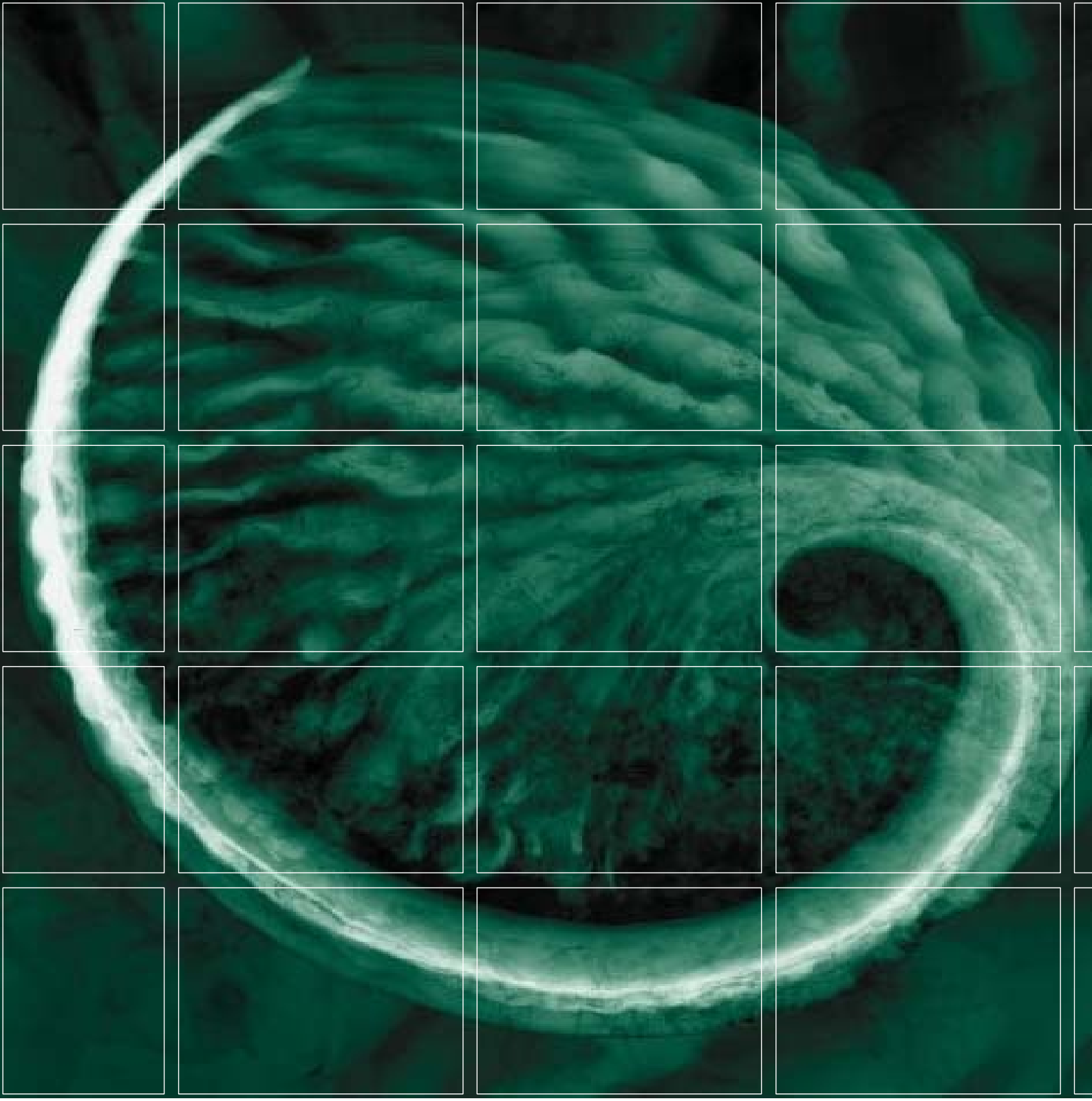

Haerses Road Sand Quarry
Site Water Management Plan

Dixon Sand (Penrith) Pty Ltd

July 2006

0049170SWMPfinal

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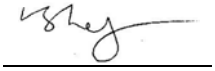
Approved by:	*Kelly Pearsall*
Position:	Project Manager
Signed:	
Date:	*26 July, 2006*
Approved by:	*Mike Shelly*
Position:	Project Director
Signed:	
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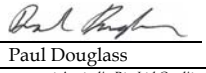
Partner:	
	Paul Douglass

Environmental Resources Management Australia Pty Ltd Quality System

Haerses Road Sand Quarry
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CONTENTS

ANNEXURES

LIST OF FIGURES

1 INTRODUCTION

This Site Water Management Plan (SWMP) was prepared by Environmental Resources Management Australia Pty Ltd (ERM) for Dixon Sand (Penrith) Pty Ltd's (Dixon Sand) recently approved quarry at Haerses Road, Maroota.

1.1 PROJECT DESCRIPTION

The site is located off Haerses Road, Maroota and includes Lot 170 DP 664767, Lots A and B DP 407341, Lots 176 and 177 DP 752039 and is shown in *Figure 1.1.*

Dixon Sand have development approval (DA 165-7-2005) to extract and haul sand on the site and process sand at an existing processing and tailings disposal plant two kilometres to the north, on Lots 29 and 196 DP 752025, and Lots 1 and 2 DP 547255 Old Northern Road, Maroota.

The operation will involve the selective extraction and screening of sand that will be sold directly from the site or trucked to the processing plant.

1.2 STATUTORY REQUIREMENTS

Development Consent

This plan has been prepared in compliance with Condition 17 and 18 of the Development Consent DA 165-7-2005, and provides procedures for implementing Condition 16 of the Development Consent. These conditions are as follows:

"*16. The Applicant shall:*

(a) install and maintain sediment basins with sufficient capacity to contain the rainfall and runoff generated from a 90 percentile, 5 day rainfall event ("the design event") for the life of the development;

(b) ensure that the accumulated sediment in all sediment dams is kept below 30% of their design capacity;

(c) ensure that no fuel, oil, or other chemicals are stored on site; and

(d) undertake appropriate measures to ensure that vehicles do not track any material onto public roads.

17. Prior to carrying out any development, the Applicant shall develop (and following approval) implement a Site Water Management Plan for the development, in consultation with the DEC, DNR, and to the satisfaction of the Director-General. The plan shall include:

(a) a Soil and Water Management Plan; and

(b) a Groundwater Monitoring Program.

18. The Soil and Water Management Plan shall:

(a) describe what measures would be implemented to minimise soil erosion, and the discharge of sediment and other pollutants, during each stage of the development including:

- *road and intersection works;*
- *initial clearing and topsoil clearing;*
- *extraction; and*
- *noise bund construction.*

(b) include control measures that have the capacity to contain the rainfall and runoff generated by the 'design' event specified in Condition 18 [sic] *above; and*

(c) be consistent with the Landcom Managing Urban Stormwater: Soil and Construction Manual (Volume 1, addition 4, March 2004)."

Protection of the Environment Operations Act, 19997

It is an offence under the *Protection of the Environment Operations Act, 1997* (POEO Act) to pollute any waters or cause any waters to be polluted. The definition of pollution under the POEO Act is very broad and defines that the pollution of waters includes *"placing in or on, or otherwise introducing into or onto, waters (whether through an act or omission) any matter, whether solid, liquid or gaseous, so that the physical, chemical or biological condition of the waters is changed"*. Pollutants include soil, mud, earth, or clay. The definition also includes placing materials in areas where they can fall or be blown into waterways, or in a dry waterway or drain (and be therefore washed away during rainfall or flooding).

The site is subject to an Environmental Protection Licence (EPL) under the POEO Act. The conditions of the EPL No. 12513 that are relevant to soil and water management are reproduced below:

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

O4.1 A Site Water Management Plan (SWMP) must be implemented for the development, in consultation with DEC and DNR. The plan must include:

1. a Soil and Water Management Plan; and

2. a Groundwater Monitoring Program

The Soil and Water Management Plan must:

1. *describe what measures would be implemented to minimise soil erosion, and the discharge of sediment and other pollutants, during each stage of the development including:*

   - *road and intersection works;*
   - *initial clearing and topsoil stripping:*
   - *extraction; and*
   - *noise bund construction.*

2. *include control measures that have the capacity to contain the rainfall and runoff generated by the "design event" specified in condition.*

O4.2 A Stormwater Management Scheme must be prepared for the development and must be implemented. Implementation of the Scheme must mitigate the impacts of stormwater run-off from and within the premises following the completion of construction activities. The Scheme should be consistent with the Stormwater Management Plan for the catchment. Where a Stormwater Management Plan has not yet been prepared the Scheme should be consistent with the guidance contained in Landcom's Manual titled "Managing Urban Stormwater Soil and Construction Volume 1, 4th Edition, March 2004".

O4.3 If mud, sediment or other raw materials are found to be tracked off the premises the Company must install, operate and maintain on the premises an automatic wheel wash or similar facility that will be capable of washing the underside of vehicles, wheels, wheel arches and axles of all vehicles leaving the premises. In addition to this, appropriate measures must be put in place that ensures that all vehicles leaving premises must go through the wheel wash facility.

O4.4 The entrance to the premises must be maintained in a sealed state.

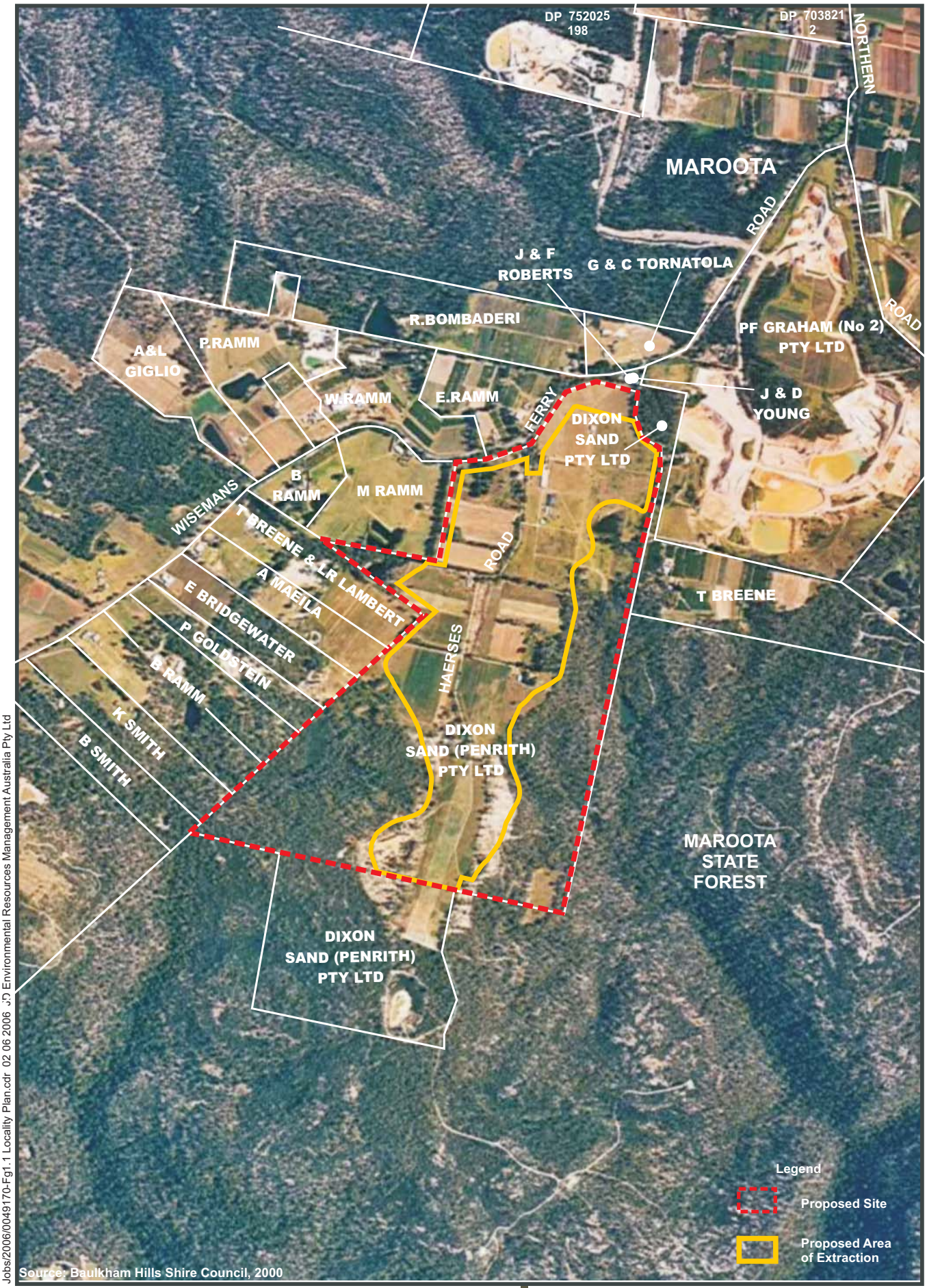
O4.5 The sealed access road to the premises must be kept free of dust, sediment and other raw materials at all times.

O4.6 A sediment basin must be installed and maintained in extraction area called stage 1 prior to any extraction activities being undertaken. The dam must have a storage capacity of no less than 222 cubic metres as specified in the additional information supplied by the proponent's consultant Environmental Resources Management Australia via letter date 11 August 2005.

O4.7 Appropriate sediment dams must be installed and maintained for every stage of the extraction area for the life of the sand quarry. The dams must be in place prior to any extraction taking place in the respective strip of each stage and must be designed and constructed in accordance with Landcom's Manual titled "Managing Urban Stormwater Soil and Construction Volume 1, 4th Edition, March 2004".

Notwithstanding the above, the capacity of the dams must have a sufficient capacity to contain the rainfall and runoff generated from a 90 percentile, 5 day rainfall event (" the design event") for the life of the development.

This plan satisfies the conditions of the EPL, in particular fulfils requirement for the preparation of a Stormwater Management Scheme under condition O4.2.



Jobs/2006/0049170-Fg1.1 Locality Plan.cdr 02 06 2006 JD Environmental Resources Management Australia Pty Ltd

ERM

0 500m

Approximate Only

Figure 1.1 **Haerses Road Quarry Locality Plan**

Dixon Sand EIS - Haerses Road Pre-Commencement Works

1.3 OBJECTIVES

In addition to ensuring compliance with the relevant conditions of consent, the objectives of soil and water management are to ensure that there is no uncontrolled discharge of surface water from the quarry, that there is no detrimental impact on groundwaters, and that, if and when necessary, the water quality leaving the site meets appropriate standards.

These objectives will be met through the implementation of the following general principles:

- maintenance of 2 metres extraction buffer to the groundwater table (wet weather high level);
- minimisation of the area of soil disturbed and exposed to erosion;
- adoption of appropriate land clearing procedures;
- conservation of topsoil for later rehabilitation and revegetation;
- control of water flow through the site (i.e. separating "clean" and "dirty" water and directing sediment laden water to sediment basins);
- rehabilitation of disturbed areas quickly; and
- maintenance of soil and water management measures appropriately throughout the life of the project.

1.4 HOW TO USE THIS DOCUMENT

This SWMP includes the following:

- description of catchment and soil characteristics;
- outline of management of surface and groundwater quality within the site and site water discharges;
- methods to minimise erosion and sedimentation of all active and rehabilitated areas; and
- a monitoring program to measure the effectiveness of surface water quality and erosion controls and groundwater buffers.

Annex A contains relevant site characteristics and data for the calculation of site erosion and sediment control structures; *Annex B* contains example calculations; and *Annex C* contains relevant standard design drawings from *Managing Urban Stormwater* (Landcom 2004).

2 SITE CHARACTERISTICS & RELEVANT DATA

2.1 CATCHMENT

The site contains a watershed which coincides approximately with the location of Haerses Road. Runoff to the east of Haerses Road currently drains to a dam in the north east of the site and an ephemeral watercourse to the east, which connects to Little Cattai Creek 150 metres to the south east. Land to the west of Haerses Road drains to three small dams on site and to an unnamed intermittent creek to the west. This ephemeral creek is a tributary of the Stone Chimney Arm of Little Cattai Creek, which ultimately discharges to the Hawkesbury River approximately 12 kilometres south west of the site.

The local catchment of which the site is a part has an area of approximately 9980 hectares (to the junction with the Hawkesbury). The site itself has high infiltration rates due to the sandy nature of the soils.

2.2 SOILS DESCRIPTION

The site is characterised by two separate soil landscape units being Maroota (ma) and Gymea (gy) (McInnes, 1997). The majority of the extraction area is consistent with the Maroota landscape unit. The qualities and limitations of the Maroota landscape are:

- high erosion hazard;
- seasonal waterlogging (localised);
- highly permeable; and
- strongly acid soils with low fertility.

The Gymea soil landscape also occurs through the site and is predominantly found on the sideslopes. This erosional landscape has the same qualities and limitations as the Maroota landscape however also exhibits the following:

- rock outcrop;
- localised rockfall hazard;
- steep slopes and high run-on; and
- shallow.

Both soil landscapes are described as having a high or extreme erosion hazard under concentrated flows. Therefore particular care will be taken with erosion control measures to prevent erosion and with sedimentation control structures

to prevent off-site sediment transport. No off-site discharge of "dirty water" is proposed from the extraction area. Exposed areas will be minimised with the progressive rehabilitation of extraction areas and maintenance of diversion drains. Given the erosion hazard of the site, works that will leave areas temporarily exposed will be minimised where possible from February to April or special erosion protection measures employed as outlined in *Managing Urban Stormwater* (Landcom, 2004).

2.3 RAINFALL

Averaged rainfall data recorded between 1928 and 2000 at RAAF Richmond (–33.6022 S, 150.7794 E. approx 25 kilometres from Maroota) is shown in *Table 2.1*.

Table 2.1 Rainfall

Month	Mean Rainfall (mm)[1]
January	93.3
February	105.6
March	92.1
April	70.3
May	58.8
June	56.4
July	35.9
August	45.8
September	40.2
October	64.1
November	76.1
December	71.7
Mean Annual Rainfall	**810.3**

Design rainfall intensities for a range of durations and average recurrence intervals (ARI) are provided in *Annex A*. This information is required for the design of sediment basins and diversion drains.

2.4 DATA

Management of erosion and sediment will be in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004). Site parameters relevant to the site conditions, for use in the design of sediment and erosion control measures, are provided in *Annex A*.

3 SOIL AND WATER MANAGEMENT

3.1 OVERVIEW

The main potential water quality pollutants from the project consist of suspended sediment and hydrocarbons (fuels/oils).

Sediment can be removed by erosion and deposited over lower areas of land. This sediment may block stormwater drains and natural channels and is eventually deposited in receiving waters. Sediment can damage water bodies as it increases turbidity, and can carry chemical pollutants such as nutrients and herbicides or pesticides.

The main potential sources of sediment within the site during construction include:

- construction of roads and other infrastructure; and
- construction of the noise bund.

The main potential sources of sediment during the operation of the quarry are:

- sequential clearing, soil stripping, and stockpiling undertaken to expose the tertiary Maroota sands;
- unsealed haul roads and surface water drains;
- active extraction areas;
- uncontrolled overflow of sediment laden water from sediment settling basins; and
- progressive rehabilitation of each stage as the quarry progresses.

Hydrocarbons include greases, oils, and fuels from machinery and can enter waterways through accidental spills or leaks from poorly maintained equipment.

3.2 *EROSION AND SEDIMENT CONTROL MEASURES*

As the soils on site are highly erodible under concentrated flows, erosion and sediment controls are proposed to control drainage on site, maximise infiltration and to minimise the area of soil exposed to surface water flows. Controls will include the following:

- maintenance of buffers and boundary setbacks and installation of silt fences where appropriate to prevent sediment transport and impact on adjoining land;
- minimisation of the area of disturbance by only clearing areas immediately prior to extraction within each stage or strip and progressive rehabilitation of completed strips (refer to rehabilitation strategy for soil stabilisation techniques);
- direction of stormwater runoff from disturbed areas to appropriate areas and sedimentation ponds for infiltration or treatment if and when necessary prior to discharge off-site;
- maintenance of the rim around the perimeter of the quarry area until rehabilitation is complete; and
- regular inspection and maintenance of sediment controls.

3.2.1 *Minimal Disturbance*

Soil disturbance will be minimised by clearing only one extraction strip at a time ahead of quarrying.

Erosion and sediment control measures will be implemented prior to or in conjunction with clearing. Topsoil will be stripped immediately following clearing and either stored temporarily or used immediately for rehabilitation. Excluding the first strips of Stages 1 and 2, topsoil will be stripped and spread immediately over previously quarried areas to be rehabilitated.

3.2.2 *Soil Stockpiles*

In the event that a rehabilitation area is not ready for topsoil spreading, the topsoil will be stockpiled temporarily away from drainage lines. Where practical, stockpiles will be contained within the quarrying area (and associated water management system). Otherwise, silt fences will be erected around the base of the stockpiles will prevent soil loss off site.

Stockpiles will be maintained at a height no greater than three metres high to preserve aerobic soil microbes and organic material (in accordance with Baulkham Hills Shire Council's DCP 16).

If stockpiling of material is required for longer than 6 months, stockpiles will be sown with a sterile cover crop.

3.2.3 Acoustic Bund Construction

The proposal includes the construction of two acoustic bunds during extraction in Stages 4 and 5. The five metre high bunds will be built of overburden, covered with topsoil and planted. Batter grades will not exceed 1 in 5 (vertical to horizontal).

Following topsoil placement, the batters of the bund will be ripped (along the slope) to improve water infiltration, seeded, and planted with native vegetation. Until the vegetation has been established, sediment fencing will be used (placed approximately 2 metres from embankment toe) to collect any sediment within surface runoff from the bund.

3.2.4 Clean Water Diversion Works

Clean water (surface runoff from areas relatively undisturbed by extraction or related activities) will be diverted around the extraction areas using earth banks constructed in accordance with Landcom (2004).

The location of the earth banks on the site will vary as extraction progresses, however will ensure that no clean water flows enter the extraction area.

Design flows for the banks will vary depending on the upslope catchment area. However, procedures for sizing the earth banks and determining appropriate levels of erosion protection are provided in *Annex B*.

Outlets of earth banks will be designed to ensure flows do not cause erosion downstream using a level spreader, or surface treatment as appropriate.

3.2.5 Haul Roads

The quarry haul roads will be constructed in accordance with Baulkham Hills Shire Council DCP 16 thereby reducing roadside erosion and sedimentation. To prevent loose gravel and soil material being tracked onto Wisemans Ferry Road, the haul road will be sealed for a distance of 300 metres along Haerses Road south of the intersection. All other roads will be unsealed, but adequately compacted and shaped to minimize erosion potential.

Mitre drains will be constructed to take water from the shoulders or table drains of the internal haul roads to nearby sediment control basin. Road runoff will be intercepted at regular intervals to reduce runoff velocity (and therefore erosive potential) in each mitre drain. Drain spacing will not exceed 50 metres.

3.2.6 Intersection Works

The proposed augmentation works at the intersection of Haerses Road and Wisemans Ferry Road include improvements to sight distance through clearing of vegetation to the east of the intersection, and shoulder widening (northern side of intersection) and sealing the existing gravel shoulders to improve the available turning radius.

An erosion and sediment control plan will be prepared as part of the intersection road design plans that includes:

- minimising the area of disturbance;
- installing sediment fences within roadside table drains to capture sediment; and
- stabilising the area immediately after completion through the use of turf strips within exposed areas.

To avoid erosion from clearing tree stumps will be left in situ and a stump grinder used to reduce these to below ground level (for safety).

3.2.7 Extraction Area

As extraction progresses, all stormwater within the quarry pit will be contained and directed to sediment basins within, or adjacent to the quarry floor.

The quarry floor will generally be graded so that all stormwater drains to the nearest sediment basin. Catch drains within the quarry floor will be constructed, to collect and control stormwater flows. The grade of the quarry floor, and/or invert of any drains will generally be within the range of 1% to 5% to avoid initiating erosion of the floor or drains.

3.2.8 Sediment Basins

Sediment basins will be constructed for all stages of the quarry extraction and will be designed to capture all sediment laden water from active quarry areas. They will be located at the lowest point of the quarry floor to ensure all stormwater can be captured.

Sediment basins will also be maintained within rehabilitated areas until such time that sufficient vegetative cover has been established and the soil surface is stabilised.

Basin sizing (volume) calculations are provided (for initial extraction of Stage 1) in *Annex B*. Constructed basins will incorporate the following design features:

- pipe outlet designed to cater for the design event approximately 300mm below the emergency spillway;
- secondary spillway designed to carry less than 150mm flow during the design event;
- built in accordance with SD-6-4 of Landcom (2004);
- markers to indicate sediment storage capacity of 30%;
- internal batter grades will be no greater than 2.5(H):1(V); and
- rock protection on pipe outlet to prevent scouring.

3.2.9 Rehabilitation Areas

Areas will be rehabilitated as quickly as possible following extraction. The area will be shaped and topsoil from cleared areas, or stockpiles spread prior to seeding and planting.

Slopes within rehabilitation areas should be uniform, and where necessary, include contour banks to capture water and reduce the length-slope factor to an acceptable level in accordance with Landcom (2004). These banks can only be used in-pit where the final pit dimensions and outside topography allows transfer of water out of pit.

Sediment basins for rehabilitation areas will be maintained until such time that the area has adequate vegetation cover and soils are stabilised. Sediment basins will then be decommissioned and the site restored using the following steps:

- test water quality of any stored water to determine its suitability for discharge;
- place erosion and sedimentation controls (silt fencing, straw bales or other suitable sediment filter) downstream of basin;
- dewater basin to site water management system or off-site;
- backfill basin wall over deposited silt; and
- reshape, seed, and revegetate.

3.3 GROUNDWATER BUFFERS

Extraction will not occur within two metres of the wet weather groundwater table based on groundwater monitoring and survey information of the

working area of the quarry. The wet weather groundwater level will be established immediately prior to commencement of quarrying each stage.

In the event of groundwater being breached, operations in the vicinity of the affected area will cease and Council and the Director-General will be consulted on how extraction may recommence.

3.4 WATER QUALITY MEASURES

No hydrocarbons or other chemicals will be stored on site and the maintenance of vehicles will be carried out on Lot 196. Only equipment refuelling will be carried out on the Haerses Road site.

Fuel will be delivered to site daily by mini-tankers or similar and will not be stored on site. Refuelling will be undertaken within a bunded area on site. Fuel and oil spill kits are to be stored on site at all times.

3.4.1 Water Recycling

To reduce overall water consumption within the project, water from sediment basins will be used on haul roads and other work areas to reduce dust emissions.

4 MONITORING & MAINTENANCE

4.1 EROSION AND SEDIMENT

Drainage and sediment controls will be inspected monthly and maintained as required to ensure effectiveness. Inspections will aim to identify erosion occurring in any part of the site, but particularly:

- quarry floor drains;
- haul road, table drains, or mitre drains;
- acoustic bund;
- clean water diversion drains; and
- rehabilitation areas.

Where erosion is observed, rehabilitation/stabilisation measures as per *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) will be implemented.

Inspections will also be carried out after heavy rain to ensure the sediment basins are operating effectively (i.e. they have not overflowed and need repair to spillways etc) and to check the sediment storage capacity. Basins will be desilted where the sediment storage capacity exceeds 30% of the design capacity (in accordance with the development consent conditions).

A summary of regular maintenance required for erosion and sediment control son site are provided in *Table 4.1.*

Table 4.1 Regular Maintenance Activities

Structure	Maintenance Activity	Frequency
Sediment fencing	Clean out trapped sediment. Reconstruct.	After heavy or prolonged rain. As required.
Drains	Clean drain of deposited sediment. Repair erosion	As required (i.e. when blocked)
Diversion drain/banks	As for drains. Repair low points in banks (to avoid overtopping)	As required.
Straw bales	Clean out trapped sediment regularly. Replace.	When blocked. As required.

Silt collected from sediment detention systems will be spread over rehabilitation areas, covered with topsoil and revegetated.

4.2 *GROUNDWATER*

Monitoring will establish the wet weather groundwater level prior to commencement of quarrying in each stage. Measurement of the groundwater levels within each of the site's monitoring bores will be undertaken monthly and following prolonged wet weather.

4.3 *WATER QUALITY*

Groundwater quality monitoring within each of the water-bearing bores will be undertaken each year. If monitoring notes a degradation of the groundwater resource quality due to quarrying, a contingency plan for the remediation of the aquifer to be prepared and implemented.

Water samples would be collected in accordance with AS/NZS 5667.1:1998 and generally follow the procedure below:

- use containers prepared and provided by a NATA certified laboratory;
- take grab sample manually from water that is representative of the time and place at which the sample is collected;
- record the location, time, date, name of sampler, and general environmental and climatic conditions;
- place sample containers in an esky with ice immediately; and
- transport to NATA certified laboratory for analysis within required holding time.

Analysis of samples at the laboratory should include testing of:

- total suspended solids;
- turbidity; and
- pH.

REFERENCES

Landcom (2004) **Managing Urban Stormwater: Soils and Construction Volume 1**, Fourth Edition, New South Wales Government.

McInnes S K (1997) **Soil Landscape of the St Albans 1:100 000 Sheet.** Report to Department of Land and Water Conservation, Sydney.

Pilgrim, D.H. (Ed.) (2000) **Australian Rainfall and Runoff: A Guide to Flood Estimation**, Institute of Engineers, Australia.

Standards Australia and Standards New Zealand (1998) **Australian and New Zealand Standard AS/NZS 5667.1:1998 Water Quality Sampling Part 1: Guidance on the design of sampling programs, sampling techniques, and the preservation of samples**.

Annex A

Design Parameters

A.1 DESIGN RAINFALL TABLES

The Intensity-Frequency Duration (IFD) table for the site is provided in *Table A.1*. Tables *A.2* to *A.4* display related design parameters.

Table A.1 Design IFD table for Maroota (mm/hour)

	Average Recurrence Interval (ARI) in years						
Duration	**1**	**2**	**5**	**10**	**20**	**50**	**100**
5min	80.58	103.52	132.69	148.51	170.63	199.69	221.88
6	75.51	97	124.29	139.08	159.78	186.96	207.72
7	71.28	91.55	117.28	131.22	150.73	176.35	195.91
8	67.67	86.91	111.3	124.52	143.01	167.3	185.84
9	64.54	82.87	106.11	118.69	136.31	159.44	177.1
10	61.77	79.32	101.54	113.57	130.42	152.53	169.41
11	59.32	76.16	97.48	109.01	125.17	146.38	162.57
12	57.11	73.32	93.83	104.92	120.46	140.86	156.43
13	55.11	70.75	90.52	101.22	116.2	135.87	150.88
14	53.29	68.41	87.51	97.84	112.32	131.32	145.82
15	51.62	66.26	84.76	94.76	108.77	127.16	141.19
16	50.09	64.29	82.22	91.91	105.5	123.33	136.93
17	48.67	62.47	79.88	89.29	102.48	119.79	133
18	47.35	60.77	77.7	86.85	99.68	116.5	129.35
20	44.98	57.72	73.78	82.46	94.63	110.59	122.77
25	40.2	51.58	65.89	73.62	84.46	98.68	109.53
30	36.55	46.89	59.88	66.88	76.72	89.61	99.45
35	33.65	43.17	55.1	61.53	70.57	82.42	91.45
40	31.29	40.12	51.2	57.16	65.55	76.54	84.92
45	29.3	37.58	47.94	53.51	61.36	71.63	79.47
50	27.62	35.41	45.16	50.41	57.79	67.46	74.83
55	26.16	33.54	42.76	47.72	54.7	63.85	70.82
60	24.89	31.9	40.67	45.38	52.01	60.7	67.32
75	21.79	27.96	35.71	39.9	45.78	53.49	59.37
90	19.51	25.06	32.07	35.87	41.18	48.16	53.49
2.0hrs	16.36	21.03	27	30.25	34.78	40.73	45.28
3	12.73	16.39	21.13	23.73	27.33	32.08	35.71
4	10.65	13.72	17.75	19.95	23.02	27.05	30.15
5	9.27	11.96	15.5	17.45	20.14	23.71	26.44
6	8.28	10.68	13.87	15.64	18.07	21.29	23.75
8	6.92	8.95	11.66	13.16	15.23	17.96	20.07
10	6.03	7.8	10.19	11.51	13.34	15.75	17.61
12	5.39	6.98	9.13	10.33	11.97	14.15	15.83
14	4.88	6.33	8.34	9.46	11	13.05	14.63
16	4.47	5.82	7.7	8.77	10.22	12.16	13.66
18	4.15	5.4	7.19	8.2	9.58	11.42	12.85
20	3.87	5.05	6.75	7.72	9.04	10.8	12.17
22	3.64	4.75	6.38	7.31	8.57	10.26	11.58
24	3.43	4.49	6.05	6.95	8.17	9.79	11.06
36	2.61	3.44	4.72	5.47	6.47	7.84	8.9
48	2.13	2.82	3.92	4.58	5.45	6.64	7.58
60	1.81	2.4	3.37	3.96	4.74	5.8	6.65
72	1.57	2.09	2.96	3.5	4.2	5.17	5.94

Source: Using data and procedures in Pilgrim (2000)

Table A.2 Site Parameters

Parameter	Value	Units
'R' rainfall erosivity	2400	-
'K' soil erodibility factor[2]	0.017	-
Soil hydrologic group	A	-
$R_{90\%ile,\ 5\text{-}day}$ design rainfall depth[3]	39.7	mm
Rainfall Intensity (2 year, 6 hour)	10.68	mm/hour
'C_{10}' runoff coefficient [4]	0.40	-
'C_v' volumetric runoff coefficient	0.15	

1. Source: Landcom, 2004
2. Average value of site soil materials (excludes tertiary sands)
3. 5-day, 90th percentile design rainfall depth for Richmond
4. Undisturbed catchments only, Pilgrim 2000.

Table A.3 Runoff coefficients for peak flow data (C_{10}) from disturbed catchments

Rainfall Intensity (mm/hour) in the design storm					
<20	21-40	41-60	61-80	81-100	>100
0.2	0.37	0.55	0.64	0.68	0.75

Source: Landcom 2004

Table A.4 Frequency Factors and Runoff Coefficients (Rural/Undisturbed Catchments)

ARI (*years*)	Frequency Factor, F_y	Runoff Coefficient, C_y
1	0.62	0.25
2	0.74	0.30
5	0.88	0.35
10	1.00	0.40
20	1.12	0.45
50	1.25	0.50
100	1.38	0.55

Source: Book IV, Table 1.1 of Pilgrim (2000)

Annex B

Design Calculations

B.1 DESIGN CALCULATIONS

This section has been prepared based on both Pilgrim (2000) and Landcom (2004). They have been presented as worksheet templates for use by Dixon Sand in the design of:

- diversion banks;
- stormwater drains; and
- sediment basins.

B.1.1 Stormwater Drains

A 1 in 10 year ARI event with a critical duration of 5 minutes has been assumed for the design of stormwater drains onsite.

Design Flow Through Drains

$Q = C \times I \times A/360$

$= 0.6 \times I_{5,10}$ (ml/hr) x area (ha) of catchment (ie strip)

Channel Cross-Section

$Q = A \times R^{2/3} \times S_o^{1/2}/n$

$= A \times R^{2/3} \times (0.01\text{-}0.05)^{1/2}/0.03$

Mitre Drains

Mitre drains will be constructed to take water from the shoulders or table drains of the internal haul roads to nearby sediment control basin. Drain spacing will not exceed 50 metres.

A.1.1 Sediment Basin Designs

The following calculation shows the sizing of a sediment basin for the first two extraction strips of Stage 1 which covers an area of 22 900 m^2.

Volume of Sediment Basin (Type F Basin)

Whilst soils on the site range from Type C to Type F, a Type F basin is assumed for all works on site to avoid the need to assess soil characteristics within each extraction strip and to allow for spatial variations in soil type.

a. Settling zone volume

V = 10 x Cv x A x $R_{90\%ile,\ 5\text{-}day}$ (m^3)

= 10 x 0.15 x 2.29(ha) x 39.7

= 136.4 m^3

b. Sediment storage zone volume

On lands of low erosion hazard (determined using slope and rainfall erosivity) the sediment storage zone may be calculated as being 50% of the settling zone capacity.

Storage zone = 0.5 x 136.4 = 68.2 m^3

c. Total basin volume

Total volume = 136.4 + 68.2 = 204.6 m^3

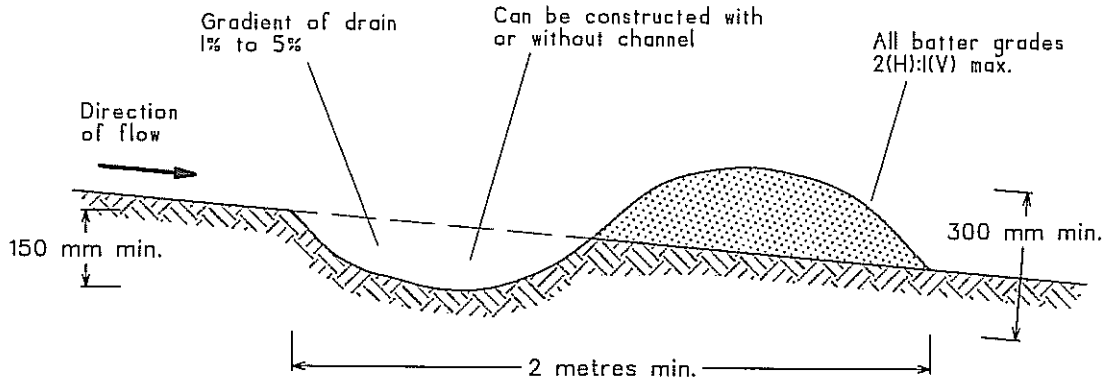
Basin Outlet Design

Outlets of constructed basins will incorporate the following design features:

- pipe outlet designed to cater for the design event approximately 300mm below the emergency spillway; and
- rock protection on pipe outlet to prevent scouring.

Annex C

Standard Drawings

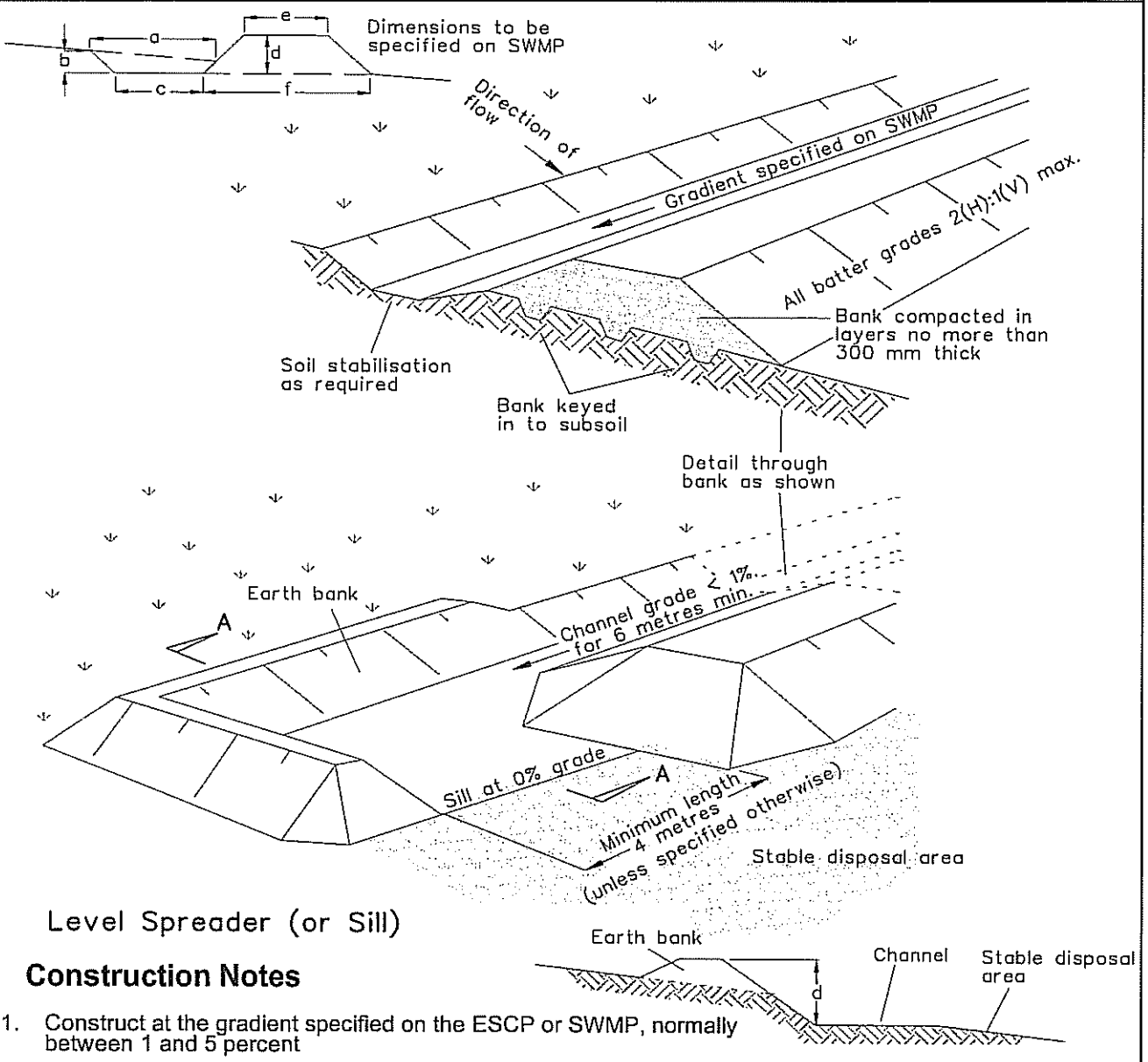


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

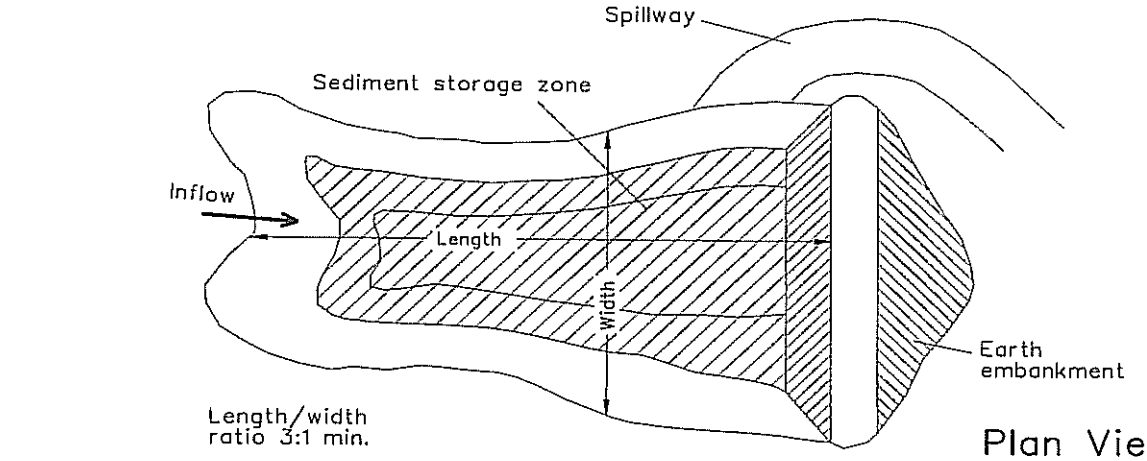
EARTH BANK (LOW FLOW) SD 5-5

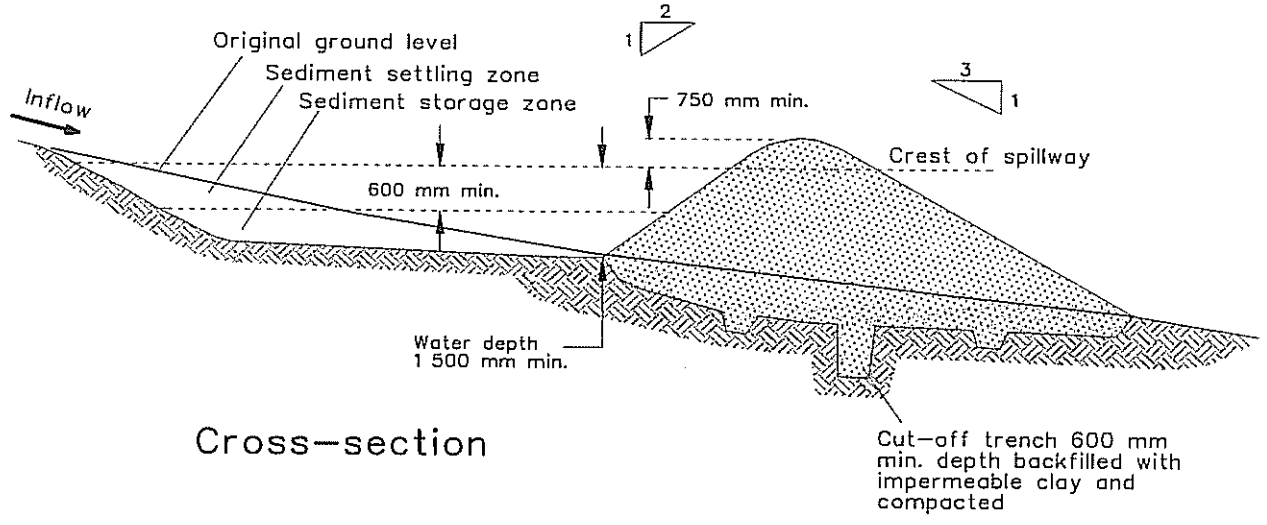


Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) SD 5-6





Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

SD 6-4