

MULTIQUIP

QUARRIES

ABN: 44 101 930 714

Ardmore Park Quarry Via Bungonia, NSW

Erosion and Sediment Control Plan

September 2017

Prepared by:



R.W. CORKERY & CO. PTY. LIMITED



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Erosion and Sediment Control Plan

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1. INTRODUCTION

This Erosion and Sediment Control Plan (ESCP) has been developed to satisfy *Conditions 3(13) and 3(15)* of Project Approval (PA) 07_0155 which are as follows.

13. *The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must:*
- a) *be prepared in consultation with DWE¹, DECC² and SCA³, and be submitted to the Director-General for approval prior to carrying out any development on site; and*
 - b) *Include a:*
 - *Site Water Balance;*
 - *Erosion and Sediment Control Plan;*
 - *Surface Water Monitoring Program;*
 - *Groundwater Monitoring Program; and*
 - *Surface and Groundwater Response Plan.*
15. *The Erosion and Sediment Control Plan must:*
- a) *be consistent with the requirements of Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004 (Landcom);*
 - b) *identify activities that could cause soil erosion and generate sediment;*
 - c) *describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters;*
 - d) *principles for the design and construction of waterway crossings along the transport route, in consultation with DPI;*
 - e) *describe the location, function, and capacity of erosion and sediment control structures;*
 - f) *demonstrate that the design capacity of basins intended to collect storm runoff will not be compromised by storage of operational water; and*
 - g) *describe what measures would be implemented to maintain (and if necessary decommission) the structures over time.*

The ESCP is designed to expand on **descriptions** contained in the *Water Management Plan*, providing additional information and operational details as at **September** 2017 and will be amended and expanded as required.

¹ Now the Department of Primary Industries – Water (DPI-Water)

² Now the NSW Environment Protection Authority (EPA)

³ Now WaterNSW



The following sections of the ESCP provide the objectives, overarching principles and general descriptions of the key features of erosion and sediment control planning to be adopted by Multiquip Quarries on the Quarry Site, Bungonia By-pass Road and sections of the public road network to be upgraded as a conditional requirement of PA 07_0155.

More detailed ESCPs for each of the following components of the Ardmore Park Quarry approval (PA 07_0155) are provided as appendices to the main text..

- Appendix 2: Quarry Site ESCP.
- Appendix 3: Bungonia By-Pass Road ESCP.
- Appendix 4: Road Widening (Oallen Ford Road – Jerrara Road) ESCP.
- Appendix 5: Mountain Ash Road – Jerrara Road Intersection Upgrade ESCP.
- Appendix 6: Major Waterway Crossing Culvert and Bridge Works – Jerrara Road ESCP.

The locations which relate to each of these detailed ESCPs is identified on **Figure 1**.

This version of the ESCP reflects the operations as at September 2017 and will be subject to amendment as the scale and nature of operations develops.

2. OBJECTIVES

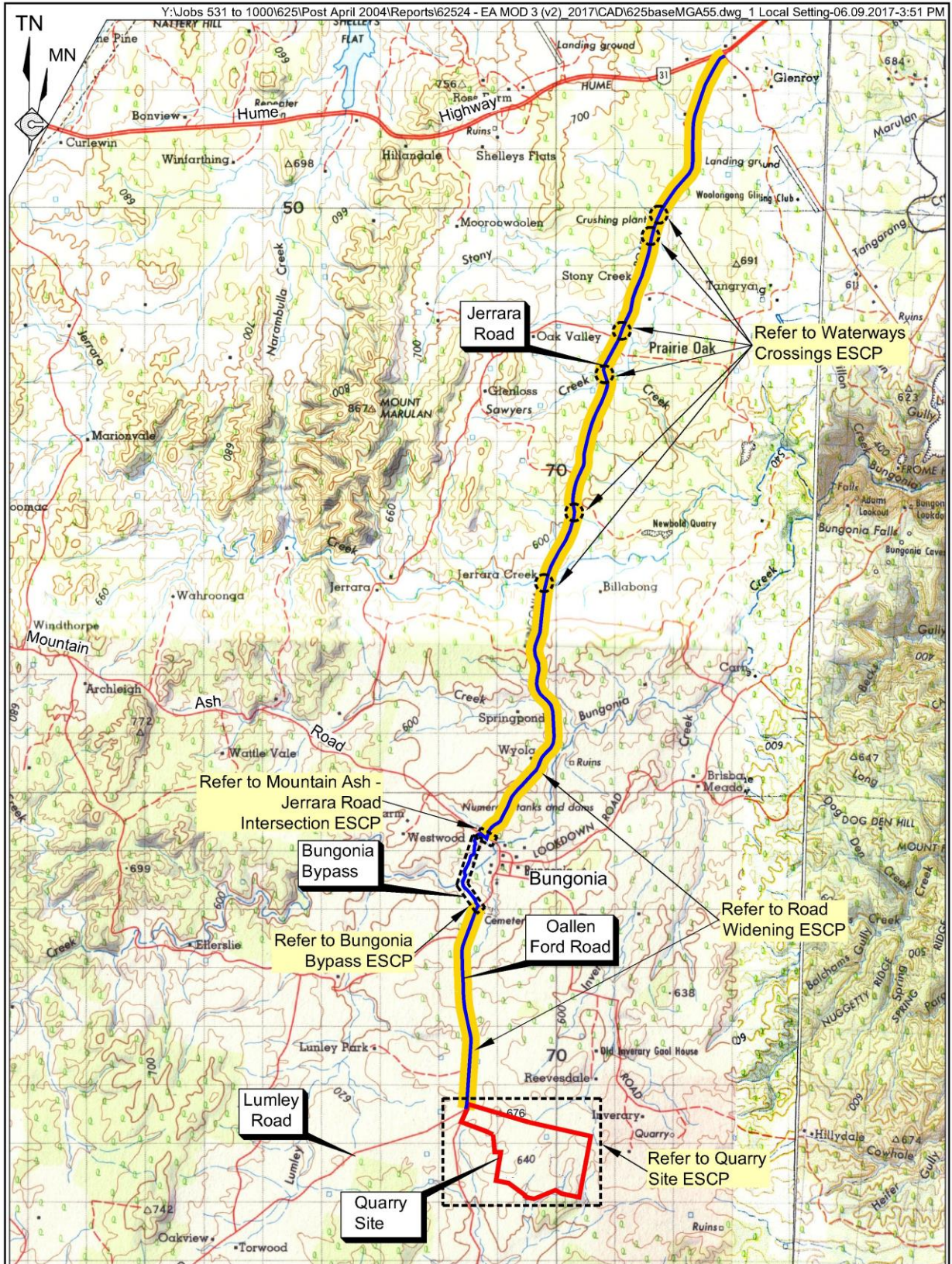
Activities associated with the development and operation of the Quarry, both on the Quarry Site and the public and private road infrastructure, has the potential to produce surface runoff high in suspended solids. The principle objective in managing this potential impact will be to either:

- reduce the concentration of suspended sediment in the runoff prior to discharge;
or
- capture and divert surface runoff to sediment basins (for initial settling of coarse material) (and subsequently to the re-use ponds and/or the clarifying ponds (for re-use and further settlement (including possible flocculation)).

The achievement of this objective will allow for the achievement of a neutral or beneficial effect on the local catchment without detriment to overall surface flow volumes from the various locations associated with Quarry operations.

In order to achieve this overall objective, the most fundamental requirements of erosion and sediment control are as follows.

- To ensure that areas of temporary disturbance with soil loss of <200/t/ha/year have downstream sediment control structures installed, e.g. sediment fencing, hat bales, turf strips, and are stabilised as soon as possible following the completion of activities.



SCALE 1:100 000 (A4)

REFERENCE
 Quarry Site Boundary

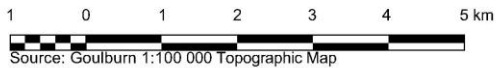


Figure 1
 LOCAL SETTING - ESCP's

- To ensure all other runoff from disturbed surfaces is directed to sediment basins, or other appropriate containment structures, designed and maintained in accordance with Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom, 2004) (“the Blue Book”).
- To ensure water which accumulates in sediment basins is transferred to the Quarry clarifying/re-use ponds within 5 days of the minimum setting zone capacity requirements of the sediment basin being exceeded.
- To ensure that water is drawn from the clarifying/re-use ponds and used regularly for dust suppression and sand processing to maintain setting zone capacity requirements.
- To monitor trapped water in the clarifying ponds and, if necessary, flocculate to achieve a total suspended solids (TSS) concentration of less than 50mg/L before it is released to receiving waters (in accordance with the guidelines provided by Appendix E of the Blue Book).
- To re-use and/or treat-and-release trapped water from the clarifying ponds within 5 days of a trigger to do so.

During the site establishment and operations on the Quarry Site and during and immediately following construction of associated road works, there will be significant earthworks to develop site structures. This will include:

- development of bunds;
- development of the plant and site facilities, including internal road developments;
- development of sediment dams and drainage infrastructure;
- development of overburden stockpiles;
- development of water supply dams; and
- road widening works and watercourse crossing upgrades on Jerrara Road, Mountain Ash Road and Oallen Ford Road.

The main issues associated with developing these structures will include stripping of vegetation and soil, resulting in exposed soil surfaces and loose stockpiled material. This material will be prone to erosion from rainfall impact and surface run-off.

During the operation of the Quarry, there will be ongoing stripping and stockpiling of overburden and exposed surfaces that will require erosion and sediment control measures.

3. PRINCIPLES OF EROSION AND SEDIMENT CONTROL

Erosion control is the first step in managing surface water run-off quality as it reduces soil loss and therefore reduces the reliance on secondary sedimentation controls such as diversion drains, sediment dams and sediment fencing.

Although there will be significant areas of disturbed soil, it is important to minimise these areas wherever possible. In addition, concentrated water flows can lead to erosion and should be controlled. Excessive erosion will be expensive to remediate, with preventative measures far more cost effective in the long run in controlling erosion. A further measure to minimise exposed areas is the early rehabilitation of non-active operational areas as quickly as possible (such as outer bund walls and overburden dumps).

The principal features of effective erosion control are to:

1. minimise areas of disturbance;
2. prevent or minimise the exposure of disturbed areas to runoff; and
3. re-consolidate exposed surfaces by re-vegetation and re-grassing.

With respect to these key principals, the fundamental requirements for erosion control, which will be adopted by Multiquip, are as follows.

- The extent and duration of disturbance is to be minimised. This will be achieved by clearly identifying and delineating areas to be disturbed and ensuring that disturbance is limited to those areas; clearing as little vegetation as required and minimising machinery disturbance outside of these areas.
- Temporary and permanent landforms that reduce the risk of erosion, e.g. short slope lengths, low slope gradients should be installed/constructed/provided in preference to those that increase the risk of erosion, e.g. long slope lengths, high slope gradients.
- Divert “clean” run-on water around exposed surfaces wherever possible.
- Any areas of bare soil that will not be re-worked within 20 days, but will be re-worked within 60 days, will have sufficient material (textile, mulch, hydro mulch, chemical stabiliser etc.) placed on them to provide at least 60% ground cover, i.e. a C-Factor of 0.1⁴.
- Any areas of bare soil that will not be re-worked within 60 days will have ground cover (of vegetation, textile, mulch, hydro mulch etc.) to provide at least 70% coverage, i.e. a C-Factor of 0.05, and that cover must be able to last indefinitely (refer to *Table A3* of Landcom, 2004).
- All concentrated flow channels will be designed to be stable carrying water up to the 1:20 year ARI storm design flow.
- Water will be drawn from the re-use ponds as required for dust suppression. Additional dust suppressant may be added to the water before it is applied to improve the effectiveness of dust suppression and/or reduce water use.

⁴ C-Factor refers to ground cover. It varies from 1.0 for bare soil to 0.005 for very well covered soil. 0.1 represents 60% ground cover and 0.05 represents 70% ground cover.

- Any dust suppressant used, e.g. Dustex, Dustguard MC, or other commercially available product, would be confirmed as biodegradable, non-toxic and non-hazardous prior to use. Dust suppressants would not be used within 5m of the bank of an identified watercourse.
- Slopes greater than 3H:1V (18°) will be avoided. Slope protection will adopt the same rules as nominated for areas of bare earth.
- Seeding and controlled fertilising of all disturbed areas to provide for rapid grass cover. Areas will be seeded with a grass mix specific to the needs of the area to be grassed.

Following the implementation of all practical erosion control measures, the general approach to manage site water will be to capture and treat the water in sediment dams. Controlling sediment-laden run-off is a secondary step as it aims to control the movement of soil (sediment) which has been removed by erosional forces. Controlling sediment laden runoff principally involves the collection and storage of water such that:

- the water can be re-used within disturbed areas of operations; or
- the sediment can be removed from the water, by natural settlement process or flocculation, prior to discharge to downstream catchments.

The various structures and approach to design and maintenance to be used by Multiquip as sedimentation controls are described in greater detail in Section 4.

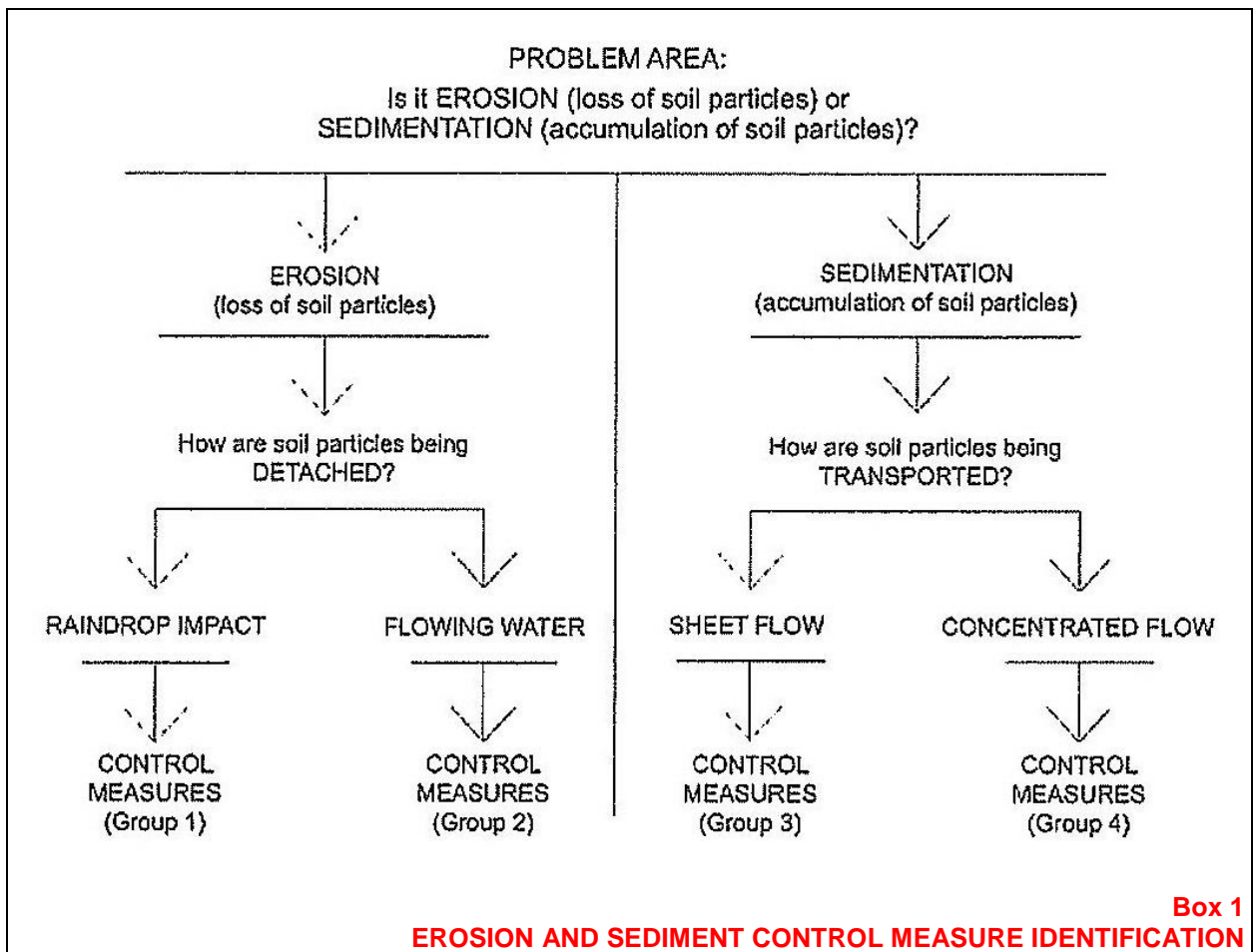
In preparing the five detailed ESCPs (refer to **Appendices 2 to 6**), and for future review of Quarry and Quarry-related activities, Multiquip Quarries selects erosion and sediment control measures based on the following key steps (see also **Box 1**).

1. Identifying the issue requiring control, i.e. erosion or sedimentation.
2. If erosion, identify whether it is caused by rainfall impact or concentrated flow.
3. If sedimentation, identify if sediment is conveyed by sheet or concentrated flow.
4. Review and adopt a relevant control measure.

The Group 1 to 4 control measures nominated in **Box 1**, along with reference to the relevant volume, section or standard drawing of the Blue Book, are summarised in **Appendix 1**.

Once a method and control measure is identified, it will be implemented as soon as practicably possible. A staged implementation of erosion and sediment controls will be implemented prior to the land disturbance works being finished, including site stabilisation and drainage.

Following the implementation of all practical erosion control measures, the general approach to manage site water will be to capture and treat the water in sediment dams.



4. **SEDIMENTATION CONTROLS (SEDIMENT BASIN AND POND MAINTENANCE)**

4.1 **SEDIMENT BASINS**

The sediment basins are the first step in the water quality treatment train. Their purpose is to trap sediment-laden water and settle out coarse particles.

Critical issues for sediment basin management are as follows.

- The sediment basins must be regularly inspected to ensure that all dirty water that should be draining to them does.
- The **minimum water settlement and sediment storage capacity of each** sediment basin **must be maintained**. This will require markers to indicate when their capacities are reached.
- **Except during and for a maximum of five days after a rainfall event, the top water level must not exceed the marker which identifies the minimum water settlement and sediment storage capacity of the sediment basin.**

- The sediment basins are designed for an approximate 6-monthly clean out cycle. This cycle could be reduced depending on rainfall, and the sediment basins must be regularly inspected to ensure the settling zone and sediment storage volumes are maintained.
- The sediment basins will be regularly checked for structural stability, particularly after significant rainfall events (more than 5mm in a day).
- All-weather access must be maintained to each basin.

4.2 IN-PIT SUMP DAMS

In order to ensure that the sump pit achieves the desired purpose of capturing all the surface run-off from disturbed areas while at the same time preventing the sump from impacting the work site a staged approach to pit sump migration and development will be adopted.

The indicative approach to in-pit sump construction and management is provided in **Figure 2**. This approach includes:

- alternating the location of the in-pit sump from one side to another;
- developing the in-pit sump progressively as the extraction area is developed; and
- progressive extraction across the base of the pit.

As the extraction area progresses this approach to in-pit sump development will ensure effective capture of surface run-off to meet operational requirements.

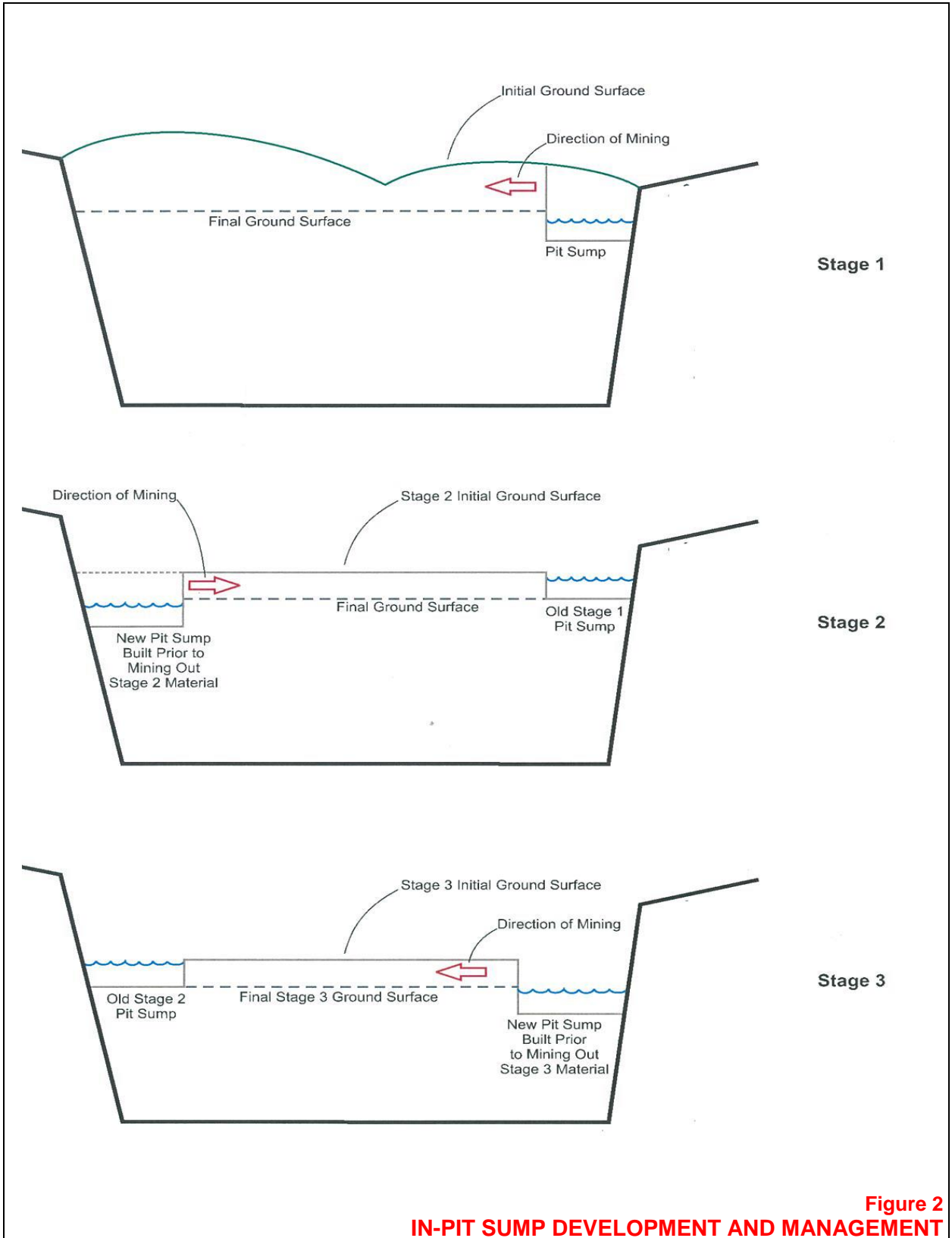
Once the pit extends below the base of the natural catchment area, the pit itself will act as a secondary water containment mechanism for water from disturbed areas. The pit is unlikely to be subject to significant leakage due to the low permeability of the basalt and it is not proposed to use liner within the pit sump.

4.3 RE-USE PONDS

The re-use ponds have been designed to capture and retain water from the processing areas or extraction area as a source of water for operational and dust suppression activities.

Critical issues for re-use pond management are as follows.

- Where a re-use pond is a permanent structure, it will be clay-lined to reduce seepage loss. Water will be preferentially drawn from a permanent re-use pond for sand washing.
- Temporary re-use pond structures will be relocated as the extraction area progresses, i.e. positioned to maximise the capture of runoff from the extraction areas. The ponds could be constructed as smaller separate ponds to maximise the capture of runoff but the combined capacity will not exceed 6 000m³ (6ML). Water will be drawn from the re-use ponds for dust suppression and as a supplementary source of water for sand washing.



- The re-use ponds must have their working capacities maintained at all times, i.e. the settling zone and sediment storage volumes identified. This will require markers to indicate when the **minimum** sediment-storage capacities is reached. When the sediment storage capacities are reached, the trapped sediment will be removed and used as part of final landform creation and rehabilitation. If necessary, it may be temporarily stored in stockpiles that drain back towards a sediment basin.
- The re-use ponds are designed for an approximate 6-monthly clean-out cycle. This cycle could be reduced depending on rainfall.
- The re-use ponds will be regularly checked for structural stability, particularly after significant rainfall events (more than 5mm in a day).
- All-weather access must be maintained to each re-use pond.
- Pumps will be metered and records will be kept.

4.4 CLARIFYING PONDS

The clarifying ponds have been designed to receive overflow from the sediment basins and the re-use ponds and in some cases where necessary from surrounding catchments. They will be clay-lined and each has been designed with the following storage capacities:

- a permanent storage capacity for re-use;
- a settling zone capacity designed hold runoff generated by the 95th percentile 5-day rainfall depth (41mm over 60ha); and
- a sediment storage capacity (designed to last approximately six months).

Critical issues for clarifying pond management are as follows.

- The clarifying ponds must be regularly inspected to ensure **they are accepting runoff from the nominated catchment**.
- The clarifying ponds must be maintained to ensure that the inlet **and outlet** is stable (no erosion).
- The clarifying ponds must have their working capacities maintained at all times, i.e. the settling zone and sediment storage volumes identified. This will require markers to indicate when the respective capacities are reached.
- If, after a rain fall event, settling zone capacities are no longer available, the pond(s) must be drawn down so the pond(s) are ready to capture the next rainfall event. Initially that will be done by drawing water for re-use. However, after some rainfall events excess water will require disposal. Before disposal, the water will be tested for Total Suspended Solids (TSS) (**<50mg/L**) and pH (6.0 to 7.5).
- Water to be disposed, will be mixed with a liquid fertiliser and sprayed over the adjoining agricultural paddocks, with particular emphasis on areas with a higher elevation.

- The re-use and draw-down must occur within five days of the rainfall event that triggered the work.
- If the water to be disposed has excessive TSS it may be necessary to flocculate. If practical, the water will be drained to a small pond of equivalent volume for flocculation before dispersing. Draining and flocculation must take no more than five days.
- Twice per year each clarifying pond will be drained and the trapped sediment removed and used as part of final landform creation and rehabilitation. If necessary it may be stored in stockpiles that drain back toward a sediment basin.
- The stability of each clarifying pond will be regularly checked, particularly after significant rainfall events (more than 5mm/day).
- All-weather access must be maintained to each clarifying pond.
- When water is drawn from the clarifying pond for use on-site, it will be drawn from the surface of the pond.
- Pumps (both re-use and release, if there are two) will be metered and records kept.
- **Under rainfall conditions which exceed the 95th percentile, 5-day rainfall depth (41mm), discharge from the site sediment basins may occur without contravening the conditions of EPL 13213. This notwithstanding, all such discharges will be logged.**

5. DRAINAGE SYSTEM

The drainage network will be designed to **collect and divert** the movement of sediment-laden water into sediment **basins of other sediment control structures** for capture.

The permanent areas of the drainage network will be designed to minimise drain erosion and will include:

- installation of appropriate liners, including concrete or other erosion control blankets or hard armour channels;
- rock check dams; and
- control of drains to reduce the grades to less than 1% where possible. Where grades are greater than 1% additional measures will be implemented to prevent drainage channel erosion.

Up-slope drainage systems will be placed around the permanent edge of the pit to prevent erosional surfaces developing around the edge of the pit and to prevent instability.

6. ROAD SYSTEMS

Internal roads will be constructed to ensure surface drainage is optimised and stabilised to reduce erosion of the road surface.

Roads will be sloped such that run-off will flow by the shortest routes to roadside drainage system that will redirect run-off to catchment drainage and sediment dams.

Roadways on stockpiles and bunded areas will be designed to slope inwards to redirect run-off into the site erosion and sediment control network.

7. SITE INSPECTION, AUDITING AND MAINTENANCE

The **specific** requirements for **daily, weekly and other site** monitoring are provided in the **detailed ESCPs for the various locations and activities of the Quarry.**

In addition, a monthly inspection of all activities and operations is required. This will include the completion of a checklist to ensure all erosion and sediment control measures are being undertaken as nominated in the detailed ESCPs, to identify whether additional or remedial measures are required, and to provide for continuing improvement in the prevention of erosion and sedimentation. A sample checklist is provided in Appendix 1.2 of the Water Management Plan, however, this will be adapted and updated as operations proceed.

The structure/activities requiring inspection include **the following.**

- Road and associated drainage system.

The roads are to be visually inspected **signs** of erosion and sedimentation within the roadside drainage networks. **In the event such signs are identified,** an assessment is to be conducted to determine the potential causes and **identify** additional measures to be put in place to **repair or remediate the issue.**

- Drainage networks, i.e. earth banks, low flow drains, clean water drainage lines.

Drainage networks are to be visually inspected for the presence of erosion of the channels and accumulation of sediment. Any damage is to be rectified immediately and any accumulated sediment cleared. Rock check dams are to be inspected for sedimentation and cleaned out as required.

- Water retention structures, i.e. sediment **basins**, clarifying ponds and re-use ponds.

All sediment dams are to be regularly inspected (not less than once a month) for sedimentation and to ensure that sedimentation is not reducing the capacity of the dams. Visual inspections of the dams to be completed on a regular basis (not less than once a monthly) checking for cracks within, leakage of the dams walls and the integrity of the dam structure and where the integrity of the dam appears compromised, immediately complete remedial work to stabilise the structure.

- Containment bunds and stockpiles (overburden, **soil, vegetation, etc.**).

- **Clearing and stripping areas in advance of extraction.**

Inspection of temporary structures around construction areas, overburden stripping areas and unconsolidated stockpiles will be undertaken prior to the commencement of works, **weekly thereafter and more frequently if a rainfall event occurs between weekly inspections.**

- General inspection of all project areas.

The **Quarry Manager, relevant Earthworks Manager, Quarry Environmental Officer** or a delegated **experienced** individual will undertake **these** inspections to assess the integrity of the erosion and sediment control systems, including any temporary structures installed in specific areas where earthworks or soils are being exposed.

At the completion of construction works associated with road upgrades, or the Site Establishment Phase in the case of activities on the Quarry Site, a Certified Professional in Erosion and Sediment Control (CPESC) or other appropriately qualified professional will be commissioned to inspect and audit implementation of the relevant detailed ESCP. The inspection and subsequent report will include the information on the following.

- **Controlled water discharges, including water quality / quantity records;**
- **Untreated discharge records, with comparison with rainfall data.**
- **Analysis of water quality monitoring results.**
- **Analysis of the volumes of water collected in dams after rainfall events (for model calibration)⁵.**
- **Inspection of all sediment basins, ponds and drainage structures.**
- **Inspection of the condition of any rehabilitated areas.**
- **Identification of disturbed areas requiring remedial erosion and sedimentation controls or rehabilitation.**
- **Clear statements as to whether the conditions of PA 07_0155 and EPL13213 are being met. If they are not he/she will report on any breaches of the operation license and liaise with DPI Water to recommend any remedial actions necessary.**
- **Recommendations to the Quarry Manager for remedial actions necessary to ensure compliance with PA 07_0155 and EPL13213;**
- **Identify and discuss any unforeseen impacts and liaise with DPI-Water, EPA, DPE, WaterNSW or Goulburn-Mulwaree Council⁶ to recommend any remedial actions necessary.**

⁵ Subject to rainfall, this will only be required for two years.

⁶ **The relevant authority will be determined based on the location, type of impacts and relevant approval, legislation or planning instrument which is affected or contravened. It is noted that more than one authority may need to be consulted.**

8. DECOMMISSIONING OF EROSION AND SEDIMENT CONTROL

As activities on the Quarry Site progress to the Operations Phase (refer to *Figure E2* of the Quarry Site ESCP – **Appendix 2**) or construction of off-site roadworks is complete (as described in the Detailed ESCPs of **Appendices 3 to 6**), erosion and sediment control features may be decommissioned and removed.

The procedure for confirming erosion and sediment control features may be decommissioned and removed is as follows.

1. Once establishment or construction works are complete and all disturbed surface are stabilised, an inspection of the site will be completed to identify evidence of:
 - a. Scour around or behind drains, discharge points, fencing or basins;
 - b. Erosion on entry to or discharge from the site;
 - c. Bank failure or extensive rilling of surrounding surfaces; and
 - d. Poor vegetation cover.
2. Where no evidence of the above is evident, proceed to decommissioning.
3. Where evidence is evident, undertake remedial matters which may include:
 - a. Light ripping or scour of rilling or erosional features;
 - b. Placement of rock, rolled erosion controlled product (RECP) or geotextile, or application of soil stabiliser to stabilise the surface;
 - c. Application of fast growing groundcover, e.g. Japanese millet; or
 - d. Seek professional advice.
4. Re-inspect the site within 1 month and review remedial actions until the surface is considered stabilised.

The following provides standard decommissioning and rehabilitation measures for the primary erosion and sediment control measures.

Sediment Fencing / Straw Bale Protection

- Confirm C-factor ≤ 0.1 (refer to relevant table of detailed ESCPs – **Appendices 2 to 6**) established upslope of fencing.
- Remove fencing taking care not to damage the material (such that it can be reused if in suitable condition).
- Lightly scarify along the contour where required to level off surface and spread any vegetative debris.

Diversion Drains

- Consider stability of each drain and discharge point. Where stable and not inhibiting surface flows of the final landform, retain.

- Gently push bank component of the drain into the channel and grade using dozer blade, excavator bucket or other means until level. Lightly scarify and allow to re-seed naturally.

Sediment Basins and Traps

- Consider use for water storage in the final landform and retain where not inhibiting surface flows of the final landform.
- Backfill with available screening reject or other stockpiled material and allow to consolidate.
- Cover with 100mm to 200mm of previously stockpiled soil and either sow with pasture species or allow to revegetate naturally.

9. RAINFALL MONITORING

Rainfall data for the region was obtained from two official Bureau of Meteorology stations at Goulburn for the initial site assessment. An automated meteorological monitoring station with a dedicated automated 'tipping bucket' rain gauge has been installed and operated on the quarry site since early 2013.

Inspections of all controls will be undertaken after a major rainfall event (being 50mm in any 24-hour period). Otherwise inspections will be undertaken on a regular basis, being not less than once a month for permanent structures and weekly for temporary measures

10. CONTINUAL IMPROVEMENT

Multiquip Quarries is committed to continually improving environmental performance at the quarry and associated roadwork projects. Therefore, should an unforeseen impact(s) occur which has the potential to result in erosion and sedimentation (or adversely affect other environmental parameter of the local setting), the following protocol would be followed.

1. The impact(s) would be identified, documented and investigated (implementing additional monitoring as required) commenced to quantify (if possible) the impact.
2. The relevant authority(ies)⁷ would be notified and advised of the actions proposed to investigate the cause and effects of the impact(s). An invitation would be provided to the personnel the relevant authority to visit the quarry and inspect the affected area(s) or quarry operation.
3. A qualified hydrologist, CPESC or other suitably qualified professional would be commissioned to review monitoring and any other available data related to the impact(s).

⁷ The relevant authority will be determined based on the location, type of impacts and relevant approval, legislation or planning instrument which is affected or contravened, It is noted that more than one authority may need to be consulted.

4. Appropriate resources would be provided to **the commissioned** professional to allow for additional testing, analyses or investigations.
5. The advice of a qualified **hydrologist, CPESC** or otherwise suitably qualified professional would be sought and taken as to measures to prevent, mitigate or remediate the impact(s).
6. The results of the investigations and subsequent implementation of additional controls, safeguards or management measures would be integrated into the overall Quarry Environmental Management System to ensure future occurrences are avoided.

11. REFERENCES

- Department of Environment and Climate Change (2008).** *Managing Urban Stormwater: Soils and Construction, Volume 2E, 1st Edition.* Department of Environment and Climate Change, NSW, Sydney.
- Landcom (2004).** *Managing Urban Stormwater: Soils and Construction, Vol. 1, 4th ed,* Landcom, NSW, Sydney.
- Macleod, A. (2008).** *MUSIC Calibration Based on Soil Conditions.* Proceedings of the 2008 NSW and Qld Joint Stormwater Industry Association Conference. July, 2008.

APPENDICES

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- Appendix 1: Selection of Control Measures (6 pages)
- Appendix 2: Quarry Site Erosion and Sediment Control Plan (14 pages)
- Appendix 3: Bungonia By-pass Road Erosion and Sediment Control Plan (20 pages)
- Appendix 4: Road Widening (Oallen Ford Road – Jerrara Road) Erosion and Sediment Control Plan (170 pages)
- Appendix 5: Mountain Ash Road – Jerrara Road Intersection Upgrade Erosion and Sediment Control Plan (14 pages)
- Appendix 6: Major Waterway Crossing Culvert and Bridge Works – Jerrara Road Erosion and Sediment Control Plan (8 pages)

Note: A colour version of the Appendices is available on the digital version of this document



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Appendix 1

Selection of Control Measures

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Table F.1 Group 1 – Erosion control RAINDROP IMPACT

Vegetation

- temporary vegetation (cover crop only)
- permanent vegetation – introduced (exotic) pasture species or native (endemic) species
- refer to vol. 1: sections 4.3.2, 7.1 and 7.2; appendices A6 and G



Batter blankets

- vegetation promotion blankets
- vegetation suppression blankets
- needle-punched geotextile membrane
- builder's plastic membrane
- refer to vol. 1: section 5.4.2; SD5-2; appendices A6 and D



Soil surface mulching

- hydromulch or hydraulic bonded-fibre matrix
- blown straw, hay, crop residue, with bitumen tack
- tub-ground or chipped organic mulch
- brush-matting
- rock or gravel mulch
- refer to vol. 1: section 7.4; figure 7.3; appendices A6 and D



Geocellular containment systems

- Non-woven geotextile type material
- Polypropylene material (perforated and non-perforated)
- refer to vol. 1: section 5.4.2; SD5-3; appendix D



Surface roughening

- roughening parallel to contour
- contour ripping or scarifying
- 'track walking'
- refer to vol. 1: section 4.3.2; figures 4.3(a) and (b)



Geobinders

- organic tackifiers
- co-polymer emulsions
- bitumen emulsion
- cementitious products
- refer to vol. 1: section 7.1.2; appendices A6 and D



Table F.1 Group 2 – Erosion control CONCENTRATED WATER FLOW

Up-slope diversions

- excavated channel-type bank
- backpush-type bank or windrow
- catch drains
- shoulder dyke
- refer to **vol. 1**: section 5.4.4; SD5-5 and SD5-6



Mid-slope diversions

- berms and benches
- temporary diversions (at cut/fill line)
- cross banks
- refer to **vol. 1**: section 4.3.1; figure 4.2; appendix A4



Soft armour channels

- trapezoidal or parabolic shape
- consider channel grade and maximum permissible velocity
- establish vegetative ground cover
- standard (un-reinforced) or re-inforced turf
- biodegradable erosion control mat (temporary) or synthetic erosion control mat (permanent)
- refer to **vol. 1**: sections 5.4.3, 7.3; SD5-7; appendix D



Hard armour channels

- loose rock
- rock-filled wire mattresses
- articulating concrete block systems
- grouted rock
- cast in-situ concrete
- builder's plastic lining or geotextile lining
- refer to **vol. 1**: section 5.4.4; table 5.2; figure 5.4; appendix D



In-stream diversions

- temporary coffer dams
- water-filled structures
- temporary lined channel (stream diversion)
- refer to **vol. 1**: section 5.3.5; appendix I



Table F.1 Group 2 – Erosion control CONCENTRATED FLOW (cont'd)

Check dams

- stacked rock
- sandbags and geotextile sausages
- straw bales
- logs
- proprietary products
- refer to vol. 1: section 5.4.3; SD5-4; figures 5.3(a) and (b)



Batter drains

- concrete (pre-cast or on-site)
- half 'armco' pipe
- sandbags
- rock-filled wire mattresses
- loose-rock rip rap
- builder's plastic or geotextile lined chutes
- refer to vol. 1: section 5.4.4; appendix D



Grade control structures and flumes

- gully pits and field inlets
- sandbag drop structures
- rock-filled wire gabions and mattress structures
- driven sheet piling
- concrete chutes
- inclined pipe spillways
- builder's plastic-lined chutes



Outlet dissipation structures

- loose-rock rip-rap aprons
- rock-filled wire mattresses
- roughness elements
- hydraulic jump-type structures
- impact-type structures
- refer to vol. 1: section 5.4.5; figures 5.8, 5.9, 5.10, 5.11 and SC5-8



Revetments and retaining walls

- rip rap
- rock-filled wire gabions and mattresses



Table F.1 Group 3 – Sediment control SHEET FLOWS

Vegetative buffers

- well established sward with good groundcover
- refer to vol. 1: section 6.3.8; table 6.4; SD6-13; appendix G



Sediment barriers/filters

- sediment fences
- vegetation, brush, rock or gravel windrows
- straw bale barriers
- refer to vol. 1: section 6.3.7; SD6-7 and SD6-8; figure 6.10; appendix D



Site exit points

- shaker ramps
- rock aprons
- wheel wash systems
- refer to vol. 1: section 6.3.9; SD6-14



Table F.1 Group 4 – Sediment control CONCENTRATED FLOWS

Sediment curtains / turbidity barriers

- floating geotextile
- proprietary polypropylene products
- temporary coffer dams
- water-filled structures
- refer to vol. 1: section 6.3.7; SD6-10; appendix D



Sediment traps

- stacked rock/timber with geotextile
- excavated sumps
- straw bale or sand bag structures
- gully pit, field inlet and kerb inlets
- refer to vol. 1: section 6.3.6, figure 6.11; SD6-11 and SD6-12



Sediment retention basins

- Type C (riser type) basin
- Type F (extended settling) basins
- Type D (flocculation) basins
- refer to vol. 1: sections 6.3.3, 6.3.4 and 6.3.5; SD6-3 and SD6-4; appendices E and J



Appendix 2

Quarry Site Erosion and Sediment Control Plan

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Appendix 3

Bungonia By-pass Road Erosion and Sediment Control Plan

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Appendix 4

Road Widening (Oallen Ford Road – Jerrara Road) Erosion and Sediment Control Plan

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Appendix 5

Mountain Ash Road – Jerrara Road Intersection Upgrade Erosion and Sediment Control Plan

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Appendix 6

Major Waterway Crossing Culvert and Bridge Works – Jerrara Road Erosion and Sediment Control Plan

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