Multiquip Quarries

ABN: *44 101 930 714*

Ardmore Park Quarry

Water Management Plan

Prepared by

R.W. Corkery & Co. Pty Limited,
Strategic Environmental and Engineering Consulting
and
Larry Cook & Associates Pty Ltd

August, 2010

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PREAMBLE

This Water Management Plan has been developed to satisfy *Condition 3(13)* of Project Approval (PA) 07_0155[1] which is 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 DWE, DECC and SCA, 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.*

Strategic Environmental and Engineering Consulting (SEEC) and Larry Cook & Associates Pty Ltd have been commissioned by Multiquip Quarries to prepare the surface water and groundwater components of the Water Management Plan respectively. Accordingly, the Water Management Plan has been divided into two parts as follows.

Part 1: Surface Water Management. This part, prepared by SEEC, includes:

- a Site Water Balance prepared in accordance with Condition 3(14);
- an Erosion and Sediment Control Plan prepared in accordance with Condition 3(15);
- a Surface Water Monitoring Program prepared in accordance with Condition 3(16); and
- a Surface Water Response Plan prepared in accordance with Condition 3(18).

Part 2: Groundwater Management, This part, prepared by Larry Cook & Associates Pty Ltd, includes:

- a Groundwater Monitoring Program prepared in accordance with Condition 3(16); and
- a Groundwater Response Plan prepared in accordance with Condition 3(18).

The entire Water Management Plan was reviewed and compiled by R.W. Corkery & Co. Pty Limited.

[1] PA 07_0155 is presented in its entirety as **Appendix 1**.

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PART 1: SURFACE WATER MANAGEMENT

1.0 SCOPE OF WORK

Strategic Environmental and Engineering Consulting (SEEC) have been commissioned by Multiquip Quarries Pty Ltd (Multiquip) to prepare the surface water components of a Water Management Plan ("the Plan") for the Ardmore Park Quarry ("the quarry") located approximately 4km south of Bungonia in the NSW southern highlands (see **Figure 1**). Project Approval (PA) 07_0155 was issued for the quarry by the NSW Minister for Planning on 20 September 2009 and **Figure 2** presents the layout as approved.

PA 07_0155 includes *Conditions 3(13)* to *3(18)* requiring the preparation of a Water Management Plan. Part 1 of the Water Management Plan addresses *Conditions 3(13)* to *3(16)* as well as *Condition 3(18)* as it refers to surface waters.

The information presented in Part 1 draws from a Soil and Water Management Plan (SWMP) prepared by SEEC for the quarry. Presented as Drawings 09000271-SWMP-01 to 09000271-SWMP-05, and included in the Plan as **Appendix 1.1**, the SWMP has been prepared to satisfy the requirements of Volumes 1 and 2E of the accepted standard for managing surface water in NSW "Soils and Construction: Managing Urban Stormwater" (Landcom, 2004 and DECCW, 2008). The SWMP contains working drawings and informational and instructional text to which the reader will be referred to this throughout the Plan.

2.0 PROJECT DESCRIPTION AND SWMP OVERVIEW

Ardmore Park Quarry is located on the eastern side of Oallen Ford Road, near the intersection with Lumley Road, approximately 4km south of the village of Bungonia. It has significant resources of basalt and sand that will be progressively quarried generally from the west towards the east (see Drawing 09000271-SWMP05) see **Appendix 1.1**. The combined resource areas are about 60ha in size and presently drain to a common storage in the south of the quarry site (identified as Dam 7 within the *Environmental Assessment* for the quarry).

Drawings 09000271-SWMP01 and 09000271-SWMP02 of the SWMP (**Appendix 1.1**) present the surface water management structures and drainage plan of the quarry during the site establishment and operational phases. Surface water flows over the extraction area will be diverted to Dam 7 which will be operated as a Water Clarifying Pond and renamed CP3. CP3 will have a dedicated re-use volume.

The processing areas and stockpile areas will drain to a common sediment basin (SB2) and thence to a common re-use pond (RE1) which, in turn, drains to CP3. The quarry services area and the quarry administration area are on lands that drain north. Runoff from the Site Administration Area will be diverted to Clarifying Pond 2 (CP2) while runoff from the Quarry Services Area will be diverted to Sediment Basin 1 (SB1) with overflow to Clarifying Pond 1 (CP1). Water will be drawn from the clarifying ponds and at least two re-use ponds (RE1 and RE2) for use in dust suppression and sand processing. A shortfall in water supply will be mitigated using bore water.

3.0 SITE WATER BALANCES

3.1.1 Revised Modelling

Previous work by SEEC, completed as part of a Surface Water Assessment to accompany an Environmental Assessment for the quarry (RWC, 2008), identified that following the development of the quarry there would be an increase in the volume of surface water flowing from the quarry site (as a result of an increase in impervious surfaces). Modelling estimated there would be an approximate excess of 20ML/year in a period of mean rainfall (650mm) and 35ML/year in a significantly wetter period (1,135 mm).

Following a review of quarry sub-catchments (see Drawings 09000271-SWMP01 and 02 of **Appendix 1.1**), the water balance for the quarry was re-modelled[2]. The new modelling now includes a scenario for a significantly drier period (500mm/year). This low-rainfall modelling scenario has been adopted as the base-line condition, with the aims of the modelling being to demonstrate that:

- the surface water volume leaving the site will be no less than before development;
- the Maximum Harvestable Right Dam Capacity ("harvestable right") is not exceeded; and
- a neutral or beneficial effect can be achieved for water quality.

The revised modelling differs from the original in that:

- the catchment areas to some of the proposed storage ponds have been increased;
- the number of ponds has been consolidated, i.e. there are fewer; and
- the ponds are bigger than originally proposed[3].

Because of these changes the revised modelling shows that there is more water available for re-use than previously estimated (approximately 68 ML/year versus 20 - 35 ML/year).

[2] The pervious fraction in the MUSIC models are calibrated according to the procedures of Macleod, A. (2008). However, the calibration of the models will be checked for this project by:

- Monitoring Dam 8 (which is an undisturbed catchment outside of the quarry area but wholly within land owned by the quarry) and measuring the inflow for any given rainfall event. Knowing the catchment size, the runoff coefficient can be calculated and checked with modelling.
- Monitoring RE2 (which will have a partly disturbed catchment) and measuring the inflow for any given rainfall event. Knowing the catchment size, the runoff coefficient can be calculated and checked with modelling.

Subject to rainfall, this monitoring will only be required for the first two years, after which time the calibration should be done.

[3] This is because DECC 2008, Volume 2E of "Managing Urban Stormwater" requires wet-type water quality basins to be designed for the 95th percentile 5-day rainfall event, rather than the 75th percentile used previously. It is also because this volume must be *additional* to any re-use storage volume.

3.1.2 Proposed Water Storages

A number of water storages will be constructed and maintained within the quarry site (refer to **Table 1** and Drawings 09000271-SWMP01 and 09000271-SWMP02) of **Appendix 1.1**. Each will have all-weather access for water tankers, maintenance crews and excavators.

There are three types of water storages.

- Initial sediment traps to settle out the coarse-fraction, identified on **Table 1.1** and Drawings 09000271-SWMP01 and 09000271-SWMP02 (**Appendix 1.1**) as Sediment Basins (SB). The sediment storage capacities of these basins equal the six-month soil loss calculated by the Revised Universal Soil Loss Equation (RUSLE).
- Re-use ponds (RE) from where semi-settled water is drawn for re-use. The water storage zone and sediment storage volume of these ponds has been calculated using the 5-day 95th percentile rainfall depth (41mm) and relevant soil characteristics.
- Water clarifying ponds (CP) in which fines can be settled and/or flocculated, and from which water will be drawn (from a dedicated storage capacity) for re-use. The settling volume and sediment storage volume of these ponds have been calculated using the 5-day 95th percentile rainfall depth (41mm) and relevant soil.

Table 1.1 presents the relevant design capacities of each of the water storages to be constructed and maintained within the quarry site.

Table 1.1
Design Capacities and Re-use for each of the Proposed Storages

Storage Identification	Settling Zone Volume	Re-use Storage Volume	Sediment Storage Volume[4]	Total Volume	Maximum Permissible Re-use per year[5]
SB1	235m^3	0	75m^3	310m^3	0
SB2	610m^3	0	300m^3	910m^3	0
SB3	1100m^3	0	300m^3	1,400m^3	0
CP1[#]	750m^3	750m^3	75m^3	1,575m^3	5.1ML
RE1	0	2,500m^3	300m^3	2,800m^3	10.2ML plus* 3.7ML to 26ML[6]
RE2	0	4,300m^3	300m^3	4,600m^3	20.4ML
CP2[#]	1,500m^3	1,500m^3	50m^3	3,050m^3	5.1ML
CP3[#]	12,400m^3	8,000m^3	600m^3	21,000m^3	27.4L
Total volume (harvestable right)	Exempt	17,050m^3 (17ML)	Exempt	-	68.2ML (+3.7ML to 26ML[5])

Note *: Total maximum permissible re-use is 68.2 ML/y (sum of Column 6) but prevailing climate conditions will dictate whether this is actually achievable. To this may be added 3.7 to 26 ML/year being the amount drained from sand processing (depending on production). The shortfall in demand will be sourced from the bore.

Note [#]: CP1, CP2 and CP3 will be flocculated as necessary (refer to the SWMP).

[4] The sediment storage volume is equivalent to the six-month soil loss calculated by RUSLE. It allows for an approximate six-month maintenance period.

[5] These are derived by iterative calculations in MUSIC. Knowing the size of the re-use volume, MUSIC was interrogated to determine the approximate permissible re-use that a pond could sustain. Once that was done, the models were re-checked to ensure the total surface water flow post-development was no less than pre-development. Depending on the prevailing climate these volumes will not always be achievable; hence the confidence in supply rises in wetter years (**Table 2**).

[6] Being drainage from the processed sand, some of which is ultimately derived from bore water. This figure will change as production changes. The site manager will calculate this monthly and keep a rolling total.

3.1.3 Water Use

Water will be used at the quarry for the following purposes and at the estimated rates.

- Dust Suppression (on roads, hardstands etc.). The estimated use is approximately 20 to 22 ML/year and will depend on prevailing weather conditions.
- Sand Washing. Multiquip estimates that approximately 700L of water will be required to wash every tonne of sand. However, between 50% and 75% of the total volume of water added will be recovered and available for re-use. The more sand that is processed, the better the recovery percentage expected. Therefore, total net use is estimated at:
    - 35ML/year at a production rate of 100,000 tonnes per year; and
    - 70ML/year at a production rate of 400,000 tonnes per year
- Domestic use in the administration buildings. Estimated use is 1kL/day (0.37ML/year.

In summary, the expected annual water demand will be between 57ML/year and 92ML/year, depending on washed-sand production. Much of this will be drawn from the re-use and clarifying ponds with the shortfall sourced from the bore (Section 3.1.4.4).

3.1.4 Sources of Water

3.1.4.1 Overview

There are several sources of water for the site:

- A 50kL tank collecting roof runoff and used for domestic supply, supplemented with off-site potable water supply (about 2ML/year);
- Surface stormwater stored in two re-use ponds (possibly three as the quarry extends) and three clarifying ponds (see Section 3.1.4.2);
- Water drained from the sand after processing; and
- A licensed bore with an allowable supply of 100ML/year (see Section 3.1.4.4).

3.1.4.2 Re-use From Ponds

MUSIC was interrogated by an iterative process to determine the approximate permissible re-use that a pond could sustain. Once complete, the model outputs were checked to ensure surface water flow post-development was no less than pre-development.

Depending on the prevailing climate the permissible re-use volumes will not always be achievable and the extra demand will be met by the bore. The MUSIC models were interrogated to determine the percentage of permissible re-use demand (the total volume of Column 6, **Table 1.1** – 68.2ML) met in different rainfall scenarios. The results are given in **Table 1.2**.

Table 1.2
Predicted Supply Storage Supply Confidence

Storage Identification	Predicted Storage Supply Confidence		
	Dry Year	**Mean Year**	**Wet Year**
CP1	75%	86%	100%
RE1	93%	100%	100%
RE2	85%	95%	95%
CP2	75%	86%	100%
CP3	66%	82%	90%
Overall Confidence	77% (52 ML)	89% (60 ML)	96% (65 ML)

Water will be drawn from the Re-use and Clarifying Ponds for sand washing and dust suppression. RE1 will preferentially be used for sand processing, as it collects water drained from the sand after washing. It is anticipated that RE2 will provide the majority of the water demand for dust suppression (between 20 to 22 ML/year) on its own (17.3ML in a dry year[7]). The remaining ponds would supplement RE2 for dust suppression as required and would supply water for sand washing (supplemented by bore water as required). Notably, no surface flows will enter ponds RE1 and RE2 and the basin has been designed to accept the maximum volume of water that could be generated by sand washing operations. Furthermore, the water re-use system will act as a closed loop with no water entering from, or discharging to the surrounding dirty water management system. As such, the water contained and managed within RE1 and RE2 would not have any influence on the volume of water, and therefore required settlement times and storage capacity of the sediment basins and clarifying ponds.

All pumps will be metered and a rolling total kept of all water drawn from each re-use and clarifying pond and from the bore. This will ensure that re-use does not exceed the maximum permissible volumes given in **Table 1.1** or the bore license.

The data in **Tables 1.1** and **1.2** are based on the first few years of extraction, where the catchment to RE2 is 20ha with up to 7ha of that area will be disturbed at any one time (i.e. active quarry, silt or overburden emplacement). As the quarry advances, and more land is disturbed, there will be an increase in runoff and more water could be harvested. At peak disturbance (a working area of 36ha of which 20ha is disturbed) modelling suggests that RE2[8] could be increased by about 2 ML to 6.3ML (6,300m^3) and re-use drawn from it at about 31ML/year. This still keeps the total re-use storage volume (19ML) less than the harvestable right allowance for the site (20ML).

In the initial stage, RE2 will still have a catchment of 20ha (see Drawing 09000271-SWMP02 of **Appendix 1.1**) but the disturbed area will be less (say 2 ha) and so stormwater runoff will be lower. In this case, depending on prevailing climatic conditions, the dependence on bore water might be increased by about 8ML/year (Section 3.1.4.4).

3.1.4.3 Drained Water

Water drained from the sand processing area will drain by gravity to SB2 and RE1 for re-use. Periodically the quarry manager will determine the approximate volume of this water based on the current production rates and the moisture content of the finished product.

[7] 20.4ML x 85% = 17.3ML.
[8] RE2 could be constructed as two ponds (of combined capacity 4,600m^3).

3.1.4.4 Bore Water

The operator has a bore license for 100ML per year. Should the early stages of the quarry coincide with a dry year, re-use of water from the re-use and clarifying ponds might be limited to 44ML/year[9] and the remainder of demand will be sourced from the bore. At peak production it is estimated that 92ML/year of water is required (Section 3.1.3). Therefore, in the worst case where peak production is achieved in the early stage and it is a dry year, the anticipated maximum volume sourced from the bore would be approximately 48ML/year.

4.0 SEDIMENT CONTROL

4.1.1 General

The development of the quarry will produce surface runoff and drained processing waters high in suspended solids. As long as these waters are directed to the 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)), a neutral or beneficial effect will be achieved without detriment to overall surface flow volumes from the site.

Therefore, the most fundamental requirements of sediment control at this site are:

- to ensure all dirty water is directed to the sediment basins, and thence to their associated clarifying/re-use ponds;
- to ensure that water is drawn from the 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 it to achieve less than 50mg/L suspended solids before it is released to receiving waters (in accordance with the guidelines provided by *Appendix E* of Landcom (2004)); and
- to re-use and/or treat-and-release trapped water from the clarifying ponds within 5 days of a trigger to do so (Section 4.1.2.3).

The SWMP provides more details on sediment control (see **Appendix 1.1**).

4.1.2 Basin and Pond Maintenance

4.1.2.1 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. The locations of the sediment basins are presented on SWMP Drawings 09000271-SWMP01 and 09000271-SWMP02. Notes to accompany the management of these sediment basins are provided on SWMP Drawing 09000271-SWMP03. 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 (in accordance with SWMP Drawings 09000271-SWMP01 and 09000271-SWMP02) does.

[9] 52ML from **Table 1.2** less 8ML from section 3.1.4.2.

- The sediment basins must have their working capacity maintained at all times, i.e. the settling zone and sediment storage volumes identified in **Table 1.1**. This will require markers to indicate when their capacities are reached. When they are reached trapped sediment will be removed and used as part of final landform creation and rehabilitation.
- 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.

4.1.2.2 Re-Use Ponds

The re-use ponds have been designed to capture and retain water from the processing areas (RE1) or extraction area (RE2) as a source of water for operational and dust suppression activities. The locations of the re-use ponds are presented on Drawings 09000271-SWMP01 and 09000271-SWMP02 (**Appendix 1.1**). Notes to accompany the management of RE1 and RE2 are provided on Drawing 09000271-SWMP03 (**Appendix 1.1**). Critical issues for re-use pond management are as follows.

- Re-use pond RE1 is a permanent structure and will be clay-lined to reduce seepage loss. Water will be preferentially drawn from RE1 for sand washing.
- Re-use pond RE2 is a temporary structure and will be relocated as the extraction area progresses, i.e. it will be positioned to maximise the capture of runoff from the extraction areas. RE2 could be constructed as a two separate ponds to maximise the capture of runoff but the combined capacity will not exceed 6 000m^3 (6ML). Water will be drawn from it 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 in **Table 1.1**. This will require markers to indicate when their sediment-storage capacities are 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, and the sediment basins must be regularly inspected to ensure the settling zone and sediment storage volumes are maintained.
- 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.

4.1.2.3 The Clarifying Ponds

The clarifying ponds have been designed to receive overflow from the sediment basins and the re-use ponds and, in the case of CP3, 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).
- A sediment storage capacity (designed to last approximately six months).

The locations of the clarifying ponds are presented on Drawings 09000271-SWMP01 and 09000271-SWMP02 (**Appendix 1.1**). Notes to accompany the management of CP1 to CP3 are provided on Drawing 09000271-SWMP03 (**Appendix 1.1**). Critical issues for clarifying pond management are as follows.

- The clarifying ponds must be regularly inspected to ensure that all water that should be draining to them does (in accordance with SWMP Drawings 09000271-SWMP01 and 09000271-SWMP02 of **Appendix 1.1**).
- The clarifying ponds must be maintained to ensure that the inlet 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 in **Table 1.1**. 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 off-site disposal. In these instances the trapped water will require flocculation (undertaken in accordance with the guidelines provided by *Appendix E* of Landcom, 2004) to reduce total suspended solids (TSS) concentration to less than 50mg/L. Before disposal off-site, the water will be tested for TSS and pH (which must be 6.0 – 7.5). The re-use, flocculation and draw-down must occur within five days of the rainfall event that triggered the work.

  Flocculation might be difficult in CP3, as it has a large volume. If so, it is permissible for the settling volume to be drained to a small pond of equivalent volume for flocculation before disposal. 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.
- In rainfall events that exceed the 95th percentile, 5-day rainfall depth (41mm) there might be untreated discharges. All such discharges will be logged (see also Section 7).

5.0 EROSION CONTROL

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.

Notes outlining specific erosion control measures for the quarry are provided on Drawing 09000271-SWMP03 (**Appendix 1.1**). The fundamental requirements for erosion control are as follows.

- Where possible, the extent and duration of disturbance should be minimised.
- 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 be not be re-worked within 20 days, but will be re-worked with 60 days, will have sufficient material (textile, mulch, hydro mulch, chemical stabiliser etc.) placed on them to provide at least 60 percent ground cover, i.e. a C-Factor of 0.1[10].
- 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, ie. 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. Whatever channel lining material is adopted it must have a suitable design life. *Table 3* of Drawing 09000271-SWMP03 (**Appendix 1.1**) provides the nominated design features of the on-site diversionary structures (EB1 to EB7).
- Water will be drawn from the re-use ponds as required for dust suppression. A dust suppressant, e.g. 'Dustbloc', will be added to the water before it is applied.
- Slopes greater than 3H:1V (18º) will be avoided. Slope protection will adopt the same rules as nominated for areas of bare earth.

6.0 SURFACE WATER MONITORING PLAN

6.1 Water Quality Monitoring – CP3

Initial base line water quality testing was done by SEEC after a moderate rainfall event in February 2010. Samples were taken from Dam 7 and Dam 8 which, at that time, both had typical agricultural catchments. The results are given in **Appendix 1.3** and show the two dams had very similar water quality, which may be taken as the initial baseline condition.

Dam 7 will become the main clarifying pond (CP3) but Dam 8 (1 ML) will not be used for quarry operations. Its catchment is entirely within land owned by the quarry operator and it will be maintained as an agricultural land use. Diversion berms will ensure water derived from the quarry cannot enter it. Dam 8 can, therefore, be used as an ongoing baseline (control) water quality monitoring pond.

[10] C-Factor refers to ground cover. It varies form 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.

Whenever the settling volume of CP3 is compromised, and off-site disposal is required, samples will be taken from it (after flocculation if required) and from Dam 8. They will be sent to an independent NATA registered laboratory within the technical holding times and tested for:

- hydrocarbons;
- total suspended solids;
- total nitrogen;
- total phosphorous;
- electrical conductivity;
- acidity; and
- aluminium (if Alum is used for flocculation).

Initially, if the pollutant concentrations in the samples from CP3 exceed those given in **Appendix 1.3**, **Table A1.3.1**, a suitably qualified consultant will be employed to investigate, report, liaise with DECCW and suggest remedial measures if and as required.

As time progresses water quality data from Dam 8 will become more reliable (as long as the catchment remains agricultural and there is no inflow from the quarry works). Once there becomes a statistically valid number of data (at least 10) a trigger for further investigation will be deemed to occur when the median concentration of an indicator taken from CP3 exceeds the 80th percentile of the same indicator from Dam 8. If that occurs a suitably qualified consultant will be employed to investigate, report, liaise with DECCW and suggest remedial measures if and as required.

6.2 Stream Health Monitoring (Receiving Water)

Overflow from CP3 drains to a natural first-order watercourse that becomes a second-order stream as it drains south through an adjoining property. Overflow from Dam 8 (to the southeast of the extraction area) follows a similar watercourse and joins this one at a point 600m downstream. The watercourse will be inspected to this confluence before operations begin and a series of five baseline cross sections will be surveyed and photographs taken. The locations of the sections will be measured by GPS. They will form a later appendix to this document.

The quarry manager will periodically (once per six months) inspect this length of watercourse and re-take the series of five photographs to document its condition. The photographs will be dated and kept as part of quarry management documentation. If there are any significant signs of accelerated erosion a suitably qualified consultant will be employed to investigate, report, liaise with DECCW and suggest remedial measures as required. Here “significant signs of accelerated erosion” means:

- an increase in channel width of 10% or more at any of the locations, over a period of one year[11]; OR

[11] The monitoring will be on adjoining land and there could be off-site reasons for accelerated erosion. The suitably qualified consultant will take that into consideration. Computer modelling predicts that, although more water will flow into the watercourse, peak flows will be lower post development than they are now (the series of ponds will attenuate the flow and so velocities in the creek will be lower).

- an increase in channel depth of 10% or more at any of the locations, over a period of one year; OR
- a clear change in the condition of the bed, if the bed was originally well vegetated.

The quarry manager will also look for any occurrences of unusual foams/froths or oil at the water surface.

6.3 Weather Monitoring

An automatic weather station will be installed on the quarry site which will be capable of measuring daily rainfall. The results will be continuously logged and kept on file. Untreated site discharges are only permissible after a rainfall event that exceeds the 95th percentile, 5-day rainfall depth (41mm). This will occur from time to time and, when it does, it must be supported by site-specific rainfall data to prove the terms of the license have not been breached.

7.0 ONSITE WASTEWATER MANAGEMENT

Applications to install wastewater management systems are assessed by Council under the requirements of the *Local Government Act 1993* and the *Environmental Planning and Assessment Act 1979*. The site operators understand their obligations to on-site wastewater management and will periodically check the treatment and disposal system to ensure:

- any alarm is responded to within 24 hours;
- the two treatment cells are switched every 6 months (Ecomax usually send a reminder);
- any filters are cleaned;
- distribution lines are buried and protected;
- no effluent is evident at the surface;
- the Ecomax mound is regularly maintained (trimmed, mown, weeded etc.);
- any unusual odours are reported to the manufactures as soon as possible and remedial action taken if required;
- only “septic safe” cleaning products are used in the buildings; and
- maintenance on the septic tank is completed approximately once every five years.

8.0 SITE AUDITING

The requirements for day-to-day site monitoring are provided in the SWMP. They include a requirement for monthly inspections of the site when a checklist will be completed. A sample checklist is given in **Appendix 1.3** but this may be adapted as operations proceed.

Once per year, a Certified Professional in Erosion and Sediment Control (CPESC) will be commissioned to inspect the site and prepare a report. The report will include the following information.

- Results of an inspection of the weather station and its records.
- Results of an inspection of the pumping records.

- Results of an inspection of the untreated discharge records, and comparison with rainfall data.
- Results of an inspection of the volumes of water collected in Dam 8 and RE2 after rainfall events (for model calibration – Section 3.1.1)[12].
- Results of an inspection of the condition of all ponds and drainage structures.
- Results of an inspection of the condition of any rehabilitated areas.
- identification of any areas of disturbed soil that could be rehabilitated.
- Results of an inspection of the water quality monitoring results;
- Results of an inspection of the condition of the receiving water (Section 6.2).
- Provide recommendations to the site manager for any remedial actions necessary to ensure compliance with the operational license.
- Provide a clear statement as to whether the conditions of the operational license are being met. If they are not he/she will report on any breaches of the operation license and liaise with DWE to recommend any remedial actions necessary.
- Report on any unforeseen impacts and liaise with DWE to recommend any remedial actions necessary.

9.0 SURFACE WATER RESPONSE PLAN

Table 3 presents a Surface Water Response Plan, identifying the trigger issues and responses. Unless otherwise indicated, each trigger will require the Quarry Manager to commission a suitably qualified consultant to investigate, report, liaise with DECCW and suggest remedial measures as required ("Action A").

Table 1.3
Surface Water Response Plan

Trigger	Action
Discharge from CP1, CP2 or CP3 when combined rainfall has been less than 41 mm in the previous five days.	Follow the procedures in Section 4.1.2.3
Unable to treat water to less than 50 mg/L before discharge	A
Water quality measurements exceed triggers described in Section 6.1	A
Significant changes to the watercourse downstream of CP3 (Section 6.2)	A
Signs of pollutants downstream of CP3 (e.g. foams, oil and scum)	A
Signs of wastewater effluent at soil surface.	A
Re-use from ponds less than predicted, over-reliance on bore water	A See also MUSIC calibration, Section 3.1.1
Re-vegetation not occurring in required time frame.	A and employ a horticulturalist
Any unforeseen impact	A
A = Quarry Manager to commission a suitably qualified consultant to investigate, report, liaise with DECCW and suggest remedial measures as required	

[12] Subject to rainfall, this will only be required for two years.

This surface water management plan has been specifically designed to mitigate any effect on downstream landowners. Water will be drawn from storage volumes that form part of the harvestable right. It will be drawn at rates that ensure flows downstream are not affected, even in dry weather. The models actually predict increases in flow post development in mean or wet periods. If necessary, the permissible re-use volumes given in Column 6, **Table 1.1** will be adjusted subject to site-specific calibration of the models (Section 3.1.1).

PART 2: GROUNDWATER MANAGEMENT

10.0 GROUNDWATER MONITORING PROGRAM

10.1 Background

The Minister for Planning issued Project Approval (PA) 07_0155 for the Ardmore Park Quarry ("the quarry") on 20 September 2009. The quarry incorporates the extraction of unconsolidated palaeo-alluvial sand and in-situ basalt (hard rock). The location of the quarry is shown in **Figure 1**.

The conditions of PA 07_0155 relevant to groundwater are 13, 17 and 18 of Schedule 3 and Section 5 (clauses 5.1 – 5.14) in *Appendix 2*. *Condition 3(17)* identifies the specific requirements of a Groundwater Monitoring Program (GMP) for the quarry.

The basalt deposit is not under saturated conditions. That is, the hydrogeological investigations indicate 'dry' conditions for hard rock quarrying. The palaeo-alluvial sand deposit has a variable water table, the level of which is directly related to rainfall.

10.2 Scope

The GMP provides a set of monitoring targets, assessment criteria and trigger levels for investigating any potentially adverse impacts from quarrying operations on the groundwater system. Notably, the GMP also provides for immediate and follow-up actions to be implemented in the event that monitoring identifies impacts or potential impacts of the quarry on groundwater level, quality or availability.

This GMP is specifically tailored for practical field use and easy (and clear) reference for the routine monitoring of groundwater in the quarry area and immediate surrounds.

In summary, this GMP:

- identifies and describes the location of monitoring sites;
- describes the type of routine monitoring activities;
- prescribes the frequency of monitoring;
- specifies the analysis and tests to be undertaken;
- describes the monitoring targets;
- prescribes the trigger levels with immediate (and follow-up) actions required if an exceedance (impact) is reported; and
- describes a protocol for reporting of results and management of technical data

The components and details of this GMP are fully summarised for easy (and clear) reference in a spreadsheet provided in **Appendix 2.1**. To avoid repetition, reference is made in the GMP to **Appendix 2.1** where relevant.

10.3 Objectives

This GMP has the following objectives.

- Describe and specify the monitoring bores and monitoring sites incorporated in the groundwater monitoring network.
- Provide figures showing the locations of the elements (bores and springs) that comprise the groundwater monitoring network.
- Document all relevant baseline data to the time of writing this GMP, including water level and water quality data.
- Identify and describe any potential adverse groundwater impacts from quarrying operations and develop criteria for assessing any impacts.
- Develop a method to measure and monitor the flow of water discharging from census springs.
- Develop a method to calculate and monitor the amount of groundwater flowing through the pit.
- Develop an ongoing 'long-term' program to monitor water levels and water quality in monitoring bores and monitoring sites.
- Develop an in-house and state government reporting protocol for the documenting and reporting of any potential groundwater impacts from quarrying operations.
- Develop a protocol for data management.
- Develop a protocol for general technical reporting separate from special reporting associated with specific impacts.

10.4 Groundwater Monitoring

10.4.1 Introduction

Groundwater monitoring is divided into two separate monitoring programs, namely:

1. monitoring of the hard rock aquifer using the "Ardmore Park" property production bore (BHAP6) and associated hard rock observation bores (BHAP1, BHAP 5 & BHAP7 to BHAP10); and
2. monitoring of shallow sand aquifer using the sand monitoring bores (BH1 to BH8) and census springs associated with sand extraction

A register of monitoring bores listing their location, elevation, depth and screened intervals (where installed), and a list of census springs is provided in **Table 2.1**. The hard rock bores were drilled and constructed in 2003 and the sand monitoring bores completed in 2004.

The location of Production Bore BHAP6 and associated hard rock observation bores (BHAP1, BHAP5, BHAP7 and BHAP10) are shown in **Figure 3**. The location of monitoring bores (BH1 to BH8) and spring systems associated with sand extraction are shown in **Figures 4** and **5**.

The two monitoring programs are described and discussed in sections 10.4.2 and 10.4.3.

Table 2.1
Register of Monitoring Bores and Monitoring Sites

Monitoring Bore	Coordinates (AMG)		Surface Elevation (m AHD)	Stickup (m AGL))	Elevation (TOC) (m AHD)	Depth (m)	Screen Position (m BGL)
	Easting (m)	Northing (m)					
Hard Rock							
BHAP1	55770000	6134780	633.3	0.15	633.45	114.0	Open
BHAP5	55770520	6134505	634.5	0.15	634.65	72.0	Open
BHAP6	55769910	6134252	640.0	0.15	640.15	124.0	95.0-113.0
BHAP7	55769660	6133780	633.0	0.15	633.15	112.0	Open
BHAP10	55769340	6134480	637.5	0.15	637.65	52.0	30.0-52.0
Sand							
BH1	55769512	6133541	631.5	0.5	632.00	10.4	7.4-10.4
BH2	55769395	6133324	623.0	0.5	623.50	12.0	9.0-12.0
BH3	55769200	6133585	619.3	0.73	620.03	13.0	10.0-13.0
BH4	55769716	6133141	619.6	0.73	620.33	17.0	14.0-17.0
BH5	55769687	6133259	622.5	0.68	623.18	12.5	9.5-12.5
BH6	55769912	6133228	627.5	0.92	628.42	14.0	11.0-14.0
BH7	55770102	6133253	630.8	-	-	TBC	-
BH8	55770400	6133144	635.0	-	-	TBC	-
APS38	55769564	6133301	628.4	0.97	629.37	80.0	multiple
Phil's Spring	55770676	6132950	624.0	-	-	-	-
Southern Spring	55769582	6133029	615.0	-	-	-	-
Western Spring	55768560	6133400	619.0	-	-	-	-

Notes: TOC denotes Top of Collar
AGL denotes Above Ground Level
BGL denotes Below Ground Level
AHD denotes Australian Height Datum
AMG denotes Australian Metric Grid
TBC denotes To Be Completed

10.4.2 Hard Rock Aquifer Monitoring Program

10.4.2.1 Description

As noted in Part 1, surface water supply to quarry operations will be supplemented by groundwater extractions from Production Bore BHAP6. An application for a groundwater license under the *Water Act 1912* for the intended multiple purpose of sand washing, fire fighting and stock has been submitted to the NSW Office of Water.

Production Bore BHAP6 is surrounded by a network of four deep, proximal hard rock monitoring bores (BHAP1, BHAP 5 & BHAP7 to BHAP10) that were used to monitor water levels during the formal pumping test in BHAP6 (**Figure 3**). This network of four monitoring bores which includes a background monitoring bore will be used in long-term monitoring of the production bore. Summary details of the production bore and monitoring bores are provided in **Table 2.1**.

A set of automated submersible Pressure and Temperature Data Recorders ('Odyssey' - *Dataflow*) will be installed in the groundwater monitoring bores. These loggers are vented to the atmosphere and will be programmed to take measurements of water level and temperature at a sample frequency of one (1) hour.

The results of baseline bore flow, water level and water quality monitoring are summarised in Appendices 2.2, 2.3, 2.4, 2.5 and 2.6.

10.4.2.2 Baseline Data

Bore Flow Data: Production Bore BHAP6

A baseline flow rate for Production Bore BHAP6 was established during formal pump testing. The flow data is provided in **Appendix 2.2**.

Water Level Data

A baseline set of water level measurements and several pre-test measurements were collected in the production bore and in each observation bore. The water level data is provided in **Appendix 2.3**.

Water Quality Data

Baseline water samples were collected from Production Bore BHAP6 and observation Bore BHAP10 and analysed for the analytes listed in **Table 2.2**.

Table 2.2
List of Baseline Analytes: Hard Rock Bores

General		
pH	Electrical Conductivity (EC)	Total Dissolved Solids (TDS)
Hardness as CaCO3		
Cations		
Sodium (Na)	Potassium (K)	Ammonia (NH4-N)
Calcium (Ca)	Magnesium (Mg)	
Anions		
Chloride (Cl)	Carbonate Alkalinity (as CaCO3)	Nitrate (NO3-N)
Sulphate (SO4)	Total Alkalinity (as CaCO3)	Bicarbonate Alkalinity (as CaCO3)
Total Phosphorus (Total P)	Phosphate (PO4)	

The baseline analytical results and water quality testing are summarised for reference in **Appendix 2.4**.

10.4.2.3 Monitoring Targets, Parameters, Frequency, Trigger Levels, Actions and Reporting

Refer to "*1.1 Water Level Monitoring – Hard Rock Production Bore and Monitoring Bores*" and "*2.1 Water Quality Monitoring - Hard Rock Production Bore and Monitoring Bores*" of **Appendix 2.1**.

10.4.3 Sand Aquifer Monitoring Program

10.4.3.1 Description

An extensive network of monitoring bores associated with the sand extraction operations was used to collect baseline water level, water quality and permeability data from beneath, and surrounding the footprint of the sand extraction area of the quarry. This GMP is centred on a core network of nine (9) monitoring bores (piezometers) located in, and peripheral to, the sand deposit (BH1 to BH8 and APS38). The network includes a control (background) monitoring bore. The locations of monitoring bores are shown in **Figure 5**.

Summary details of the sand-hosted monitoring bores are provided in **Table 2.1**.
A set of automated submersible Pressure and Temperature Data Recorders ('Odyssey' - *Dataflow*) will be installed in the groundwater monitoring bores. These loggers are vented to the atmosphere and will be programmed to take measurements of water level and temperature at a sample frequency of one (1) hour.

The results of baseline water level and water quality monitoring are summarised in Sections 9.4.3.2 and 9.4.3.3.

10.4.3.2 Baseline Data

Water Level Data

A baseline set of water level measurements were collected in the sand-hosted monitoring bores. The water level data is provided in **Appendix 2.5**.

Water Quality Data

Baseline water samples were collected from six monitoring bores and analysed for the analytes listed in **Table 2.3**.

Table 2.3
List of Baseline Analytes: Shallow Sand-Hosted Bores

General		
pH	Electrical Conductivity (EC)	Total Dissolves Solids (TDS)
Cations		
Sodium (Na)	Potassium (K)	Ammonia (NH4-N)
Calcium (Ca)	Magnesium (Mg)	
Anions		
Chloride (Cl)	Fluoride (F)	Nitrate (NO3-N)
Sulphate (SO4)	Bicarbonate Alkalinity (as CaCO3)	
Metals		
Copper (Cu)	Chromium (Cr)	Mercury (Hg)
Lead (Pb)	Dissolved Iron (Fe)	Arsenic (As)
Zinc (Zn)	Cadmium (Cd)	Manganese (Mn)

The baseline analytical results and water quality testing are summarised for reference in **Appendix 2.6**.

10.4.3.3 Monitoring Targets, Parameters, Frequency, Trigger Levels, Actions and Reporting

Refer to "*1.2 Water Level Monitoring – Sand Monitoring Bores*" and "*2.2 Water Quality Monitoring – Sand Monitoring Bores*" of **Appendix 2.1**.

10.4.4 SPRING MONITORING PROGRAM

10.4.4.1 Description

Three spring systems have been identified for long-term monitoring.

- Phil's Spring.
- Southern Spring.
- Western Spring.

The locations of all three census springs are shown on a copy of the aerial photo over the Project Site in **Figure 4**. The locations of Phil's Spring and the Southern Spring are shown in **Figure 5**. Summary details of the three census springs are provided in **Table 2.1**.

The results of baseline flow and water quality monitoring are summarised in Sections 9.4.4.2 and 9.4.4.3.

A 'V' notch weir (or similar device) will be installed at the discharge points of the three census springs to monitor spring flow. A water level data logger will be installed in each weir and initial measurements taken. The water depth measured in the weir will then be calibrated with spring flow and subsequent water depth measurements recorded on the water level logger converted to flow.

10.4.4.2 Baseline Data

Flow Data

Baseline flow measurements were undertaken in Phil's Spring. A flow of approximately 0.3L/s was measured. No baseline flow measurements were carried out in the Southern Spring or in the Western Spring.

Water Quality Data

A baseline water sample was collected from Phil's Spring and submitted for the analytes and tests listed in **Table 2.4**.

Table 2.4
List of Baseline Analytes: Springs

General		
pH	Electrical Conductivity (EC)	Total Dissolves Solids (TDS)
Cations		
Sodium (Na)	Potassium (K)	Ammonia (NH4-N)
Calcium (Ca)	Magnesium (Mg)	
Anions		
Chloride (Cl)	Fluoride (F)	Nitrate (NO3-N)
Sulphate (SO4)	Bicarbonate Alkalinity (as CaCO3)	
Metals		
Copper (Cu)	Chromium (Cr)	Mercury (Hg)
Lead (Pb)	Dissolved Iron (Fe)	Arsenic (As)
Zinc (Zn)	Cadmium (Cd)	Manganese (Mn)

The baseline analytical results and water quality testing are summarised for reference in **Appendix 2.7**.

10.4.4.3 Monitoring Targets, Parameters, Frequency, Trigger Levels, Actions and Reporting

Refer to "1.3 *Spring Flow Monitoring - Census Springs*" and "*2.2 Water Quality Monitoring – Census Springs*" of **Appendix 2.1**.

10.4.4.4 Photo Points

Photo points will be established on Phil's Spring, Southern Spring and Western Spring prior to commencement of sand extraction operations. Photos will then be taken at least annually to provide a photographic snapshot of the status of spring discharge and an indication of any floristic changes that may be associated with fluctuations in spring flow.

10.4.5 RAINFALL MONITORING

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

Further detail is provided by "3 Rainfall Monitoring" of **Appendix 2.1**.

10.5 Assessment Criteria and Trigger Levels

A set of criteria (and trigger levels) for assessing any impacts from the proposed quarry operations on water levels and water quality in the groundwater monitoring network and on the census springs are tabled in **Appendix 2.1**. A plan for immediate action and follow-up action if an impact is detected is also documented in **Appendix 2.1**.

Statistical analysis of monitoring data will provide warning on an impending impact or whether and impact has occurred. Two well documented methods are the Exponentially Weighted Moving Average (EWMA) and the Cumulative Sum (Cusum) methods which are considered to be relevant to the assessment of any potential environmental impacts associated with the quarry. A description of these statistical analytical methods is provided in **Appendix 2.7**.

10.6 Prevention of Groundwater Contamination

Clauses 5.1 – 5.5, of PA 07_0155 *Appendix 2* refer to best environmental practices associated with storage of hydrocarbons, refuelling activities, equipment maintenance and management of wash-down water. The prescribed practices are reproduced as follows.

- Securely store all hydrocarbon products within designated and bunded areas.
- Refuel all of the project fleet within designated areas of the Project Site.

- Undertake all maintenance activities within designated areas of the Project Site facilities area, i.e. Maintenance workshop.
- Direct all water from wash-down areas and workshops to oil/water separators and containment systems.
- Ensure all storage tanks are either self bunded tanks or bunded with an impermeable surface and a capacity to contain a minimum 110% of the largest storage tank capacity.

10.7 Impact Reporting Protocol

A protocol for in-house and state government reporting where there is an assessed impact from the proposed quarry operations on either water levels or water quality in the groundwater monitoring network or flow in the census springs is provided in **Appendix 2.1**.

10.8 Data Management Protocol

The recommended protocol for data management is summarised as follows.

- The water level data downloaded from the loggers in the monitoring bores and census springs will be imported into an electronic database or spreadsheet and viewed following each round of monitoring. This process will ensure that a progressive record of the data is stored and maintained, and the integrity/quality of the data can be checked on a regular basis. If a problem with the data is discovered, for example the corrected water level in the data logger does not reasonably correspond with the manual measurement taken at the time of downloading, remedial measures can be implemented immediately. If there is a problem, the worst case scenario is that water level data may be lost for that period or part of the monitoring period since the last downloading was carried out. In this way, any problem should not be carried through in the medium to long term.
- Email a copy of the water level data to a hydrogeological consultant for assessment and keep a backup copy of the water level database in a secure **off-site** place.
- Develop and maintain a water usage record for the quarry. This database can be part of the electronic water level monitoring database.
- Develop and maintain an electronic water quality database or spreadsheet. This database can also be part of the electronic water level monitoring database. A suitable database and progressive charting will be developed.
- Develop and maintain an electronic spring flow database or spreadsheet. This database can also be part of the electronic water level and water quality monitoring database. A suitable database and progressive charting will be developed.
- Develop and maintain an electronic rainfall database or spreadsheet. This database can also be part of the electronic water level monitoring database.

10.9 General Reporting Protocol

The recommended protocol for reporting, separate from special reporting associated with specific impacts documented in Section 9.8, is summarised as follows:

- All water level data, groundwater quality monitoring results and spring flow will be recorded, collated and duly reported in-house on at least a six-monthly basis for the first 12 months, henceforth on an annual basis. The data will be reviewed by a consulting hydrogeologist. The aim is to assess any changes in water levels, groundwater chemistry or spring flow and identify reasons for the changes if they occur. The monitoring schedule will be reviewed annually and changed if deemed appropriate by the consultant.
- A complete set of audit results from the monitoring program will be formally reported to the Senior Hydrogeologist of the NSW Office of Water (NOW) on an annual basis.
- The report will provide a summary of the water extraction records for the quarry and monitoring results. The report will include a figure showing the locations of the monitoring sites, and a set of hydrographs with rainfall correlations.
- The report will be sent in hard copy to the Senior Hydrogeologist of NOW. The raw water level data can be appended to the report in electronic form. The complete report will also be submitted in electronic format to NOW and to the Quarry Manager.

11.0 GROUNDWATER RESPONSE PLAN

11.1 Background

Condition 3(18) identifies the specific requirements of a Groundwater Response Program for the quarry which are as follows

18. The Surface and Groundwater Response Plan must include:

(a) *a protocol for the investigation, notification and mitigation of any exceedances of the surface and ground water impact assessment criteria;*

(b) *measures to mitigate and/or compensate potentially affected landowners, including provision of alternative long-term supply of water to the affected landowner that is equivalent to the loss attributed to the project; and*

(c) *the procedures that would be followed if any unforeseen impacts are detected during the project.*

11.2 Impact Assessment, Notification and Mitigation Protocol

The protocol for identifying potential impacts, investigating the cause of these impacts (to determine whether these are quarry related or simply natural fluctuation), notifying relevant stakeholders and implementing mitigation procedures would be as follows.

1. Monitoring of groundwater levels as nominated in the GMP would be undertaken to identify any decreasing groundwater level trend.
2. Should a decline in groundwater of greater than 15% that of the baseline value, be observed, an investigation into the cause of such a decline would be initiated.

3. The investigation would involve a review of monitoring data and operational activities to identify correlation with pumping cycles, extraction rates and/or climatic data (rainfall). Statistical analyses of monitoring record, pumping cycle, quarry development and rainfall would be used to determine whether any decrease in water level/s may be due to extraction from the groundwater system.
4. If the groundwater drawdown is determined to be resultant (either solely or partially) from extraction, the likely distance of drawdown impacts would be calculated with respect to the observation bores.
5. Based on the calculated area of drawdown impact, the potential for bores (or springs) on surrounding properties to be affected would be assessed. In the event that the impacted area is considered as having the potential to impact on any of these bores, the quarry operator would notify the relevant land owner an inquire as to the availability of groundwater from the potentially affected bore (or spring).
6. Should there be any conjecture over the scale of impact, the quarry operator would offer to test the relevant bore (or review the flow from the spring) to confirm the magnitude of any reduction in water availability.
7. In the event that it is confirmed that the quarry operations have indeed led to a reduction in water availability on properties, the quarry operator would commission a qualified hydrogeologist to assess the impacts and advise on the appropriate mitigation or compensatory measures. Section 10.1.3 provides an overview of the potential mitigation or compensation measures that might be implemented, however, the most practical of these could only be determined following professional assessment of the type and scale of impact.
8. Concurrently with the commissioning of a qualified hydrogeologist to assess the impacts and advise on the appropriate mitigation or compensatory measures, the quarry operator would inform the NOW of the observed groundwater drawdown and commencement of investigations to identify the most appropriate mitigation and/or compensatory measures.
9. The results of the hydroegeological investigations would be forwarded to the affected land owner(s) and NOW nominating the mitigation or compensatory measures to be undertaken (see Section 10.1.3 for an overview of the potential mitigation or compensation measures that might be implemented). In the event that these are deemed satisfactory by the affected land owner(s) and NOW, the nominated measures would be commenced.
10. In the event that the nominated mitigation or compensatory measures are deemed unsatisfactory by the affected land owner(s) and/or NOW, the hydrogeologist would be asked to review the hydroegeological investigation to investigate alternative mitigation or compensation. Should there be no feasible alternative, or the alternative be deemed unsatisfactory again, the quarry operator would initiate the dispute resolution process as outlined by *Appendix 5* of PA 07_0155.

11.3 Mitigation and Compensation Measures

The following mitigation or compensation measures would be considered in the event that a quarry-related reduction in groundwater availability is identified in a bore or spring located off the quarry site and “Ardmore Park” property.

- Pumping rates from BHAP6 would be reduced (initially through reducing water provided for ongoing stock watering and if required through a reduced processing rate at the sand washing plant). Should this have no influence on the local groundwater table and therefore groundwater yields of surrounding bores, the quarry operator would consider one of the following measures.

- Improvements to pump infrastructure would be made to improve the rate of extraction from increased depths.
- The affected bore would be deepened and appropriate pump infrastructure installed to increase the saturated thickness of the bore.
- A replacement bore would be constructed to provide the measured and documented loss of groundwater with a quality commensurate or better.
- Groundwater would be supplied to the affected water user from the quarry operator's production bore (BHAP6) to the measured and documented loss and with a water quality commensurate or better.

As noted in Section 10.1.2, the actual mitigation or compensatory measure that would be nominated by a qualified hydrogeologist after a specific investigation of the affected water supply is made.

11.4 Continual Improvement

The quarry operator is committed to continually improving environmental performance at the quarry. Therefore, should an unforeseen impact on groundwater resources (or any other environmental parameter of the quarry site and surrounds) eventuate, the following protocol would be followed.

1. The impact(s) would be documented and additional monitoring/investigation commenced to quantify (if possible) the impact.
2. Relevant personnel of NOW 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 of NOW to visit the quarry and inspect the affected area(s) or quarry operation.
3. A qualified hydrogeologist (or other relevant professional) would be commissioned to review monitoring and any other available data related to the impact(s).
4. Appropriate resources would be provided to the qualified hydrogeologist (or other relevant professional) to allow for additional testing, analyses or investigations. The results of hydrogeological investigation would be made available to the NOW for review.
5. The advice of the qualified hydrogeologist would be sought and taken as to measures to prevent, mitigate or remediate the impact(s). If necessary, additional advice would be sought from a second hydrogeologist.
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.

12.0 REFERENCES

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Figures

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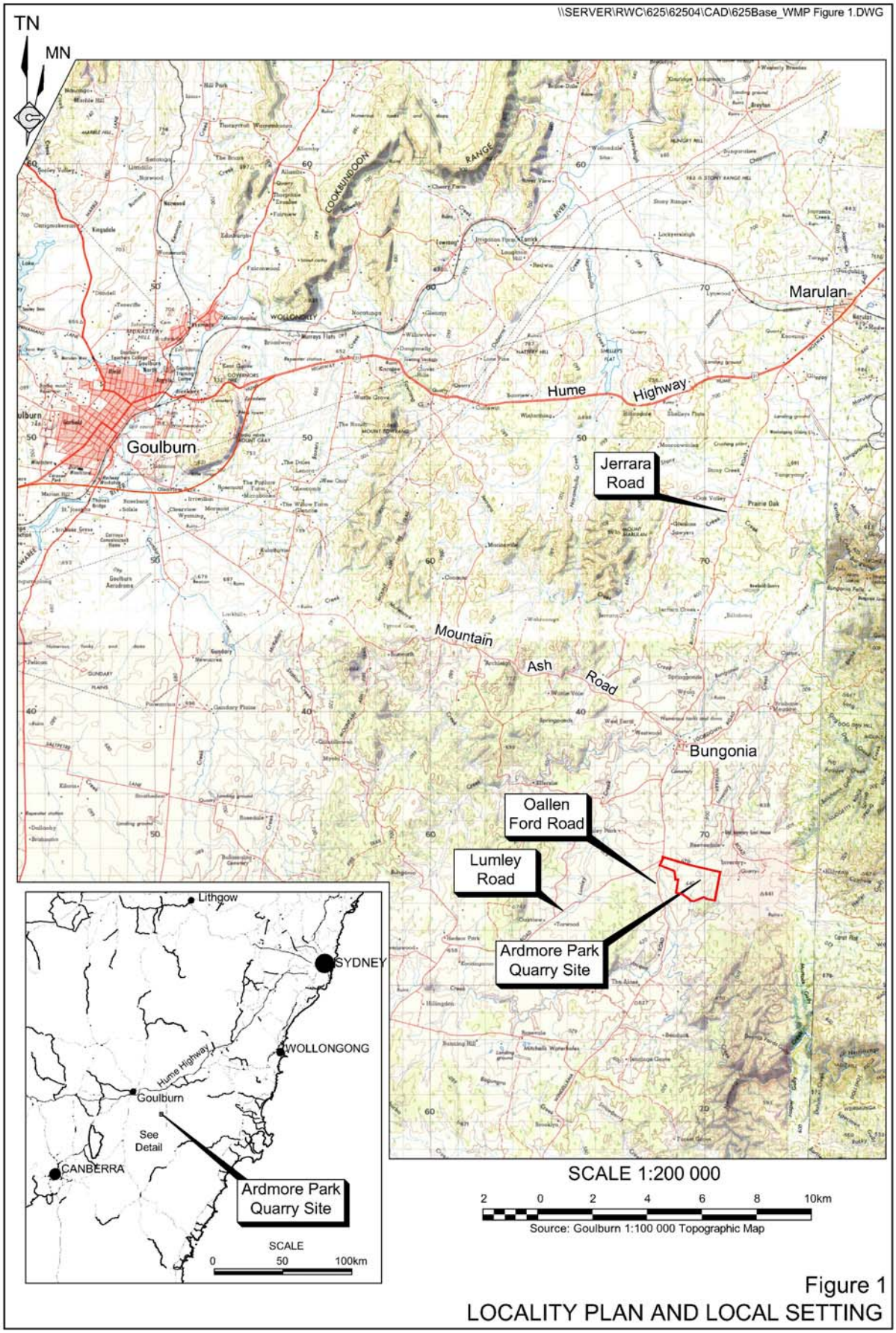


Figure 1
LOCALITY PLAN AND LOCAL SETTING

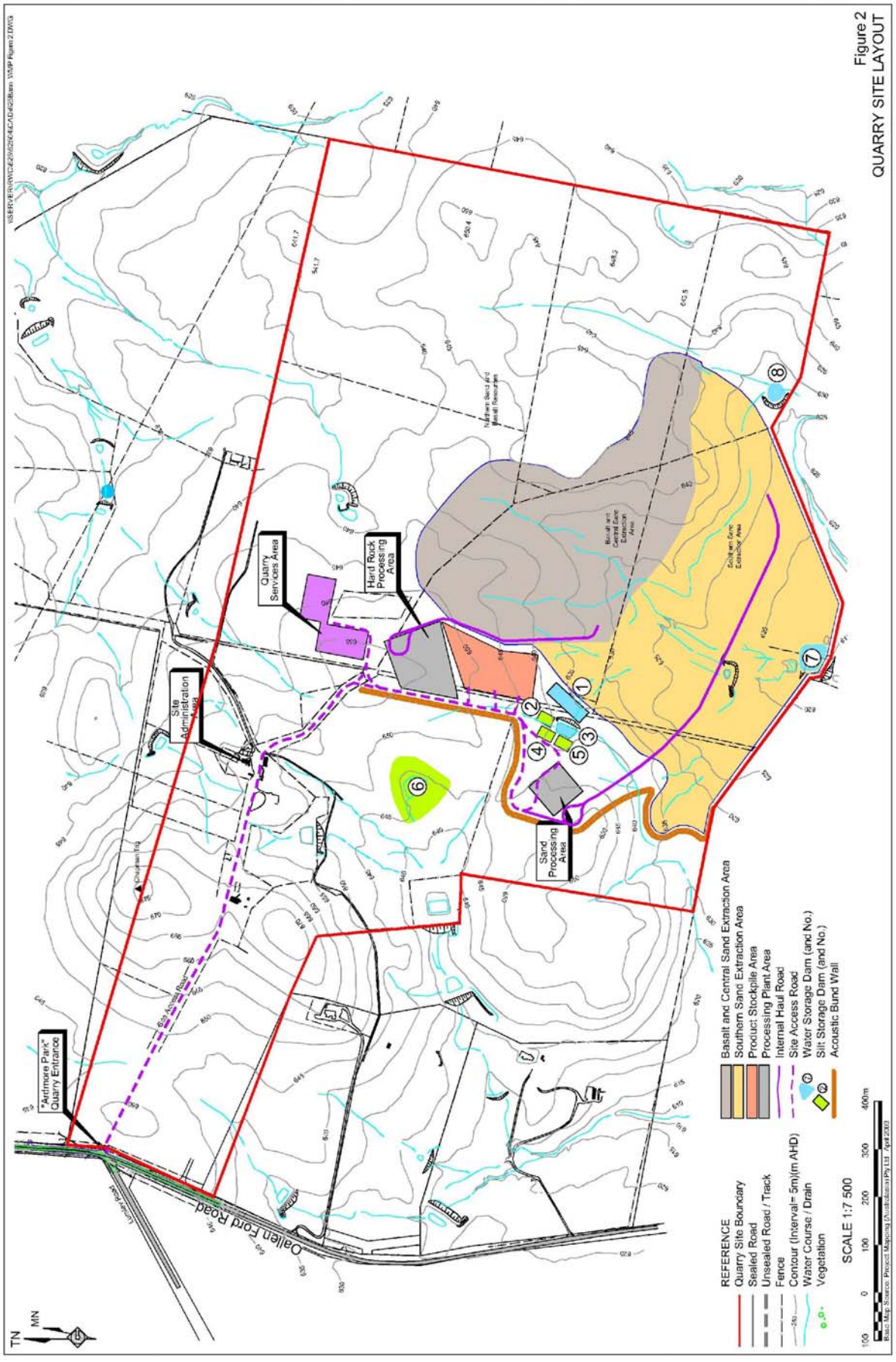
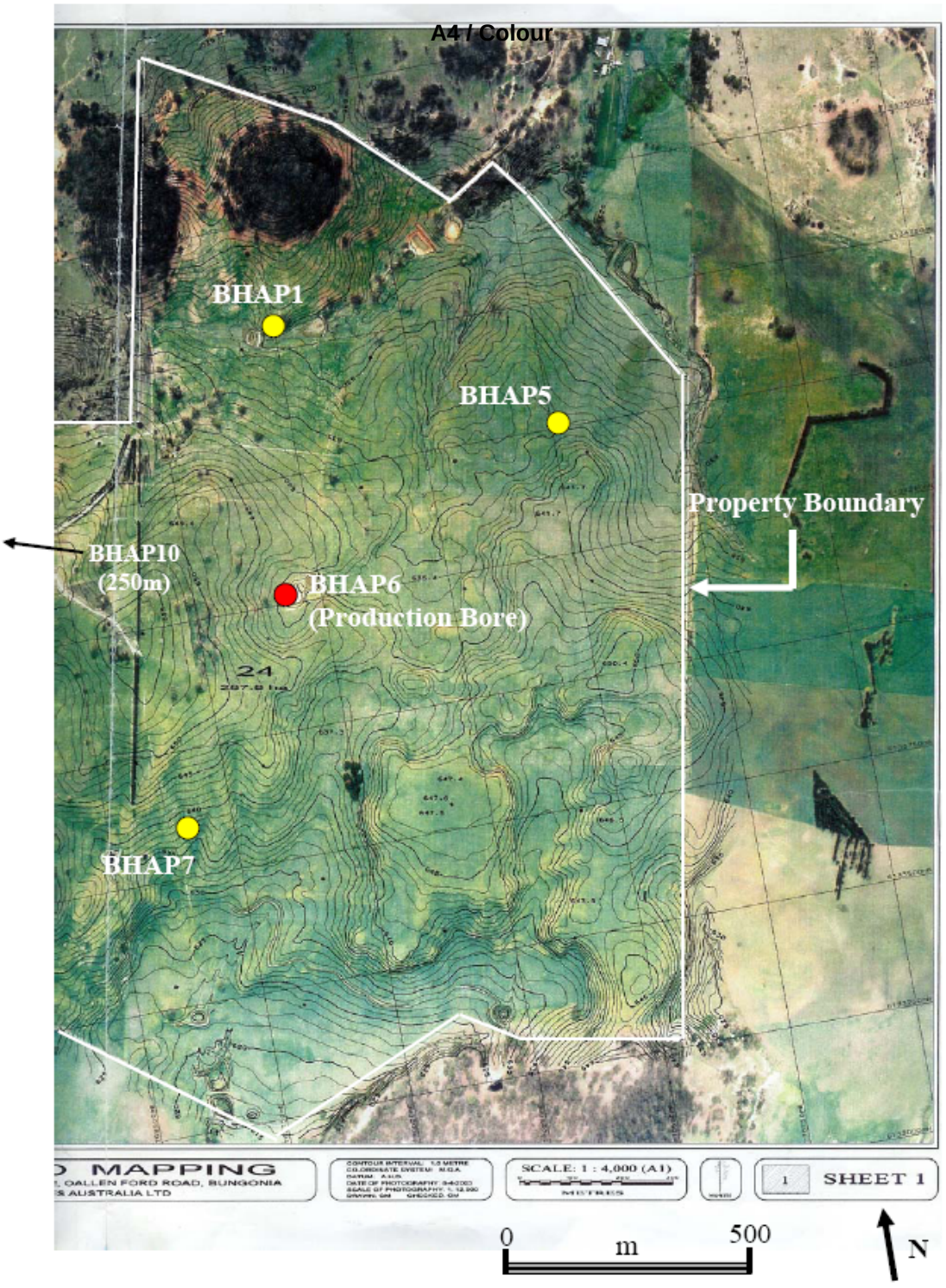
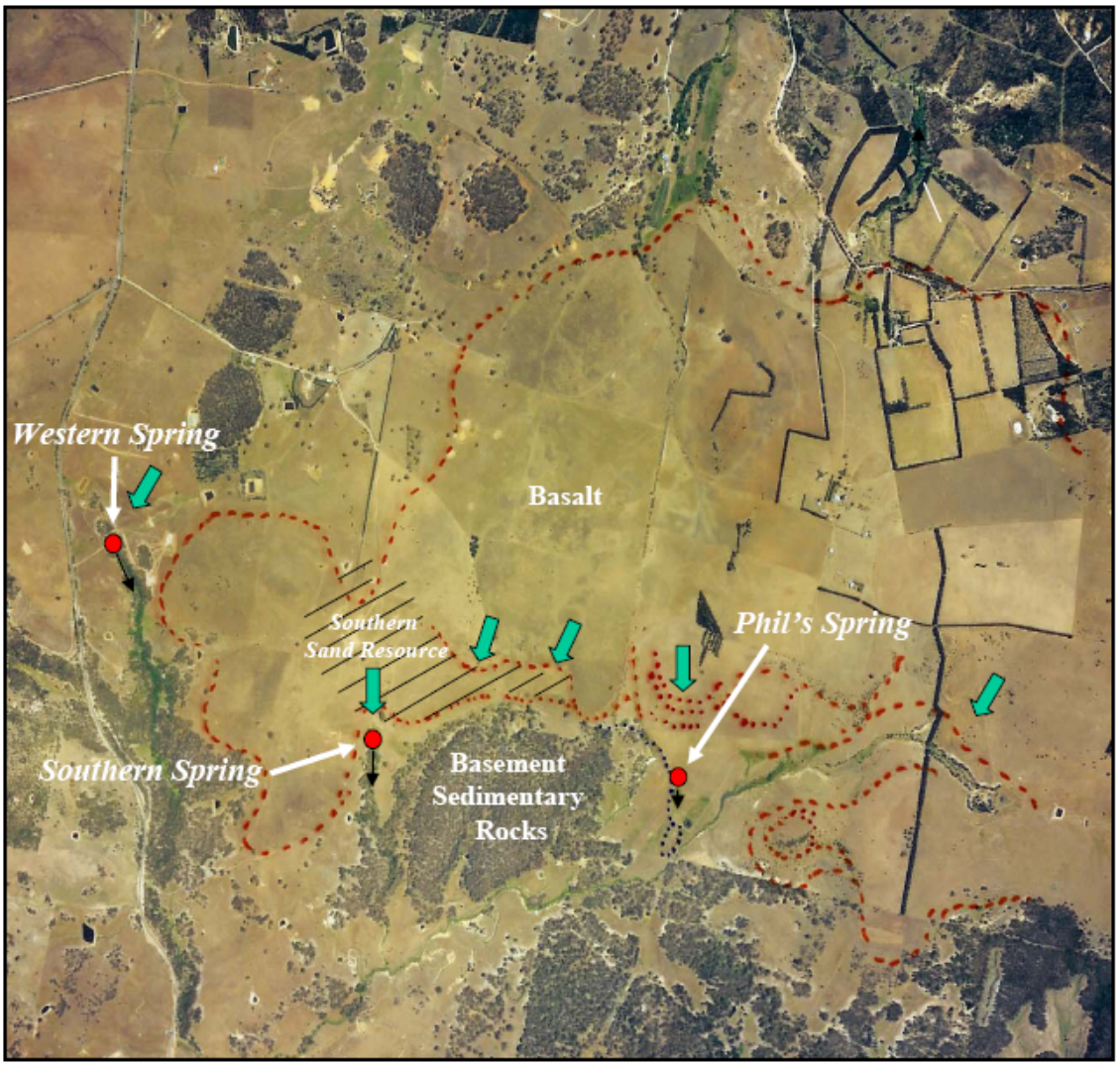


Figure 2
QUARRY SITE LAYOUT
"Ardmore Park" Quarry Entrance
Quarry Services Area
Hard Rock Processing Area
Site Administration Area
Sand Processing Area
Dallen Ford Road
TN
MN
REFERENCE
Quarry Site Boundary
Sealed Road
Unsealed Road / Track
Fence
Contour (Interval= 5m)(m AHD)
Water Course / Drain
Vegetation
Basalt and Central Sand Extraction Area
Southern Sand Extraction Area
Product Stockpile Area
Processing Plant Area
Internal Haul Road
Site Access Road
Water Storage Dam (and No.)
Silt Storage Dam (and No.)
Acoustic Bund Wall
SCALE 1:7 500
100 0 100 200 300 400m



Larry Cook & Associates PO Box 8146 Tumbi Umbi NSW 2261 Phone: 02 4385 6084	**Groundwater Monitoring Program** **Ardmore Park Project**	Scale: As shown
	Figure 3 **Location of Hard Rock Production and Observation Bores**	



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Groundwater Monitoring Program
Ardmore Park Project

Scale: As shown

Figure 4
Location of Sand Monitoring Bores, Phil's Spring, Southern Spring and Western Spring (on Aerial Photo)

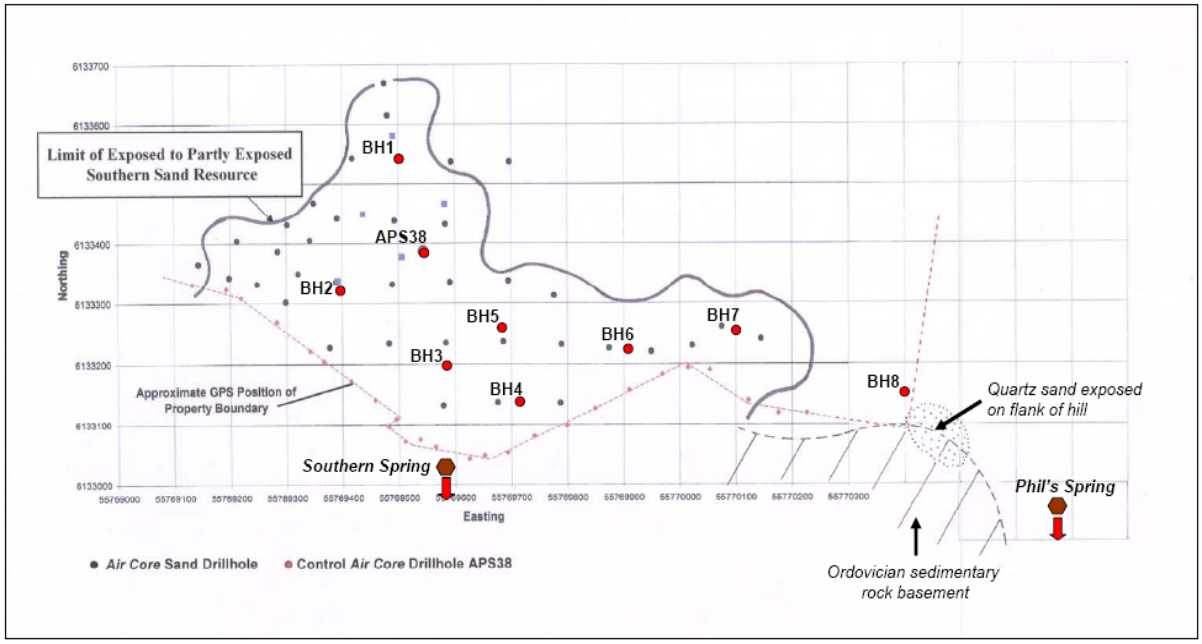

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Figure 5
Location of Sand Monitoring Bores, Phil's Spring and Southern Spring

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APPENDICES

(No. of pages excluding this page = 57)

Appendix 1.1: Soil and Water Management Plan

Appendix 1.2: Site Audit Checklist

Appendix 1.3: Initial base line water quality data and proposed initial trigger levels

Appendix 2.1: Groundwater Monitoring Program – Operational Guide

Appendix 2.2: Baseline Bore flow data – Production Bore BHAP6

Appendix 2.3: Baseline Water Level Measurements - Production Bore BHAP6 and Hard Rock Observation Bores

Appendix 2.4: Baseline Water Quality Measurements – BHAP6 and BHAP10

Appendix 2.5: Baseline Water Level Measurements – Sand-hosted Observation Bores

Appendix 2.6: Baseline Water Quality Measurements – BH2-BH6, AP38 and Phil's Spring

Appendix 2.7: Statistical Analysis Methodology

Please note colour versions of these Appendices can be viewed on the CD found on the inside back cover of this document.

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Appendix 1.1

Soil and Water Management Plan

(No. of pages excluding this page = 5)

NB. The Soil and Water Management Plan comprises five A1 scale drawings. For the Purpose of this document, the drawings are printed as A3 pages.

When printing these drawings, please note the scale at which these are prepared.

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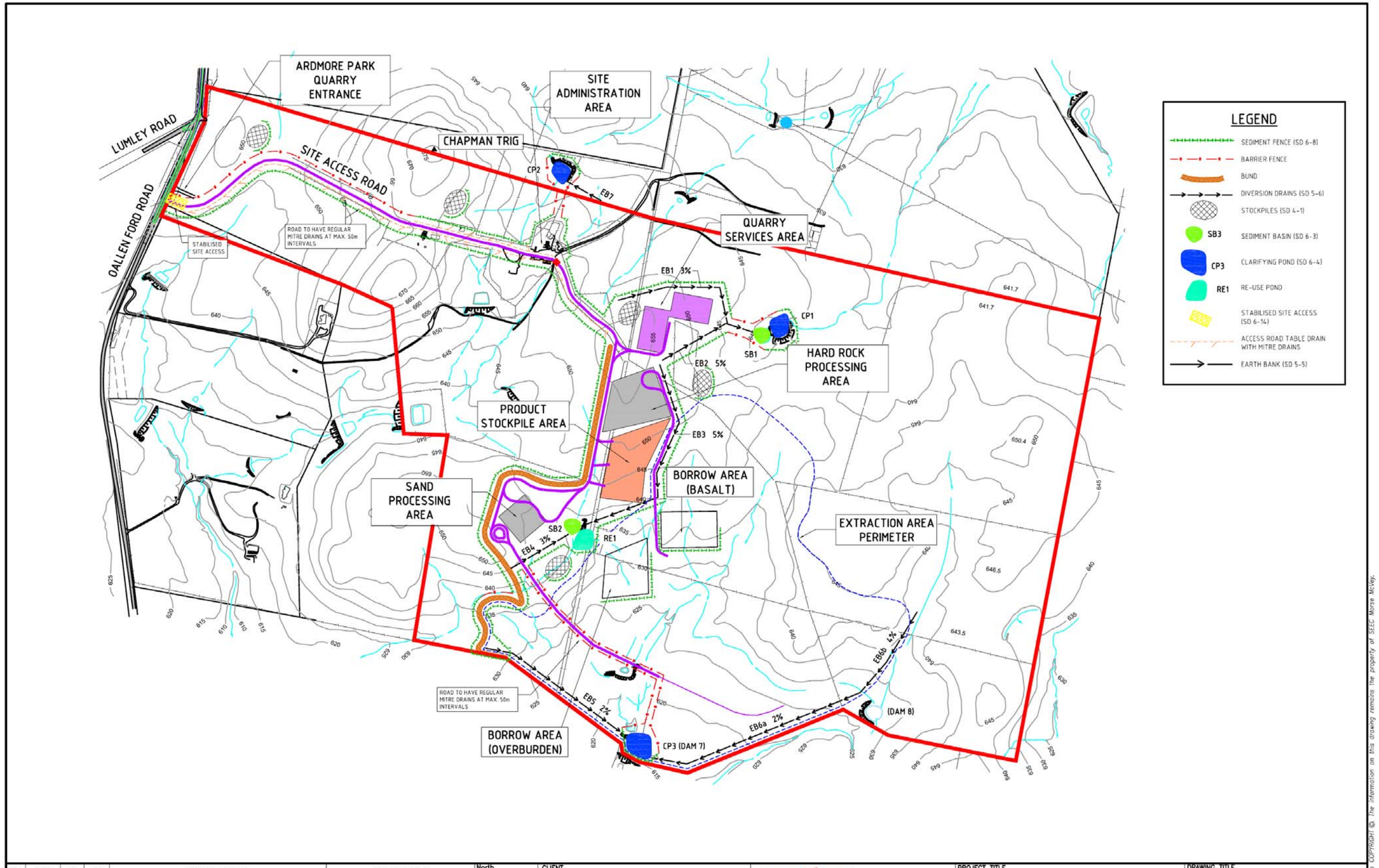

REV	DATE	BY	APP.	REVISION DETAILS

DRAWING STATUS

DESIGN BY	M.P.	01/10
DRAWN BY	A.J.B.	01/10
FINAL APPROVAL	M.P.	01/11

SCALE: (on A1 Original) 1 : 4000

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PROJECT TITLE: ADMORE PARK QUARRY

DRAWING TITLE: SOIL & WATER MANAGEMENT PLAN ESTABLISHMENT PHASE

PROJECT NO.	SHEET NO.	REV
09000271	SWMP01	

Plot Date: Friday, 14 January 2011 9:05:38 AM CAD File Name: Q:\09000271 Ardmore Park Hard Rock and Sand Quarry\Drawings\09000271.dwg

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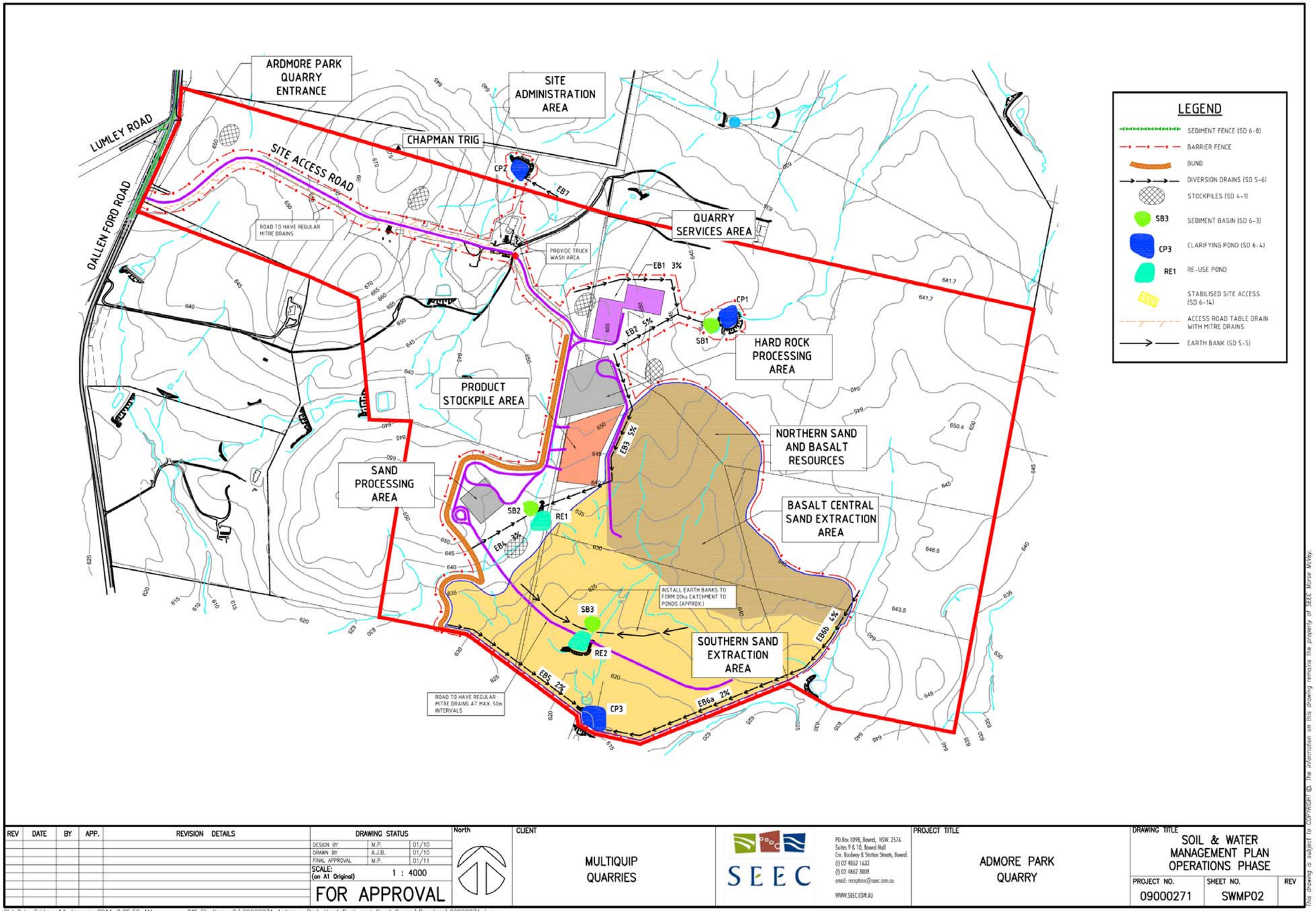

REV	DATE	BY	APP.	REVISION DETAILS

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PROJECT TITLE: ADMORE PARK QUARRY

DRAWING TITLE: SOIL & WATER MANAGEMENT PLAN OPERATIONS PHASE

PROJECT NO.	SHEET NO.	REV
09000271	SWMP02	

Plot Date: Friday, 14 January 2011 9:05:59 AM CAD File Name: Q:\09000271 Ardmore Park Hard Rock and Sand Quarry\Drawings\09000271.dwg

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GENERAL NOTES

- This plan is to be read in conjunction with the accompanying Water Management Plan (WMP) report by SEEC, Larry Cook & Associates and R.W. Corkery & Co. Pty Limited.
- All water management structures (i.e. erosion and sediment control structures, table drains and pipes) are to remain in place and be maintained for the duration of the quarry unless otherwise instructed. This includes all structures and measures set up for the establishment phase.

STAGING

Works are to proceed in the following order:
1. Install erosion and sediment control measures for the establishment phase (Refer to drawing number 09000271-SWMP-01).
2. Establish the site.
3. Install erosion and sediment control measures for the extraction phase (Refer to drawing number 09000271-SWMP-02).
4. Commence extraction works.
5. Adapt the SWMP as extraction proceeds and rehabilitate quarried lands.

ESTABLISHMENT PHASE

1. Before commencement of earthworks, the site is to be secured and the following erosion and sediment control measures installed in order:
2. Establish a stabilised site access (Standard Drawing SD 6-14 on Drawing 09000271-SWMP04) in the location shown (Drawing 09000271-SWMP01) and anywhere where construction vehicles enter a works area from a bitumen road.
3. Establish a site office, toilet and parking area (most likely this will be the administration buildings).
4. Establish sediment fencing in the locations shown (Drawing 09000271-SWMP01) and following Standard Drawing SD 6-8 in drawing 09000271-SWMP04.
5. Establish barrier fencing in the locations shown (Drawing 09000271-SWMP01) to delineate the edge of the works area (Refer to the Barrier Fencing notes).
6. Construct Sediment Basins SB1 to SB2, Reuse Pond RE1 and Clarifying Ponds CP1 to CP3 as shown on 09000271-SWMP01 and to the engineering drawings. Rehabilitate the disturbed lands as per Table 1.
7. Construct table drains/diversion drains EB1 to EB7 as shown on drawing number 09000271-SWMP01 and in accordance with Table 3. Ensure they drain to their respective sediment basins, reuse ponds or clarifying ponds.
8. Stabilise table drains and batters using kikuyu grass or rock lining as shown on drawing 09000271- SWMP01. Install temporary check dams at every 80 m (SD 4-5).
9. Install the truck-wash facility.
10. Install the weather station.
11. Once all of the above measures are complete and stable, construction works for the quarry's establishment may begin in accordance with the engineering plans.

- Strip the topsoil from the access road and hardstand areas.
- Strip when soils are moist (not dry or wet).
- Stockpiles are to be located and sized according to SD 4-1 (drawing 09000271-WMP03).
- As works progress, ensure ongoing rehabilitation as per Table 1.
- Ensure all dirty water drains to the relevant sediment basin/re-use ponds. Instigate the monitoring programs for all clarifying ponds.
- Local materials will be sourced for the establishment phase (e.g. rock pitching in EB3 and EB6, quarry road pavement).
- Once all infrastructure works have finished, and all ground surfaces, table drains and batters are stabilised (in accordance with Table 1), the following erosion and sediment control measures for the establishment phase can be removed:

– Sediment fencing. Possibly to be replaced with barrier fencing (see drawing 09000271-SWMP02); and
– Check dams.

- (NOTE: EB1 to EB7, the table drains, batters, culverts/pipes and any energy dissipaters are permanent fixtures and will remain in place after site establishment.
- Before commencement of quarry extractions, the site will be inspected by a Certified professional in Erosion and Sediment Control (CPESC) to ensure all soil and water management structures are in place and operational.

QUARRY OPERATION PHASE

- Begin extraction. Ensure all dirty water from the extraction area drains to SB3 and thence RE2 and thence CP3. Note the position of SB3 and RE2 will move over time as the extraction proceeds. There could also be more than one sediment basin and reuse pond system in the extraction area.
- Ensure all water from the processing and service areas drains to the respective sediment basins and storages.
- Continue to monitor and flocculate the clarifying ponds (Section 4.12.3 of the WMP).
- Ensure all monitoring and maintenance procedures are instigated and adhered to.

WATER DISTRIBUTION

- Water will be drawn from the reuse ponds and the clarifying ponds for dust suppression (preferentially from RE1 and RE2) and for sand processing.
- The maximum permissible volumes per day are given in Table 2 (refer also to the WMP).
- All water drawn will be metered daily and records kept by the site manager.
- Water for sand processing will be supplemented by bore water.
- Processed sand will be stockpiled and allowed to drain, with the drained water directed to SB2 and thence RE1.

SEDIMENT BASINS

- SB1 to SB3 are sediment basins designed to trap the coarse fraction. They have two components to their volume:

– a settling volume; and
– a sediment storage volume.

- A marker will be installed in each basin to identify when the sediment storage capacity is reached. When it is, the basin will be cleaned with trapped sediment either sold or used for rehabilitation.
- The sediment basins will conform to SD 6-3 (Drawing 09000271-SWMP04.

CLARIFYING PONDS

- CP1, CP2 and CP3 are combined clarification and re-use ponds. They will conform to SD 6-4 and their total volume is made up of three components:

– A temporary volume sufficient to trap the 95th percentile, 5-day rainfall depth (41 mm);
– A permanent volume dedicated to reuse; and
– A volume dedicated to sediment storage.

- Markers will be installed in each pond to identify the various levels of each volume, EXCEPT during, and for a maximum of five days after, a rainfall event the top water level must not exceed the combined level of the reuse and sediment storage volumes.
- If the water level rises above the top of the combined sediment storage and reuse volume, the pond will be flocculated and the water level reduced (by pumping) until it reaches that level.

– Flocculation is to be achieved by using gypsum or other approved flocculant at prescribed rates, to achieve 50mg/L or less of suspended sediment.
– Flocculation may be done by either manual or automatic dosing. Refer to Appendix E, Landcom, 2004, for more details. Automatic dosing might be more practicable for CP3 as it is large.
– If applied manually, it is essential that the flocculating agent is spread evenly over the entire pond surface.
– Do not exceed manufacturer's recommended dosing rates or, if using gypsum, apply it at the rate of (initially) 30 kg per 100 m3 , perhaps slightly more if necessary. Remember to include the reuse volume in the calculations.

- Twice per year the clarifying ponds will be emptied and the trapped sediment removed for use in rehabilitation.
- Water will be drawn from each clarifying pond in preference to using bore water, subject to not exceeding the permissible volumes given in Table 2.

REUSE PONDS

- RE1 and RE2 are reuse ponds from which water will drawn for dust suppression and, if suitable, for sand processing. They have two components to their volume:

– a storage volume; and
– a sediment storage volume.

- A marker will be installed in each basin to identify when the sediment storage capacity is reached. When it is the basin will be cleaned, with trapped sediment used for rehabilitation.
- Flocculation is not required in these ponds, as they ultimately drain to CP3.

BARRIER FENCING

- Barrier fencing can simply be made from tape wound around star pickets or stakes. Alternatively, sediment fence or chain wire fences can be used for this purpose if so desired.
- Barrier and sediment fencing is to be used to ensure that all vehicles entering and leaving the site pass over a stable access point to minimise bogginess in these areas and minimise sediment tracking onto public roads.
- Barrier fencing is to be used at the discretion of the site manager to delineate 'no go' areas.

CONTAINMENT BUNDS

- Bunds are to be provided around fuel, oil and chemical storage areas. The bunds will:

– Have walls and floors constructed of impervious materials;
– Have floors graded to a collection sump;
– Not have a drain valve incorporated into the bund structure;
– Have walls not less than 250mm high;
– Be of sufficient capacity to contain 110% of the volume of the largest tank that is installed.

- Maintenance on mobile plant and equipment must be conducted within a hardstand bunded area.
- Drainage from any vehicle servicing and workshop areas must be treated by a wastewater treatment facility with an oil separator and sediment trap.

DUST SUPPRESSION

- The access road, haul roads and hardstands will require dust suppression. Water will be sourced from RE1 and RE2, then CP1 to CP3 in preference to the bore.
- The application rate for the access road and truck turning area is estimated at 2mm per non-rainy day, however application rates will be dependent on weather, temperature, vehicle movements and surface infiltration rates. The site manager will adjust application rates as necessary.

EROSION CONTROL

- Ground cover fundamentally affects erosion.
- Any areas of bare soil that will be not be re-worked within 20 days, but will be re-worked with 60 days, will have sufficient material (textile, mulch, hydro mulch, chemical stabiliser etc.) placed on them to provide at least 50 percent ground cover (i.e. a C-Factor of 0.1). Refer to Table A3 in Landcom, 2004.
- Any areas of bare soil that will be not be re-worked within 60 days will have sufficient ground cover (vegetation, textile, mulch, hydro mulch etc.) to provide at least 70 percent ground cover (i.e. a C-Factor of 0.05) and that cover must be able to last indefinitely. Refer to Table A3 in Landcom, 2004.
- All concentrated flow channels will have at least 70 percent ground cover that is stable in the 120 year ARI storm design flow. Whatever channel lining material is adopted it must have a suitable design life. Refer to Table 3 and Table D1 in Landcom, 2004.
- The soil erosion hazard on the site will be kept as low as practicable by minimising unnecessary land disturbance:

– Do not open up new quarry areas early;
– Rehabilitate previously quarried land promptly; and
– Look for any areas around the site that can be rehabilitated.

- Stockpiles are to be stabilised as per Drawing SD 4-1 (Drawing 09000271-SWMP04).
- Concentrated flow outlets are to be stabilised in accordance with the engineering drawings, refer also to SD 5-8 (Drawing 09000271-SWMP03).
- Rehabilitation will be progressive as the quarry expands. After sufficient silt and/or overburden has been placed to provide the final landform:

– Prepared the filled surface by loosening it (SD7-1)
– Place topsoil at 75 mm thickness, 50 mm if slope exceeds 4:1 (SD4-2)
– Incorporate any ameliorants necessary to ensure good growth.
– Seed the surface as per the rehabilitation plan. Incorporate sterile crops such as oats and/or Japanese Millet to quickly form a good ground cover until native species grow.
– Sow when ground moisture is sufficient; irrigate using bore water if required.
– Keep traffic off rehabilitated areas.

- Intermediate benching will be used to reduce slope lengths and hence erosion potential. The benches will slope back to the face at about 1 percent. Drains will collect runoff and convey it safely down the slope per the engineering drawings.

SELF-AUDITING PROGRAM

A self-auditing program will be initiated for the site. The site manager is to inspect the site at least monthly and maintain a written log of inspections, paying particular attention to:
- Ensuring the stability of the storages.
- Ensuring barrier fencing is maintained and exclusion zones are being observed by all workers and contractors.
- Constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved.
- Maintaining erosion and sediment control measures in their functioning condition for the duration of the excavation works.
- Removing trapped sediment and disposal to safe areas (silt emplacements).
- Identifying areas of localised soil erosion and taking appropriate preventative measures. These might include:

– Planting additional stabilising vegetation or wind breaks;
– Stabilising soils with mulches or alternative soil binders;
– Taking steps to minimise any unnecessary concentrated stormwater flow; and
– Installing formalised drainage channels or pipes.

- Ensuring all fuels and chemicals are stored appropriately and that any spill kits are maintained.
- Ensuring any waste materials (such as rocks and debris) are to be removed from any publically trafficked road surface as soon as possible. This includes ensuring the truck-wash is operational.
- Ensuring waste receptacles are emptied as necessary. Disposal of waste must be in a manner approved by the site superintendent.
- Ensuring records of water usage, rainfall, water quality and auditing are being kept.

WATER QUALITY MONITORING

- An automatic rain gauge capable of measuring rainfall intensity will be installed at the site compound. A daily record of rainfall events will be kept.
- Suspended solids and pH will be measured in all clarifying ponds after flocculation and prior to release. Results will be kept on file.
- More detailed water quality testing is to be undertaken yearly by a suitable qualified consultant. Samples are to be taken from CP3 after flocculation. The results will be compared to baseline data provided in the WMP and a report submitted to DWE. Refer to the WMP for more details.
- If necessary the consultant will investigate reasons for deterioration in water quality, in association with DWE.

TABLE 1 MAXIMUM ACCEPTABLE C-FACTORS AT NOMINATED TIMES DURING WORKS

LANDS	MAXIMUM C-FACTOR	REMARKS
Waterways and other areas subjected to concentrated flows (e.g. table drains), post construction and during operation	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows will be limited to those shown in Table 5.2 of Landcom (2004). Foot and vehicular traffic will be prohibited in these areas
Stockpiles and batters, post construction and during operation	0.10	Applies after ten working days from completion of formation. Maximum C-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction and operation	0.15	Applies after 20 working days of inactivity, even though works might continue later. Maximum C-factor of 0.15 equals 50% ground cover
All lands, including waterways and stockpiles during construction and operation	0.05	Applies after 60 working days of inactivity. Maximum C-factor of 0.05 equals 70% ground cover

TABLE 2 DESIGN CAPACITIES AND REUSE FOR PROPOSED STORAGES

Storage Identification	Water Quality Volume	Re-use Storage Volume	Sediment Storage Volume[1]	Total Volume	Maximum Re-use Per day.	Predicted Supply Confidence		
						Dry	Mean	Wet
SB1	235 m^3	0	75 m^3	310 m^3	0	-	-	-
SB2	610 m^3	0	300 m^3	910 m^3	0	-	-	-
SB3	1100 m^3	0	300 m^3	1,400 m^3	0	-	-	-
CP1	750 m^3	750 m^3	75 m^3	1,575 m^3	14 kL	75%	86%	100%
RE1	0	2,500 m^3	300 m^3	2,800 m^3	28 kL plus 10 kL to 72 kL[2]	93%	100%	100%
RE 2	0	4,300 m^3	300 m^3	4,600 m^3	56 kL	85%	95%	95%
CP2	1,500 m^3	1,500 m^3	50 m^3	3,050 m^3	14 kL	75%	86%	100%
CP 3 (Dam 7)	12,400 m^3	8,000 m^3	600 m^3	21,000 m^3	75 kL[2]	66%	82%	90%
Total volume - harvestable right	Exempt	17 ML	-	-	-	-	-	-
Total permitted re-use per day	-	-	-	-	187 kL (approx 67.5 ML/y) Plus 10kL to 72kL[2]	77% (52 ML)	89% (60 ML)	95% (64.5 ML)

TABLE 3
DIVERSION DRAIN SIZING AND LINING CHARACTERISTICS

Drain	Base Width (m)	Drain Slope (%)	Side Slopes (V:H)	Drain Depth (m)	Suggested Base Material
EB1	1.00	3	3 : 1	0.5	Grass lined (or equivalent)
EB2	1.00	5	3 : 1	0.5	Grass lined (or equivalent)
EB3	2.00	5	3 : 1	0.5	Rock pitched. 300mm rocks on geotextile
EB4	2.50	3	3 : 1	0.5	Grass lined (or equivalent)
EB5	1.00	2	3 : 1	0.5	Grass lined (or equivalent)
EB6a	2.00	2	3 : 1	0.5	Rock pitched. 300mm rocks on geotextile
EB6b	1.00	4	3 : 1	0.5	Grass lined (or equivalent)
EB7	1.00	1	3 : 1	0.5	Grass lined (or equivalent)

Mitre drain construction (Figure 1)

A mitre drain conveys runoff from the track to a disposal area away from the alignment. They keep the flow to a non-erosive velocity by reducing the length of run and the potential flow velocity. Flow is diverted to a stable surface. Mitre drains are a simple low-cost drainage option that do not cause any impediment to vehicles.

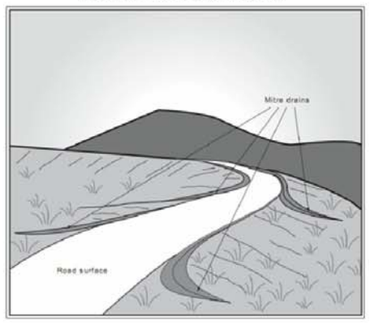
- Determine the length of the drain on-site as this will depend on the location of an appropriate outlet point.
- Position the discharge site so that water does not re-enter the road from another drainage line.
- Excavate to a depth of no more than 300 mm. A deep excavated channel is not necessary, as the runoff should flow freely into the drain and be directed into roadside vegetation.
- Ensure that the runoff will enter (not bypass) the mitre drain from the table drain. It may be necessary to 'dish' the mitre drain entrance to encourage water to flow, or construct a cross bank to direct flows.
- Construct the sump (sediment trap) at the spoon drain outlet.

Mitre Drain Maintenance

- Mitre drains will be inspected to ensure they have adequate capacity and are not eroding or causing erosion.
- Sediment build-up (more than 30%) will be removed to ensure that the drain has adequate capacity to prevent runoff overtopping or bypassing.
- Water bypassing mitre drains has the potential to cause track erosion and increases the likelihood of failure in the next drainage structure. Where mitre drains are eroding, it might be necessary to install further mitre drains, reduce their grade or, where this is not possible, to reinforce existing drains using rock and geotextile.
- Sometimes after grading operations the pavement can become lower than the inlet of mitre drains. It is important after grading that mitre drains are reopened (deepened if necessary) and cleared of any windrowed soil.
- It might be necessary to resurface a track when the mitre drains no longer function. Windrowed material can be reused on the track surface by regrading it towards the centre of the road.

Aknowledgement:
This information regarding mitre drains is drawn from DECC, 2008. Managing Urban Stormwater Soils and Construction, Volume 2C – Unsealed Roads

FIGURE 1 – MITRE DRAIN DETAIL



REV	DATE	BY	APP.	REVISION DETAILS

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PROJECT TITLE: ADMORE PARK QUARRY

DRAWING TITLE: SOIL & WATER MANAGEMENT PLAN NOTES

PROJECT NO.	SHEET NO.	REV
09000271	SWMP03	

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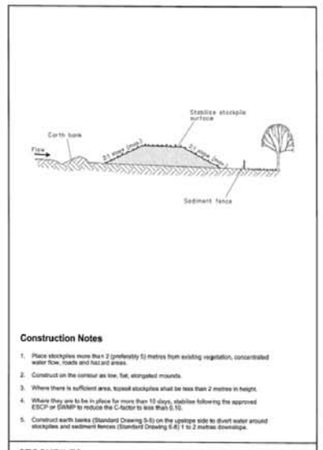
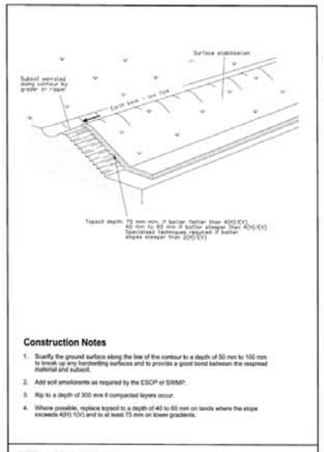


Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and haul and areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6.4) 1 to 2 metres downslope.

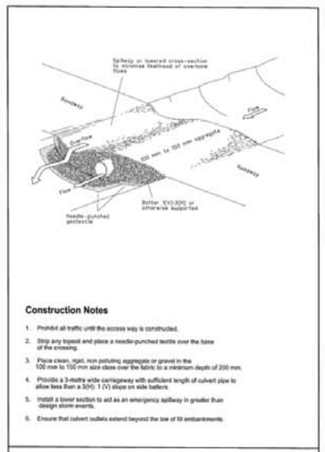
STOCKPILES SD 4-1



Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

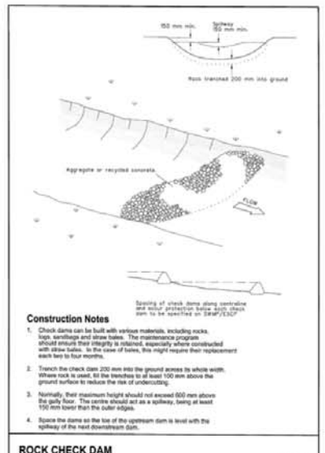
REPLACING TOPSOIL SD 4-2



Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H):1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

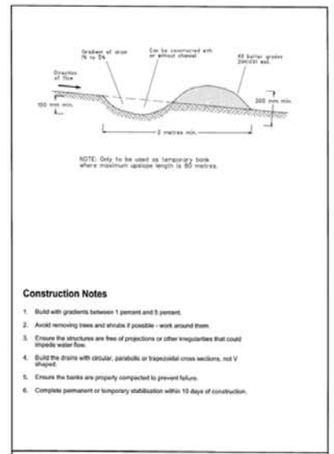
TEMPORARY WATERWAY CROSSING SD 5-1



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

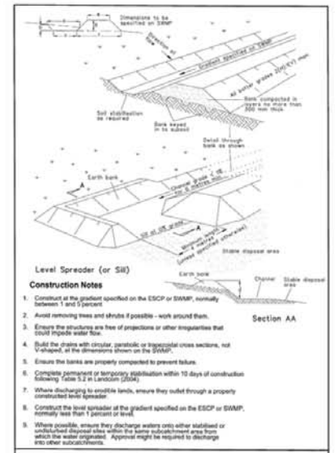
ROCK CHECK DAM SD 5-4



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.

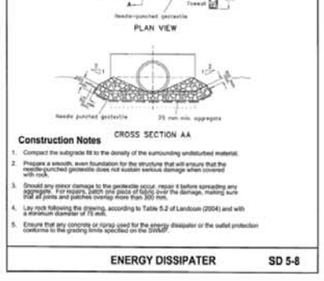
EARTH BANK (LOW FLOW) SD 5-5



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

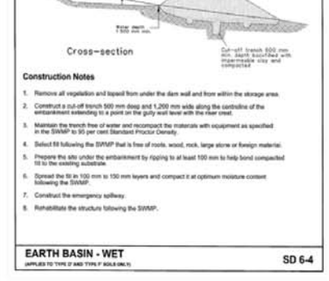
1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipator or the outlet protection conforms to the grading limits specified on the SWMP.

ENERGY DISSIPATER SD 5-8

Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Form a cut-off trench under the centreline of the embankment 600 mm deep and 1,200 mm wide, extending to a point on the watercourse wall above the riser crest level.
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 according to the SWMP that is free from rocks, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond the 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. Install the pipe outlet with seepage collars as specified in the SWMP and Standard Drawing 6-3b.
8. Form batter grades at 2(H):1(V) upstream and 3(H):1(V) downstream or as specified in the SWMP.

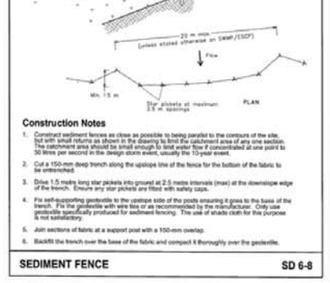
EARTH BASIN - DRY (APPLIES TO TYPE C SOILS ONLY) SD 6-3



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 as 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



Construction Notes

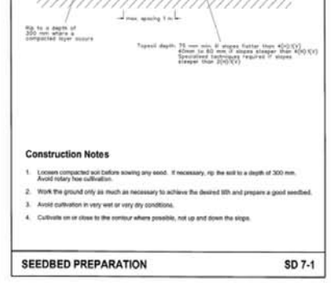
1. Construct sediment fences as close as possible to being parallel to the contours of the site, so that long sections of fence do not run steeply downhill. The catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE SD 6-8

Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence.

STABILISED SITE ACCESS SD 6-14



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION SD 7-1

REV	DATE	BY	APP.	REVISION DETAILS

DRAWING STATUS

DESIGN BY	M.P.	01/10
DRAWN BY	A.J.B.	01/10
FINAL APPROVAL	M.P.	01/11

SCALE: (on A1 Original) 1 : 4000

FOR APPROVAL

North

CLIENT: MULTIQUIP QUARRIES

SEEC

P.O.Box 1098, Bowral, NSW. 2576
Suites 9 & 10, Bowral Mall
Cnr. Bowlaway & Station Streets, Bowral.
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PROJECT TITLE: ADMORE PARK QUARRY

DRAWING TITLE: STANDARD DETAILS

PROJECT NO. 09000271 | SHEET NO. SWMP04 | REV

Plot Date: Friday, 14 January 2011 9:07:05 AM CAD File Name: Q:\09000271 Ardmore Park Hard Rock and Sand Quarry\Drawings\09000271.dwg

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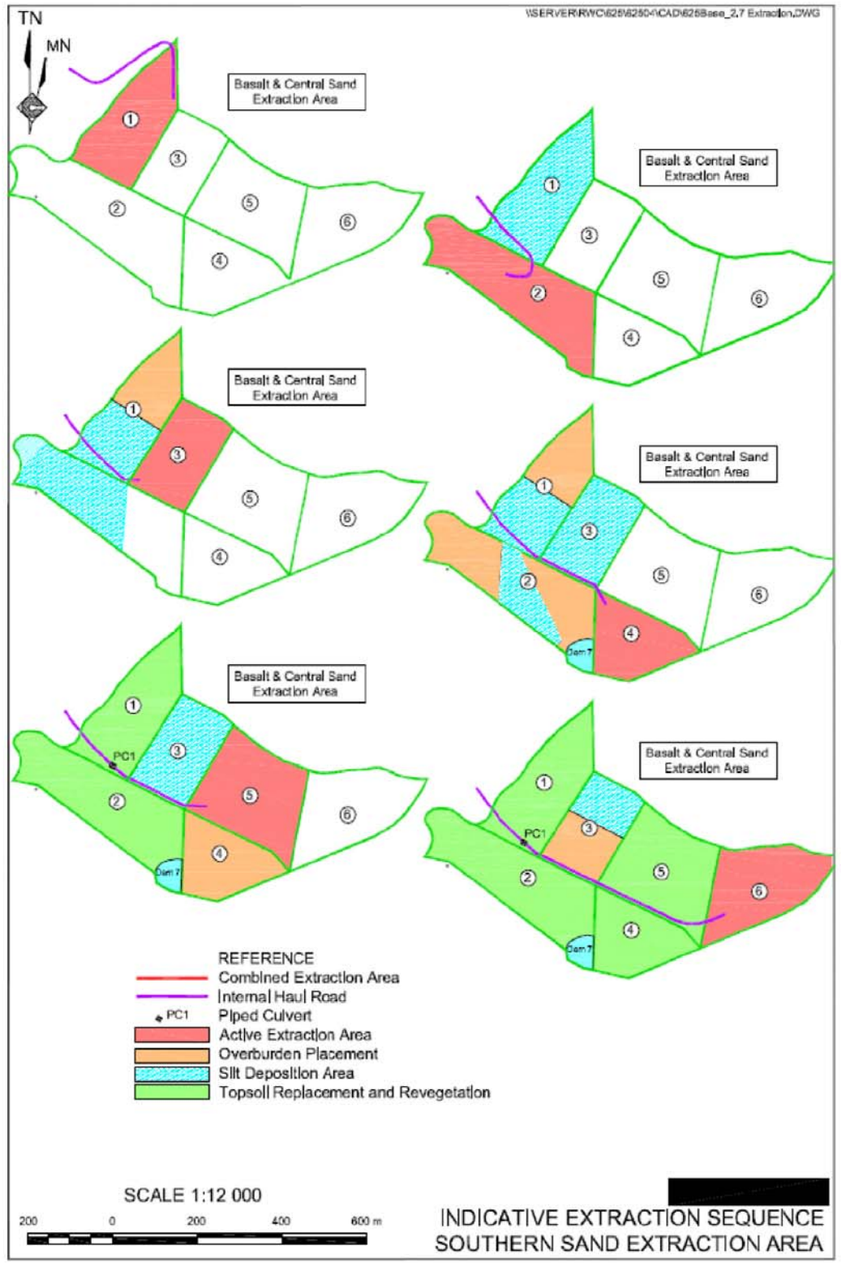

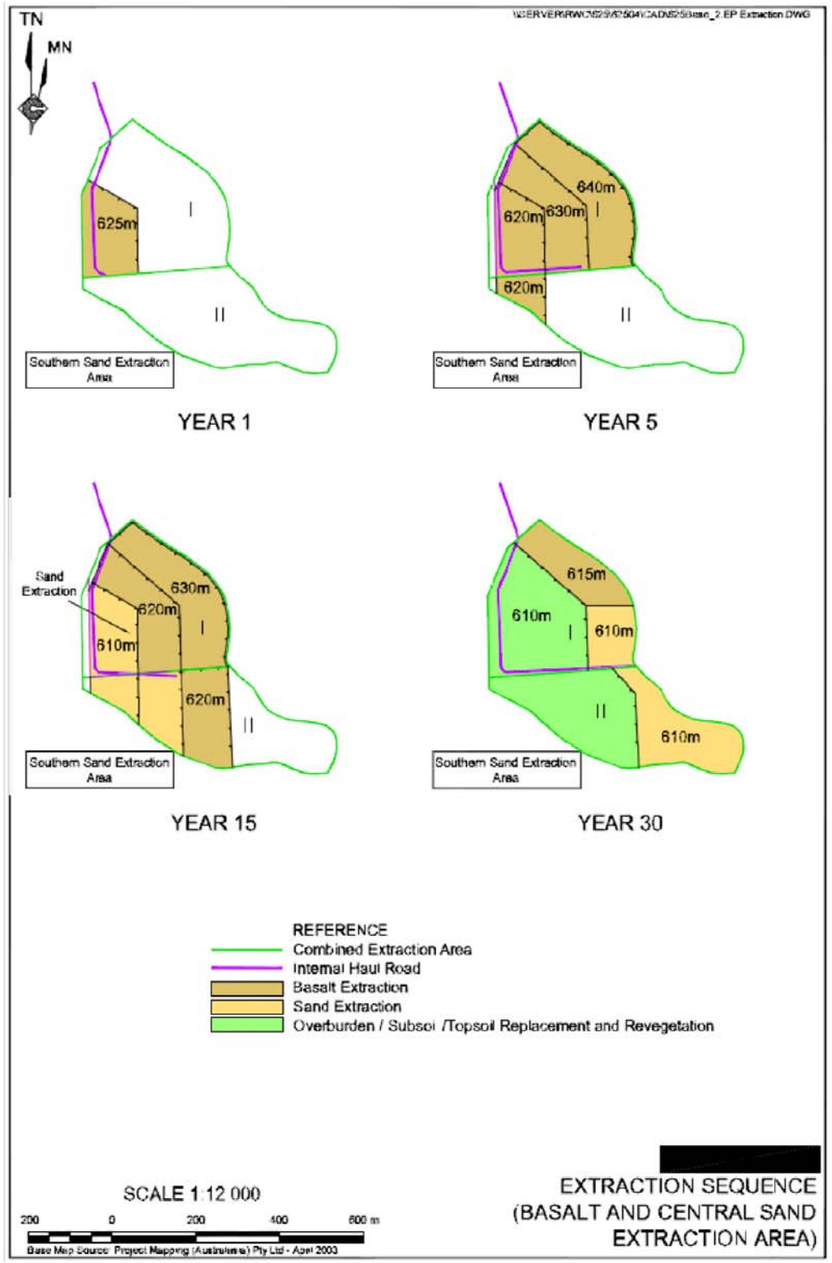

REFERENCE: ENVIRONMENTAL ASSESSMENT FOR THE MODIFIED ARDMORE PARK QUARRY PROJECT, RW CORKERY JULY 2008

REV	DATE	BY	APP.	REVISION DETAILS

DRAWING STATUS

DESIGN BY	M.P.	01/10
DRAWN BY	A.J.B.	01/10
FINAL APPROVAL	M.P.	01/11

SCALE: (on A1 Original) 1 : 4000

FOR APPROVAL

North

CLIENT: MULTIQUIP QUARRIES

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PROJECT TITLE: ADMORE PARK QUARRY

DRAWING TITLE: PROPOSED STAGING

PROJECT NO.	SHEET NO.	REV
09000271	SWMP05	

Plot Date: Friday, 14 January 2011 9:10:18 AM CAD File Name: Q:\09000271 Ardmore Park Hard Rock and Sand Quarry\Drawings\09000271.dwg

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Appendix 1.2

Initial Baseline Water Quality and Proposed Initial Trigger Limits

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Table A1.4.1
Initial Baseline Water Quality and
Proposed Initial Trigger Limits

Parameter	Baseline Data (Feb 2010)		Proposed Initial Trigger Limits (CP3)
	Dam 7	Dam 8	
Hydrocarbons	Not Detectable	Not Detectable	Detectable
PAH	Not Detectable	Not Detectable	Detectable
TSS	44 mg/L	34 mg/L	50 mg/L
TP	0.83 mg/L	0.68 mg/L	1.0 mg/L
TN	1.5 mg/L	3.8 mg/L	5 mg/L
pH	-	-	<6.5 >8
Electrical Conductivity	48 µS/cm	67 µS/cm	100 µS/cm

Note:

These triggers will only be used until there is a statistically valid number of baseline samples taken from Dam 8 (we recommend at least 10). When that becomes so a trigger for further investigation will be deemed to occur when the concentration of an indicator taken from CP3 exceeds the eightieth percentile of the same indicator from Dam 8 (or, in the case of pH, lies outside the recommended values)

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Appendix 1.3

Site Audit Checklist

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Erosion and Sediment Control Checklist

Ardmore Park Quarry		Date:	
Inspected by:			
Signature:			

Instructions:

- This checklist is to be completed by the Site Manager (or approved representative) at the time of making the site inspection.
- A tick (✓) should be placed in the applicable **Yes/No** box as appropriate.
- Where an item is not applicable, the notation **N/A** should be placed in the **Comments and Actions** box.
- Where a non-conformance is identified (a tick in a shaded box), a brief explanation is to be provided in the corresponding **Comments and Actions** box.
- The completed checklist and details of any corrective actions must be placed in the project file.

Weather conditions (tick appropriate box):				
Fine ☐	Light rain ☐	Heavy rain ☐	Light wind ☐	Strong wind ☐
Maximum 5-day rainfall since last inspection				____mm

General	**Yes**	**No**	**Comments & Actions**
Is the site is in a generally tidy condition?			
Is all equipment, materials, etc. contained within work area boundary?			
Are there any obvious signs of construction-related disturbance outside of construction area(s)?			
Is the weather station active and is data recorded since last inspection?			
Soil Disturbance and Erosion Control			
Have required erosion control measures been correctly installed and are they functional? Check that there are/is: ▪ no gaps in silt fences/barriers ▪ correct ground cover to achieve required C-Factors ▪ any areas of concentrated flow that do not flow to sediment basins/traps?			
Are there any obvious signs of uncontrolled drainage leaving the site?			

	Yes	No	Comments & Actions
Are piped drainage inlets protected by sediment trapping measures?			
Are any materials, temporary structures/works in drainage lines?			
Where required, are drainage outlets provided with energy dissipaters to minimise erosion?			
Have works been scheduled to minimise areas exposed at any one time?			
Are areas where quarrying activities have ceased being stabilised and rehabilitated? Are these areas being rehabilitated in a timely manner? (Refer to the SWMP)			
Is there dirt on adjacent public roads?			
Are diversion banks stable?			
Sediment Control			
Are **ALL** dirty water diversion drains functional, unblocked, and connected to their correct storages (refer to the SWMP)?			
Are any sediment fences in place and intact? Do they conform to SD 6-8 (refer to the SWMP)			
Are all other sediment traps operational and below capacity?			
Is the truck wash operational with dirty water directed to a sediment basin?			
Stockpile Management			
Do stockpiles appear adequately maintained and managed (measures in place to prevent dust and soil run-off)?			
Are there separate stockpiles for different materials?			
Are topsoil stockpiles less than 2 m in height?			
Are stockpiles located at least 5m from concentrated water flow and on slopes less than 10%?			
Are there are diversion banks on the upper sides of stockpiles?			

Storage Maintenance	**Yes**	**No**	**Comments & Actions**
Re-use ponds			
Are the various volume markers clearly visible?			
Is the top water level at or above the maximum permissible water storage level?			
If yes, are the re-use pumps operational?			
Is the sediment level above the maximum sediment storage level?			
Are the inlets and outlets stable?			
Are pump records being kept and up to date?			
Sediment Basins			
Are the various volume markers clearly visible?			
Is the top water level at or above the maximum permissible water storage level?			
If yes, has it rained in the last 48 hours and are the pumps operational?			
Is the sediment level above the maximum sediment storage level?			
Are the inlets and outlets stable?			
Clarifying Ponds			
Are the various volume markers clearly visible?			
Is the top water level at or above the maximum permissible water storage level?			
If yes, has there been rain in the last five days and is the pond being flocculated?			
If it has not rained recently is the water level at or below the permissible permanent water level?			
Are the pumps operational?			
Is the sediment level below the maximum sediment storage level?			
Are the inlets and outlets stable?			
Are records being kept and are they up to date? ▪ Pumps ▪ Flocculation ▪ Water Quality (pH and TSS)			

	Yes	No	Comments & Actions
If there have been any discharges since the last inspection, was there a rainfall event that exceeded 41 mm in any five day period?			The discharge was unauthorised. Investigate why and report as necessary.
Onsite Wastewater			
Are there any foul odours at the treatment system?			
Is there any sign of concentrated runoff at the Ecomax mound?			
Has the active Ecomax cell been switched in the last 6 months?			
Air Quality			
Is dust suppression equipment readily accessible?			
Are there any obvious signs of dust deposition outside of construction area(s)?			
Is spoil evident on public roads?			
Are the haul roads being kept damp (if required)?			
Is the air quality monitoring equipment (if installed) operating correctly			
Is there spraying for dust control?			
Is there stabilisation of stockpiles or erection of dust screens?			
Do trucks removing material from the site have their loads covered?			
Waste Management and Minimisation			
Are waste receptacles accessible and clearly marked with regard to waste type?			
Is all recyclable material separated as per the waste management plan (records available)?			
Are records of the type, amounts, date, transport, and disposal site of waste kept in a Waste Management Register?			

	HAZARDS IDENTIFIED	Signed off and Date

- Attached copies of any Site Instructions issued.
- Results of the Inspection must be discussed at Site Meetings.
- Results of the Inspections must be discussed with the Site Manager (or delegate).
- The Group General Manager requires Regional and Group Managers to include in the Executive Board Reports number of Projects that were subject to a Site Environmental Inspection.
- Provide a copy of this page (with "Corrective Actions Required", including NIL Actions) to Head Office. If required send further copy of page once all corrective actions have been signed off.

Site Manager (or delegate) for the project _____ Signature & Date __/__/__

Acknowledged as sighted, Team Leader_____ Signature & Date __/__/__

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APPENDIX 2.1

GROUNDWATER MONITORING PROGRAM – OPERATIONAL GUIDE

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Groundwater Monitoring Program ARDMORE PARK QUARRY

VERSION: 26 February 2010

1.1 Water Level Monitoring - Hard Rock Production Bore and Monitoring Bores

Bore Description (see note 1)	NOW Licence No. (see note 1)	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
BHAP1	10BL603202	Peripheral hardrock observation bore 540 m N of Production Bore BHAP6	Lot 24 DP 1001312	E:770000 N: 6134780	Water level changes over time in the confined 'hardrock' aquifer at approximately the same depth as the Production Bore BHAP6	Possible decline in piezometric level (water level) due to industrial production pumping	open	Dedicated automated water level (pressure transducer) data logger. Pressure measurements collected initaially at 1-hourly intervals. Review and assess data after 12 months and decrease sample frequency to 4-hourly if considered appropriate.	Pressure (converted to water level), temperature.	Monthly downloads following commencement of quarrying. Review and assess data after 12 months and decrease download frequency to 3-monthly (quaterly) if considered appropriate.	A 'significant' decrease in water level over time that may or may not be observed in other monitoring bores particularly in the control (background) monitoring bore BHAP1. A significant decrease is herein defined as the reduction in Available Drawdown in monitoring bores greater than 15% that is attributable to the project.	Continue to monitor and assess water level data, establish trends and correlate with pumping cycles, extraction rates and climatic data (rainfall). Apply statistical analysis to assess trends if required. Determine whether any decrease in water level/s may be due to 'mining' of the groundwater system. Calculate and assess any distance drawdown effects with respect to the observation bores.	If any water level declines are assessed to be significant and due to impacts on the sustainability of the groundwater system, and there is a 'significant' impact on neighbouring water users (bores), access to the potentially affected bore/s should be requested in order to confirm and monitor any impact that may be solely or partly due to production pumping. Contingency plans may include deepening the affected bore, developing a new groundwater source, supplying a volume of water commensurate with the calculated loss and/or a solution agreed to between Multiquip and the affected owner, reduce pumping rates, initially through reducing water provided for ongoing stock watering and if required through a reduced processing rate at the sand washing plant. If impacts on the pumped aquifer in Bore BHAP6 indicate a decline in aquifer sustainability, consider exploration for a new test bore on 'Ardmore Park'.	Normal annual reporting protocol in place as per the GMP. However, if distance impacts due to production pumping are documented, further reporting (and consultation with the NOW) at months 1, 3, & 6. This particularly applies if a significant impact on any neighbouring water user can be demonstrated.
BHAP5	10BL603202	Peripheral hardrock observation bore 670 m E-NE of Production Bore BHAP6	Lot 24 DP 1001312	E:770520 N:6134505			open							
BHAP6	10BL603200	Production Bore	Lot 24 DP 1001312	E: 769910 N:6134252			95.0 - 113.0							
BHAP7	TBA	Peripheral hardrock observation bore 530 m S-SW of Production Bore BHAP6	Lot 24 DP 1001312	E:769660 N:6133780			open							
BHAP10	10BL603383	Peripheral hardrock observation bore 640 m W-NW of Production Bore BHAP6	Lot 24 DP 1001312	E: 769340 N: 6134480			30.0 - 52.0							

1.2 Water Level Monitoring - Sand Monitoring Bores

Bore Description (see note 2)	NOW Licence No.	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
BH1	TBA	Within sand extraction area	Lot 24 DP 1001312	E:55769512 N:6133541	Water level changes over time in the sand extraction area and in peripheral area within the confines and depth extent of the proposed extraction area.	Possible decrease in water table due to sand extraction operations.	7.4 - 10.4	Dedicated automated water level (pressure transducer) data logger. Pressure measurements collected initaially at 1-hourly intervals. Review and assess data after 12 months and decrease sample frequency to 4-hourly if considered appropriate.	Pressure (converted to water level), temperature.	Monthly downloads following commencement of quarrying. Review and assess data after 12 months and decrease download frequency to 3-monthly (quaterly) if considered appropriate Pressure (converted to water level), temperature.	A 'significant' decrease in water level (water table) over time that may or may not be observed in other monitoring bores. A significant decrease is herein defined as: 1. a relatively 'sudden' decrease where the rate of fall exceeds the established 'normal' rate of water level decrease (recession) observed in all background water level data, and 2. an absolute (standing) water table level lower than the minium water level recorded for that monitoring bore in the background water level data.	Continue to monitor and assess water level data, establish trends and correlate with extraction rates and climatic data (rainfall). Apply statistical analysis to assess trends if required. Determine whether any decrease in water level/s may be due to sand extraction. Replace any monitoring bores that are destroyed during the staged sand extraction process with strategically positioned and suitably installed new monitoring bores where appropriate.	If some, or all of the water level declines in the monitoring bore network are assessed by the hydrogeological consultant to be due to impacts on the sand-hosted groundwater system from sand extraction operations (after analysis and correlation of rainfall recharge data), engage a consultant to reassess the degree and extent of any impact on the environment.	Normal annual reporting protocol in place as per the GMP. However, if 'significant' impacts due to sand extraction are documented, further reporting (and consultation with the NOW) at months 1, 3, & 6. This particularly applies if a significant impact on the environmental can be demonstrated.
BH2	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769395 N: 613324			9.0 - 12.0							
BH3	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769200 N: 6133585			10.0 - 13.0							
BH4	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769716 N: 6133141			14.0 - 17.0							
BH5	TBA	Within sand extraction area	Lot 24 DP 1001312	E:55769687 N: 6133259			9.5 - 12.5							
BH6	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769912 N: 6133228			11.0 - 14.0							
BH7	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55770102 N: 6133253			TBA							
BH8	TBA	East of, and peripheral to, sand extraction area	Lot 24 DP 1001312	E: 55770400 N: 6133144			TBA							
APS38	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769564 N: 6133301			multiple							

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1.3 Spring Flow Monitoring - Census Springs

Spring Description	NOW Licence No.	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth (see note 3)	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
Phil's Spring	N/A	Approx. 500 m east of sand extraction area	Lot 2 DP 84966	E: 55770676 N: 6132950	Water level (and flow rate) changes over time in Phil's Spring system.	Possible decrease in flow rate due to sand extraction operations.	Depth of water measured in a 'V notch' weir or similar device constructed at the discharge of the spring system.	Dedicated automated water level (pressure transducer) data logger. Pressure measurements collected initaially at 1-hourly intervals. Review and assess data after 12 months and decrease sample frequency to 4-hourly if considered appropriate.	Pressure (converted to water level), temperature. Water level calibrated (and converted) to flow rate	Monthly downloads following commencement of sand extraction. Review and assess data after 12 months and decrease download frequency to 3-monthly (quaterly) if considered appropriate Pressure (converted to water level and flow rate), temperature.	A 'significant' decrease in flow rate (converted from automated water depth measurements in 'V' notch weir or similar device). The average flow rate from previous measurements is 0.3 L/s. A significant decrease is considered to be a flow rate of less than 0.2 L/s.	Continue to monitor and assess water level 9flow rate) data, establish trends and correlate with climatic data (rainfall). Apply statistical analysis to assess trends if required. Determine whether any decrease in water level/flow rate may be due to sand extraction.	If the significant water flow (water level) decline in the spring system is assessed by the hydrogeological consultant to be scientifically demonstrated to be associated with impacts from sand extraction on Ardmore Park (in consultation with the NOW) and not related to rainfall variation, mitigation/contingency plans may include developing a new groundwater source on the affected propoerty, supplying a volume of water commensurate with the calculated loss and/or a solution agreed to between Multiquip and the affected owner.	Normal annual reporting protocol in place as per the GMP. However, if a 'significant' impact due to sand extraction is documented, further reporting (and consultation with the NOW) at months 1, 3, & 6.
Southern Spring	N/A	Approx. 70 m south of extraction area	Lot 6 DP 854407	E: 55769582 N: 6133029										
Western Spring	N/A	Approx. 1000 m west of extraction area	Lot 21 DP 1001312	E: 55768560 N: 6133400										

2.1 Water Quality Monitoring - Hard Rock Production Bore and Monitoring Bores

Bore Description (see note 1)	NOW Licence No. (see note 1)	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth/s	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
BHAP1	10BL603202	Peripheral hardrock observation bore 540 m N of Production Bore BHAP6	Lot 24 DP 1001312	E:770000 N: 6134780	Significant' water quality changes over time in the confined 'hardrock' aquifer at approximately the same depth as the Production Bore BHAP6	Possible water quality changes due to production pumping in Bore BHAP6.	25.9	Groundwater sampling and field water quality tests in all monitoring bores at 3-monthly intervals for 12 months (1 sample per bore every 3 mths.). Submit representative groundwater sample/s to a NATA registered laboratory for analytes listed in Table 2 of the GMP. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	Field water quality tests: pH, EC, DO, Temperature, ORP. Laboratory Testing and Analysis: pH, EC, TDS, hardness, major cations: sodium, calcium, potassium, phosphate, total phosphorus, magnesium, ammonia, nitrate, nitrite, major anions: chloride, sulphate, bicarbonate alkalinity , carbonate alkalinity, total alkalinity, Total Petroleum Hydrocarbons (TPH), Benzene-Toluene-Ethylbenzene-Xylenes (BTEX) and metals: copper, lead, zinc, cadmium, chromium, nickel, iron (total), iron (dissolved), arsenic, mercury. See Table 2.2 in GMP	Groundwater sampling and field water quality tests in all monitoring bores at 3-monthly intervals for 12 months. Submit representative groundwater samples to a NATA registered laboratory. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	A 'significant' decrease in water quality in particular decreasing pH, increasing EC and increasing TDS in time in monitoring bores other than the control (background) monitoring bore BHAP1. A significant decrease is herein defined as: 1. a pH less than 6.0 2. a gradually increasing trend in EC & TDS values compared with any trends observed in the background control bores.	Continue to monitor and assess bore water quality data, establish trends and correlate with production pumping rates and climatic data (rainfall) to determine a causal link (if any) . Correlate with any fluctautions in water level. Apply statistical analysis to assess trends if required. Compare water quality data in bores with water quality data in the monitoring bore BHAP1.	If evolving geochemical anomalies are detected in groundwater sampled from the peripheral monitoring bores (compared with water quality in the background control bore) and an impact from production pumping is demonstrated, assess for any significant water level declines in the observation bores. If complaints of groundwater deterioration are received from other water users, seek permission to sample and anayse groundwater from the alledged affected bore to astablsih a baseline water chemsitry. Resample affected bore after 1 month to assess occurrence of an impact and degree of any impacts. Continue to monitor and assess trends.	Normal annual reporting protocol in place as per the GMP. However, if distance impacts due to production pumping are documented, further reporting (and consultation with the NOW) at months 1, 3, & 6. This particularly applies if a significant impact on any neighbouring water user can be demonstrated.
BHAP5	10BL603202	Peripheral hardrock observation bore 670 m E-NE of Production Bore BHAP6	Lot 24 DP 1001312	E:770520 N:6134505			22.4							
BHAP6	10BL603200	Production Bore	Lot 24 DP 1001312	E: 769910 N:6134252										
BHAP7	TBA	Peripheral hardrock observation bore 530 m S-SW of Production Bore BHAP6	Lot 24 DP 1001312	E:769660 N:6133780			21.0							
BHAP10	10BL603383	Peripheral hardrock observation bore 640 m W-NW of Production Bore BHAP6	Lot 24 DP 1001312	E: 769340 N: 6134480			17.1							

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2.2 Water Quality Monitoring - Sand Monitoring Bores

Bore Description (see note 2)	DWE Licence No.	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth/s	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
BH1	TBA	Within sand extraction area	Lot 24 DP 1001312	E:55769512 N:6133541	Significant' water quality changes over time in the Southern Sand Resource within the confines and depth extent of the proposed quarry.	Possible water quality changes due to sand extraction operations	25.9	Groundwater sampling and field water quality tests in all monitoring bores at 3-monthly intervals for 12 months (1 sample per bore every 3 mths.). Submit representative groundwater sample/s to a NATA registered laboratory for analytes listed in Table 2.3 of the GMP. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	Field water quality tests: pH, EC, DO, Temperature, ORP. Laboratory Testing and Analysis: pH, EC, TDS, hardness, major cations: sodium, calcium, potassium, phosphate, total phosphorus, magnesium, ammonia, nitrate, nitrite, major anions: chloride, sulphate, bicarbonate alkalinity , carbonate alkalinity, total alkalinity, turbidity, Total Petroleum Hydrocarbons (TPH), Benzene-Toluene-Ethylbenzene-Xylenes (BTEX) and metals: copper, lead, zinc, cadmium, chromium, nickel, iron (total), iron (dissolved), arsenic, mercury. See Table 2.3 in GMP	Groundwater sampling and field water quality tests in all monitoring bores at 3-monthly intervals for 12 months. Submit representative groundwater samples to a NATA registered laboratory. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	A 'significant' decrease in water quality in particular decreasing pH, increasing EC and increasing TDS in time in monitoring bores other than the control (background) monitoring bore 2.3. A significant decrease is herein defined as: 1. a pH less than 6.0 2. a gradually increasing trend in EC & TDS values compared with any trends observed in the background control bore.	Continue to monitor and assess bore water quality data, establish trends and correlate with sand extraction rates, any water removal production and climatic data (rainfall) to determine a causal link (if any) . Correlate with any fluctautions in water level. Apply statistical analysis to assess trends if required.	If evolving geochemical anomalies are detected in groundwater sampled from the monitoring bores (compared with water quality in the background control bore) and an impact from sand extraction is demonstrated, assess for any significant water level declines in the observation bores. Continue to monitor and assess trends.	Normal annual reporting protocol in place as per the GMP. However, if distance impacts due to production pumping are documented, further reporting (and consultation with the NOW) at months 1, 3, & 6. This particularly applies if a significant impact on any neighbouring water user can be demonstrated.
BH2	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769395 N: 613324			22.4							
BH3	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769200 N: 6133585			21.0							
BH4	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769716 N: 6133141			17.1							
BH5	TBA	Within sand extraction area	Lot 24 DP 1001312	E:55769687 N: 6133259			9.5 - 12.5							
BH6	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769912 N: 6133228			11.0 - 14.0							
BH7	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55770102 N: 6133253			TBA							
BH8	TBA	East of, and peripheral to, sand extraction area	Lot 24 DP 1001312	E: 55770400 N: 6133144			TBA							
APS38	TBA	Within sand extraction area	Lot 24 DP 1001312	E: 55769564 N: 6133301			multiple							

2.3 Water Quality Monitoring - Census Springs

Spring Description	DWE Licence No.	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth/s	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
Phil's Spring	N/A	Approx. 500 m east of sand extraction area	Lot 2 DP 84966	E: 55770676 N: 6132950	Significant' water quality changes over time in the spring discharge.	Possible water quality changes due to sand extraction operations		Groundwater sampling and field water quality tests in the spring discharge zone at 3-monthly intervals for 12 months (1 sample per bore every 3 mths.). Submit representative groundwater sample/s to a NATA registered laboratory for analytes listed in Table 2.4 of the GMP. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	Field water quality tests: pH, EC, DO, Temperature, ORP. Laboratory Testing and Analysis: pH, EC, TDS, hardness, major cations: sodium, calcium, potassium, phosphate, total phosphorus, magnesium, ammonia, nitrate, nitrite, major anions: chloride, sulphate, bicarbonate alkalinity , carbonate alkalinity, total alkalinity, turbidity and metals: copper, lead, zinc, cadmium, chromium, nickel, iron (total), iron (dissolved), arsenic, mercury. See Table 2.4 in GMP for Phil's Spring	Groundwater sampling and field water quality tests in spring discharge zone at 3-monthly intervals for 12 months. Submit representative groundwater samples to a NATA registered laboratory. Review and assess geochemical data after 12 months and decrease sample frequency to 6-monthly if considered appropriate by the hydrogeological consultant.	A 'significant' decrease in water quality in particular decreasing pH, increasing EC and increasing TDS in time in spring discharge. A significant decrease is herein defined as: 1. a pH less than 6.0 2. a gradually increasing trend in EC & TDS values.	Continue to monitor and assess water discharge quality data, establish trends and correlate with sand extraction rates, any water removal production and importantly climatic data (rainfall) to determine a causal link (if any) . Correlate with any fluctautions in flow rate of spring. Apply statistical analysis to assess trends if required.	If evolving geochemical anomalies are detected in groundwater sampled from the spring and an impact from sand extraction is demonstrated, assess for any significant water flow (water level) declines in the spring. If a 'significant' impact on the spring is scientifically demonstrated to be associated with sand extraction, (in consultation with the NOW) and not related to rainfall variation, mitigation/contingency plans may include developing a new groundwater source on the affected property, supplying a volume of water commensurate with the calculated loss and/or a solution agreed to between Multiquip and the affected owner. Continue to monitor and assess trends.	Normal annual reporting protocol in place as per the GMP. However, if distance impacts due to production pumping are documented, further reporting (and consultation with the NOW) at months 1, 3, & 6. This particularly applies if a significant impact on any neighbouring water user can be demonstrated.
Southern Spring	N/A	Approx. 70 m south of extraction area	Lot 6 DP 854407	E: 55769582 N: 6133029										
Western Spring	N/A	Approx. 1000 m west of extraction area	Lot 21 DP 1001312	E: 55768560 N: 6133400										

3 Rainfall Monitoring

Gauge	NOW Licence No.	Location Description	Property ID Lot/DP	Coordinates	Monitoring Target/s	Monitoring Effect of	Monitoring Depth/s	Sampling Frequency	Sampling Parameters	Frequency of Data Download	Trigger Value or level indicating potential impact	Action Required	Any follow up actions	Reporting to NOW
BOM Stations 070037 & 070263	N/A	Goulburn City	N/A	N/A	Rainfall variation over time	Variation of rainfall on water levels in monitoring bores and springs	N/A	Daily rainfall measurements	Rainfall depth	Daily rainfall measurements	N/A	N/A	N/A	Normal Project reporting to the NOW
On-Site Tipping Bucket Rain Gauge	N/A	On-site (near proposed site office)	Lot 24 DP 1001312	TBA					Rainfall depth and other parameters		N/A	N/A	N/A	

TBA: To Be Advised
N/A: Not Applicable

NOTES:

1. The monitoring bores are retrofitted 'open' resource assessment drill holes and as such were not dedicated monitoring bores under the Water Act, 1912. These monitoring bores are licensed as such under the Water Act,1912. Note that BHAP1 and BHAP5 share the same groundwater license number. This discrepancy is under investigation.
2. The monitoring bores are retrofitted 'open' resource assessment drill holes with surface PVC casing and dedicated automated water level data loggers installed.
3. A standard design V-notch weir (or similar device) with an automated water level data logger installed in the weir pool. Plus suitable calibration.

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APPENDIX 2.2

BASELINE BORE FLOW DATA PRODUCTION BORE BHAP6

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In 2004, a 46-hour constant-rate pumping test was carried out in Bore BHAP6 at a constant discharge rate of 13.0 L/s in accordance with Australian Standard for test pumping of wells (AS 2368-1990). The discharge rate was chosen using the results of the airlift test at the completion of the test drilling. The aim of the pumping test was to:

- Assess whether the proposed bore could supply sufficient quantities of suitable quality water to satisfy the requirements of the proposed quarry development.
- Estimate the long-term safe and sustainable yield of the aquifer system.
- Assess any potential impacts on the surrounding environment or aquifer systems.

A summary of the details of the pumping test in Bore BHAP6 is listed in **Table B1**.

Table B1

Summary Details for Constant-Rate Pumping Test – Bore BHAP6

Date	Test	Drawdown				Recovery		
		Discharge Rate (L/s)	Duration (hrs)	SWL at Start (m)	SWL at End (m)	Duration (hrs)	SWL at Start (m)	SWL at End (m)
8.4.04	1	13.0	46	57.19	84.92	45	84.92	*59.88

Note: Standing Water Levels (SWL) w.r.t Top of Collar (TOC).
* Manual reading after 65 minutes following cessation of pumping

Following the cessation of test pumping, the water level recovered to approximately 90% of the pre-test water level in approximately 60 minutes and 97% in 180 minutes.

The results of the pumping test indicate that the likely long-term sustainable flow rate is greater than 13 L/s.

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APPENDIX 2.3

BASELINE WATER LEVEL MEASUREMENTS

PRODUCTION BORE BHAP6 AND HARDROCK OBSERVATION BORES

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Baseline Water Level Measurements
Production Bore APBH6 and Hard Rock Observation Bores

Bore	Host Geology	Baseline Measurement	25.7.03		29.10.03		16.4.04		14.5.04	
			SWL (m)	Elev. mAHD	SWL (m)	Elev. mAHD	SWL (m)	Elev. mAHD	SWL (m)	Elev. mAHD
BHAP1	Basement Rocks	9.00m (9.7.03)	8.05	625.3	8.80	624.5	8.57	624.7	8.90	624.4
BHAP5 (deep)	Palaeo-alluvial	23.60m (21.7.03)	21.50	613.0	21.50	613.0	21.19	613.3	21.43	613.1
BHAP6	Basement Rocks	57.00m (24.7.03)	57.00	583.0	57.20	582.8	56.92	583.1	56.44	583.6
BHAP7	Basement Rocks	52.10m (24.11.03)					52.76	580.2	52.83	587.2
BHAP8	Palaeo-alluvial	Dry (15.7.03)	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
BHAP9	Palaeo-alluvial	Dry (15.7.03)	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
BHAP10	Basement Rocks	25.20m (27.11.03)					25.30	612.2	25.43	612.1
APS38A (deep)	Palaeo-alluvial	33.61m (6.4.04)					33.72	590.3	33.66	590.3
APS38B (shallow)	Palaeo-alluvial	8.55m (6.4.04)					8.65	615.4	8.50	615.5

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APPENDIX 2.4

BASELINE WATER QUALITY MEASUREMENTS

BHAP6 AND BHAP10

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Summary Baseline Analytical Results BHAP6 and BHAP10				
Analyte	**Unit**	**Limit of Reporting**	**BHAP6**	**BHAP10**
pH	pH units	0.04	7.6	6.3
Electrical Conductivity (EC)	µS/m	0.01	1100	-
Total Alkalinity	mg/L $CaCO_3$	14	340	-
Sodium (Na)	mg/L	0.02	90	550
Chloride (Cl)	mg/L	7	160	1530
Calcium (Ca)	mg/L	0.01	84	130
Potassium (K)	mg/L	0.01	2.1	7.7
Magnesium (Mg)	mg/L	0.01	34	190
Ammonia (NH4-N)	mg/L	0.1		<0.1
Nitrate (NO3)	mg/L	0.1		0.25
Sulphate (SO4)	mg/L	0.1		28
Bicarbonate (HCO3)	mg/L	0.1		170
Phosphate (PO4)	mg/L	0.1		<0.1
Iron (Fe)	mg/L	0.01	<0.01	<0.01
Hardness	mg/L $CaCO_3$	1	350	-
Calcium Carbonate Saturation Index			0.8	-
Sodium Adsorption Ratio	NTU	0.07	2.1	-
Turbidity			5	-

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APPENDIX 2.5

BASELINE WATER LEVEL MEASUREMENTS

SAND-HOSTED OBSERVATION BORES

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Water Level Measurements Sand-Hosted Observation Bores				
Monitoring Well	**Date**	**SWL (m TOC)**	**Casing Stickup (m)**	**SWL Elevation (mAHD)**
BH1	10.11.04	Dry	0.50	Dry
BH2	10.11.04	3.62	0.50	620.88
BH3	10.11.04	0.84	0.73	619.99
BH4	10.11.04	1.06	0.73	619.27
BH5	10.11.04	3.35	0.68	619.83
BH6	10.11.04	6.99	0.92	621.40
APS38	10.11.04	5.80	0.97	619.70

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APPENDIX 2.6

BASELINE WATER QUALITY MEASUREMENTS

BH2-BH6, AP38 AND PHIL'S SPRING

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Summary Baseline Analytical Results BH2-BH6, APS38, Phil's Spring								
Analyte	**Unit**	**Sample**						
		BH2	**BH3**	**BH4**	**BH5**	**BH6**	**APS38**	**Phil's Spring**
pH (field)	unit	6.7	7.6	7.6	7.2	7.2	6.0	7.2
pH (lab)	unit	6.6	7.2	7.3	7.1	7.2	6.0	7.2
EC (field)	us/cm	675	967	1241	1095	1670	352	1183
EC (lab)	us/cm	560	800	1160	970	1580	240	1000
TDS	mg/L	360	510	760	630	1040	150	650
Cations								
Na	mg/L	60	66	110	78	165	30	100
Ca	mg/L	14	54	91	85	135	8.9	66
K	mg/L	0.3	1.1	3.8	1.6	5.9	0.5	0.4
Mg	mg/L	45	55	59	54	60	13	62
Anions								
Cl	mg/L	190	120	230	160	410	76	140
F	mg/L	0.22	0.15	0.30	0.13	0.24	<0.1	0.30
NO_3	mg/L	8	9.2	3.7	8.5	1.4	11	<0.1
SO_4	mg/L	4	12	18	13	32	2	16
HCO_3	mg/L	88	390	470	450	430	27	530
NH4-N	mg/L	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Metals								
Cu	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/L	0.005	0.007	0.002	0.003	0.011	0.006	<0.001
Cd	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mn	mg/L	0.32	0.05	0.06	0.09	0.26	0.09	0.09
As	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

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APPENDIX 2.7

STATISTICAL ANALYSIS METHODOLOGY

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There are a range of spreadsheet-based statistical control chart methods that are used in the processing industry. Two well documented methods are the Exponentially Weighted Moving Average (EWMA) and the Cumulative Sum (Cusum) methods which are considered to be relevant to the assessment of any potential environmental impacts associated with this project. It is recommended that the two methods be implemented. The methods are briefly described as follows:

The EWMA control chart is a data analysis technique for determining if a measurement process has got out of control. The EWMA chart plots a weighted average of the current data and the previously plotted point and uses statistical control limits. The chart is sensitive to drift and therefore in the context of the Project would effectively detect any geochemical changes in groundwater due to the Project.

The Cusum chart is similar to the EWMA method. The chart is sensitive to drift and will detect small changes in the mean. The chart does not use fixed or parallel statistical control limits but plots the cumulative sum of the deviations between each plotted value (sample average) and a background value. The interpretation of the chart is more concerned with the slope of the plotted line, not just the distance between the plotted values and the centreline

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