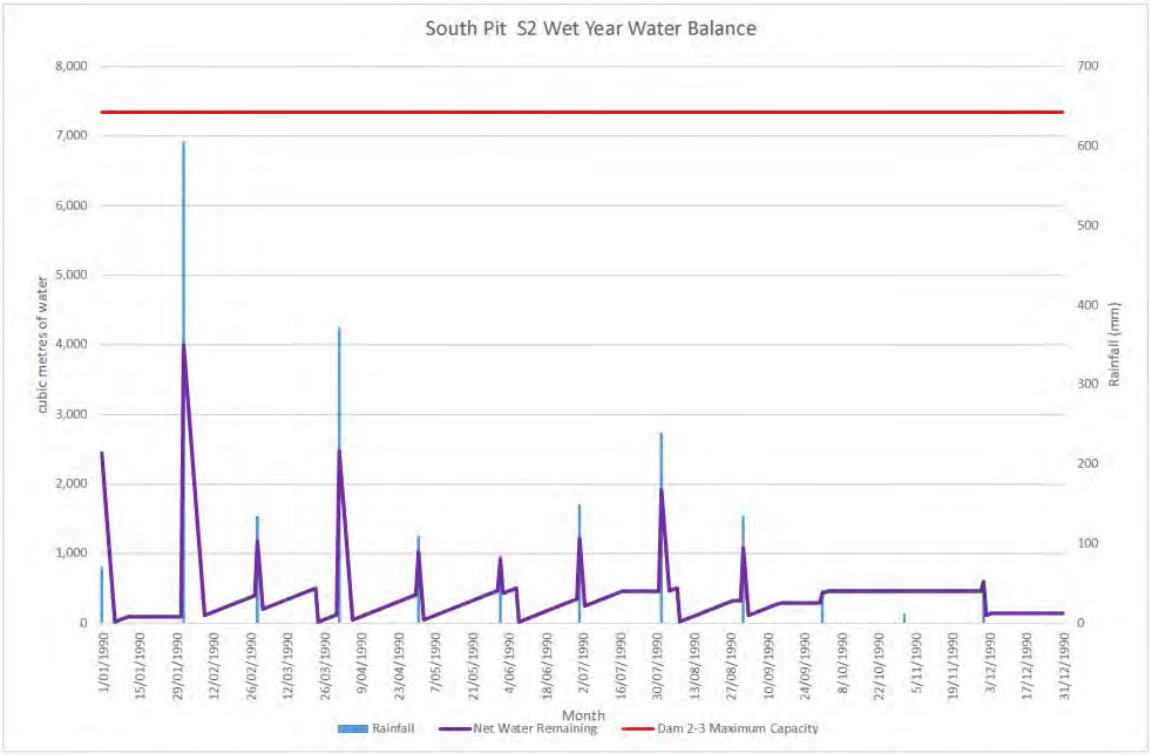
The South Pit (S2) water balance has been addressed separately. It essentially will be managed as it is now as it will not be involved in the recycling operation. Note, it is fed not only by incident rainfall but by Dam 4 via a filter pipe under the emplacement area.

Graph 15: South Pit (S2) Average Rainfall Year Water Balance



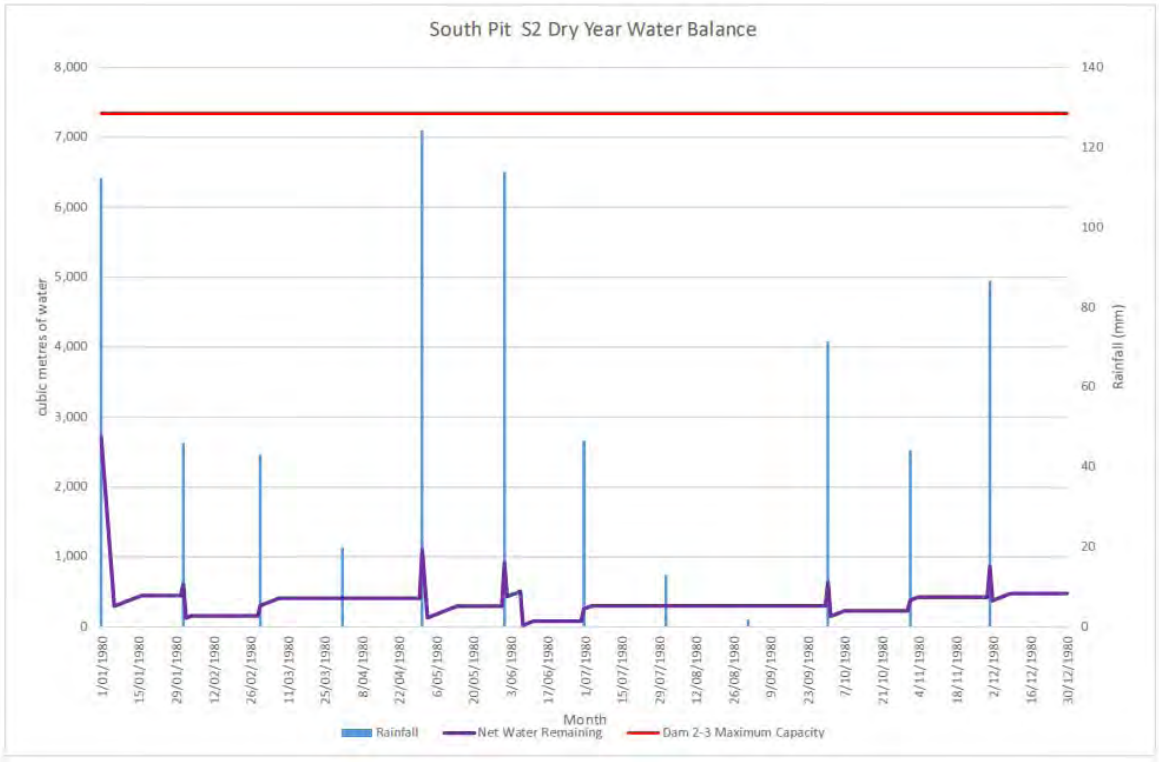
As can be seen from the graph above during an average rainfall year the pit will not spill from Dam 2. The discharge regime is able to maintain sufficient capcity for the design storm event at all times within a 20 day management period.

Graph 16: South Pit (S2) Wet Year Water Balance



The pit will not spill from Dam 2 in a wet year. The discharge regime is able to maintain sufficient capcity for the design storm event within a 20 day management period.

Graph 17: South Pit (S2) Dry Year Water Balance



During a dry year the pit will not spill from Dam 2. The discharge regime is able to maintain sufficient capcity for the design storm event at all times within a 20 day management period.

7.5. Final Void

The conceptual final landform was envisaged to provide a space suitable for a caravan park/camping area with appropriate landscaping and site regrading. The sand pit in the south will be graded to a 3V:1H slope, topsoiled and planted. The hard rock quarry in the north would also be battered to a 3V:1H slope. A number of small water bodies would remain on the site which would be permitted to overtop when sufficient rainfall is received.

At the cessation of mining and completion of rehabilitation it may be necessary to obtain Water Access Licences for the dams to be retained on the site. For the 40Ha site the Maximum Harvestable Right is 4.4ML and this would need to be considered in the development of the final landform and site closure.

Section 8. Impacts and Mitigation

8.1. Surface Water

Management of the risks to surface water quality are focused on regulating the volume of water discharges off the site and the maintenance of a suitable quality of the water to be returned to the downstream environment. The management program aims to minimise the impact of flow volumes by restoring as much surface water as practicable to the downstream ecosystems, reduce the volume of sediment entrained in the discharge water and prevent contaminants (other than sediment) entering the surface water to be discharged.

8.1.1. Surface Water Discharge Volumes

Management of sediment on the site requires the installation of sediment dams designed according to the best practice document, *Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries* for the design storm event of a 90th percentile, 5 day rainfall event for a standard receiving environment. As part of the management of these dams they are required maintain a sufficient freeboard to contain this storm event. Once the sediment dams have been tested and meet the required quality criteria, they will be discharged downstream. Some water will be retained on site to fulfil dust suppression and processing requirements. The controlled discharge rate of the dams downstream will be much lower than the rate expected by a 1 in 10 year ARI event that was expected in the watercourses prior to development as can be seen in the table below. It should be noted that the flows will essentially be restored to the downstream environment once rehabilitation is completed.

Table 10. Flow Rates for 1 in 10 year storm event

Catchment	Flow rate (cubic metres per second)
Northern Catchment prior to development	5.57*
Northern Catchment controlled discharge	0.011
Southern Catchment prior to development	3.05*
Southern Catchment controlled discharge	0.009

*Calculated using the Blue Book and IFD data.

In an average rainfall year approximately 91% of the rainfall retained in the dams is returned to the downstream environment in the North Pit whilst 29% of the rainfall received in the south pit is returned to the stream. The lower figure for the South Pit is primarily due to the dissipation of the retained water into the sandy soil in the disturbed area. Groundwater flows would ensure that the infiltrated water will still reach the wetlands and beach areas downstream without affecting the overall water balance significantly.

8.1.2. Sediment Management

Reduction of sediment in the surface water is primarily managed through the minimisation of entrainment through erosion control measures. Secondary management of sediment involves the capturing of the sediment prior to the surface water leaving the site. Thus all sediment dams will be constructed according to the Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries for the design storm event of a 90th

percentile, 5 day rainfall event for a standard receiving environment for a 20 day management period.

Generally the water discharged from the site is of sufficient quality due to use of a series of well reeded polishing dams and the retentions time of the surface water. Treatment of the water with flocculants has not been necessary to date to meet the EPL criteria. Discharge from the dams is controlled via pipes with a tap installed. Installation of all sediment dams, diversion banks and drainage structures is to be undertaken prior to the commencement of operations on the site.

Drains and diversions will be designed according to the Managing Urban Stormwater-Soils and Construction Volume 1 for a 1 in 10 year ARI design storm event. Spillways will be designed for a 1 in 100 ARI design storm event.

8.1.3. Hydrocarbons

The primary risk of contamination of the surface water is from the fuels and oils used by the plant and machinery on the site. Refuelling and minor repairs and maintenance is undertaken within the workshop area which is bunded. Minimal fuel and oil is stored on site, approximately 200L of diesel and 200L of oil. The diesel fuel is mainly contained within the plant and trucks and minor amounts held in a mobile refuelling tank which is filled off site as required. A self-bunded fuel storage tank will also be installed in the workshop compound with a capacity of approximately 30,000L. Oil is stored within a bunded area in the workshop and waste oil is removed to a licenced waste facility when required. The site maintains a spill kit and all contractors are required to carry a spill kit on plant or equipment.

Due to the small volumes of hydrocarbons held on site it is unlikely that a spill would cause significant material harm to the environment. Should a spill occur it could be managed with the spill kits and localised contamination removed from the site.

All water is tested for the presence of Oil and Grease prior to discharge both visually and by analysis.

8.1.4. Other Contaminants'

Although all care will be taken to ensure that waste not suitable for the recycling process is not brought onto the site there is a possibility that some contaminated material will be imported. Imported material will only be permitted to be tipped off in the Tip and Sort Area which will be designed to have an impervious surface and will be surrounded by a 200mm bund. All surface water from this site is directed to a dedicated sump. The initial sorting process once the material is tipped off will reveal the presence of metal, asbestos or other similar contaminants and these will be separated and removed from the site. The presence of other contaminants such as heavy metals, hydrocarbons etc in the imported waste for recycling is unlikely. Imported waste includes cemiticious materials, bricks, glass and tiles for reprocessing and blending with onsite aggregates. These materials are inert and would be unlikely to be a source of contamination. Materials not meeting the recycling requirements would be removed from the site as soon as practicable.

If, despite all the above procedures, contaminated material is tipped off on site, it is only likely to leach into the water management system when exposed to prolonged rainfall. In this sense, it is very unlikely that contaminants will enter the main water management system. If however, suspect material cannot be removed immediately and rainfall is expected, the material may be tarped to prevent leaching prior to removal off site. Should leaching of suspect material still occur, the surface water is collected in a dedicated sump and can be tested, treated and discharged or removed as required.

8.2. Downstream Water Users

There are no water sharing plans in this area not any water users identified downstream from the site. Regardless of this the impact of the development downstream is considered negligible in terms of water volume and water quality.

8.3. Groundwater

8.3.1.1. Groundwater Volumes and Levels

Any impact of the project on groundwater is expected to be localised and limited mainly to the vicinity of the quarry pit. According to the 1982 EIS drilling carried out on the development site showed that the groundwater table occurs at an average of 18 to 20 metres below the natural surface of the conglomerate and below the level proposed for quarrying. Groundwater within the sand deposit was not confirmed by drilling but it was expected to be at 10-12 metres below the natural surface. The groundwater in the conglomerate was not expected to be affected whilst within the sand the groundwater table could be expected to be locally lowered 1-2metres. This was not expected to have any adverse effects.

No recent groundwater studies have been undertaken. At the time of the 1982 EIS the floor of the conglomerate pit was approximately 60m AHD (Figure 12 of the EIS) and the floor of the sand pit was approximately 50 to 60m AHD with the application stating that it would be deepened another 15m. The floor of the conglomerate pit is currently approximately 50mAHD and the floor of the sand pit is approximately 50m AHD. It is therefore assumed that since there has been minimal change in the depth of the quarry that equally there has been no measureable groundwater impact to surface water systems in adjacent creeks as a result of extraction activities.

The recycling activities themselves are not expected to contribute to any changes in groundwater levels as it does not involve extraction of material or extraction of groundwater.

8.3.1.2. Groundwater Quality

Fuel and oil from the plant, machinery and haul trucks comprise the main risk to the groundwater. Refuelling and minor maintenance therefore are undertaken within the bunded workshop shed and all fuel storage is adequately bunded. Only small volumes of fuel and oil are held on site currently and all contractors are required to carry spill kits.

The surface water collected from the recycling area is collected in a lined dedicated sump reducing the potential for unidentified contaminants entering the groundwater system. From there the sump water will be tested for key analytes, treated (if required) and discharged, if of a suitable quality, downstream. If the water is unable to meet the water quality criteria the disposal off-site by a licenced waste contractor will be investigated.

On a routine basis prior to discharge the sump water will be tested for those parameters listed in the EPL licence. That is, pH, Total Suspended Solids and Oil and Grease with the EPL limits applied. If other contaminants are suspected of having entered the sump water, then the presence of targeted analytes will be tested for via a NATA accredited laboratory. The results will be compared with background data where available or the ANZECC guidelines for 90% level of protection for aquatic ecosystems for suitability for discharge.

8.3.1.3. Groundwater Dependant Ecosystems

There are no identified ‘high priority’ groundwater dependant ecosystems within or surrounding the project area. The surrounding coastal woodland on the ridges are likely to be supported by localised perched water near the surface or rainfall. Due to the limited drawdown caused by the project, quarry operations are not expected to stress the woodlands or the downstream groundwater systems approaching the coast.

8.4. Flooding

The development is located in the headwater of the catchment and is above recorded flood levels. Because of the steepness of the upper parts of the site localised flooding does not occur since peak flows are generally confined within creek banks and are quickly conveyed to the swamp areas east of the site.

8.5. Erosion and Sediment Control

8.5.1. Erosion Controls

The highest risk of erosion and sediment entrainment is from the active quarry faces and rehabilitation areas that have not been adequately revegetated yet. Active faces are exposed and generally have greater slopes than the pit floor where the processing and recycling will be undertaken. This increases the risk of erosion and sediment entrainment in these areas. It is inevitable that erosion will occur within the quarry thus water management structures such as sediment dams and drains will be installed prior to commencement of quarrying or recycling. The main purpose of these dams is to prevent the egress of sediment laden water into the surrounding environment.

The soil erosion hazard on the site will be kept as low as practicable by minimising disturbance. Extraction, processing and recycling will take place within a defined work area and materials will be transported only within the site for processing. Entry to land not involved directly in the extraction, processing or recycling process will be prohibited and will be managed as natural bushland or rehabilitation areas. A water cart will be deployed when required to suppress dust generated over the site, particularly the haul and access roads and process area.

Vehicular access to the site will be limited to that essential for extraction or rehabilitation as shown in the table below.

Table 11. Limitations to Access

Landuse	Access Limitations	Comments
Extraction	Land disturbances beyond five (preferably two) metres from the edge of the operations are prohibited.	All site workers should clearly recognise these areas and they should be clearly marked — suitable materials include barrier mesh, sediment fencing, etc. The project manager will determine their actual location on site. They can vary in position to conserve existing vegetation best while being considerate of the needs of efficient works activities.
Access Roads	Roads and tracks are limited to a width that are the minimum necessary to allow safe operation of heavy equipment.	
Processing and Recycling Area	Access to these areas will be denied to the general public and vehicles importing waste via barrier fencing or similar.	
Tip and Sort Area	Vehicles importing waste to the Tip and Sort Area will be directed to the appropriate areas via barrier fencing or similar. Access to other areas of the site will be prohibited unless authorised by management.	
Sediment Dams and other Water Management Structures	Public access to any water management structure or sediment dams will be prohibited. Access by the watercart to Sediment Dams will be maintained on clearly defined access roads.	
Remaining Lands	Land disturbances are prohibited except for essential management works.	

Rehabilitation means:

Achieving a C-factor (Revised Universal Soil Loss Equation) of less than 0.1 and set in motion a program that should ensure it will drop permanently, by reducing the risk of erosion by vegetation, paving, armouring, etc. as soon as practicable after extraction activities cease.

It should be noted that the cover factor, C, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. A C-factor of 1.0 corresponds to that of bare soil.

While C-factors are likely to rise to 1.0 during the work's program, they should not exceed those given in Table 12 within the specified times.

Table 12. Maximum acceptable C-factors at nominated times during works

Lands	Maximum C-Factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction.	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows are limited to those indicated in "Blue Book". Foot and vehicular traffic are prohibited in these areas.
Top soil or overburden stockpiles, post clearance	0.1	Applies after thirty working days from completion of formation.

Note: *working days* does not include public holidays, weekends or days when work is not possible due to wet weather.

The required C factors can be achieved in the short term (temporary protection for up to six months) with either:

- a suitable soil binder in areas of sheet flow, e.g. topsoil stockpiles
- anionic bitumen emulsion sprayed over hessian cloth (at 0.5 L/m2) in areas of concentrated flow, e.g. diversion banks and waterways
- a temporary vegetative cover.

Any soil binders applied should be employed following the manufacturer's instructions.

A suggested listing of suitable plant species is shown in Table 13. Before sowing, additional tests should be undertaken to assess the requirements of ameliorants such as lime to help plant growth.

Table 13. Plant Species for Temporary Cover

Sowing Season	Seed Mix
Autumn/Winter	Oats @ 40kg/Ha Japanese Millet @ 10kg/Ha
Spring/Summer	Oats @ 20kg/Ha Japanese Millet @ 20kg/Ha

While ever the C-factor is higher than 0.1, maintain the lands in a condition that resists removal by wind. This can be achieved by keeping the soil moist (not wet) by sprinkling with water and where practicable, leaving the surface in a cloddy state. Notwithstanding the above, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 10 days on slopes steeper than 30 per cent and 20 days on slopes less steep than 30 per cent.

Lands planted recently with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Follow-up seed and fertiliser will be applied as necessary in areas of minor soil erosion and/or inadequate vegetative protection. Where practicable, foot and vehicular traffic will be kept away from all recently stabilised areas.

Topsoil is to be stripped in a moist condition to avoid pulverisation and dust and topsoil stockpiles are not to exceed 3m in height with a minimum crest width of 3m. They should be seeded with a temporary vegetation cover if stockpiles are to remain longer than 30 days. Stockpiles of topsoil to be located at least five metres from areas of likely concentrated or high velocity flows, especially drainage lines and access roads. If necessary, earth banks or drains will be constructed to divert localised run-on. Soil materials are to be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of works.

All waterways, drains, spillways and outlets will be constructed to be stable in accordance with the "Blue Book" for soils with high erodibilities.

8.6. Post Closure

The impact of the proposed final landform on surface water is not expected to be significant. The flatter profile of the area post closure compared to the existing site will potentially reduce runoff from the area. The extent to which the area is woodland or grassland could also impact on the runoff volumes. The Surface Water Management Plan will remain in place until the water quality from the site meets the target objectives for the area. With the use of vegetation and reduced slopes it is expected that there will be limited risk of impacts on surface water post closure.

Section 9. Monitoring and Maintenance

9.1. Surface Water

9.1.1. Quality

Water sampling is undertaken monthly during discharge according to the EPL. Samples are collected and tested by a NATA Accredited Facility. There will be no changes to this procedure. Routine analytes tested and concentration limits will be those listed in the EPA licence and are as follows

- pH is to be between 6.5 to 8.5
- Oil and Grease <10mg/L and none visible
- Total Suspended Solids <40mg/L

Other analytes may be assessed at the discretion of the proponent. Monitoring of the surface water outside the EPL Licence Points may be undertaken from time to time such as the other sediment dams in and out of the pit.

The results of all monitoring are recorded and assist in the compilation of the 6 monthly review of the Environmental Management Report to Council and to the EPA in the Annual Return.

9.1.2. Surface Water Flows

The following management checks on the surface water flows will be undertaken monthly and recorded on the Monthly Site Audit Checklist.

- Visual check of stability and operation of all banks, ponds, channels and spillways to be undertaken monthly. Effecting any necessary repairs.
- Visually check the discharge points into to ensure that the discharge does not cause erosion or scouring of the creeks. Effecting any necessary repairs
- Drains and culverts for both clean water and dirty water will be examined for vegetation cover and blockages and maintenance will be performed to ensure they are working as designed.
- Diversion bund walls will be inspected regularly to assess the integrity and effectiveness. Maintenance will be performed when required.
- Removal of spilled materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads.
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved

9.2. Erosion and Sediment Control

Monitoring of the soil erosion, sediment and water is undertaken monthly and recorded on the Monthly Site Audit Checklist.

9.2.1. Erosion Controls

- Topsoil stripping to be visually monitored to check moisture content of soil and depth of stripping.
- Stockpiles to be visually assessed at time of forming to check they do not exceed 3 metres high.
- Removal of spilled clay or other materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads.
- Ensuring rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- Constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved.

9.2.2. Sediment Dam Management

Sediment dams will be managed using the following:

- Level indicators will be installed in dams with relevant marks located on the peg to indicate the amount of sediment load in the dam.
- All sediment basins will be maintained by de-silting when the capacity is diminished.
- Sediment dams and clean water dams will be visually assessed for water quality and volumes on a weekly basis or as required after high rainfall events.
- If discharge is required, the visual assessment will be followed by sampling and testing of the water quality prior to discharge to ensure water quality criteria are met.
- The EPL limits of pH 6.5 – 8.5, Total Suspended Solids <40 mg/L and Oil and Grease <10mg/L (none visible) in the discharged water will be adopted.
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved.

Trigger levels for the de-silting of sediment dams have been developed below. As a number of the dams exceed the design storm criteria by a large margin it has been determined for these dams that the need for desilting is based upon a percentage of the total maximum capacity of the sediment dam.

Table 14. Trigger Levels for De-silting Sediment Dams

Dam Identification/ Catchment	Sediment Basin Storage (soil) volume for 90th percentile, 5 day rainfall event with 5 day management period (m^3)	Sediment Basin Storage (soil) volume for 90th percentile, 20 day rainfall event with 5 day management period (170%) (m^3)	Dam Volume Required for 90th percentile, 5 day rainfall event with 20 day management period (170%) (m^3)	Sediment Basin Storage (soil) volume for 90th percentile, 5 day rainfall event with 20 day management period (170%) as percentage of total volume required (%)	Sediment Dam maximum capacity (m^3)	Maximum estimated Sediment Basin Storage (soil) volume (m^3)
N1A (Dam 8)	696	1183	4,508	26	-	-
N1B (Dam 8)	31	53	1,523	3	-	-
Total N1	**727**	1236	**6,031**	20	13,509	2,768
N2 (Dam 7)	54	92	1,855	5	3,578	177
N3 (Dam 5 & 6)	137	233	3,048	8	51,970	3,971
N4 (Dam 12)	134	228	648	35	992	349
N5 (Dam 11)	448	762	570	134	360	481
N6 (Dam 9 &10)	146	248	2,805	9	37,984	3,361
Tip and Sort Area	6	10	252	4	252	10
S1 (Dam 4 & 4A)	922	1567	7,215	22	69,891	15,376
S2 (Dam 1, 2, & 3)	39	66	772	8	7,343	587

Section 10. Performance Criteria

Table 15. Performance Criteria and Trigger Action Response Plan

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
Water discharged from the site is consistent with the baseline hydrological conditions of the surrounding environment	Total volume of water discharged from the site to be as close as possible to the natural volumes expected pre-development.	Significant changes to volume of water discharged harms ecological communities downstream.	Sediment dams are not emptied to return to design storm capacity within the 20 day management period.	Review water management procedures to ensure that the dams can be emptied to the design storm capacity within the 20 day management period.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Flow rate of the discharged water to not exceed that expected by natural flow rates expected pre-development.	Significant changes to flow rates of water discharged erodes the creeks or otherwise harms ecological communities downstream.	Flow rates for controlled discharge exceed those in *Table 10* for a 1 in 10 year ARI storm for the catchments pre-development.	Review discharge procedures and capacity of pipes and pumps used to discharge water to ensure flow rates are not exceeded.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
Sediment to be contained on site	Sediment Dams are sized according to the 'Blue Book' Criteria for a 5 day 90th percentile storm event with 20 day management period (see *Table 6*).	Sediment is not contained within the sediment dams and is observed as uncontrolled discharge exiting the site due to incorrect dam sizing.	Annual review of SWMP finds dams are found to be a smaller size than indicated in *Table 6*, as reviewed by aerial survey and/or on-site measurements.	• Dam sizes are to be verified against current catchments. • Dams are to be enlarged to meet the required capacity.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Sediment Dam capacity is maintained at a level sufficient for the design 5 day 90th percentile storm event with 20 day management period (see *Table 6*).	Sediment is not contained within the sediment dams and is observed exiting the site as uncontrolled discharge due to dams having diminished capacity as requiring desilting or dam not emptied from previous storm event.	Maximum volume of sediment before desilting of each dam is required is listed in *Table 14*.	Sediment dams will be pegged with markers indicating the maximum sediment level. Once this level has been reached the dams will be desilted.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	All surface water received over exposed surfaces prone to sediment entrainment is directed to the dirty water management system.	Surface water received over exposed surfaces prone to sediment entrainment that egresses off site as no sediment dam or drains provided for disturbed catchments.	Expansion of the quarry or changes to the mining sequence that may impact the current water management system.	• Review of site and SWMP to determine water management requirements. • No work will commence in new areas or changes to the mining sequence until the SWMP is reviewed and appropriate water management structures are constructed.	Environmental Management Report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Constructed drains direct sediment laden water to the sediment dams and clean water around the site.	• Sediment leaves the site due to the failure to construct suitable drains to contain the design storm event to direct dirty water to the sediment dams. • Excessive clean water is diverted onto the site and sediment dam capacity for dirty water is impacted causing overtopping of dams	• Clean or dirty water drains observed to be blocked or damaged. • Inspection during rainfall events shows dirty water egressing the site via drain overflow. • Inspection during rainfall events shows additional drains required to redirect dirty water to sediment dams. • Inspection during rainfall events	• Blocked or damaged drains are to be repaired. • Drains sizes are to be checked by on-site measurements to ensure compliance with Blue Book calculations i.e. All drains will be designed for the 1 in 10 year design storm event. Install additional drains as required.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
			shows additional drains required to redirect clean water around the site.		
	Sediment Dam spillways and earth embankments are vegetated and stable for the design storm event.	• Sediment leaves the site due to the failure of the dam wall or spillway due to not being designed for the design storm flows. • Sediment leaves the site due to the erosion of the dam wall or spillway.	• Inspection during a 5 day rainfall event of <62.2mm shows overtopping of the sediment dams. • Erosion or tunnelling on the dam walls observed. • Dam wall failure. • Inspections shows dam walls (earth embankments) are not adequately vegetated and spillways protected from erosion adequately.	• Spillways to be measured to check if complies with Blue Book calculations i.e All spillways to be designed for the 1 in 100 year design storm event. • Dam walls and batters to be measured to ensure they are not too steep i.e.>3H:1V • Replace vegetation on eroded surfaces if required. • Repair dams as required	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
Erosion is minimised	Rehabilitation slopes are designed to minimise the effects of erosion according to the Blue Book	• Excessive sediment build up in sediment dams. • Re-vegetation unable to establish. • Loss of topsoil for rehabilitation.	• Slopes in rehabilitated areas observed to be greater than 3 horizontal to 1 vertical. • Slope lengths shall not exceed 20m for a 3H:1V batter. • Slope lengths shall not exceed 30m for a 4H:1V batter. • Slope lengths shall not exceed 40m for batters >4H:1V. • Visual inspection shows evidence of excessive rilling or gullying on rehabilitation slopes. • Visual inspection shows established rehabilitated areas lose vegetation coverage or are unable to establish adequate vegetation coverage i.e. <70% coverage. • Visual inspection shows spread topsoil on areas awaiting revegetation is eroding.	• Install catch drains or earth banks on slopes where slope lengths exceed recommendations. • Review rehabilitation areas to determine where slopes and catch drains need maintenance or repair or reworking. • Reseeding/replant areas that require increased vegetation cover. Replace/ rework topsoil as required	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Revegetation whether temporary or permanent is undertaken as soon as practicable to reduce the exposed surface area.	• Excessive sediment build up in sediment dams. • Re-vegetation unable to establish. • Loss of topsoil.	A C-factor (Revised Universal Soil Loss Equation) of less than 0.1 is not achieved on rehabilitated surfaces i.e. equivalent of 70% coverage by	Review rehabilitation areas to determine where revegetation requires maintenance or repair.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
			vegetation.		Construction- Volume 2E Mines and Quarries & SWMP
	Long term topsoil stockpiles and overburden stockpiles are protected from erosion within 10 days of formation.	• Excessive sediment build up in sediment dams. • Loss of topsoil for rehabilitation.	A C-factor (Revised Universal Soil Loss Equation) of less than 0.1 is not achieved on rehabilitated surfaces i.e. equivalent of 70% coverage by vegetation.	Review topsoil and overburden stockpiles to determine where maintenance or repair is required.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Access to rehabilitated areas and works areas are limited to necessary vehicles and personnel	• Erosion of rehabilitation areas due to tracks by vehicles. • Disturbance and erosion of areas outside the quarry extraction footprint.	Monthly visual inspections shows evidence of vehicle tracks or earthworks outside of approved works areas or within rehabilitation areas.	• Repair damage to rehabilitation areas or areas outside the quarry extraction footprint. • Ensure adequate signage and/or barrier fencing is erected to limit traffic access to sensitive areas • Review staff training to ensure personnel are aware of 'no go' areas.	Monthly inspection reports & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Tracks suitable for private access or pedestrian usage will not be subject to excessive erosion	Excessive sediment build up in sediment dams.	Visual inspection indicates excessive road erosion and deterioration.	• Slopes of major tracks <10° or have cross drains/banks installed. • Where unsuitable soils are present, tracks to be stabilised with crushed bricks, concrete, gravel or similar.	Monthly inspection reports & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
Water discharged from the site is consistent with the baseline ecological and geomorphic conditions of the surrounding environment	Water quality monitoring results show that the discharge is non-polluting.	Significant changes to quality of water discharged harms ecological communities downstream.	Water Quality does not meet the objective of Section 120 of the Protection of the Environment Operations Act 1997. In particular Monitoring Point 1 and 2 shows water quality parameters outside the EPL criteria of pH between 6.5 and 8.5, total suspended solids <40mg/L and O&G <10mg/L(none visible).	• Discharge is to cease immediately. • Sediment dams are to be treated as appropriate to ensure the water to be discharged meets the EPL criteria • Discharge will not recommence until the quality of the water is sufficient.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	• Fuel and oil storage is bunded and spill kits are accessible. • No spills of hydrocarbons occur.	Releases of hydrocarbons changes quality of water discharged and harms ecological communities downstream.	• Hydrocarbon spill occurs that has not been contained and contaminants observed to enter the water management system. • Water Quality does not meet the	• Discharge is to cease immediately. • Sediment dams are to be treated as appropriate to ensure the water to be discharged meets the EPL criteria	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
			objective of Section 120 of the Protection of the Environment Operations Act 1997. In particular Monitoring Point 1 and 2 shows water quality parameters outside the EPL criteria of O&G <10mg/L (none visible).	• Discharge will not recommence until the quality of the water is sufficient. • All hydrocarbon spills are to be cleaned up. • Procedures for handling hydrocarbons to be revised and updated if required. • Staff and contractors to be re-trained in the handling of hydrocarbons.	Mines and Quarries & SWMP
	Surface water collected in the Tip and Sort area sump has not been polluted with potential contaminants from materials received in the Tip and Sort area.	Significant changes to quality of water discharged harms ecological communities downstream	• Water Quality does not meet the objective of Section 120 of the Protection of the Environment Operations Act 1997. In particular Monitoring Point 1 and 2 shows water quality parameters outside the EPL criteria of pH between 6.5 and 8.5, total suspended solids <40mg/L and O&G <10mg/L(none visible). • Material that does not meet the recycling criteria and is suspected to be contaminated is received and is not tarped during rainfall (prior to removal off-site).	• The Tip and Sort sediment dam is to be tested to determine if the water to be discharged meets the EPL criteria and as appropriate the ANZECC criteria for Freshwater (95% level of protection). • The Tip and Sort sediment dam is to be treated as appropriate to ensure the water to be discharged meets the EPL criteria and as appropriate the ANZECC criteria for Freshwater (95% level of protection). • Discharge will not commence until the quality of the water is sufficient. • If water quality parameters cannot be achieved the water will be pumped out and disposed of by a licenced waste contractor.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
No impacts to groundwater quality of quantity	• Groundwater is not encountered during extraction activities. • Extraction is not to proceed lower than the consented depth of extraction.	Changes to groundwater flow rates that may harm ecological communities downstream.	Encountering groundwater in the extraction area.	• Deeper extraction is to cease. • Consultation with NOW will be undertaken to determine the course of action.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Groundwater is not extracted from the site.	Changes to groundwater flow rates that may harm ecological communities downstream.	Installation of groundwater bores (other than for the purposes of monitoring).	If groundwater bores were to be installed for 'works' (not for water sampling) then a review of the impacts to the groundwater system would be undertaken.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	No spills or leaks of potential contaminants that may enter the groundwater system.	Significant changes to quality of groundwater harms ecological communities downstream	Hydrocarbon spill occurs that has not been contained and contaminants are suspected to have entered the groundwater system.	• All hydrocarbon spills are to be cleaned up. • Extent of spill is to be determined and documented. • Procedures for handling hydrocarbons to be revised and updated if required. • Staff and contractors to be re-trained in the handling of hydrocarbons.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Section 11. Reporting

An Environmental Management Report is submitted to Council on a 6 monthly basis which summarises all site activities including the performance of the Water Management System. It is envisaged that this reporting will continue and will incorporate the new Conditions of Consent reporting requirements as outlined by the Secretary should the proposal be approved. In addition, the site completes an annual return to the EPA according to the EPL requirements.

Monthly inspections of the site will be recorded and will include inspection of the water management system. The results of these inspections will inform the 6 monthly reports to Council and/or the Secretary. All incidents will be recorded according to the PIRMP requirements.

The effectiveness of the water management system will be assessed in the six monthly reviews and audits as may be required by consent conditions.

These reviews will report on the progress towards the performance criteria as outlined in *Table 15*. Where an action response has been implemented, details of the action and any results obtained will be included in the review. The reviews will be submitted to the Council and/or the Secretary until the consent relinquished at the completion of rehabilitation.

As part of the measurement of the effectiveness of the water management system the following will be assessed.

- Water imported, water use, volumes stored and any discharges from the site and report results or changes to the balance.
- Water quality results for compliance and trends.
- Identifying non-compliances and actions taken to ensure compliance.
- Discrepancies between the predicted and actual impacts of the development.
- Measures that may be undertaken to improve the environmental performance of the development.

Section 12. References

Ref. 1. DECC (2004) *Managing Urban Stormwater Soils and Construction V1*

Ref. 2. DECC (2009) *Managing Urban Stormwater Soils and Construction V2E Mines and Quarries*

Ref. 3. , *Environmental Impact Statement for Extensions to Conglomerate and Sand Extractive Operations at Frazer Park* (1982) Resource Planning

Ref. 4. Resource Planning Pty Limited (September 1991) *D&J Quarries Gravel and Sand Quarry, Frazer Park, Modification of Consent and Plan of Management*.

Ref. 5. Valerie Smith (September 2007) *Soil and Water Management, Frazer Park Quarry*,

Appendix A: Blue Book Calculations

1. Erosion Hazard and Sediment Basins

Site Name: **Frazer Park**

Site Location: **North Pit**

Precinct/Stage: **Gravel Soils Catchment**

Other Details: **Current**

Site area	Sub-catchment or Name of Structure						Notes
	N1A	N1B	N2	N3	N4	N5	
Total catchment area (ha)	3.98	3.43	1.71	3.57	1.01	0.78	
Disturbed catchment area (ha)	3.98	3.43	1.71	3.57	1.01	0.78	

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D	C	C	From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D	C	C	Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5	5	See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	90	90	90	90	90	90	
x-day, y-percentile rainfall event (mm)	62.2	62.2	62.2	62.2	62.2	62.2	
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	11.7	11.7	11.7	11.7	11.7	11.7	

RUSLE Factors

Rainfall erosivity (*R* -factor)	2950	2950	2950	2950	2950	2950	Auto-filled from above
Soil erodibility (*K* -factor)	0.041	0.041	0.041	0.041	0.041	0.041	RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	100	150	150	100	50	120	
Slope gradient (%)	20	3	4	7	6	10	
Length/gradient (*LS* -factor)	8.68	0.88	1.27	2.02	1.11	3.70	
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.79	0.79	0.79	0.79	0.57	0.57	See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	1364	138	200	318	174	582	
Soil Loss Class	6	1	2	3	2	5	See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	1049	106	154	245	134	448	Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	696	61	44	146	23	58	See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	1956	1685	840	1754	358	277	See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	2652	1746	884	1900	381	335	

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

1. Erosion Hazard and Sediment Basins

Site Name: Frazer Park

Site Location: North Pit

Precinct/Stage: Gravel Soils Catchment

Other Details: Current

Site area	Sub-catchment or Name of Structure						Notes
	N6	S1	S2				
Total catchment area (ha)	3.06	9.37	1.17				
Disturbed catchment area (ha)	3.06	9.37	0.29				

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	C	C				From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	C	C				Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5				See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	90	90	90				
x-day, y-percentile rainfall event (mm)	62.2	62.2	62.2				
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	11.7	11.7	11.7				

RUSLE Factors

Rainfall erosivity (*R* -factor)	2950	2950	2950				Auto-filled from above
Soil erodibility (*K* -factor)	0.041	0.041	0.041				RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	100	180	70				
Slope gradient (%)	8	10	20				
Length/gradient (*LS* -factor)	2.37	4.88	6.61				
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.79	0.57	0.57				See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	373	768	1040				
Soil Loss Class	4	6	6				See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	287	590	800				Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	146	922	39				See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	1504	3322	415				See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	1650	4244	454				

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

1. Erosion Hazard and Sediment Basins

Site Name: Frazer Park

Site Location: North Pit

Precinct/Stage: Gravel Soils Catchment

Other Details: Future

Site area	Sub-catchment or Name of Structure						Notes
	N1A	N1B	N2	N3	T&S		
Total catchment area (ha)	3.98	1.76	2.11	3.37	0.4		
Disturbed catchment area (ha)	3.98	1.76	2.11	3.37	0.4		

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D	D		From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D	D		Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5		See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	90	90	90	90	90		
x-day, y-percentile rainfall event (mm)	62.2	62.2	62.2	62.2	62.2		
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	11.7	11.7	11.7	11.7	11.7		

RUSLE Factors

Rainfall erosivity (*R* -factor)	2950	2950	2950	2950	2950		Auto-filled from above
Soil erodibility (*K* -factor)	0.041	0.041	0.041	0.041	0.041		RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	100	150	150	100	100		
Slope gradient (%)	20	3	4	7	3		
Length/gradient (*LS* -factor)	8.68	0.88	1.27	2.02	0.72		
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.79	0.79	0.79	0.79	0.57		See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	1364	138	200	318	114		
Soil Loss Class	6	1	2	3	1		See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	1049	106	154	245	88		Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	696	31	54	137	6		See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	1956	865	1037	1656	142		See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	2652	896	1091	1793	148		

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

2. Flow Calculations

Peak flow is given by the Rational Formula: $Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$

where:
- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years.
- F_y is a frequency factor for "Y" years.
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent. Place an x in the appropriate row below to automatically halve the time of concentration for that sub-catchment.

Structure Details									**Notes**
Name	north	south							
Catchment Area (ha)	17.54	11.52							
Place an x here to halve tc	x	x							Place an x if disturbed catchment
Time of concentration (tc)	12	10							minutes

Rainfall Intensities

1-year, tc	68.2	68.2							Enter the relevant rainfall intensities (in mm/hr) for each of the nominated rainfall events. The time of concentration (tc) determines the duration of the event to be used
2-year, tc	87.7	87.7							
5-year, tc	112	112							
10-year, tc	127	127							
20-year, tc	146	146							
50-year, tc	170	170							
100-year, tc	189	189							

C10 runoff coefficient	0.9	0.75							Use AR&R or Table F3, pg F-6

Frequency Factors

FF, 1-year	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	Can use 0.8 for a construction site
FF, 2-year	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	Can use 0.85 for a construction
FF, 5-year	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	Can use 0.95 for a construction
FF, 10-year	1	1	1	1	1	1	1	1	Generally always 1
FF, 20-year	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	Can use 1.05 for a construction
FF, 50-year	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	Can use 1.15 for a construction
FF, 100-year	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	Can use 1.2 for a construction site

Flow Calculations									**Notes**
1-year, tc (m^3/s)	2.394	1.31							
2-year, tc (m^3/s)	3.271	1.791							
5-year, tc (m^3/s)	4.669	2.556							
10-year, tc (m^3/s)	5.573	3.05							
20-year, tc (m^3/s)	6.728	3.682							
50-year, tc (m^3/s)	8.58	4.696							
100-year, tc (m^3/s)	9.953	5.448							

NB for flow calculations on sediment basin spillways, see Worksheet 3 (if required).

3. Sediment Basin Spillway Design

Structure Details

Structure Name	north	south					Auto-filled from Worksheet 1
Catchment Area (ha)	17.54	11.52					Auto-filled from Worksheet 1
Time of concentration (tc)	12	10					Auto-calculated assuming tc is halved

Rainfall Intensities (IFD Values)

1 year, tc	68.2	68.2					Enter the relevant rainfall intensities (in mm/hr) for each of the nominated rainfall events. The time of concentration (tc) determines the duration of the event to be used
2 year, tc	87.7	87.7					
5 year, tc	112	112					
10 year, tc	127	127					
20 year, tc	146	146					
50 year, tc	170	170					
100 year, tc	189	189					

C_{10} runoff coefficient	0.9	0.9					Use AR&R or Table F3, pg F-6
Design ARI event (select):	100	100	100	100	100	100	Select design ARI (years) from dropdown
Frequency Factor	1.2	1.2	1.2	1.2	1.2	1.2	Auto-filled based on selected ARI
Flow Calculation	9.953	6.537					Auto-calculated based on selected ARI

4. Volume of Type C (Coarse) Sediment Basins

Type C Basin Design Criteria

Structure Name	north	south					Auto-filled from Worksheet 1
Catchment Area (ha)	17.54	11.52					Auto-filled from Worksheet 1
Sediment type (C, F or D)	D	D					Auto-filled from Worksheet 1
Design rainfall event							Choose design event from dropdown
Flow volume (m^3/s)							Calculated from IFD values above
Area Factor	4100	4100	4100	4100	4100	4100	Default is 4,100. See pg 6-12
Depth of settling (water zone) (m)	0.6	0.6	0.6	0.6	0.6	0.6	Minimum is 0.6m (pg 6-12)

Type C Basin Volume Calculations

Basin Surface Area (m^2)	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Auto-calculated
Settling (water) zone volume (m^3)	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Auto-calculated
Storage (soil) zone volume (m^3)	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Auto-calculated
Total basin volume (m^3)	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Not Type C	Auto-calculated

Basin Shape

Enter length:width ratio	3	3	3	3	3	3	E.g. for 3:1 (L:W) enter 3.
Length (m)	N/A	N/A	N/A	N/A	N/A	N/A	These figures should be taken as a guide only. Detailed calcs might be required.
Width (m)	N/A	N/A	N/A	N/A	N/A	N/A	

Appendix B: Blue Book Standard Drawings

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BERM, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY.

4. FORM THE BERM FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

6. CHECK THE ALIGNMENT OF THE BERM TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

7. ENSURE THE BERM DISCHARGES TO A STABLE OUTLET.

8. ENSURE THE BERM DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW CONTROL BERMS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BERM FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BERM THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW CONTROL BERM SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

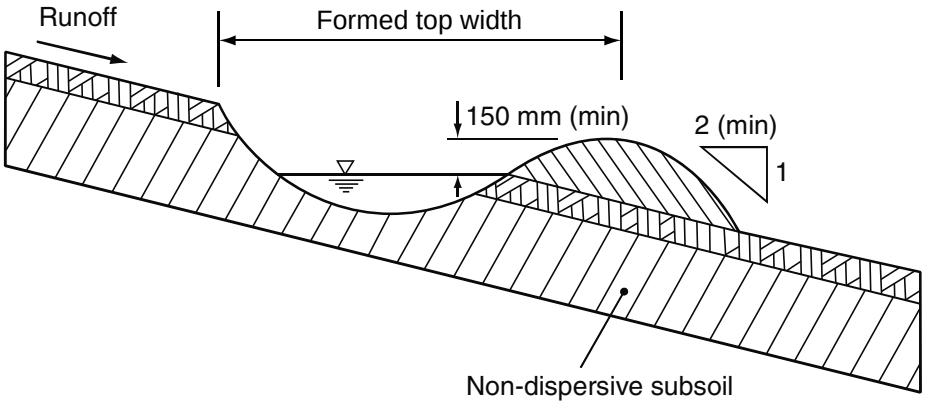
3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

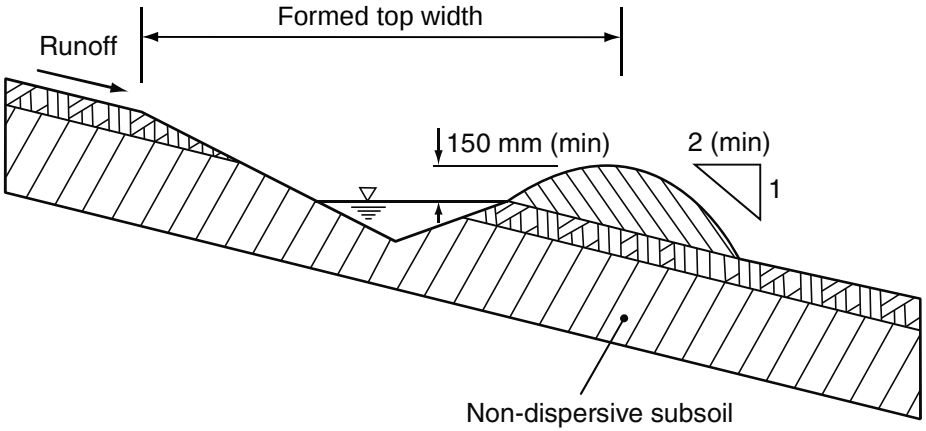
Table 1 - Recommended dimensions of flow control berms

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

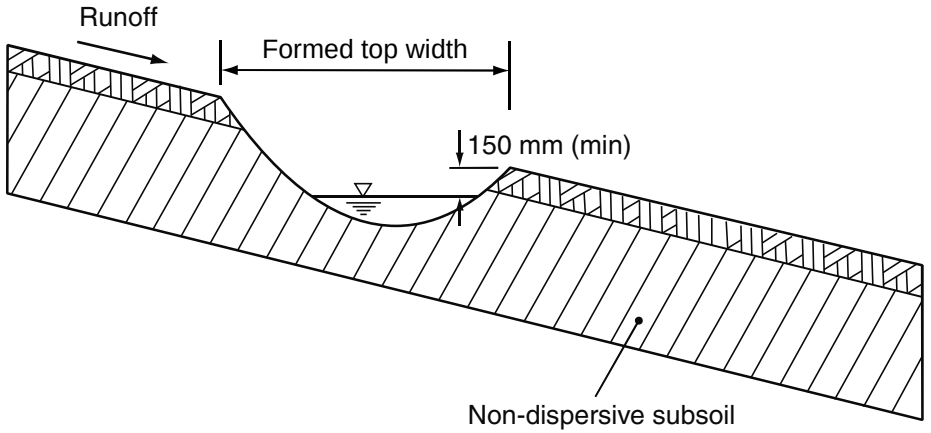
Drawn:	Date:		
GMW	Dec-09	Flow Control Berms	CB-01



(a) Parabolic catch drain with down-slope bank



(b) Triangular V-drain with down-slope bank



(c) Parabolic catch drain without bank

Constructed dimensions of parabolic catch drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-A	1.6 m	0.30 m
Type-B	2.4 m	0.45 m
Type-C	3.6 m	0.65 m

Constructed dimensions of triangular V-drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-AV	2.0 m	0.30 m
Type-BV	2.7 m	0.45 m
Type-CV	3.9 m	0.65 m

NOT TO SCALE

Drawn:	Date:		
GMW	Dec-09	Catch Drains	CD-01

INSTALLATION (EARTH-LINED)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF REQUIRED CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. SPECIFICALLY, ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE TEMPORARY DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED SITE REHABILITATION PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Earth Lined	CD-02

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

6. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

7. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT. WHERE NECESSARY, CUT THE DRAIN SLIGHTLY DEEPER THAN THAT SPECIFIED ON THE PLANS SUCH THAT THE CORRECT CHANNEL DIMENSIONS ARE ACHIEVED FOLLOWING PLACEMENT OF THE TURF.

8. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

9. TURF SHOULD BE USED WITHIN 12-HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

10. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

11. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

12. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

13. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

14. FOR WIDE DRAINS AND HIGH VELOCITY CHUTES, LAY THE FIRST ROW OF TURF IN A STRAIGHT LINE DIAGONAL TO THE DIRECTION OF FLOW. STAGGER SUBSEQUENT ROWS IN A BRICK-LIKE (STRETCHER BOND) PATTERN. THE TURF SHOULD NOT BE STRETCHED OR OVERLAPPED. USE A KNIFE OR SHARP SPADE TO TRIM AND FIT IRREGULARLY SHAPED AREAS.

15. FOR NARROW DRAINS, LAY THE TURF ALONG THE DIRECTION OF THE DRAIN, ENSURING, WHEREVER PRACTICABLE, THAT A LONGITUDINAL JOINT BETWEEN TWO STRIPS OF TURF IS NOT POSITIONED ALONG THE INVERT OF THE DRAIN.

16. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

17. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST 2-WEEKS FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

18. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

19. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH.

20. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT DOWN-SLOPE SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Grass Lined	CD-03

INSTALLATION (DRAIN FORMATION)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

INSTALLATION (MAT PLACEMENT)

THE METHOD OF MAT INSTALLATION VARIES WITH THE TYPE OF MAT. INSTALLATION PROCEDURES SHOULD BE PROVIDED BY THE MANUFACTURER OR DISTRIBUTOR OF THE PRODUCT. A TYPICAL INSTALLATION PROCEDURE IS DESCRIBED BELOW, BUT SHOULD BE CONFIRMED WITH THE PRODUCT MANUFACTURER OR DISTRIBUTOR.

1. EROSION CONTROL MATS MUST BE STORED AWAY FROM DIRECT SUNLIGHT OR COVERED WITH ULTRAVIOLET LIGHT PROTECTIVE SHEETING UNTIL THE SITE IS READY FOR THEIR INSTALLATION.

2. VEHICLES AND CONSTRUCTION EQUIPMENT MUST NOT BE PERMITTED TO MANOEUVRE OVER THE GEOTEXTILE UNLESS IT HAS BEEN COVERED WITH A LAYER OF SOIL OR GRAVEL AT LEAST 150mm THICK. FILL MATERIAL SHALL NOT BE MIXED OVER THE GEOTEXTILE.

3. IF THE CHANNEL IS TO BE GRASSED, PREPARE A SMOOTH SEED BED OF APPROXIMATELY 75mm OF TOPSOIL, SEED, FERTILISE, WATER AND RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

4. EXCAVATE A 300mm DEEP BY 150mm WIDE ANCHOR TRENCH ALONG THE FULL WIDTH OF THE UPSTREAM END OF THE AREA TO BE TREATED.

5. AT LEAST 300mm OF THE MAT MUST BE ANCHORED INTO THE TRENCH WITH THE ROLL OF MATTING RESTING ON THE GROUND UP-SLOPE OF THE TRENCH.

6. STAPLE THE FABRIC WITHIN THE TRENCH AT 200 TO 250mm SPACING USING 100mm WIDE BY 150mm PENETRATION LENGTH U-SHAPED, 8 TO 11 GAUGE WIRE STAPLES. NARROWER U-SECTIONS MAY EASILY TEAR THE MATTING WHEN PLACED UNDER STRESS.

7. WHEN ALL MATS HAVE BEEN ANCHORED WITHIN THE TRENCH ACROSS THE FULL WIDTH OF THE TREATED AREA, THEN THE TRENCH IS BACKFILLED AND COMPACTED. THE MATS ARE THEN UNROLLED DOWN THE SLOPE SUCH THAT EACH MAT COVERS AND PROTECTS THE BACKFILLED TRENCH.

8. WHEN SPREADING THE MATS, AVOID STRETCHING THE FABRIC. THE MATS SHOULD REMAIN IN GOOD CONTACT WITH THE SOIL.

9. IF THE CHANNEL CURVES, THEN SUITABLY FOLD (IN A DOWNSTREAM DIRECTION) AND STAPLE THE FABRIC TO MAINTAIN THE FABRIC PARALLEL TO THE DIRECTION OF CHANNEL FLOW.

10. STAPLE THE SURFACE OF THE MATTING AT 1m CENTRES. ON IRREGULAR GROUND, ADDITIONAL STAPLES WILL BE REQUIRED WHEREVER THE MAT DOES NOT INITIALLY CONTACT THE GROUND SURFACE.

11. AT THE END OF EACH LENGTH OF MAT, A NEW TRENCH IS FORMED AT LEAST 300mm UP-SLOPE OF THE END OF THE MAT SUCH THAT THE END OF THE MAT WILL BE ABLE TO FULLY COVER THE TRENCH. A NEW ROLL OF MATTING IS THEN ANCHORED WITHIN THIS TRENCH AS PER THE FIRST MAT. AFTER THIS NEW MAT HAS BEEN UNROLLED DOWN THE SLOPE, THE UP-SLOPE MAT CAN BE PINNED IN PLACE FULLY COVERING THE NEW TRENCH AND AT LEAST 300mm OF THE DOWN-SLOPE MAT. THE PROCESS IS CONTINUED DOWN THE SLOPE UNTIL THE DESIRED AREA IS FULLY COVERED.

12. IN HIGH-VELOCITY CHANNELS, INTERMEDIATE ANCHOR SLOTS ARE USUALLY REQUIRED AT 10M INTERVALS DOWN THE CHANNEL.

13. ANCHOR THE OUTER MOST EDGES (TOP AND UPPER MOST SIDES) OF THE TREATED AREA IN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

14. IF THE CHANNEL WAS GRASS SEEDED PRIOR TO PLACEMENT OF THE MATS, THEN THE MATS SHOULD BE ROLLED WITH A SUITABLE ROLLER WEIGHING 60 TO 90kg/m, THEN WATERED.

15. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE MAT ACHIEVES AND RETAINS GOOD CONTACT WITH THE SOIL.

16. DAMAGED MATTING MUST BE REPAIRED OR REPLACED.

ADDITIONAL INSTRUCTIONS FOR THE INSTALLATION OF JUTE MESH (NOT JUTE BLANKETS):

1. ENSURE THE JUTE MESH IS LAID ON A FIRM EARTH SURFACE THAT HAS BEEN TRIMMED, TOPSOILED, WATERED, SOWN WITH SEED AND FERTILISER.

2. THE JUTE MESH IS THEN EITHER TAMPED OR ROLLED FIRMLY ONTO THE PREPARED SURFACE, AVOIDING STRETCHING, WATERED TO ENCOURAGE THE PENETRATION OF THE BITUMEN EMULSION, AND FINALLY SPRAYED WITH A TOP LAYER OF BITUMEN AT 1 TO 3 LITRES PER SQUARE METRE.

3. THE RATE OF EMULSION APPLICATION SHOULD BE ADJUSTED SUCH THAT THE EMULSION JUST STARTS TO POND IN THE MESH SQUARES.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	May-10	Catch Drains - Geotextile Lined	CD-04

MATERIALS

ROCK:
(i) ALL ROCK MUST BE HARD, WEATHER RESISTANT, AND DURABLE AGAINST DISINTEGRATION UNDER CONDITIONS TO BE MET IN HANDLING, PLACEMENT AND OPERATION.

(ii) ALL ROCK MUST HAVE ITS GREATEST DIMENSION NOT GREATER THAN 3 TIMES ITS LEAST DIMENSIONS.

(iii) THE ROCK USED IN FORMATION OF THE DRAIN MUST BE EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND HAVE SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. DIRT, FINES, AND SMALLER ROCK MUST NOT EXCEED 5% BY WEIGHT.

(iv) THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

(v) THE COLOUR OF THE RIPRAP SHALL BE [INSERT] AND MUST BE APPROVED BY THE ENGINEER. ONCE APPROVED, THE COLOUR SHALL BE KEPT CONSISTENT THROUGH THE PROJECT.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. PRIOR TO PLACEMENT, ALL ROCKS MUST BE VISUALLY CHECKED FOR SIZE, ELONGATION, CRACKS, DETERIORATION AND OTHER VISIBLE. THE DEGREE AND THOROUGHNESS OF SUCH CHECKING MUST BE APPROPRIATE FOR THE POTENTIAL CONSEQUENCES ASSOCIATED WITH FAILURE OF THE STRUCTURE OR PURPOSE FOR WHICH THE MATERIAL WILL BE USED.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. REMOVE ALL SOFT, YIELDING MATERIAL; REPLACE WITH SUITABLE ON-SITE MATERIAL; COMPACT TO SMOOTH FIRM SURFACE.

6. EXCAVATE THE DRAIN TO THE LINES AND GRADES SHOWN ON THE APPROVED PLANS. OVER-CUT THE DRAIN TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED TOP SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND. PLACEMENT OF THE ROCK LINING MUST NOT REDUCE THE DRAIN'S TOP WIDTH AND DEPTH AS SPECIFIED WITHIN THE APPROVED PLANS.

7. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10CM EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

8. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

9. IF THE DRAIN IS CUT INTO A DISPERSIVE (SODIC) SOIL, THEN PRIOR TO PLACING FILTER CLOTH, THE EXPOSED DISPERSIVE SOIL MUST BE COVERED WITH A MINIMUM 200mm THICK LAYER OF NON-DISPERSIVE SOIL PRIOR TO PLACEMENT OF FILTER CLOTH OR ROCKS.

10. IF A FILTER CLOTH UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER CLOTH IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm, AND SECURE ANCHOR PINS AT MINIMUM 1M SPACING ALONG THE OVERLAP.

11. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

12. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

13. PLACE ROCK LINING TO THE EXTENT AND DEPTH INDICATED WITHIN THE APPROVED PLANS.

14. ENSURE THE ROCK IS PLACED IN AN APPROPRIATE MANNER TO AVOID DISPLACING UNDERLYING MATERIALS OR PLACING UNDUE IMPACT FORCE ON THE BEDDING MATERIALS.

15. ENSURE THE ROCK IS PLACED WITH A MINIMUM THICKNESS OF 1.5 TIMES THE NOMINAL ROCK SIZE (D50).

16. ENSURE MATERIALS THAT ARE D50 AND LARGER ARE POSITIONED FLUSH WITH THE TOP SURFACE WITH FACES AND SHAPES MATCHED TO MINIMISE VOIDS.

17. ENSURE PROJECTIONS ABOVE OR DEPRESSIONS UNDER THE SPECIFIED TOP SURFACE ARE LESS THAN 20% OF THE ROCK LAYER THICKNESS. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

18. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT (AVERAGE SURFACE PLANE ALONG CHANNEL INVERT) TO THE TOP OF THE EMBANKMENT. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

19. TO THE MAXIMUM DEGREE PRACTICABLE, THE MATERIAL BETWEEN LARGER ROCK MUST NOT BE LOOSE OR EASILY DISPLACED BY THE EXPECTED FLOW.

20. AFTER PLACEMENT OF THE ROCK LINING, ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

21. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE ROCK-LINED AREA IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE OR REPOSITION THE SURFACE ROCK SUCH THAT THE DRAIN FUNCTIONS AS REQUIRED AND THE DRAIN'S REQUIRED HYDRAULIC CAPACITY IS NOT REDUCED.

5. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

6. ENSURE SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

7. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Rock Lined	CD-05

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BANK, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. FORM THE BANK FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF EARTH IS USED, THEN ENSURE THE SIDES OF THE BANK ARE NO STEEPER THAN A 2:1 (H:V) SLOPE, AND THE COMPLETED BANK MUST BE AT LEAST 500mm HIGH.

6. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

7. CHECK THE BANK ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

8. THE BANK SHOULD BE VEGETATED (TURFED, SEEDED AND MULCHED), OR OTHERWISE STABILISED IMMEDIATELY, UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS OR IF SIGNIFICANT RAINFALL IS NOT EXPECTED DURING THE LIFE OF THE BANK.

9. ENSURE THE EMBANKMENT DRAINS TO A STABLE OUTLET, AND DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW DIVERSION BANKS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BANK FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BANK THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW DIVERSION BANK SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

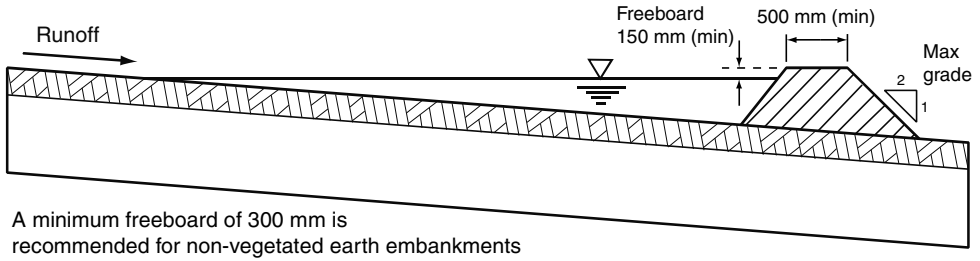


Figure 1 - Typical profile of flow diversion bank formed from earth

Table 1 - Recommended dimensions of flow diversion banks

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn:	Date:		
GMW	Dec-09	Flow Diversion Banks	DB-01

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CHANNEL, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND CONSTRUCTION EQUIPMENT.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD ANY ASSOCIATED EMBANKMENTS.

5. EXCAVATE THE DIVERSION CHANNEL TO THE SPECIFIED SHAPE, ELEVATION AND GRADIENT. THE SIDES OF THE CHANNEL SHOULD BE NO STEEPER THAN A 2:1 (H:V) IF CONSTRUCTED IN EARTH, UNLESS SPECIFICALLY DIRECTED WITHIN THE APPROVED PLANS.

6. STABILISE THE CHANNEL AND BANKS IMMEDIATELY UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS. IN EITHER CASE, TEMPORARY EROSION PROTECTION (MATTING, ROCK, ETC.) WILL BE REQUIRED AS SPECIFIED WITHIN THE APPROVED PLANS OR AS DIRECTED.

7. ENSURE THE CHANNEL DISCHARGES TO A STABLE AREA.

ADDITIONAL REQUIREMENTS FOR TURF PLACEMENT:

1. TURF SHOULD BE USED WITHIN 12 HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

2. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

3. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

4. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

5. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

6. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

7. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST TWO WEEK FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

8. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

9. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH

MAINTENANCE

1. DURING THE SITE'S CONSTRUCTION PERIOD, INSPECT THE DIVERSION CHANNEL WEEKLY AND AFTER ANY INCREASE IN FLOWS WITHIN THE CHANNEL. REPAIR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE CHANNEL. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE CONSTRUCTION WORK ABOVE A TEMPORARY DIVERSION CHANNEL IS FINISHED AND THE AREA IS STABILISED, THE AREA SHOULD BE APPROPRIATELY REHABILITATED.

2. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

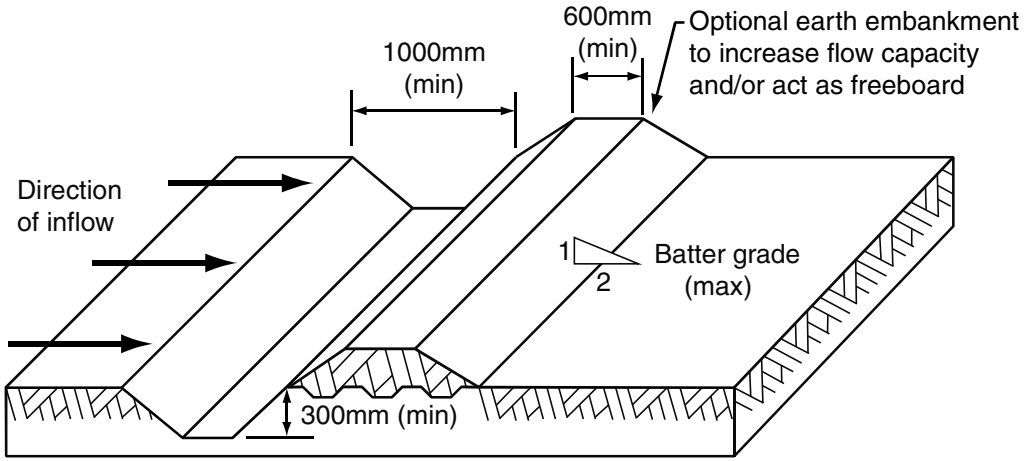


Figure 1 - Typical profile of diversion channel with bank

Drawn:	Date:		
GMW	Dec-09	Diversion Channels	DC-01

CONSTRUCTION

1. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

2. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

3. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

4. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN 1 SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

5. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

6. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

7. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

8. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

9. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE SPILLWAY PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORM EVENTS, OR OTHERWISE ON A WEEKLY BASIS. MAKE REPAIRS AS NECESSARY.

2. CHECK FOR MOVEMENT OF, OR DAMAGE TO, THE SPILLWAY'S LINING, INCLUDING SURFACE CRACKING.

3. CHECK FOR SOIL SCOUR ADJACENT THE SPILLWAY. INVESTIGATE THE CAUSE OF ANY SCOUR, AND REPAIR AS NECESSARY.

4. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SPILLWAY TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED.

REMOVAL

1. TEMPORARY SPILLWAYS SHOULD BE REMOVED WHEN AN ALTERNATIVE, STABLE, DRAINAGE SYSTEM IS AVAILABLE.

2. REMOVE ALL MATERIALS AND DEPOSITED SEDIMENT, AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA IN PREPARATION FOR STABILISATION, THEN STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

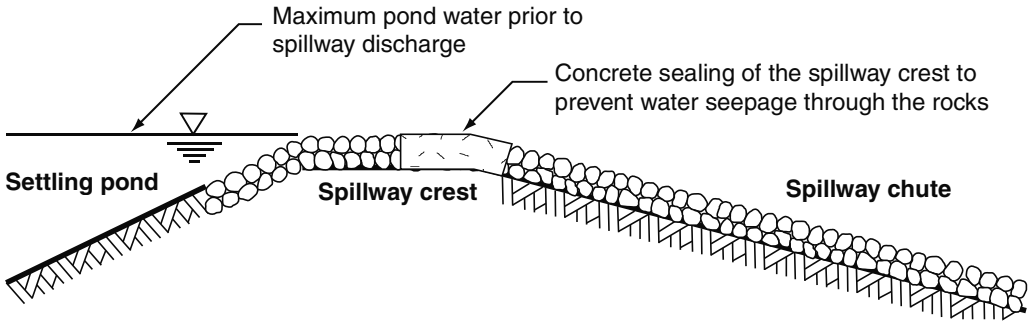
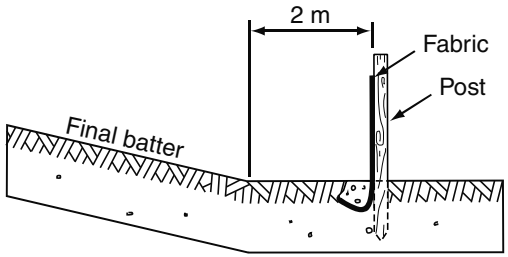
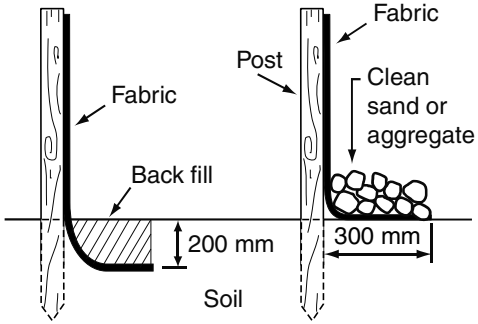


Figure 1 - Example of seepage control on the spillway crest

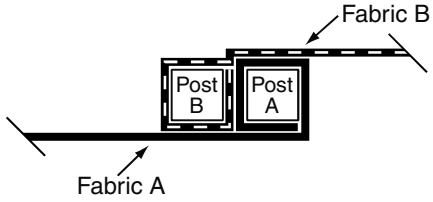
Drawn:	Date:		
GMW	Dec-09	Emergency Spillways	ES-1



(a) Location of fence relative to base of slope

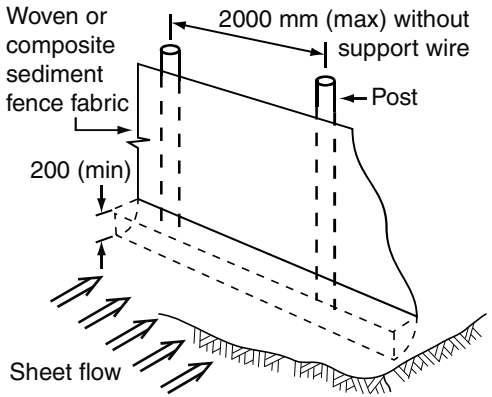


(b) Anchoring base of fabric

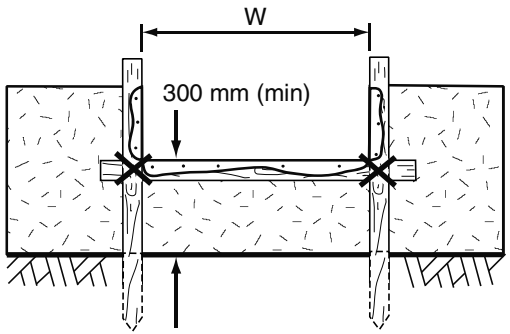


Fabric to fold around each stake one full turn.
Stake B to be drive tightly against Stake A.
The tops of both stakes to be secured with wire.

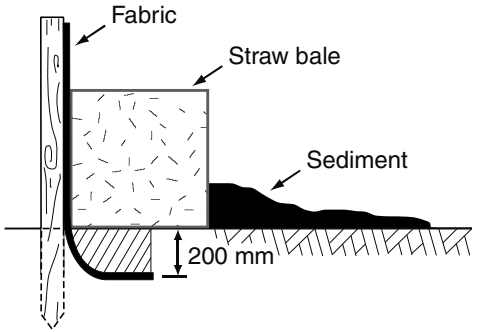
(c) Joining fabric - Method 1



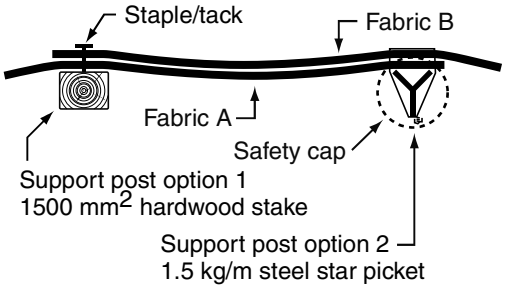
(d) Installation without backing support



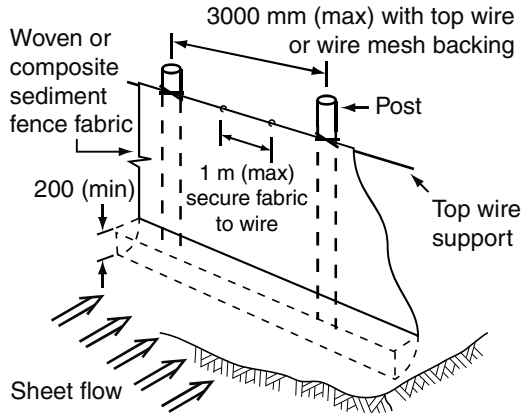
(e) Spill-through weir



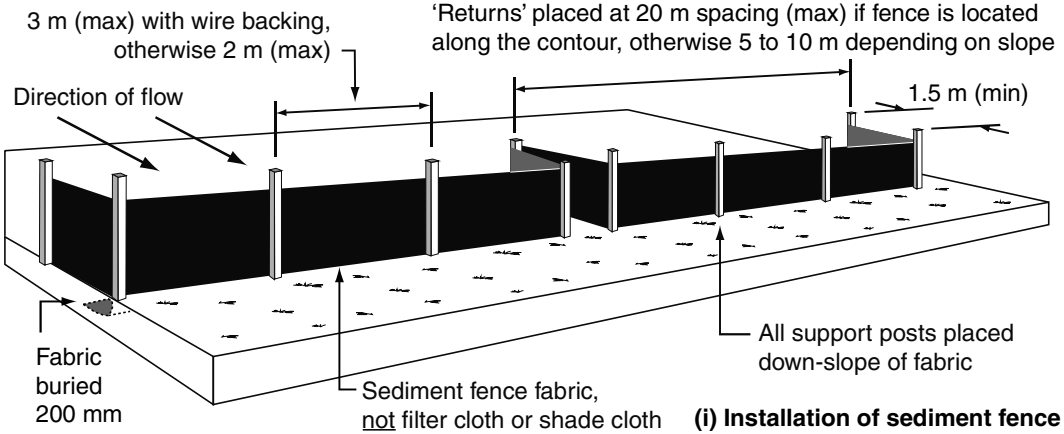
(f) Placement of up-slope straw bale



(g) Joining fabric - Method 2



(h) Installation with top wire support



(i) Installation of sediment fence

Notes:

1. Sediment fence to be installed along a line of constant ground elevation wherever practical.
2. Both end of the sediment fence to extend up the slope at least 1m.
3. Support post to be spaced a maximum 2m unless the fence is supported by a top wire or wire mesh backing, in which case 3m maximum spacing.
4. Fence 'returns' shall be installed at maximum 20m spacing if fence is installed along the contour, otherwise 5 to 10m maximum spacing.
5. Minimum 4 staples or tie wires per stake.

Drawn:	Date:		
GMW	Dec-09	Sediment Fence	ESC-04

MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140g/m^2. ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND REQUIRED TYPE OF FABRIC (IF SPECIFIED). IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, FABRIC TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TO THE MAXIMUM DEGREE PRACTICAL, AND WHERE THE PLANS ALLOW, ENSURE THE FENCE IS LOCATED:
(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;
(ii) ALONG A LINE OF CONSTANT ELEVATION WHEREVER PRACTICAL;
(iii) AT LEAST 2m FROM THE TOE OF ANY FILLING OPERATIONS THAT MAY RESULT IN SHIFTING SOIL/FILL DAMAGING THE FENCE.

3. INSTALL RETURNS WITHIN THE FENCE AT MAXIMUM 20m INTERVALS IF THE FENCE IS INSTALLED ALONG THE CONTOUR, OR 5 TO 10m MAXIMUM SPACING (DEPENDING ON SLOPE) IF THE FENCE IS INSTALLED AT AN ANGLE TO THE CONTOUR. THE 'RETURNS' SHALL CONSIST OF EITHER:
(i) V-SHAPED SECTION EXTENDING AT LEAST 1.5m UP THE SLOPE; OR
(ii) SANDBAG OR ROCK/AGGREGATE CHECK DAM A MINIMUM 1/3 AND MAXIMUM 1/2 FENCE HEIGHT, AND EXTENDING AT LEAST 1.5m UP THE SLOPE.

4. ENSURE THE EXTREME ENDS OF THE FENCE ARE TURNED UP THE SLOPE AT LEAST 1.5m, OR AS NECESSARY, TO MINIMISE WATER BYPASSING AROUND THE FENCE.

5. ENSURE THE SEDIMENT FENCE IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE FENCE, AND THE UNDESIRABLE DISCHARGE OF WATER AROUND THE ENDS OF THE FENCE.

6. IF THE SEDIMENT FENCE IS TO BE INSTALLED ALONG THE EDGE OF EXISTING TREES, ENSURE CARE IS TAKEN TO PROTECT THE TREES AND THEIR ROOT SYSTEMS DURING INSTALLATION OF THE FENCE. DO NOT ATTACH THE FABRIC TO THE TREES.

7. UNLESS DIRECTED BY THE SITE SUPERVISOR OR THE APPROVED PLANS, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE PROPOSED FENCE LINE, PLACING THE EXCAVATED MATERIAL ON THE UP-SLOPE SIDE OF THE TRENCH.

8. ALONG THE LOWER SIDE OF THE TRENCH, APPROPRIATELY SECURE THE STAKES INTO THE GROUND SPACED NO GREATER THAN 3m IF SUPPORTED BY A TOP SUPPORT WIRE OR WEIR MESH BACKING, OTHERWISE NO GREATER THAN 2m.

9. IF SPECIFIED, SECURELY ATTACH THE SUPPORT WIRE OR MESH TO THE UP-SLOPE SIDE OF THE STAKES WITH THE MESH EXTENDING AT LEAST 200mm INTO THE EXCAVATED TRENCH. ENSURE THE MESH AND FABRIC IS ATTACHED TO THE UP-SLOPE SIDE OF THE STAKES EVEN WHEN DIRECTING A FENCE AROUND A CORNER OR SHARP CHANGE OF DIRECTION.

10. WHEREVER POSSIBLE, CONSTRUCT THE SEDIMENT FENCE FROM A CONTINUOUS ROLL OF FABRIC. TO JOIN FABRIC EITHER:
(i) ATTACH EACH END TO TWO OVERLAPPING STAKES WITH THE FABRIC FOLDING AROUND THE ASSOCIATED STAKE ONE TURN, AND WITH THE TWO STAKES TIED TOGETHER WITH WIRE; OR
(ii) OVERLAP THE FABRIC TO THE NEXT ADJACENT SUPPORT POST.

11. SECURELY ATTACH THE FABRIC TO THE SUPPORT POSTS USING 25 X 12.5mm STAPLES, OR TIE WIRE AT MAXIMUM 150mm SPACING.

12. SECURELY ATTACH THE FABRIC TO THE SUPPORT WIRE/MESH (IF ANY) AT A MAXIMUM SPACING OF 1m.

13. ENSURE THE COMPLETED SEDIMENT FENCE IS AT LEAST 450mm, BUT NOT MORE THAN 700mm HIGH. IF A SPILL-THOUGH WEIR IS INSTALLED, ENSURE THE CREST OF THE WEIR IS AT LEAST 300mm ABOVE GROUND LEVEL.

14. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC AND MESH TO PREVENT WATER FROM FLOWING UNDER THE FENCE.

ADDITIONAL REQUIREMENTS FOR THE INSTALLATION OF A SPILL-THROUGH WEIR

1. LOCATE THE SPILL-THROUGH WEIR SUCH THAT THE WEIR CREST WILL BE LOWER THAN THE GROUND LEVEL AT EACH END OF THE FENCE.

2. ENSURE THE CREST OF THE SPILL-THROUGH WEIR IS AT LEAST 300mm THE GROUND ELEVATION.

3. SECURELY TIE A HORIZONTAL CROSS MEMBER (WEIR) TO THE SUPPORT POSTS/ STAKES EACH SIDE OF THE WEIR. CUT THE FABRIC DOWN THE SIDE OF EACH 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 SOIL EROSION AND APPROPRIATELY DISCHARGE THE CONCENTRATED FLOW PASSING OVER THE WEIR.

MAINTENANCE

1. INSPECT THE SEDIMENT FENCE AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. IF THE FENCE IS SAGGING BETWEEN STAKES, INSTALL ADDITIONAL SUPPORT POSTS.

5. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 1/3 THE HEIGHT OF THE FENCE.

6. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. REPLACE THE FABRIC IF THE SERVICE LIFE OF THE EXISTING FABRIC EXCEEDS 6-MONTHS.

REMOVAL

1. WHEN DISTURBED AREAS UP-SLOPE OF THE SEDIMENT FENCE ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE FENCE MUST BE REMOVED.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	May-10	Sediment Fence	ESC-05

MATERIALS

GEOTEXTILE FABRIC: NON-WOVEN FILTER CLOTH (MINIMUM 'BIDIM' A34 OR THE EQUIVALENT), WIDE STRIP TENSILE STRENGTH (AS3706.2) MINIMUM 15kN/m IN BOTH DIRECTIONS, PORE SIZE (EOS, O95, AS 3706.7) LESS THAN 110mm, MASS PER UNIT AREA (AS3706.1) MINIMUM 200GSM.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

BACKING MESH: PLASTIC OR STEEL MESH WITH A MAXIMUM MESH OPENING OF 200mm.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. UNLESS OTHERWISE DIRECTED BY THE RESPONSIBLE ON-SITE OFFICER, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE PROPOSED ALIGNMENT OF THE FILTER FENCE, PLACING THE EXCAVATED MATERIAL UP-SLOPE OF THE FENCE.

3. IF THE FILTER FENCE IS TO BE STAKED WITHOUT A MESH BACKING, THEN SECURE THE SUPPORT POSTS INTO THE GROUND AT A SPACING NO GREATER THAN 1.5m.

4. IF THE FILTER FENCE IS TO BE STAKED WITH A MESH BACKING, SECURE THE SUPPORT POSTS INTO THE GROUND AT A SPACING NO GREATER THAN 2.0m, THEN SECURELY ATTACH THE BACKING MESH TO THE UP-SLOPE SIDE OF THE SUPPORT POSTS FROM A CONTINUOUS LENGTH OF MESH. EXTEND THE MESH INTO THE EXCAVATED TRENCH.

5. IF THE FILTER FENCE IS THE BE SUPPORTED BY STRAW BALES, THEN AFTER SUITABLE ANCHORING THE BOTTOM 300mm OF FABRIC, PLACE A CONTINUOUS ROW OF STRAW BALES IMMEDIATELY DOWN-SLOPE OF THE FABRIC AND WRAP THE FABRIC OVER THE TOP OF THE STRAW BALES. SECURELY ANCHOR THE FILTER FENCE WITH A SINGLE STAKE DRIVEN THROUGH THE FABRIC AND CENTRE OF EACH BALE.

6. USING A CONTINUOUS LENGTH OF NON-WOVEN GEOTEXTILE, SECURELY ATTACH THE FABRIC TO THE UP-SLOPE SIDE OF THE SUPPORT POSTS OR BACKING MESH, WITH THE FABRIC EXTENDED AT LEAST 200mm INTO THE TRENCH.

7. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC TO PREVENT DISPLACEMENT OF THE FABRIC AND TO PREVENT THE FREE MOVEMENT OF WATER UNDER THE FABRIC.

8. IN ALL CASES, INSTALL THE FILTER FENCE IN A MANNER THAT WILL MINIMISE THE RISK OF SEDIMENT-LADEN WATER FLOWING AROUND THE FENCE.

MAINTENANCE

1. INSPECT THE FILTER FENCE REGULARLY AND AT LEAST DAILY DURING DE-WATERING OPERATIONS. MAKE REPAIRS AS NEEDED TO THE FABRIC AND SUPPORT FRAME.

2. INSPECT THE FABRIC FOR OBVIOUS LEAKS RESULTING FROM HOLES, TEARS OR JOINT FAILURE IN THE FABRIC.

3. CHECK THAT WATER HAS NOT OVERTOPPED THE FENCE AT LOW POINTS.

4. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC PLACED INSIDE THE OLD FABRIC, EXTENDING AT LEAST FROM SUPPORT POST TO SUPPORT POST.

5. CHECK FOR MATERIALS LEANING UP AGAINST THE FILTER FENCE. MAKE REPAIRS AS NEEDED TO THE FABRIC AND SUPPORT FRAME.

REMOVAL

1. REMOVE ALL ACCUMULATED SEDIMENT AND DISPOSE OF IT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

2. REMOVE ALL MATERIALS AND REPAIR DAMAGE TO THE GROUND SURFACE AS NECESSARY.

3. APPROPRIATELY REHABILITATE (E.G. REVEGETATE) THE GROUND AS NECESSARY TO MINIMISE THE RISK OF AN ONGOING EROSION HAZARD.

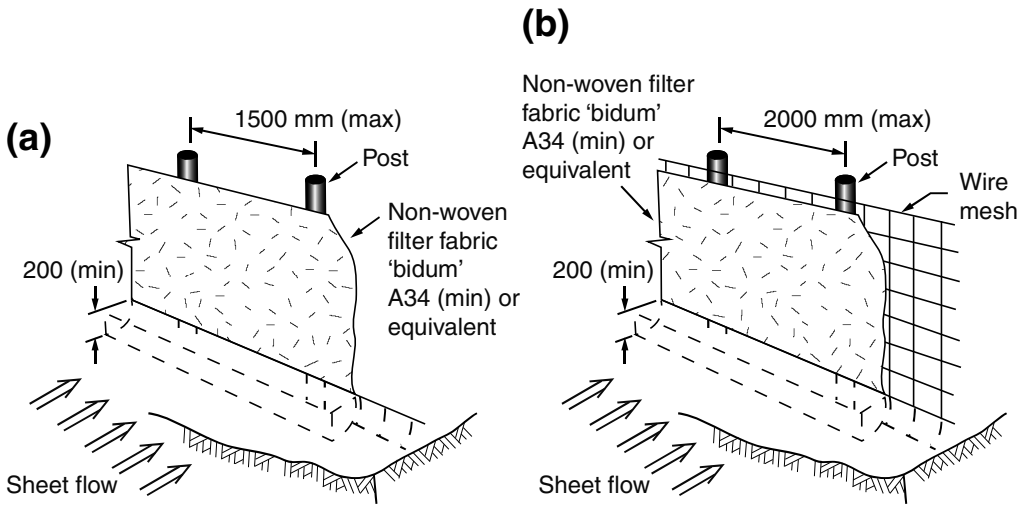


Figure 1 - Various installation methods

Drawn:	Date:		
GMW	Apr-10	Filter Fence	FF-01

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.

3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.

4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200mm WIDE EXTENDING AT LEAST 300mm UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150mm IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150mm LONG.

5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.

6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.

MAINTENANCE

1. INSPECT THE LEVEL SPREADER AFTER EVERY RAINFALL EVENT UNTIL VEGETATION IS ESTABLISHED.

2. AFTER ESTABLISHMENT OF VEGETATION OVER THE LEVEL SPREADER, INSPECTIONS SHOULD BE MADE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

3. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW.

4. ENSURE THAT THERE IS NO SOIL EROSION OR CHANNEL DAMAGE UPSTREAM OF THE LEVEL SPREADER, OR SOIL EROSION OR VEGETATION DAMAGE DOWNSTREAM OF THE LEVEL SPREADER.

5. INVESTIGATE THE SOURCE OF ANY EXCESSIVE SEDIMENTATION.

6. MAINTAIN GRASS IN A HEALTH CONDITION WITH NO LESS THAN 90% COVER UNLESS CURRENT WEATHER CONDITIONS REQUIRE OTHERWISE.

7. GRASS HEIGHT SHOULD BE MAINTAINED AT A MINIMUM 50mm BLADE LENGTH WITHIN THE LEVEL SPREADER AND DOWNSTREAM DISCHARGE AREA, AND A MAXIMUM BLADE LENGTH NO GREATER THAN ADJACENT GRASSES.

REMOVAL

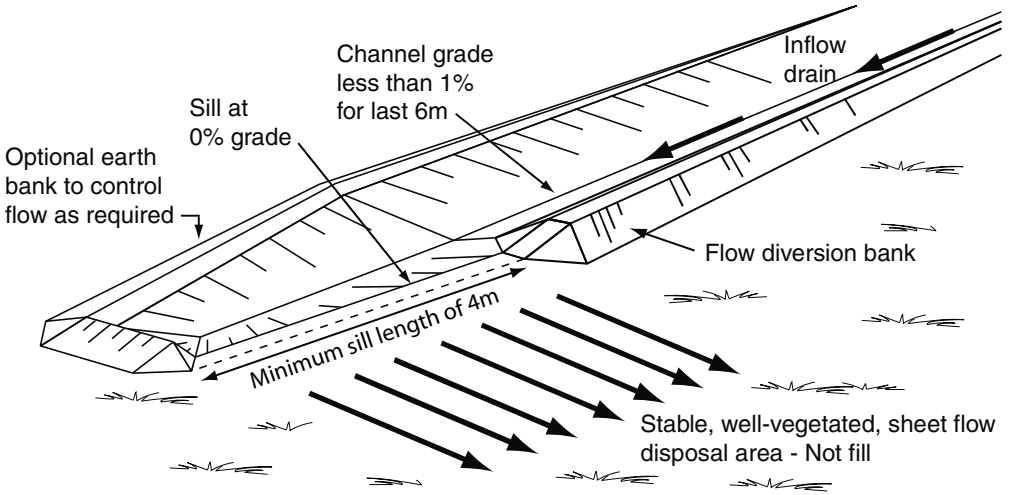
1. TEMPORARY LEVEL SPREADERS SHOULD BE DECOMMISSIONED ONLY AFTER AN ALTERNATIVE STABLE OUTLET IS OPERATIONAL, OR WHEN THE INFLOW CHANNEL IS DECOMMISSIONED.

2. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

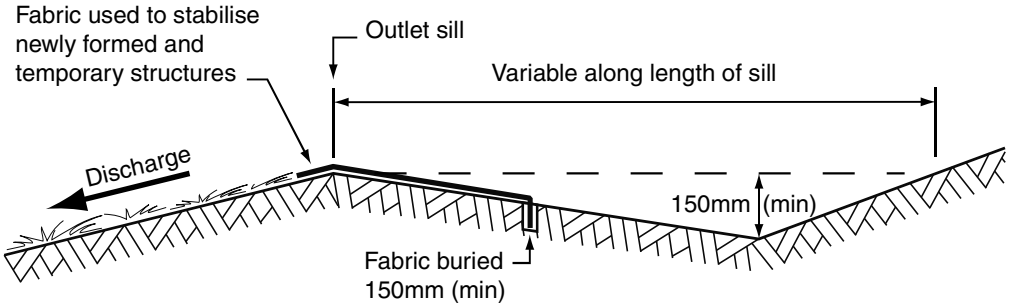
3. REMOVE AND APPROPRIATELY DISPOSE OF ANY EXPOSED GEOTEXTILE.

4. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

5. STABILISE THE AREA AS SPECIFIED ON THE APPROVED PLAN.

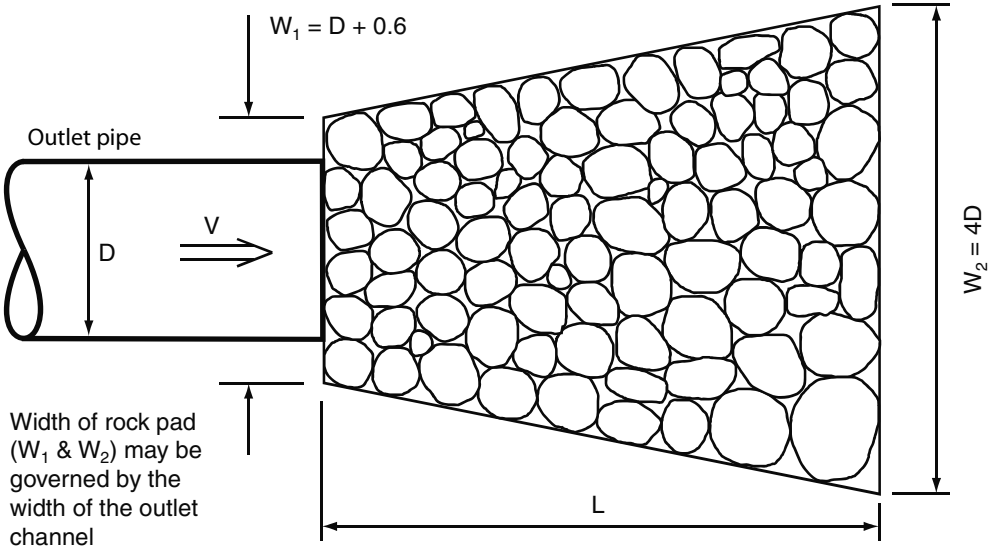


(a) Typical layout of level spreader

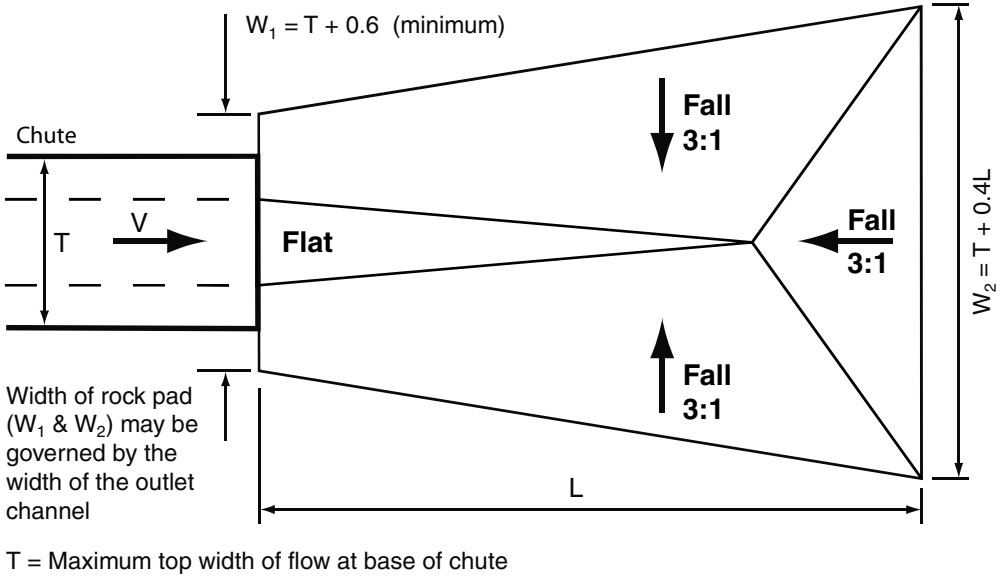


(b) Typical profile of the the outlet weir

Drawn:	Date:		
GMW	Dec-09	Level Spreaders	LS-01

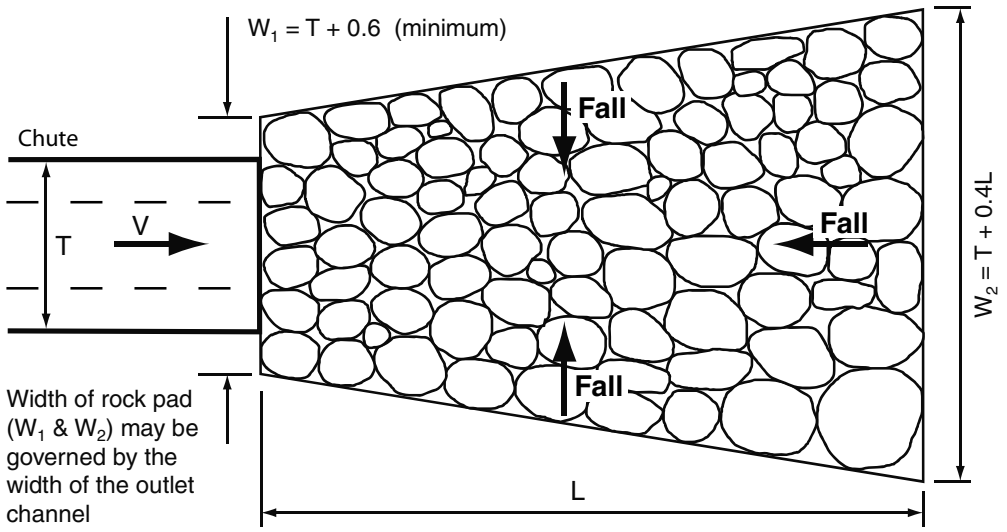


(a) Typical layout of a rock pad outlet structure for a pipe outlet

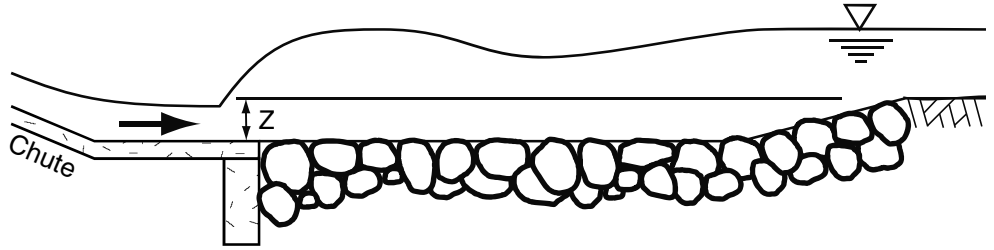


T = Maximum top width of flow at base of chute

(b) Typical form of a rock pad outlet structure for a drainage chute



(c) Typical layout of a rock pad outlet structure for a drainage chute



(d) Typical profile of a rock pad outlet structure for a drainage chute

Notes:

1. Drawings applicable to temporary drainage chutes and slope drains.
2. Rock pad outlet structures for slope drains usually are not required to be recessed below natural ground level as is the case for chute outlets (see Figure B).

Drawn:	Date:		
GMW	Dec-09	Outlet Structures	OS-01

MATERIALS (ROCK PADS)

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION (ROCK PADS)

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. THE DIMENSIONS OF THE OUTLET STRUCTURE MUST ALIGN WITH THE DOMINANT FLOW DIRECTION.

3. EXCAVATE THE OUTLET PAD FOOTPRINT TO THE SPECIFIED DIMENSION SUCH THE WHEN THE ROCK IS PLACED IN THE EXCAVATED PIT THE TOP OF THE ROCKS WILL BE LEVEL WITH THE SURROUNDING GROUND, UNLESS OTHERWISE DIRECTED.

4. IF THE EXCAVATED SOILS ARE DISPERSIVE, OVER-EXCAVATED THE ROCK PAD BY AT LEAST 300mm AND BACKFILL WITH STABLE, NON-DISPERSIVE MATERIAL.

5. LINE THE EXCAVATED PIT WITH GEOTEXTILE FILTER CLOTH, PREFERABLY USING A SINGLE SHEET. IF JOINTS ARE REQUIRED, OVERLAP THE FABRIC AT LEAST 300mm.

6. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

7. ENSURE THERE ARE AT LEAST TWO LAYERS OF ROCKS. WHERE NECESSARY, REPOSITION THE LARGER ROCKS TO ENSURE TWO LAYERS OF ROCKS ARE ACHIEVED WITHOUT ELEVATING THE UPPER SURFACE ABOVE THE PIPE INVERT.

8. ENSURE THE ROCK IS PLACED IN A MANNER THAT WILL ALLOW WATER TO DISCHARGE FREELY FROM THE PIPE.

9. ENSURE THE UPPER SURFACE OF THE ROCK PAD DOES NOT CAUSE WATER TO BE DEFLECTED AROUND THE EDGE OF THE ROCK PAD.

10. IMMEDIATELY AFTER CONSTRUCTION, APPROPRIATELY STABILISE ALL DISTURBED AREAS.

MAINTENANCE

1. WHILE CONSTRUCTION WORKS CONTINUE ON THE SITE, INSPECT THE OUTLET STRUCTURE PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, AND ON AT LEAST A WEEKLY BASIS.

2. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

REMOVAL

1. TEMPORARY OUTLET STRUCTURES SHOULD BE COMPLETELY REMOVED, OR WHERE APPROPRIATE, REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

2. FOLLOWING REMOVAL OF THE DEVICE, THE DISTURBED AREA MUST BE APPROPRIATELY REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

3. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

Drawn:	Date:		
GMW	Dec-09	Outlet Structure - Rock Pad	OS-02

MATERIALS

ROCK: 150 TO 300mm NOMINAL DIAMETER, HARD, EROSION RESISTANT ROCK. SMALLER ROCK MAY BE USED IF SUITABLE LARGE ROCK IS NOT AVAILABLE.

SANDBAGS: GEOTEXTILE BAGS (WOVEN SYNTHETIC, OR NON-WOVEN BIODEGRADABLE) FILLED WITH CLEAN COARSE SAND, CLEAN AGGREGATE, STRAW OR COMPOST.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. PRIOR TO PLACEMENT OF THE CHECK DAMS, ENSURE THE TYPE AND SIZE OF EACH CHECK DAMS WILL NOT CAUSE A SAFETY HAZARD OR CAUSE WATER TO SPILL OUT OF THE DRAIN.

3. LOCATE THE FIRST CHECK DAM AT THE DOWNSTREAM END OF THE SECTION OF CHANNEL BEING PROTECTED. LOCATE EACH SUCCESSIVE CHECK DAM SUCH THAT THE CREST OF THE IMMEDIATE DOWNSTREAM DAM IS LEVEL WITH THE TOE OF THE CHECK DAM BEING INSTALLED.

4. ENSURE THE CHANNEL SLOPE IS NO STEEPER THAN 10:1 (H:V). OTHERWISE CONSIDER THE USE OF A SUITABLE CHANNEL LINER INSTEAD OF THE CHECK DAMS.

5. CONSTRUCT THE CHECK DAM TO THE DIMENSIONS AND PROFILE SHOWN WITHIN THE APPROVED PLAN.

6. WHERE SPECIFIED, THE CHECK DAMS SHALL BE CONSTRUCTED ON A SHEET OF GEOTEXTILE FABRIC USED AS A DOWNSTREAM SPLASH PAD.

7. EACH CHECK DAM SHALL BE EXTENDED UP THE CHANNEL BANK (WHERE PRACTICABLE) TO AN ELEVATION AT LEAST 150mm ABOVE THE CREST LEVEL OF THE DAM.

MAINTENANCE

1. INSPECT EACH CHECK DAM AND THE DRAINAGE CHANNEL AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CORRECT ALL DAMAGE IMMEDIATELY. IF SIGNIFICANT EROSION OCCURS BETWEEN ANY OF THE CHECK DAMS, THEN CHECK THE SPACING OF DAMS AND WHERE NECESSARY INSTALL INTERMEDIATE CHECK DAMS OR A SUITABLE CHANNEL LINER.

3. CHECK FOR DISPLACEMENT OF THE CHECK DAMS

4. CHECK FOR SOIL SCOUR AROUND THE ENDS OF EACH CHECK DAM. IF SUCH EROSION IS OCCURRING, CONSIDER EXTENDING THE WIDTH OF THE CHECK DAM TO AVOID SUCH PROBLEMS.

5. IF SEVERE SOIL EROSION OCCURS EITHER UNDER OR AROUND THE CHECK DAMS, THEN SEEK EXPERT ADVICE ON AN ALTERNATIVE TREATMENT MEASURE.

6. REMOVE ANY SEDIMENT ACCUMULATED BY THE CHECK DAMS, UNLESS IT IS INTENDED THAT THIS SEDIMENT WILL REMAIN WITHIN THE CHANNEL.

7. DISPOSE OF COLLECTED SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN CONSTRUCTION WORK WITHIN THE DRAINAGE AREA ABOVE THE CHECK DAMS HAS BEEN COMPLETED, AND THE DISTURBED AREAS AND THE DRAINAGE CHANNEL ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, ALL TEMPORARY CHECK DAMS MUST BE REMOVED.

2. REMOVE THE CHECK DAMS AND ASSOCIATED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

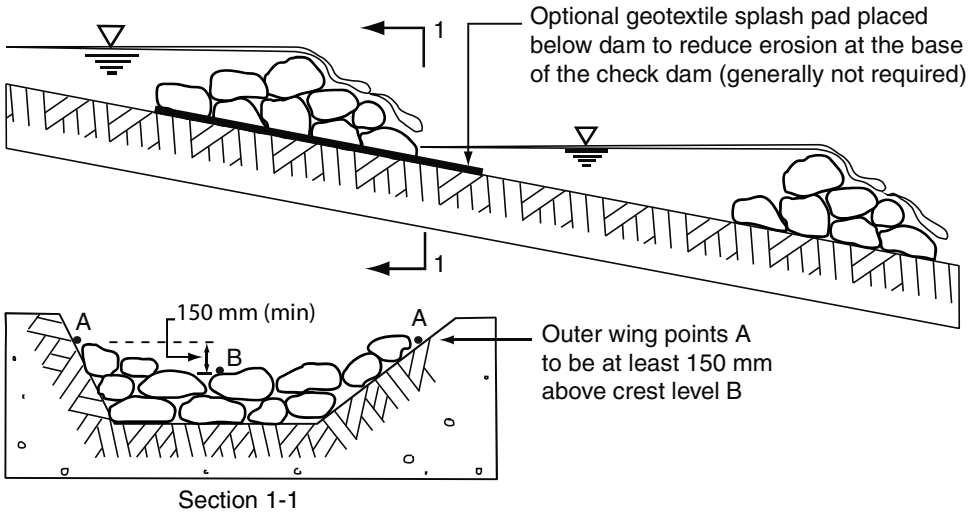
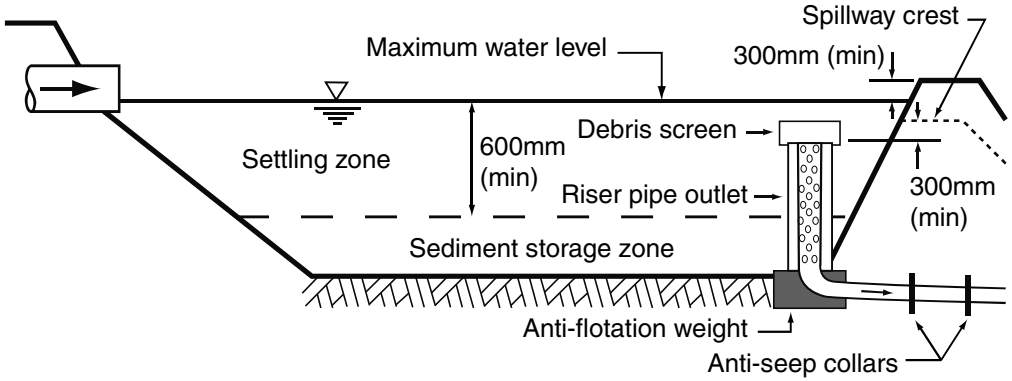
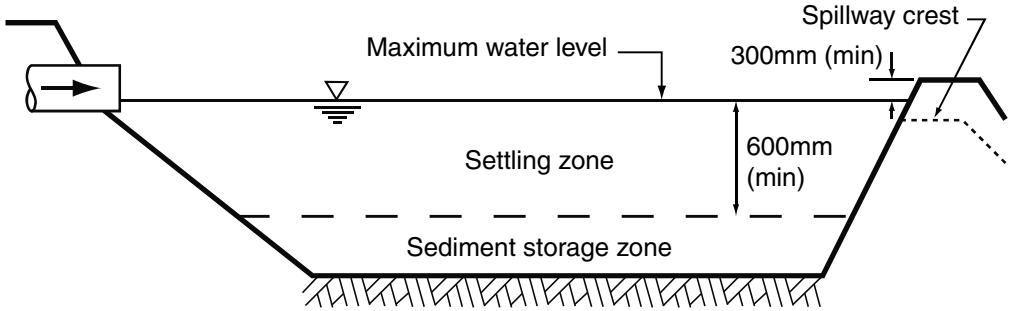


Figure 1 - Layout and profile of check dams (rock check dams shown)

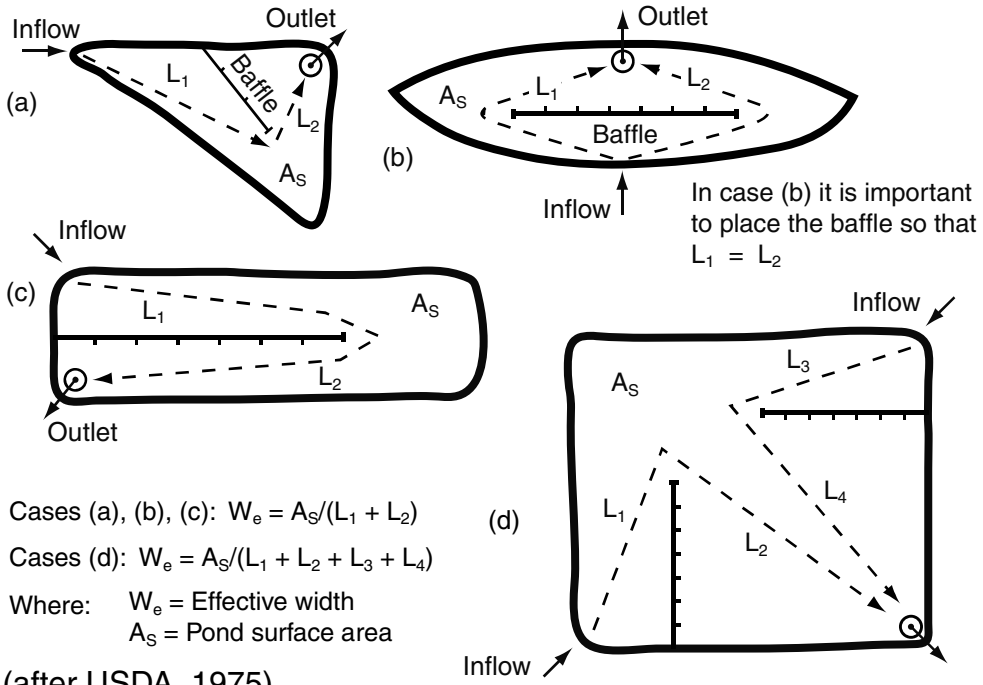
Drawn:	Date:		
GMW	Dec-09	Check Dams	RCD-01



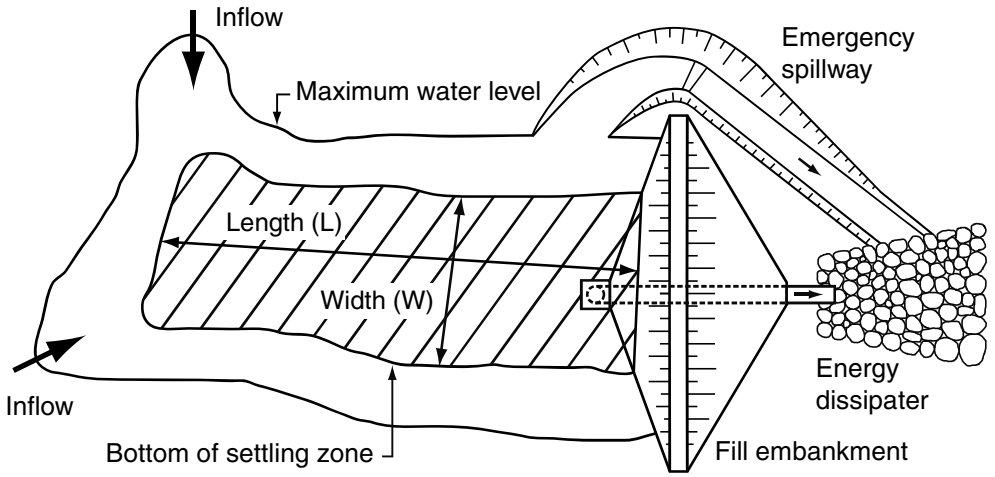
(a) Type C (dry) basin with riser pipe outlet system



(b) Typical profile of Type F/D (wet) basin



(c) Typical arrangement of internal flow control baffles



(d) Type C (dry) basin with riser pipe outlet system (plan view)

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-01

MATERIALS

EARTH FILL: CLEAN SOIL WITH EMERSON CLASS 2(1), 3, 4, OR 5, AND FREE OF ROOTS, WOODY VEGETATION, ROCKS AND 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. THIS SPECIFICATION MAYBE REPLACED BY AN EQUIVALENT STANDARD BASED ON THE EXCHANGEABLE SODIUM PERCENTAGE.

RISER PIPE: MINIMUM 250mm DIAMETER.

SPILLWAY ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED ROCK WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL (d50) ROCK SIZE. LARGE ROCK SHOULD DOMINATE, WITH SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. THE SPECIFIC GRAVITY SHOULD BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM 'BIDIM' A24 OR EQUIVALENT.

CONSTRUCTION

1. NOTWITHSTANDING ANY DESCRIPTION CONTAINED WITHIN THE APPROVED PLANS OR SPECIFICATIONS, THE CONTRACTOR SHALL BE RESPONSIBLE FOR SATISFYING THEMSELVES AS TO THE NATURE AND EXTENT OF THE SPECIFIED WORKS AND THE PHYSICAL AND LEGAL CONDITIONS UNDER WHICH THE WORKS WILL BE CARRIED OUT. THIS SHALL INCLUDE MEANS OF ACCESS, EXTENT OF CLEARING, NATURE OF MATERIAL TO BE EXCAVATED, TYPE AND SIZE OF MECHANICAL PLANT REQUIRED, LOCATION AND SUITABILITY OF WATER SUPPLY FOR CONSTRUCTION AND TESTING PURPOSES, AND ANY OTHER LIKE MATTERS AFFECTING THE CONSTRUCTION OF THE WORKS.

2. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. BEFORE STARTING ANY CLEARING OR CONSTRUCTION, ENSURE ALL THE NECESSARY MATERIALS AND COMPONENTS ARE ON THE SITE TO AVOID DELAYS IN COMPLETING THE POND ONCE WORKS BEGIN.

4. INSTALL REQUIRED SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE PROPOSED EARTHWORKS TO CONTROL SEDIMENT RUNOFF DURING CONSTRUCTION OF THE BASIN.

5. THE AREA TO BE COVERED BY THE EMBANKMENT, BORROW PITS AND INCIDENTAL WORKS, TOGETHER WITH AN AREA EXTENDING BEYOND THE LIMITS OF EACH FOR A DISTANCE NOT EXCEEDING FIVE (5) METRES ALL AROUND MUST BE CLEARED OF ALL TREES, SCRUB, STUMPS, ROOTS, DEAD TIMBER AND RUBBISH AND DISPOSED OF IN A SUITABLE MANNER. DELAY CLEARING THE MAIN POND AREA UNTIL THE EMBANKMENT IS COMPLETE.

6. ENSURE ALL HOLES MADE BY GRUBBING WITHIN THE EMBANKMENT FOOTPRINT ARE FILLED WITH SOUND MATERIAL, ADEQUATELY COMPACTED, AND FINISHED FLUSH WITH THE NATURAL SURFACE.

CUT-OFF TRENCH:

7. BEFORE CONSTRUCTION OF THE CUT-OFF TRENCH OR ANY ANCILLARY WORKS WITHIN THE EMBANKMENT FOOTPRINT, ALL GRASS GROWTH AND TOPSOIL MUST BE REMOVED FROM THE AREA TO BE OCCUPIED BY THE EMBANKMENT AND MUST BE DEPOSITED CLEAR OF THIS AREA AND RESERVED FOR TOPDRESSING THE COMPLETING THE EMBANKMENT.

8. EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE LINE OF THE EARTH FILL EMBANKMENT. CUT THE TRENCH TO STABLE SOIL MATERIAL, BUT IN NO CASE MAKE IT LESS THAN 600mm DEEP. THE CUT-OFF TRENCH MUST EXTEND INTO BOTH ABUTMENTS TO AT LEAST THE ELEVATION OF THE RISER PIPE CREST. MAKE THE MINIMUM BOTTOM WIDTH WIDE ENOUGH TO PERMIT OPERATION OF EXCAVATION AND COMPACTION EQUIPMENT, BUT IN NO CASE LESS THAN 600mm. MAKE THE SIDE SLOPES OF THE TRENCH NO STEEPER THAN 1:1 (H:V).

9. ENSURE ALL WATER, LOOSE SOIL, AND ROCK ARE REMOVED FROM THE TRENCH BEFORE BACKFILLING COMMENCES. THE CUT-OFF TRENCH MUST BE BACKFILLED WITH SELECTED EARTH-FILL OF THE TYPE SPECIFIED FOR THE EMBANKMENT, AND THIS SOIL MUST HAVE A MOISTURE CONTENT AND DEGREE OF COMPACTION THE SAME AS THAT SPECIFIED FOR THE SELECTED CORE ZONE.

10. MATERIAL EXCAVATED FROM THE CUT-OFF TRENCH MAY BE USED IN CONSTRUCTION OF THE EMBANKMENT PROVIDED IT IS SUITABLE AND IT IS PLACED IN THE CORRECT ZONE ACCORDING TO ITS CLASSIFICATION.

EMBANKMENT:

11. SCARIFY AREAS ON WHICH FILL IS TO BE PLACED BEFORE PLACING THE FILL.

12. ENSURE ALL FILL MATERIAL USED TO FORM THE EMBANKMENT MEETS THE SPECIFICATIONS CERTIFIED BY A SOIL SCIENTIST OR GEOTECHNICAL SPECIALIST.

13. THE FILL MATERIAL MUST CONTAIN SUFFICIENT MOISTURE SO IT CAN BE FORMED BY HAND INTO A BALL WITHOUT CRUMBLING. IF WATER CAN BE SQUEEZED OUT OF THE BALL, IT IS TOO WET FOR PROPER COMPACTION. PLACE FILL MATERIAL IN 150 TO 250mm CONTINUOUS LAYERS OVER THE ENTIRE LENGTH OF THE FILL AREA AND THEN COMPACT BEFORE PLACEMENT OF FURTHER FILL.

14. PLACE RISER PIPE OUTLET SYSTEM, IF SPECIFIED, IN APPROPRIATE SEQUENCE WITH THE EMBANKMENT FILLING. REFER TO SEPARATE INSTALLATION SPECIFICATIONS.

15. UNLESS OTHERWISE SPECIFIED ON THE APPROVED PLANS, COMPACT THE SOIL AT ABOUT 1% TO 2% WET OF OPTIMUM AND TO 95% MODIFIED OR 100% STANDARD COMPACTION.

16. WHERE BOTH DISPERSIVE AND NON-DISPERSIVE CLASSIFIED EARTH-FILL MATERIALS ARE AVAILABLE, NON-DISPERSIVE EARTH-FILL MUST BE USED IN THE CORE ZONE. THE REMAINING CLASSIFIED EARTH-FILL MATERIALS MUST ONLY BE USED AS DIRECTED BY [INSERT TITLE].

17. WHERE SPECIFIED, CONSTRUCT THE EMBANKMENT TO AN ELEVATION 10% HIGHER THAN THE DESIGN HEIGHT TO ALLOW FOR SETTLING; OTHERWISE FINISHED DIMENSIONS OF THE EMBANKMENT AFTER SPREADING OF TOPSOIL MUST CONFORM TO THE DRAWING WITH A TOLERANCE OF 75mm FROM THE SPECIFIED DIMENSIONS.

18. ENSURE DEBRIS AND OTHER UNSUITABLE BUILDING WASTE IS NOT PLACED WITHIN THE EARTH EMBANKMENT.

19. AFTER COMPLETION OF THE EMBANKMENT ALL LOOSE UNCOMPACTED EARTH-FILL MATERIAL ON THE UPSTREAM AND DOWNSTREAM BATTER MUST BE REMOVED PRIOR TO SPREADING OF TOPSOIL.

20. TOPSOIL AND REVEGETATE/STABILISED ALL EXPOSED EARTH AS DIRECTED WITHIN THE APPROVED PLANS.

(continued on SB-06)

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-05

SPILLWAY CONSTRUCTION:

21. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

22. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

23. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

24. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

25. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

26. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

27. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

28. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

29. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION. ESTABLISHMENT OF SETTLING POND:

30. THE AREA TO BE COVERED BY THE STORED WATER OUTSIDE THE LIMITS OF THE BORROW PITS MUST BE CLEARED OF ALL SCRUB AND RUBBISH. TREES MUST BE CUT DOWN STUMP HIGH AND REMOVED FROM THE IMMEDIATE VICINITY OF THE WORK.

31. ESTABLISH ALL REQUIRED INFLOW CHUTES AND INLET BAFFLES, IF SPECIFIED, TO ENABLE WATER TO DISCHARGE INTO THE BASIN IN A MANNER THAT WILL NOT CAUSE SOIL EROSION OR THE RE-SUSPENSION OF SETTLED SEDIMENT.

32. INSTALL A SEDIMENT STORAGE LEVEL MARKER POST WITH A CROSS MEMBER SET JUST BELOW THE TOP OF THE SEDIMENT STORAGE ZONE (AS SPECIFIED ON THE APPROVED PLANS). USE AT LEAST A 75mm WIDE POST FIRMLY SET INTO THE BASIN FLOOR.

33. IF SPECIFIED, INSTALL INTERNAL SETTLING POND BAFFLES. ENSURE THE CREST OF THESE BAFFLES IS SET LEVEL WITH, OR JUST BELOW, THE ELEVATION OF THE EMERGENCY SPILLWAY CREST.

34. INSTALL ALL APPROPRIATE MEASURES TO MINIMISE SAFETY RISK TO ON-SITE PERSONNEL AND THE PUBLIC CAUSED BY THE PRESENCE OF THE SETTLING POND. AVOID STEEP, SMOOTH INTERNAL SLOPES. APPROPRIATELY FENCE THE SETTLING POND AND POST WARNING SIGNS IF UNSUPERVISED PUBLIC ACCESS IS LIKELY OR THERE IS CONSIDERED TO BE AN UNACCEPTABLE RISK TO THE PUBLIC.

MAINTENANCE OF SEDIMENT BASIN

1. INSPECT THE SEDIMENT BASIN DURING THE FOLLOWING PERIODS:

(i) DURING CONSTRUCTION TO DETERMINE WHETHER MACHINERY, FALLING TREES, OR CONSTRUCTION ACTIVITY HAS DAMAGED ANY COMPONENTS OF THE SEDIMENT BASIN. IF DAMAGE HAS OCCURRED, REPAIR IT.

(ii) AFTER EACH RUNOFF EVENT. INSPECT THE EROSION DAMAGE AT FLOW ENTRY AND EXIT POINTS. IF DAMAGE HAS OCCURRED, MAKE THE NECESSARY REPAIRS.

(iii) AT LEAST WEEKLY DURING THE NOMINATED WET SEASON (IF ANY) OTHERWISE AT LEAST FORTNIGHTLY.

(iv) PRIOR TO, AND IMMEDIATELY AFTER, PERIODS OF 'STOP WORK' OR SITE SHUTDOWN.

2. CLEAN OUT ACCUMULATED SEDIMENT WHEN IT REACHES THE MARKER BOARD/POST, AND RESTORE THE ORIGINAL STORAGE VOLUME. PLACE SEDIMENT IN A DISPOSAL AREA OR, IF APPROPRIATE, MIX WITH DRY SOIL ON THE SITE.

3. DO NOT DISPOSE OF SEDIMENT IN A MANNER THAT WILL CREATE AN EROSION OR POLLUTION HAZARD.

4. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.

5. CHECK ALL EMBANKMENTS FOR EXCESSIVE SETTLEMENT, SLUMPING OF THE SLOPES OR PIPING BETWEEN THE CONDUIT AND THE EMBANKMENT; MAKE ALL NECESSARY REPAIRS.

6. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.

7. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DE-SILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.

REMOVAL OF SEDIMENT BASIN

1. WHEN GRADING AND CONSTRUCTION IN THE DRAINAGE AREA ABOVE A TEMPORARY SEDIMENT BASIN IS COMPLETED AND THE DISTURBED AREAS ARE ADEQUATELY STABILISED, THE BASIN MUST BE REMOVED OR OTHERWISE INCORPORATED INTO THE PERMANENT STORMWATER DRAINAGE SYSTEM. IN EITHER CASE, SEDIMENT SHOULD BE CLEARED AND PROPERLY DISPOSED OF AND THE BASIN AREA STABILISED.

2. BEFORE STARTING ANY MAINTENANCE WORK ON THE BASIN OR SPILLWAY, INSTALL ALL NECESSARY SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE SEDIMENT BASIN.

3. ALL WATER AND SEDIMENT MUST BE REMOVED FROM THE BASIN PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

4. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT, AND STABILISE AND/OR REVEGETATE AS REQUIRED TO ESTABLISH A STABLE LAND SURFACE.

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-06

MATERIALS

STRAW BALES: STRAW BALES CONTAINING WITH MINIMUM SEED CONTENT. HAY OR LUCERNE BALES MUST NOT BE USED.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS.

FILTER CLOTH: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH MINIMUM 'BIDIM' A34 OR EQUIVALENT.

AGGREGATE: 15 TO 25mm CLEAN GRAVEL OR AGGREGATE.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SUITABLY CLEAR AND PREPARE THE SURFACE WHERE THE BALES WILL BE INSTALLED.

3. LAY THE FILTER FABRIC ON THE GROUND WITH THE UP-SLOPE EDGE EXTENDING AT LEAST 200mm UP-SLOPE OF THE INTENDED UP-SLOPE EDGE OF THE BALES.

4. IF MORE THAN ONE SHEET OF FABRIC IS USED, THEN OVERLAP THE FABRIC A MINIMUM OF 600mm AT ALL JOINTS.

5. PLACE THE BALES END TO END (LENGTH-WISE) ON THE FABRIC WITH THE UP-SLOPE EDGE AT LEAST 200mm DOWN-SLOPE OF THE UP-SLOPE EDGE OF THE FABRIC.

6. FOLD THE REMAINDER OF THE FILTER CLOTH OVER THE BALES SUCH THAT THE END OF THE FABRIC RESTS FIRMLY ON THE GROUND AND EXTENDS AT LEAST 200mm UP-SLOPE OF THE BALES.

7. SECURELY ANCHOR THE BALES WITH A MINIMUM OF ONE STAKE OR PICKET DRIVEN THROUGH THE CENTRE LINE OF EACH BALE. IF THE BALES ARE NOT WRAPPED IN FILTER CLOTH (NOT RECOMMENDED), THEN USE AT LEAST TWO STAKES PER BALE. THE FIRST STAKE BEING DRIVEN TOWARDS THE ADJOINING BALE AT A 45-DEGREE ANGLE TO FORCE THE BALES TOGETHER.

MAINTENANCE

1. REPLACE THE STRAW BALE BARRIER IF FULL OR PARTIAL COLLAPSE OF THE BALES OCCURS.

2. REMOVE AND SUITABLY DISPOSE OF ACCUMULATED SEDIMENT PRIOR TO REPLACING THE BALES.

3. REPLACE THE FILTER FABRIC WHEN IT BECOMES BLOCKED WITH SEDIMENT AND/OR THE FLOW RATE THROUGH THE BARRIER BECOMES UNACCEPTABLY LOW.

REMOVAL

1. WHEN WORK AREA UP-SLOPE OF THE STRAW BALE BARRIER IS SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BARRIER MUST BE REMOVED.

2. REMOVE ALL MATERIALS AND DEPOSITED SEDIMENT AND DISPOSE OF IN A MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

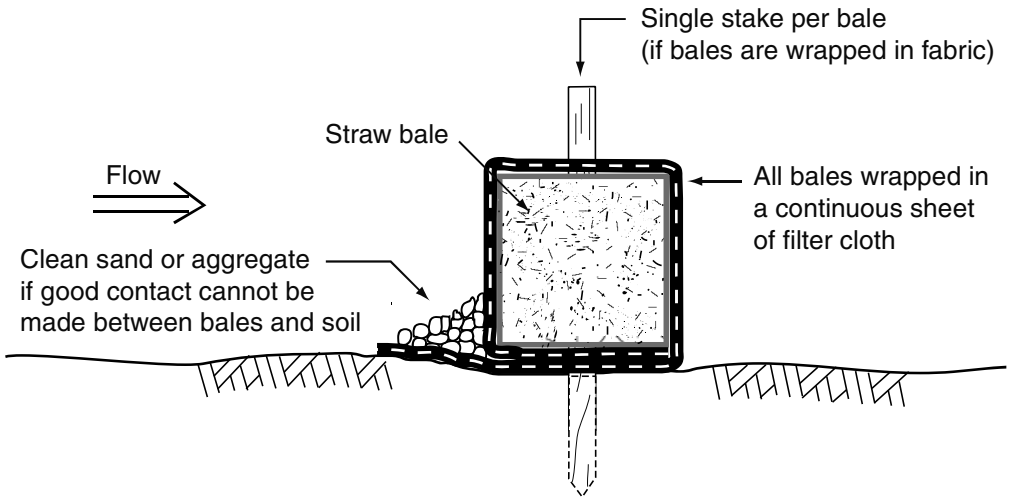


Figure 1 - Installation of straw bale barrier

Drawn:	Date:		
GMW	Apr-10	Straw Bale Barrier	SBB-01