MULTIQUIP QUARRIES

ABN: 44 101 930 714

Water Management Plan

for the

Ardmore Park Quarry Via Bungonia, NSW

November 2017

Prepared by:

R.W. CORKERY & CO. PTY. LIMITED

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for the

Ardmore Park Quarry
Via Bungonia, NSW

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PREAMBLE

This Water Management Plan ("the Plan") represents an update of the original Water Management Plan (of August, 2010) for the Ardmore Park Quarry prepared by RW Corkery Pty Limited, Strategic Environmental and Engineering Consulting (SEEC) and Larry Cook & Associates Pty Ltd. This version (Version 2.3) has been compiled by Multiquip Quarries in response to an Order given in accordance with *Section 121B* of the *Environmental Planning & Assessment Act 1979*.

As for previous versions, the WMP follows a report structure to satisfy *Condition 3(13)* of Project Approval (PA) 07_0155, 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[1], DECC[2] and SCA[3], 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.*

Version 2.3 of the Plan incorporates and builds upon information prepared by Strategic Environmental and Engineering Consulting (SEEC) and Larry Cook & Associates Pty Ltd to address the surface water and groundwater components of the Plan respectively. SEEC has also supplied supplementary information in the form of two detailed Erosion and Sediment Control Plans (ESCP) which are appended to the Quarry ESCP. The Plan is divided into two parts as follows.

Part 1: Surface Water Management. This part, includes:

- a Site Water Balance prepared in accordance with *Condition 3(14)*;
- 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).*

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[1] Now the Department of Primary Industries – Water (DPI-Water)
[2] Now the NSW Environment Protection Authority (EPA)
[3] Now WaterNSW

Part 2: Groundwater Management. This part includes:

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

Appendix 1.1 has been prepared to satisfy the requirements of *Condition 3(15)* for an Erosion and Sediment Control Plan.

Appendices 1.2 and **1.3** provide additional and supplementary information to support Part 1. **Appendices 2.1** to **2.6** provide additional and supplementary information to support Part 2.

PART 1: SURFACE WATER MANAGEMENT

1. SCOPE OF WORK

Strategic Environmental and Engineering Consulting (SEEC) were 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), Condition 3(16),* as well as *Condition 3(18)* as it refers to surface waters.

An Erosion and Sediment Control Plan (ESCP) which covers all Quarry Site and off-site components of PA 07 0155 is provided as **Appendix 1.1**. The ESCP provides the overarching objectives and principles to be applied by Multiquip in managing construction and operations to minimise erosion and sedimentation. This is identified as the Central ESCP of the Quarry. Five 'Detailed' ESCPs are appended to the Central ESCP providing the specific design and management details of erosion and sediment control to be applied across the various components of PA 07_0155 which have the potential to result in erosion and sedimentation impacts.

The ESCP has been prepared with the input of SEEC and in accordance with the recommendations and guidance provided by Volumes 1, 2C and 2E of "Soils and Construction: Managing Urban Stormwater" (Landcom, 2004 and DECCW, 2008) ("the Blue Book").

2. PROJECT DESCRIPTION AND PLAN OVERVIEW

The 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 **Figure 2**).

The Quarry incorporates an extraction area of approximately 47ha, with additional disturbance associated with the construction of processing areas, water management structures and an internal road network increasing the overall area of disturbance to approximately 61ha. The basalt is sufficiently jointed such that no blasting will be required to break / fracture the rock for removal, with the sand and basalt extracted by ripping, excavating and loading. 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 ripped and removed raw materials will then be transferred to either a crushing and screening plant (basalt), mobile dry screening plant (sand) or washing plant (sand) for processing. The screening, crushing and/or washing will produce various quality sand, aggregate and road building materials for use in the growing construction markets of Sydney, Canberra, the South Coast and Goulburn. The processing areas and stockpile areas will drain to a sediment basins (SB2 and SB3) with water accumulating in this structure transferred to a re-use pond (RE1 or RE2) which, in turn, drains to CP3 (Dam 7). 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. The design and management of surface water management structures on the Quarry Site, both for present the of the Quarry during the site establishment and operational phases are provided in the relevant Detailed ESCP provided in **Appendix 1.1**

All Quarry products will be despatched by road and Multiquip will upgrade those public roads (to the Hume Highway) to be used to meet the desired standard of Council (3.5m pavement width with a 0.5m sealed shoulder) and construct a private by-pass road to the west of Bungonia Village. The design and management of surface water management structures at these off-site construction works are provided in the relevant Detailed ESCPs provided in **Appendix 1.1**.

3. SITE WATER BALANCES

3.1 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 135mm).

Following a review of Quarry sub-catchments (to reflect **Figure 2** and the Detailed Quarry Site ESCP of **Appendix 1.1**), the water balance for the Quarry was re-modelled[4]. The revised modelling 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;

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[4] The previous 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.

- 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 differed from the original in that:

- the catchment areas to some of the proposed storage ponds had been increased;
- the number of ponds have been consolidated, i.e. there are fewer; and
- the ponds are bigger than originally proposed[5].

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

3.2 PROPOSED WATER STORAGES

A number of water storages will be constructed and maintained within the Quarry Site (refer to **Table 1** and the Detailed Quarry Site ESCP 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** and the Detailed Quarry Site ESCP of **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 presents the relevant design capacities of each of the water storages to be constructed and maintained within the Quarry Site.

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[5] 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.

Table 1
Design Capacities and Re-use for each of the Proposed Storages

Storage Identification	Settling Zone Volume	Re-use Storage Volume	Sediment Storage Volume[6]	Total Volume	Maximum Permissible Re-use per year[7]
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[8]
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)[7]

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).

3.3 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 22ML/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.

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

7 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**).

8 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.

- 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 3.4.4).

3.4 SOURCES OF WATER

3.4.1 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 3.4.2);
- Water drained from the sand after processing; and
- A licensed bore with an allowable supply of 100ML/year (see Section 3.4.4).

3.4.2 Re-use From Ponds

As part of the revised water balance modelling undertaken by SEEC for the Version 1 of the Plan, the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was interrogated iteratively 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 outputs were interrogated to determine the percentage of permissible re-use demand (the total volume of Column 6, **Table 1** – 68.2ML) met in different rainfall scenarios (see **Table 2**).

Table 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 22ML/year) on its own (17.3ML in a dry year[9]).

The remaining ponds will supplement RE2 for dust suppression as required and supply water for sand washing (supplemented by bore water as required). Notably, no surface flows will enter ponds RE1 and RE2 and SB2 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** or the bore license.

The data in **Tables 1** and **2** are based on the first few years of extraction (Site Establishment stage), where the catchment to RE2 is 20ha with up to 7ha of that area 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[10] could be increased by about 2ML 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 Site Establishment 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 2ha) 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 3.4.4).

3.4.3 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.

3.4.4 Bore Water

Multiquip holds a license to extract up to 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[11] and the remainder of demand will be sourced from the bore. At peak

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9 20.4ML x 85% = 17.3ML

10 RE2 could be constructed as two ponds (of combined capacity 4 600m^3)

11 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

production it is estimated that 92ML/year of water is required (see Section 3.3). 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. SURFACE WATER MONITORING PLAN

4.1 WATER QUALITY MONITORING – CP3

Initial base line water quality testing was completed by SEEC after a moderate rainfall event in February 2010. Samples were taken from Dam 7 and Dam 8 (see **Figure 2**) 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 (1ML) 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.

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**, a suitably qualified, experienced consultant will be employed to investigate, report, liaise with EPA 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 80^{th} percentile of the same indicator from Dam 8. If that occurs a suitably qualified consultant will be employed to investigate, report, liaise with EPA and suggest remedial measures if and as required.

4.2 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 EPA 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[12]; OR
- 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.

4.3 WEATHER MONITORING

An automatic weather station is operated on the Quarry Site which measures 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.

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[12] 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).

5. 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.

6. 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 1.2** but this may be adapted as operations proceed.

Once per year, a hydrological consultant, Certified Professional in Erosion and Sediment Control (CPESC) or other appropriately qualified professional 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)[13].
- 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.

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

- Results of an inspection of the water quality monitoring results;
- Results of an inspection of the condition of the receiving water (Section 4.2).
- 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 DPI Water to recommend any remedial actions necessary.
- Report on any unforeseen impacts and liaise with DPI Water to recommend any remedial actions necessary.

7. 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 DPE and EPA and suggest remedial measures as required (“Action A”).

Table 3
Surface Water Response Plan

Trigger	**Action**
Discharge from CP1, CP2 or CP3 when combined rainfall has been less than 41mm in the previous five days.	Follow the procedures in **Appendix 1.1** (*Section 4.4*)
Unable to treat water to less than 50mg/L before discharge.	A
Water quality measurements exceed triggers described in Section 4.1.	A
Significant changes to the watercourse downstream of CP3 (Section 4.2).	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
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 DPE and EPA and suggest remedial measures as required	

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 of **Table 1** will be adjusted subject to site-specific calibration of the models (Section 3.1).

PART 2: GROUNDWATER MANAGEMENT

8. GROUNDWATER MONITORING PROGRAM

8.1 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. *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 extraction. The palaeo-alluvial sand deposit has a variable water table, the level of which is directly related to rainfall.

8.2 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.

8.3 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 extraction 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 extraction operations.
- Develop a protocol for data management.
- Develop a protocol for general technical reporting separate from special reporting associated with specific impacts.

8.4 GROUNDWATER MONITORING

8.4.1 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, BHAP5 & BHAP10); and
2. monitoring of shallow sand aquifer using the sand monitoring bores (BH1 to BH6) and three springs (Phil's Spring, Southern Spring and Western Spring) associated with sand extraction.

The location of Production Bore (BHAP6) and associated hard rock observation bores (BHAP1, BHAP5 and BHAP10) are shown in **Figure 3**. The location of monitoring bores (BH1 to BH6) and spring systems associated with sand extraction are shown in **Figures 3** and **4**.

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 4**. The hard rock bores were drilled and constructed in 2003 and the sand monitoring bores completed in 2004.

Table 4
Register of Monitoring Bores and Monitoring Sites

Monitoring Bore[1]	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
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
Phil's Spring	55770676	6132950	624.0	-	-	-	-
Southern Spring	55769582	6133029	615.0	-	-	-	-
Note 1: Observation Bore BAHP7 and monitoring bores BH7 and BH8 referenced in previous versions of this GMP have be destroyed or decommissioned and removed from the monitoring program.							
Reference: 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							

The two monitoring programs are described and discussed in Sections 8.4.2 and 8.4.3.

8.4.2 Hard Rock Aquifer Monitoring Program

8.4.2.1 Description

As noted in Part 1, surface water supply to Quarry operations will be supplemented by groundwater extractions from Production Bore BHAP6.

Production Bore BHAP6 is surrounded by three deep, proximal hard rock monitoring bores (BHAP1, BHAP5 & BHAP10) (used along with now destroyed BHAP7 to monitor water levels during the formal pumping test in BHAP6). This network of monitoring bores, which includes a background monitoring bore (BHAP10), will be used in long-term monitoring of the production bore. Summary details of the production bore and monitoring bores are provided in **Table 4**.

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 2.1**, **2.2**, **2.3**, **2.4** and **2.5**.

8.4.2.2 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 2.1**.

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 2.2**.

Water Quality Data

Baseline water samples were collected from Production Bore BHAP6 and observation Bore BHAP10 and analysed for the analytes listed in **Table 5**.

Table 5
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 2.3**.

8.4.2.3 Monitoring Locations, Parameters and Frequency

Monitoring of the four hard rock groundwater bores would be undertaken on an approximately quarterly basis (four times per year).

The following parameters would be monitored or measured on a quarterly basis.

- Water level.
- pH, Electrical Conductivity, Total Dissolved Solids.

The following parameters would be monitored or measured on an annual basis.

- Cation / Anion Suite: Calcium, Potassium, Sodium, Magnesium, Hydroxide Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Total Alkalinity, Sulphate, Chloride, Ionic Balance.
- Metals Suite: Fe, Mn, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, Mn.

8.4.2.4 Trigger, Actions and Reporting

Table 6 provides the triggers, actions, responses and reporting associated with monitoring of groundwater and spring flow at the Quarry.

8.4.3 Sand Aquifer Monitoring Program

8.4.3.1 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 six (6) monitoring bores (piezometers) located in, and peripheral to, the sand deposit (BH1 to BH6). The network includes a control (background) monitoring bore. The locations of monitoring bores are shown in **Figure 4**.

Summary details of the sand-hosted monitoring bores are provided in **Table 4**.

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 Section 8.4.3.2.

8.4.3.2 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 2.4**.

Water Quality Data

Baseline water samples were collected from six monitoring bores and analysed for the analytes listed in **Table 7**.

Table 7
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 2.5**.

8.4.3.3 Monitoring Locations, Parameters and Frequency

Monitoring of the six sand aquifer groundwater bores would be undertaken on an approximately quarterly basis (four times per year).

The following parameters would be monitored or measured.

- Water level.
- pH, Electrical Conductivity, Total Dissolved Solids.
- Organic Suite: Total Recoverable Hydrocarbons (TRH), BTEX (benzene, toluene, ethylbenzene, m+p –xylene), o –xylene.

The following parameters would be monitored or measured on an annual basis.

- Cation / Anion Suite: Calcium, Potassium, Sodium, Magnesium, Hydroxide Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Total Alkalinity, Sulphate, Chloride, Ionic Balance.
- Metals Suite: Fe, Mn, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, Mn.

8.4.3.4 Trigger, Actions and Reporting

Table 6 provides the triggers, actions, responses and reporting associated with monitoring of groundwater and spring flow at the Quarry.

Table 6
Triggers, Actions, Responses and Reporting

<table>
<tr><th>Parameter</th><th>Trigger</th><th>Action</th><th>Response</th><th>Reporting</th></tr>
<tr><td>Water Level</td><td>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.
A significant decrease is herein defined as the reduction in Available Drawdown in monitoring bores greater than 15% that is attributable to the project.</td><td>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</td><td>If following Action water level declines are assessed as significant impacting on neighbouring water users (bores), access to the potentially affected bore/s should be requested in order to confirm and monitor any impact.
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 any other agreed solution.</td><td>Normal annual reporting protocol in place as per the GMP.
However, if impacts due to production pumping or extraction are documented, further reporting (and consultation with DPI-Water) at months 1, 3, & 6.</td></tr>
<tr><td>Water Quality</td><td>An observed decrease in water quality defined through the following trigger values[1].
Bores
<table>
<tr><th>Parameter</th><th>Hardrock Bores[2]</th><th>Sand Bores[3]</th></tr>
<tr><td>pH</td><td><6.0</td><td><6.0</td></tr>
<tr><td>EC (µS/cm)</td><td>>3,200</td><td>>2,000</td></tr>
<tr><td>TDS (mg/L)</td><td>>2,000</td><td>>1,400</td></tr>
<tr><td>TRH (µg/L)</td><td>N/A</td><td>>600</td></tr>
<tr><td>Benzene (µg/L)</td><td>N/A</td><td>>950</td></tr>
<tr><td>m+p-xylene (µg/L)</td><td>N/A</td><td>>200</td></tr>
<tr><td>o-xylene (µg/L)</td><td>N/A</td><td>>350</td></tr>
</table>
Springs
<table>
<tr><th>Parameter</th><th>Phil’s Spring</th><th>Southern Spring</th></tr>
<tr><td>pH</td><td><6.0</td><td><6.5</td></tr>
<tr><td>EC (µS/cm)</td><td>>1,500</td><td>>700</td></tr>
<tr><td>TDS (mg/L)</td><td>>1,000</td><td>>500</td></tr>
<tr><td>TRH (µg/L)</td><td>>600</td><td>>600</td></tr>
<tr><td>Benzene (µg/L)</td><td>>950</td><td>>950</td></tr>
<tr><td>m+p-xylene (µg/L)</td><td>>200</td><td>>200</td></tr>
<tr><td>o-xylene (µg/L)</td><td>>350</td><td>>350</td></tr>
</table>
An increasing trend in other anions, cations or metals when compared to the control (background) monitoring bore BHAP1</td><td>Correlate with any fluctuations in water level. Apply statistical analysis to assess trends. Compare water quality data in bores with water quality data in the monitoring bore BHAP1.
Continue to monitor and assess bore/spring water quality data, establish trends and correlate with production pumping rates and climatic data (rainfall) to determine a causal link of any exceedance/s (if any).</td><td>If geochemical anomalies are detected from the monitoring bores (compared with the control bore) and/or springs and an impact from production pumping or extraction activities is demonstrated, assess for any significant water level declines in the monitoring bores and flow in springs.
If exceedance/s occurs, resample affected bore/spring within two weeks of recorded exceedance.
If complaints of groundwater deterioration are received, seek permission to sample and analyse groundwater from the alleged affected bore/spring. Resample affected bore/spring after 1 month to assess occurrence of an impact and degree of any impacts.
Continue to monitor and assess trends.</td><td>Normal annual reporting protocol in place as per the GMP.
However, if impacts due to production pumping or extraction are documented, further reporting (and consultation with DPI-Water) at months 1, 3, & 6.</td></tr>
<tr><td>Spring Flow</td><td>A 'significant' decrease in flow rate (converted from automated water depth measurements in 'V' notch weir) from the average flow rate (0.1-0.3L/s) or water quality.
A significant decrease is considered to be a flow rate of less than 0.1L/s.</td><td>Continue to monitor and assess flow rate, establish trends and correlate with climatic data (rainfall).
Apply statistical analysis to assess trends if required.
Determine whether any decrease in water flow rate may be due to extraction activities.</td><td>Resample affected spring within two weeks of he recorded exceedance.
If a significant impact is confirmed by a hydrogeological consultant to be associated with impacts from sand extraction (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 another agreed solution.</td><td>Normal annual reporting protocol in place as per the GMP.
However, if impacts due to production pumping or extraction are documented, further reporting (and consultation with DPI-Water) at months 1, 3, & 6.</td></tr>
<tr><td colspan="5">Note 1: Trigger values developed by Larry Cook & Associates Pty Ltd based on:
• Potential pollutant risks.
• A review of the minimum, median and maximum values obtained from monitoring/testing with statistical analysis.
• ANZECC Guidelines October 2000. Volumes 1 & 2.
• NEPM 1999. Schedule B1.
• Dutch Intervention Levels. 2000 (for TRH only).
Note 2: BHAP1, BHAP5, BHAP6, BHAP10 Note 3: BH1, BH2, BH3, BH4, BH5, BH6</td></tr>
</table>

8.4.4 SPRING MONITORING PROGRAM

8.4.4.1 Description

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

- Phil's Spring.
- Southern Spring.

The locations of the census springs are shown on a copy of the aerial photo over the Project Site in **Figure 3**. Summary details of the three census springs are provided in **Table 4**.

The results of baseline flow and water quality monitoring are summarised in Sections 8.4.4.2 and 8.4.4.3.

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.

8.4.4.2 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.

Water Quality Data

A baseline water sample was collected from Phil's Spring and submitted for the analytes and tests listed in **Table 8**.

Table 8
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 2.6**.

8.4.4.3 Monitoring Locations, Parameters and Frequency

Monitoring of the two springs would be undertaken on an approximately quarterly basis (four times per year).

The following parameters would be monitored or measured.

- Water level.
- pH, Electrical Conductivity, Total Dissolved Solids.
- Organic Suite: Total Recoverable Hydrocarbons (TRH), BTEX (benzene, toluene, ethylbenzene, m+p –xylene), o –xylene.

The following parameters would be monitored or measured on an annual basis.

- Cation / Anion Suite: Calcium, Potassium, Sodium, Magnesium, Hydroxide Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Total Alkalinity, Sulphate, Chloride, Ionic Balance.
- Metals Suite: Fe, Mn, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, Mn.

8.4.4.4 Trigger, Actions and Reporting

Table 6 provides the triggers, actions, responses and reporting associated with monitoring of groundwater and spring flow at the Quarry.

8.4.4.5 Photo Points

Photo points will be established on Phil's Spring and the Southern Spring. 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.

8.4.5 RAINFALL MONITORING

Rainfall is collected and measured at the Quarry weather station and reported annually. Rainfall data will in used for analysis of any trends observed of water level or spring flow.

8.5 ASSESSMENT TRIGGERS

A set of trigger levels for assessing any impacts from the Quarry on water levels and water quality in the groundwater monitoring network and on the census springs are identified in **Table 6**. **Table 6** also identified the actions and responses to be followed in the event impacts on local groundwater are observed or claimed.

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.

8.6 PREVENTION OF GROUNDWATER CONTAMINATION

Multiquip will implement best environmental practice 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 Quarry Site.
- Undertake all maintenance activities within designated areas of the Quarry 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.

8.7 IMPACT REPORTING PROTOCOL

A protocol for in-house and government reporting where there is an assessed impact from the Quarry operations on either water levels or water quality in the groundwater monitoring network or flow in the census springs is provided in **Table 6**.

8.8 DATA MANAGEMENT PROTOCOL

The 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 location.
- 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.

8.9 GENERAL REPORTING PROTOCOL

The recommended protocol for reporting, separate from special reporting associated with specific impacts documented in Section 8.8, 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 (DPI-Water) 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 DPI-Water. 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 DPI-Water and to the Quarry Manager.

9. GROUNDWATER RESPONSE PLAN

9.1 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.

9.2 IMPACT ASSESSMENT, NOTIFICATION AND MITIGATION PROTOCOL

Table 6 provides 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. The following provides further detail on the various steps of this protocol.

1. Monitoring of groundwater levels as nominated in the GMP would be undertaken to identify any decreasing groundwater level trend.
2. Should the triggers identified in **Table 6** 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. **Table 6** 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 DPI-Water of the observed groundwater drawdown and commencement of investigations to identify the most appropriate mitigation and/or compensatory measures.
9. The results of the hydrogeological investigations would be forwarded to the affected land owner(s) and DPI-Water nominating the mitigation or compensatory measures to be undertaken (see **Table 6** 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 DPI-Water, 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 DPI-Water, the hydrogeologist would be asked to review the hydrogeological 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.

9.3 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 **Table 6**, 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.

9.4 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 DPI-Water 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 DPI-Water 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 DPI-Water 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.

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.

10. REFERENCES

Department of Environment and Climate Change (2008). *Managing Urban Stormwater: Soils and Construction, Volume 2E, 1st Edition.* Department of Environment and Climate Change, NSW, Sydney.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction, Vol. 1, 4th ed,* Landcom, NSW, Sydney.

Macleod, A. (2008). *MUSIC Calibration Based on Soil Conditions*. Proceedings of the 2008 NSW and Qld Joint Stormwater Industry Association Conference. July, 2008.

Corkery & Co Pty Limited (RWC) (2008). *Environmental Assessment for the Modified "Ardmore Park" Quarry*. Prepared on behalf of Multiquip Quarries.

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FIGURES

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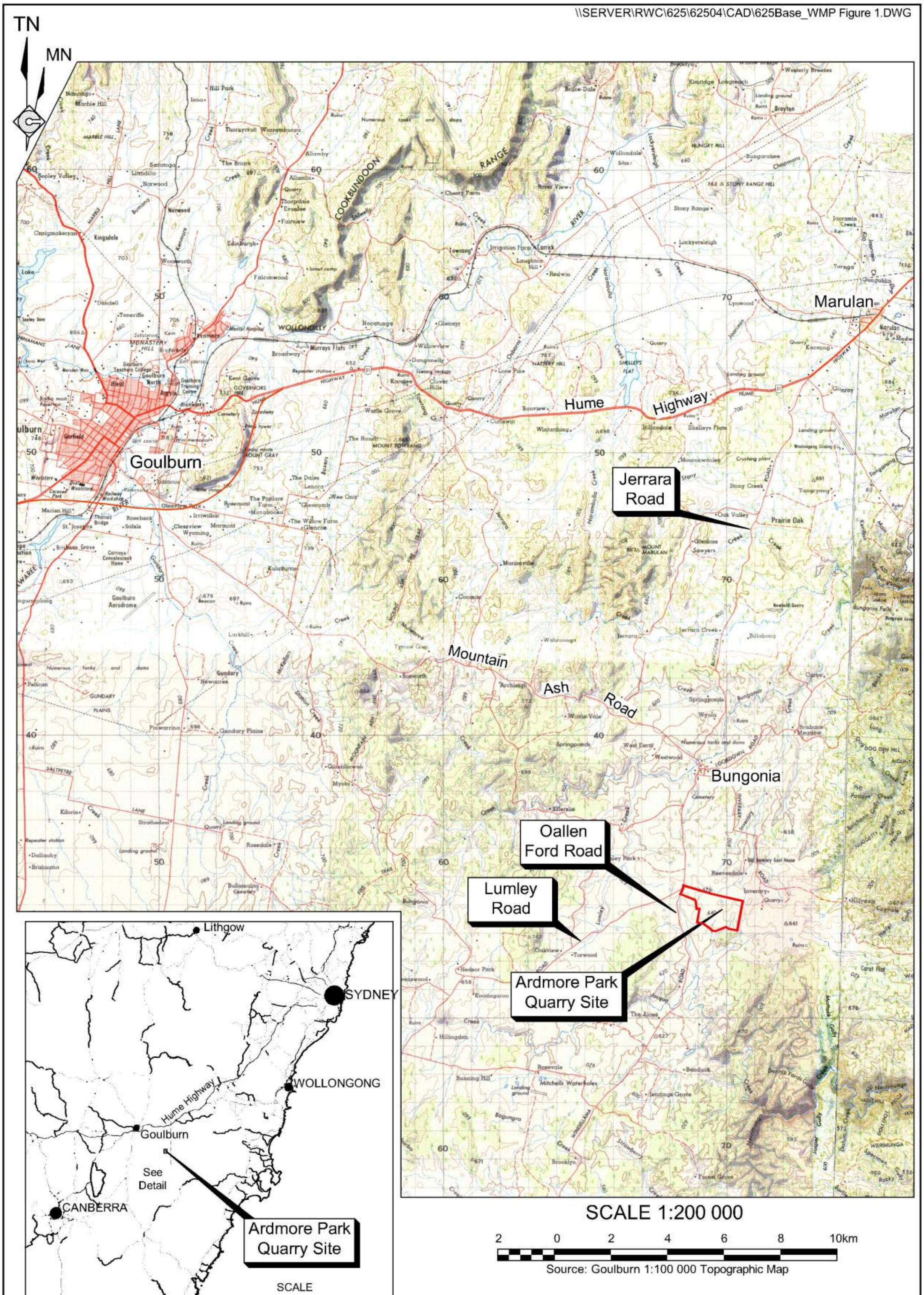


Figure 1
LOCALITY PLAN AND LOCAL SETTING

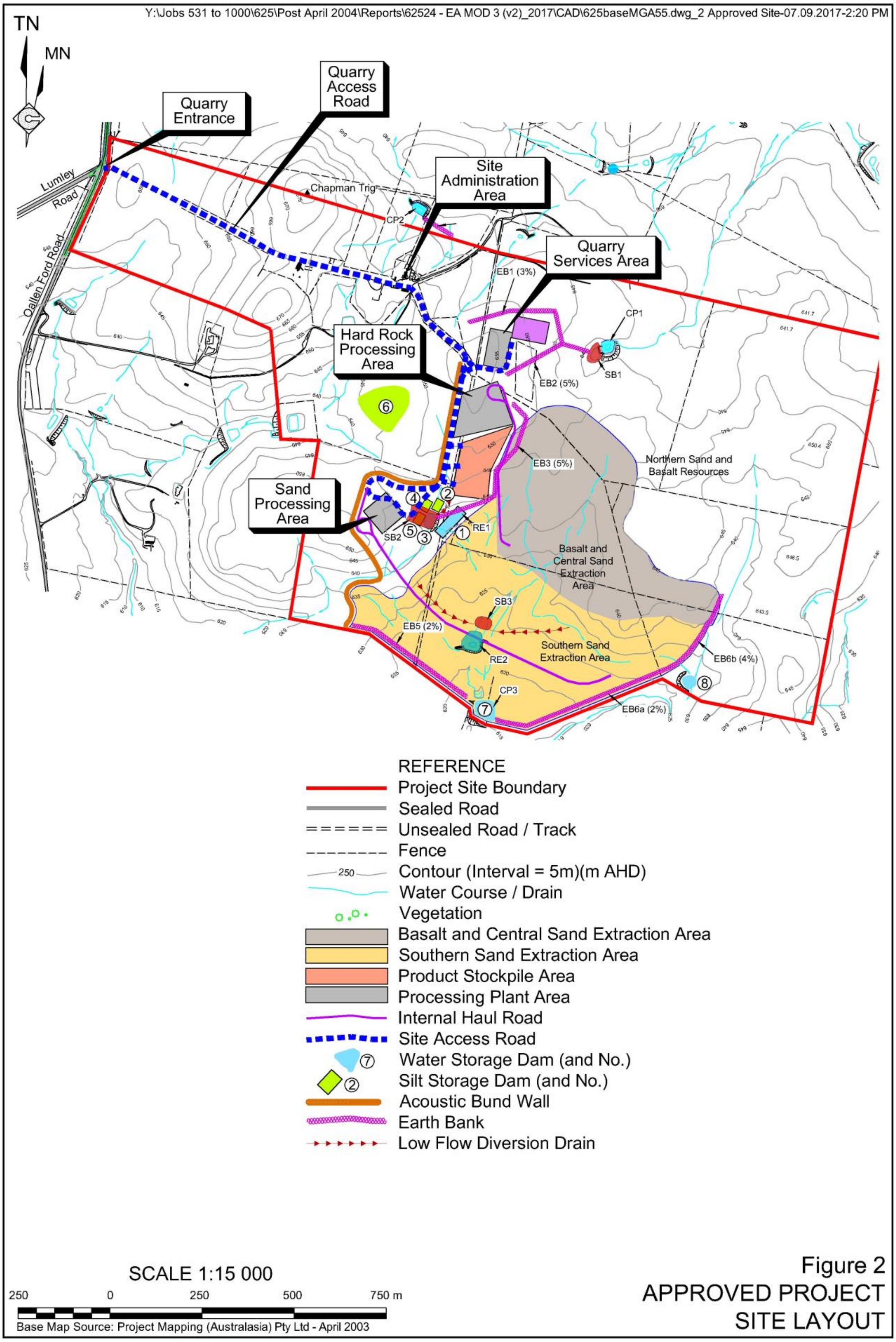
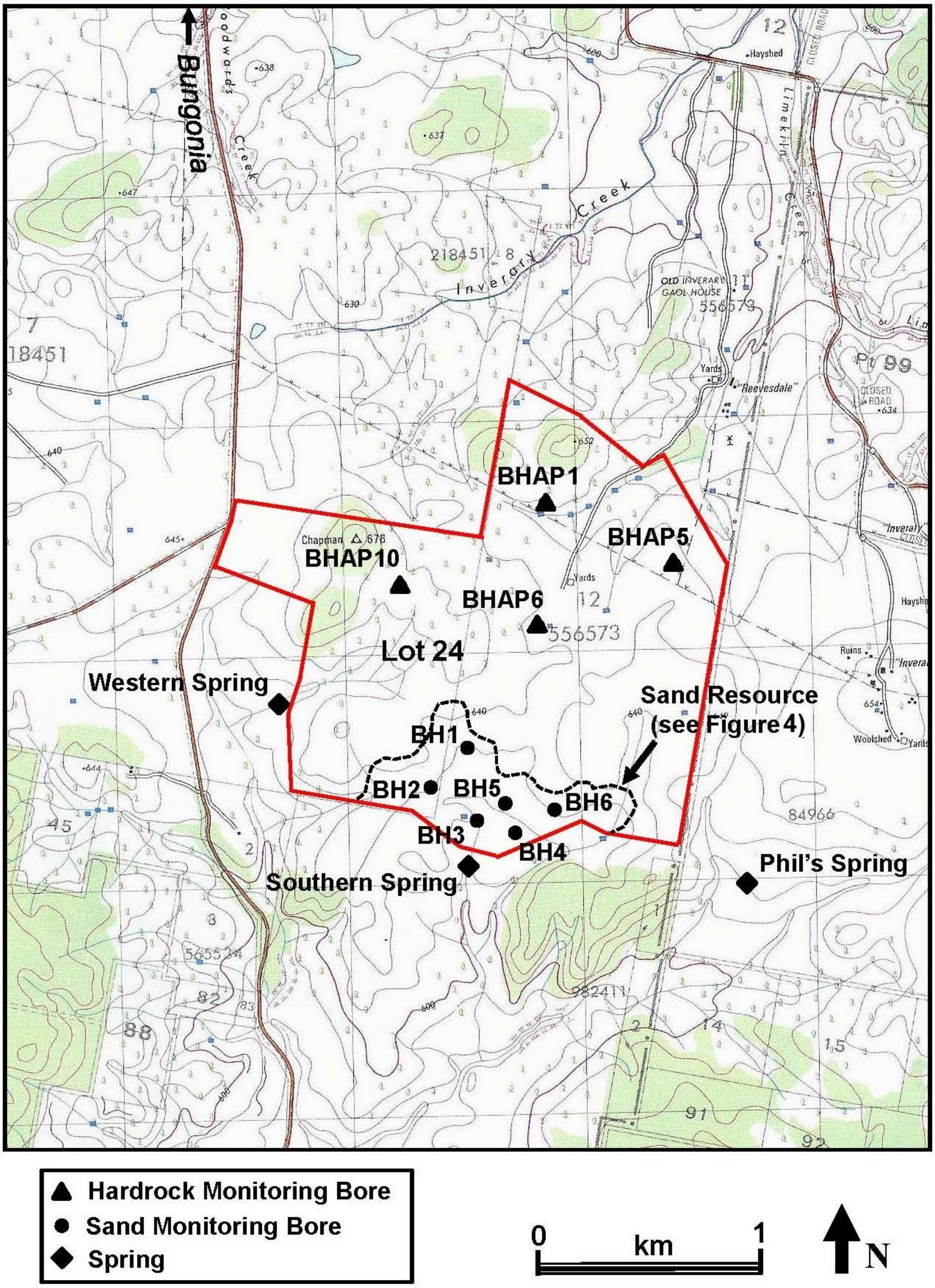
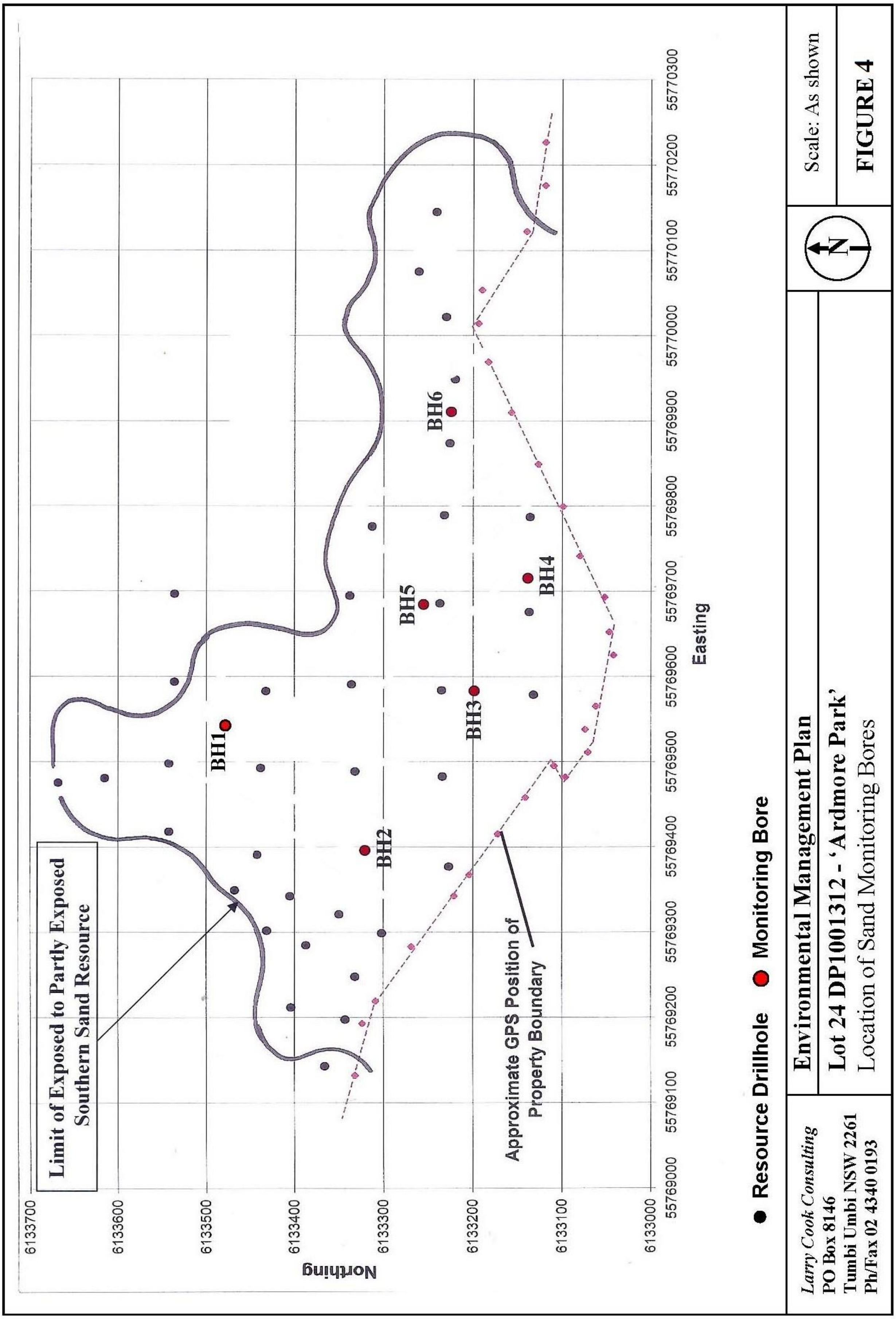


Figure 2
APPROVED PROJECT
SITE LAYOUT



Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Ph 02 4340 0193**	**Environmental Management Plan**	Scale: As shown
	Lot 24 DP1001312 - 'Ardmore Park' Location of Monitoring Sites	**FIGURE 3**


Limit of Exposed to Partly Exposed Southern Sand Resource
Approximate GPS Position of Property Boundary
BH1
BH2
BH3
BH4
BH5
BH6
Northing
Easting
6133700
6133600
6133500
6133400
6133300
6133200
6133100
6133000
55769000
55769100
55769200
55769300
55769400
55769500
55769600
55769700
55769800
55769900
55770000
55770100
55770200
55770300
Resource Drillhole
Monitoring Bore
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PO Box 8146
Tumbi Umbi NSW 2261
Ph/Fax 02 4340 0193
Environmental Management Plan
Lot 24 DP1001312 - 'Ardmore Park'
Location of Sand Monitoring Bores
N
Scale: As shown
FIGURE 4