Appendix 15

Ardmore Park Quarry – Modification 3

Response regarding Groundwater Issues

prepared by

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6th September 2018
REF: 18099-A

SUBJECT: RESPONSE TO DEPARTMENT OF INDUSTRY COMMENTS ON EA ARDMORE PARK QUARRY (PA 07_0155 MOD 3) LOT 24 in DP1001312 5152 OALLEN FORD ROAD BUNGONIA NSW 2580

1. INTRODUCTION

This letter provides a response to a request for further information documented in a submission from the Department of Industry (DoI) regarding the proposal to modify the existing Project approval for the Ardmore Park Quarry (PA 07_0155 MOD 3) (Ref. OUT17/2274 dated 27th February 2018). The responses relevant to groundwater issues are provided in the following sections consistent with the bullet points in the Department of Industry letter.

2. DoI

The proponent should provide an assessment of quarrying impact upon groundwater within the connected palaeo-alluvial aquifer to address the requirements of the Aquifer Interference Policy. The maximum annual groundwater take will need to be accounted for by holding sufficient entitlement in a Water Access Licence for the relevant water source.

Response

It is noted that the proposed modification of the extractive operations at the Ardmore Park Quarry (PA 07_0155 MOD 3) relates to a small extension (3.1ha) to the area of basalt extraction which was approved by the Minister for Planning in 2009 (Project Approval (PA) 07_0155 dated 20 September 2009). PA 07_0155 also incorporated the extraction of sand which underlies the basalt resource and presently exposed on the receding (eroding) fringes of the basalt.

Extraction of basalt will be to the base of the lowest basalt flow (approximately 615m AHD). Importantly, the proposed modification (PA 07_0155 MOD 3) does not incorporate any modification to the approved sand extraction operations.

An assessment of the local hydrogeology (with reference to the regional hydrogeological setting) centred on the location of the proposed extension of basalt extraction was undertaken in late 2017. The report assessed the potential impacts on the groundwater system that may be associated with the proposed additional extraction operations. Detailed hydrogeological investigations and assessments were undertaken in 2003 and 2004 as part of the

Environmental Assessment relating to the proposed extraction of sand and basalt on Ardmore Park (LCA, 2004, 2008) which was approved in September 2009 (PA 07_0155).

Extensive percussion drilling in the basalt resource on parts of 'Ardmore Park' in the early to mid-2000s revealed the existence of unsaturated conditions throughout the basalt resource. That is, no groundwater was intersected. An explanation of the unsaturated conditions is provided as follows.

- The basalt sequence is relatively thin, varying from approximately 8m to about 35m, where tested.
- Groundwater flow in the basalt is likely to radiate outward from the central part/s with the majority of flow migrating via fractures and joint networks with negligible flow through pores spaces.
- The sequence is, in parts, strongly weathered and heavily jointed with an extensive network of close-spaced sub-vertical joints formed as a consequence of shrinkage during cooling of the lava. Although the basalt mass has negligible porosity and are relatively low permeability groundwater systems, these joints can provide substantial vertical conductivity. The hydraulic conductivity can be relatively high.
- Thick basalt flows can incorporate unconfined aquifers especially if the flows overlay relatively 'low permeability' materials such as a shale unit. The basalt on 'Ardmore Park' is relatively thin and directly underlain by a thick sequence of highly permeable fine to coarse sand. The permeability of the sand significantly exceeds the permeability of the basalt.

Any recharge (all from rainfall) would percolate vertically to the base of the basalt sequence and effectively drain into the sand sequence. The vertical joints intersect the sub-horizontal interlayer contacts that may have increased permeability. However, the vertical joints act as groundwater conduits which effectively drain the basalt sequence.

Notwithstanding the lack of groundwater within the basalt resource, *Section 10* of the Hydrogeology Assessment prepared for the proposed modification (LCA, 2017) provides and assessment against the Aquifer Interference Policy (as relevant to the impacts associated with the proposed modification). LCA (2017) demonstrates that:

1) No additional water would be taken, given the unsaturated nature of the basalt, and therefore this is properly accounted for (see above);

2) the minimal impact thresholds are therefore not exceeded (refer to Section 10.4 of LCA, 2018); and

3) planning for measures in the event that the actual impacts are greater than predicted including a contingency for monitoring has been provided (refer to *Section 10.5* of LCA (2017).

Reiterating the conclusion of LCA (2017), as the basalt is unsaturated and the proposed modification does not incorporate any changes to the approved sand extraction operations, no additional impact on the water table, groundwater pressure and availability or water quality would result from the extension of the basalt extraction area. It is considered that the Aquifer Interference Policy should not retrospectively apply to the approved sand extraction operations.

The Applicant holds an allocation of 110 units (110ML) from the Fractured Rock Groundwater Source of the Greater Metropolitan Region Groundwater Sources - Goulburn Fractured Aquifer Water Sharing Plan. The proposed modification to the basalt extraction area will have no influence on groundwater take. With respect to the proposed increase in production, the Applicant records water drawn from the production bore and will ensure that this remains within

the entitlement of the water access licence. A revised site water balance has been prepared by others to demonstrate water requirements will remain within the allocated volume.

3. DoI

To assist in understanding the site and predicted impact, cross sections of the conceptual hydrogeology model and plots of contoured groundwater level for each separate aquifer presented in the Hydrogeology Assessment should be provided.

Response

Detailed geological and hydrogeological investigations carried out in 2004 as part of the EIS revealed the presence of flat-lying, stacked remnants of Tertiary basalt over the southern, central and eastern parts of 'Ardmore Park' (**Figure 1**).

The basalt overlies a thick sequence of palaeo sand and gravel which incorporates a 20 to 40 m-thick aerially extensive clay aquitard. The palaeo sand deposit overlies a basement sequence of folded and faulted Silurian, Devonian and Ordovician sedimentary and volcano-sedimentary rocks.

A schematic cross section showing the principal geological elements described above is presented in **Figure 2** and Conceptual Cross Section A-B-C presented in **Figure 3**. The location of the cross section is shown in **Figure 1.**

The hydrogeological investigations revealed the presence of three types of aquifers beneath the central part of 'Ardmore Park' as follows:

- partly saturated 'alluvial' aquifers associated with the stacked and interbedded alluvial sand and gravel deposits beneath the base of the basalt (palaeo-alluvials/deep leads); and
- 'hardrock' aquifers associated with sub-vertical geological discontinuities (fractures, faults) that have dissected the Palaeozoic basement rocks underlying the palaeo sand deposits.
- 'hardrock' aquifers associated with the possible southern extensions of limestone formations (karst) hosted by the Silurian basement sedimentary rocks.

There appears to be a significant geological and hydrogeological (hydraulic) disconnect between the deeper 'fracture-controlled' hardrock aquifers hosted by the 'old' deformed rock basement sequence and the relatively shallow and younger 'unconfined' alluvial sand aquifer.

A strategic network of monitoring bores (piezometers) was historically installed in the palaeo sand resource and underlying Palaeozoic basement rock complex. Monitoring bores were not constructed in the basalt resource because baseline and follow-up monitoring in the resource drill holes sunk in the mid-2000s revealed that the basalt sequence is unsaturated. Accessible bores in the basalt resource are checked for the presence of groundwater from time to time during scheduled prescribed water level (and water quality) monitoring in the network of sand and basement monitoring bores. The basalt resource remains unsaturated.

A baseline contour plan showing the water table in the 'upper' sand resource is presented in **Figure 4**. The location of the 'upper' sand resource is annotated in **Figure 5**. Water levels in the basement rock sequence are also recorded on a scheduled prescribed basis.

4. DoI

There is a notable lack of groundwater level monitoring data at the site of the basalt quarry operations and proposed extension area. The proponent should, within the next month, install a nested groundwater monitoring bore, measuring levels of groundwater in both basalt and palaeo-alluvial aquifers, immediately north of the current basalt - sand quarrying and planned extension area.

Response

As previously documented, monitoring bores were not constructed in the basalt resource because baseline and follow-up monitoring in the resource drill holes sunk in the mid-2000s revealed that the basalt sequence is unsaturated. Accessible bores in the basalt resource are checked for the presence of groundwater from time to time during scheduled prescribed water level (and water quality) monitoring in the network of sand and basement monitoring bores. The basalt resource remains unsaturated

In order to verify the existence of unsaturated conditions in the basalt resource recorded since the mid-2000s, a nested (or twinned) set of two monitoring bores can be constructed immediately north of the existing quarry footprint in the northern part of the proposed extension of the basalt quarry. An approximate location of the monitoring site is shown in **Figure 6**. A generalised profile of each monitoring bore is provided in **Appendix A**. The shallow monitoring bore will be designed to monitor the presence (and fluctuations) of groundwater in the basalt sequence. The deeper monitoring bore will be designed to intercept the water table in the underlying paleo sand sequence. The final depth of each monitoring bore would be determined based on the results of drilling.

5. DoI

Groundwater level monitoring bore BHAP7 is listed as "lost". The proponent should be required to replace this bore prior to any approval being granted.

Response

Bore BHAP7 was installed in the Palaeozoic basement rock sequence and drilled as a groundwater exploration bore in these 'old' rocks. The bore was not drilled as a dedicated monitoring bore. The bore was inadvertently covered by farm activities several years ago. Subsequent attempts to relocate the bore were not successful. The network of three 'hard rock' monitoring bores and one 'deep' sand monitoring bore drilled elsewhere on 'Ardmore Park' (**see Figure 5**) are considered to provide adequate water level monitoring in the 'old' basement rock sequence. The monitoring network enables assessment of any impacts on the hard rock aquifers from production pumping in Bore BHAP6. In this regard, a proposal to the NSW EPA in 2015 to remove 'lost' Bore BHAP7 from Environment Protection Licence 13213 from the inventory of

monitoring bores was successful. This bore is not considered necessary for water level monitoring.

Sand and basalt extraction activities on 'Ardmore Park' will not impact on the 'hard rock' aquifer systems.

6. DoI

The water level response trigger for affected bores refers to drawdown of greater than 15% attributable to the project. To aid in interpretation, the proponent should clarify what the corresponding water level is in each bore.

Response

It is noted that the water level response trigger has been endorsed as part of the Quarry *Water Management Plan* and the proposed modification is simply restating this as an ongoing commitment for the modified Quarry operations. The baseline measurements, as included in *Appendices 2.2* and *2.4* of the Water Management Plan are reproduced in **Tables 1 and 2**.

Table 1
Baseline Water Level Measurements: Hard Rock Monitoring Bores

Bore	Host Geology	Baseline Measurement (date)	Standing Water Level (m)							
			25.7.03		29.10.03		16.4.04		14.5.04	
			BGL	AHD	BGL	AHD	BGL	AHD	BGL	AHD
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	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

Table 2 Baseline Water Levels: Sand-Hosted Monitoring 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

The Applicant will review the Water Management Plan following determination of the proposed modification. This review will include consideration of monitoring data collected since 2003 on the property, and in registered bores of the local area (in similar geology), to establish a long-term baseline and modify the triggers (if necessary) to reflect natural fluctuations in water levels.

7. DoI

The spring flow trigger in Table 21 refers to a significant decrease in the spring flow rate, which is defined as a flow rate of less than 0.1L/s. It is recommended this be reviewed to consider the acceptability of the impact before this trigger is reached.

Response

A 'V' notch weir and calibrated automated flow sensor were installed in the 'spring' on 'Inverary Park' in Lot 2 in DP84966 which adjoins the eastern boundary of 'Ardmore Park in early 2018 to accurately log spring flow. The spring is known as Phil's Spring. The spring flow, as measured, has fluctuated since installation, primarily in response to rainfall and recharge of the sand, however, a reduction from approximately 8,800L/day to 7,800L/day has been recorded. When converted this approximates 0.1L/s. Accordingly, the Applicant commissioned an investigation of the spring flow as nominated in the Quarry *Water Management Plan* (and reproduced in *Table 21* of the *Environmental Assessment* accompanying the proposed modification).

Larry Cook Consulting Pty Ltd was commissioned to assess the declining performance of Phil's Spring. The spring assessment was prepared in July 2018 (Ref. 18059-A dated 13th July 2018) and concluded that the overall decline in flow rates from Phil's Spring between 2003 and 2018 is not due to an impact from basalt quarrying activities or any sand extraction on 'Ardmore Park', or from pumping from licensed Production Bore APBH6 on 'Ardmore Park'.

The above notwithstanding, the Applicant recently met with the owners of 'Inverary Park' and offered to subsidise the cost of a supplementary water supply (bore). The offer was not accepted.

8. DoI

In the case that approval is granted for the project, the following should be included as conditions of consent:

- *Inclusion of the new nested monitoring bore in the groundwater monitoring plan and the updated Water Management Plan.*
- *The proponent must update the Surface Water Management Plan and Groundwater Management Plan in consultation with DoI Water.*

Response

Acknowledged.

9. CLOSURE

Please do not hesitate to contact Larry Cook if you have any questions or require further information.

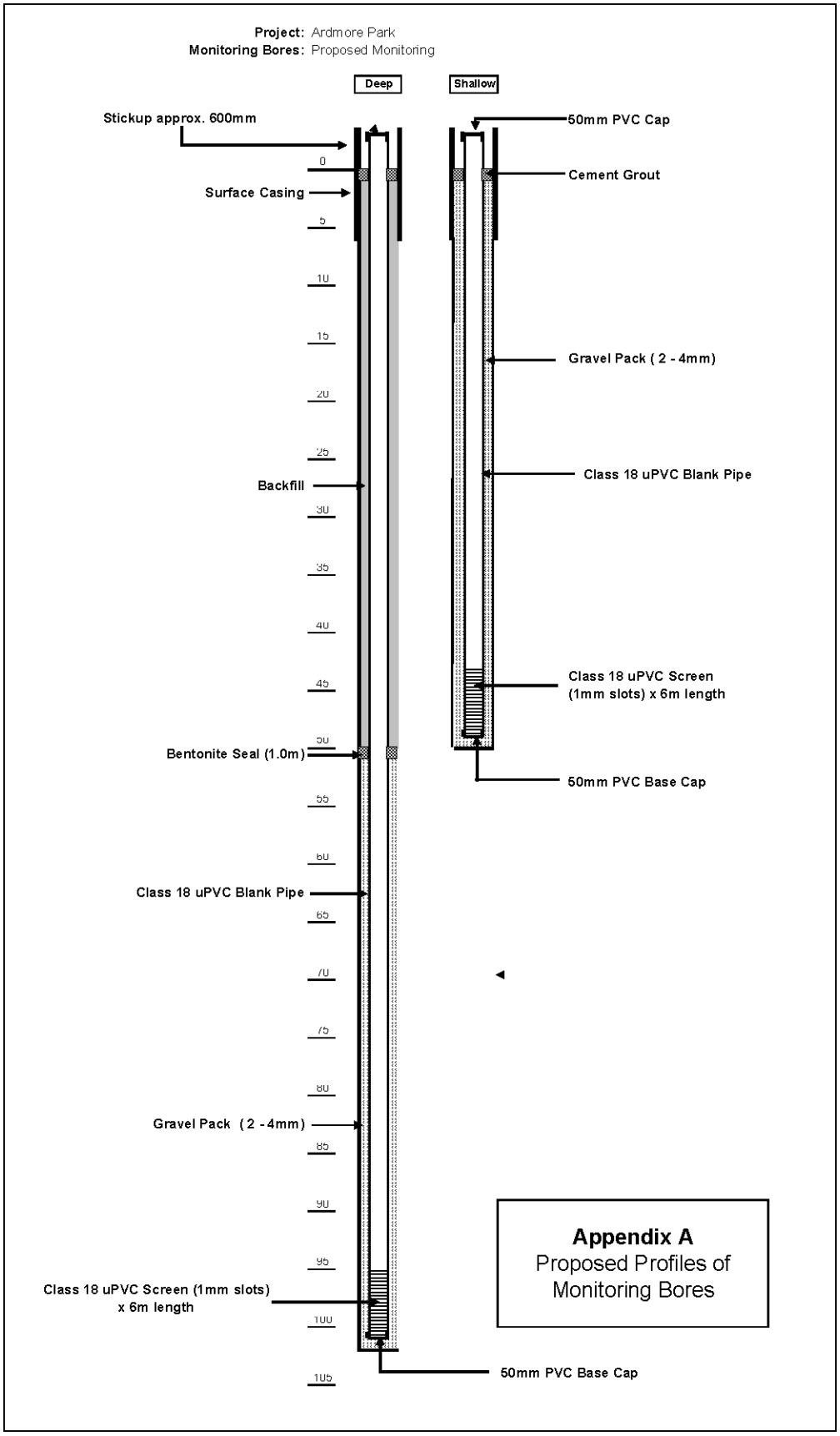
Yours sincerely

Larry Cook (BSc, MSc)
Hydrogeologist
Larry Cook Consulting

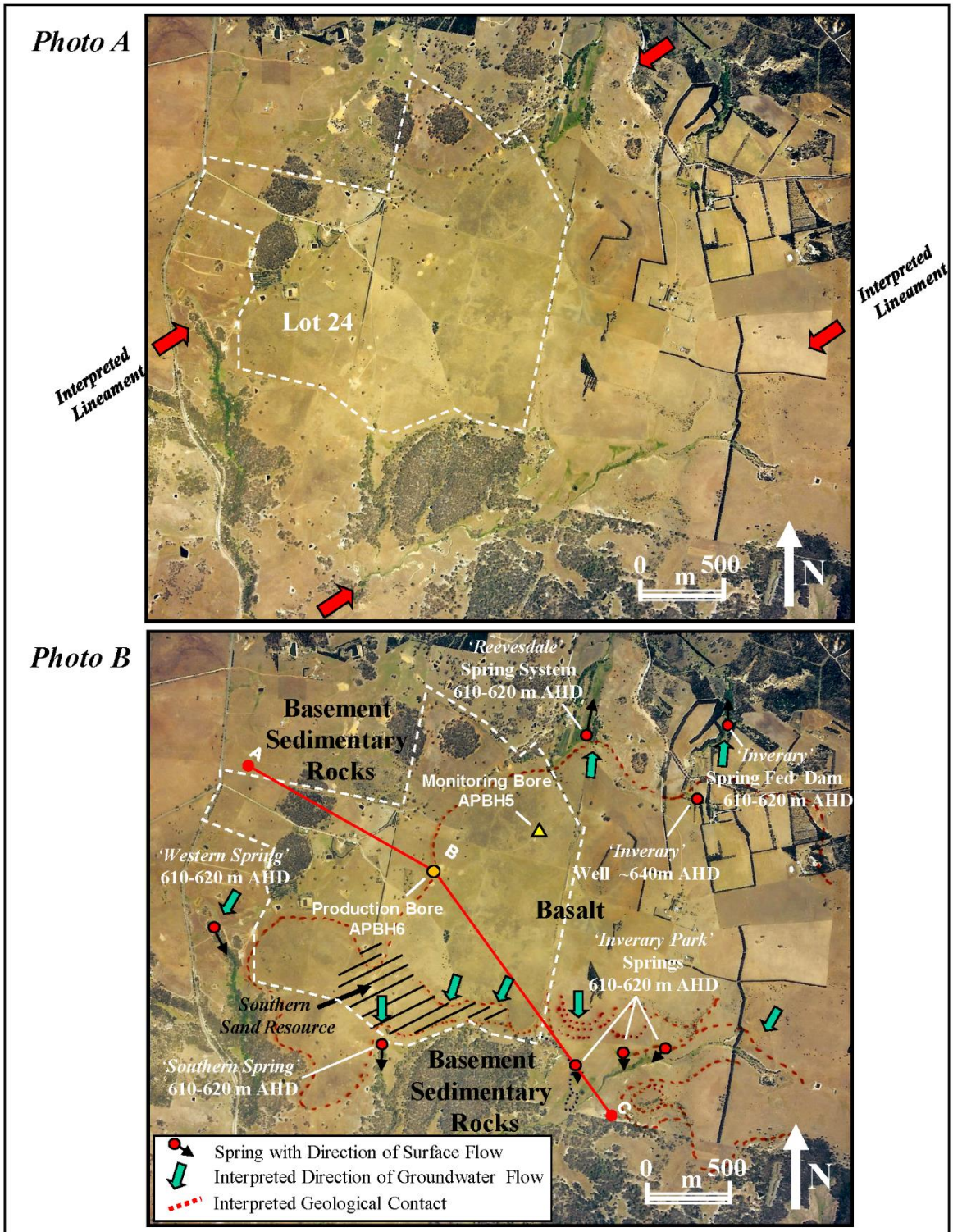
Attachments: Appendix A
Figures 1 to 6

APPENDIX A

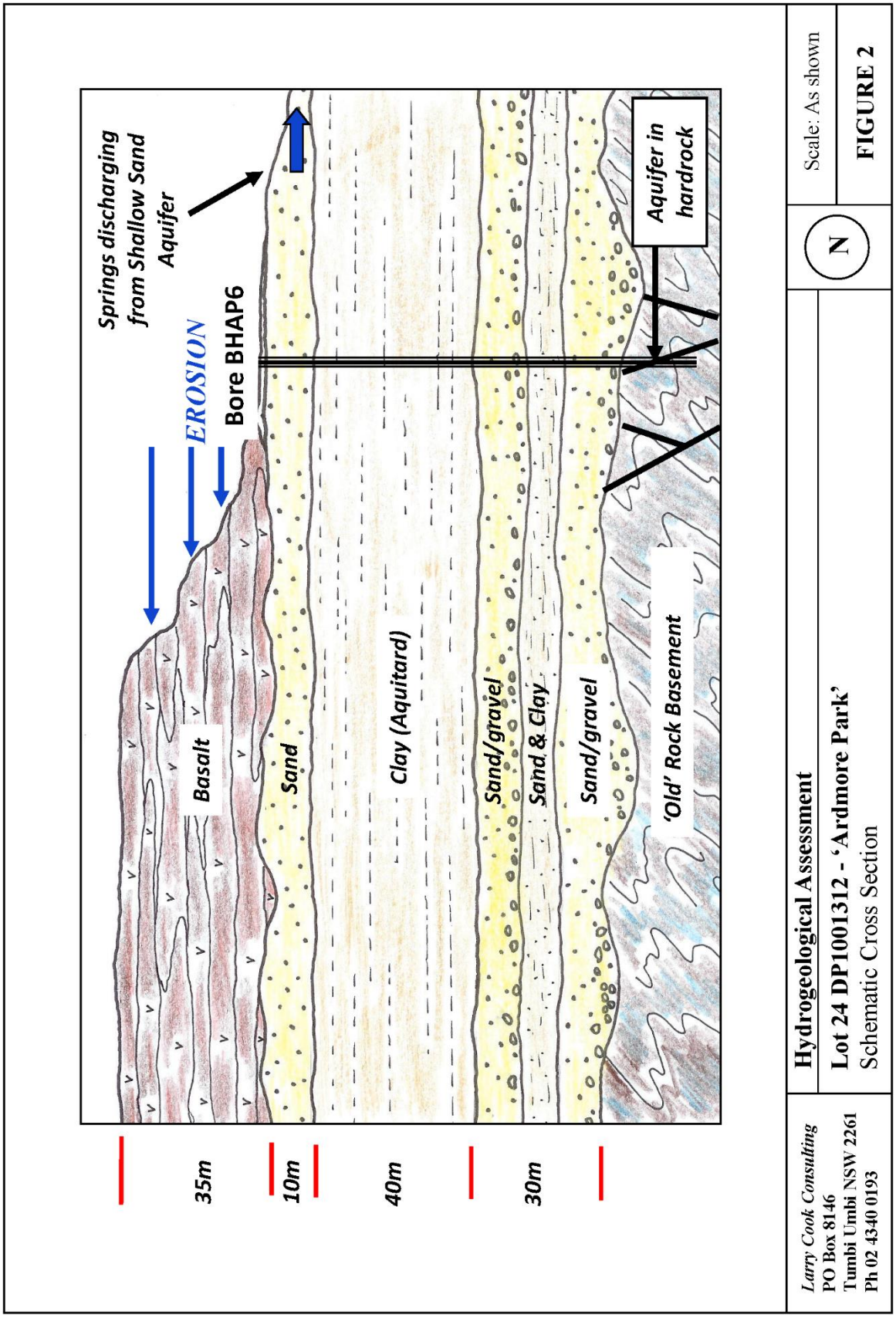
Monitoring Bore Design

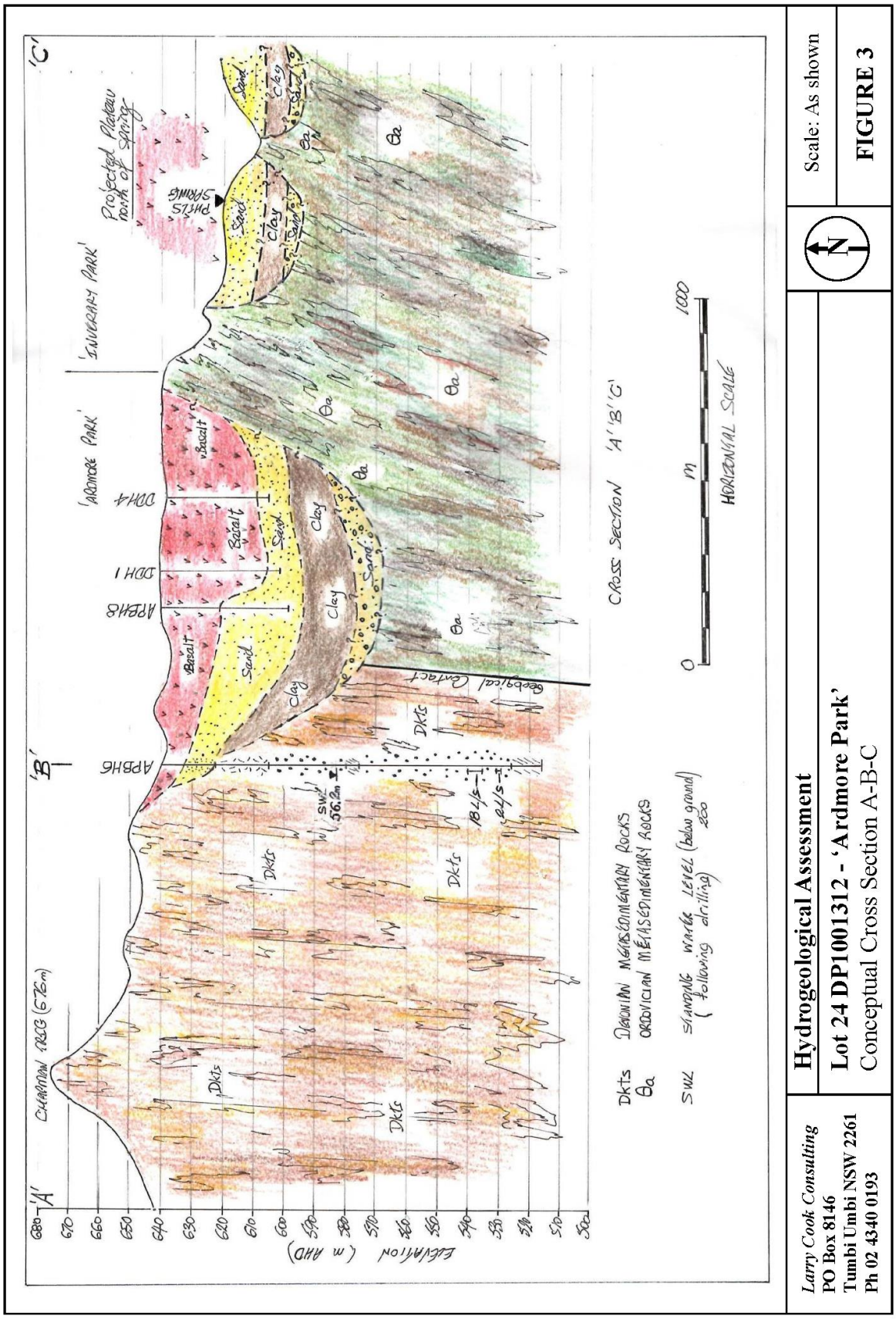

Project: Ardmore Park
Monitoring Bores: Proposed Monitoring
Deep
Shallow
Stickup approx. 600mm
50mm PVC Cap
Cement Grout
Surface Casing
Gravel Pack (2 - 4mm)
Class 18 uPVC Blank Pipe
Backfill
Class 18 uPVC Screen
(1mm slots) x 6m length
Bentonite Seal (1.0m)
50mm PVC Base Cap
Class 18 uPVC Blank Pipe
Gravel Pack (2 - 4mm)
Class 18 uPVC Screen (1mm slots)
x 6m length
50mm PVC Base Cap
Appendix A
Proposed Profiles of
Monitoring Bores

FIGURES



Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Ph 02 4340 0193**	**Hydrogeological Assessment**	Scale: As shown
	Lot 24 DP1001312 - 'Ardmore Park' Local Geology and Cross Section ABC	**FIGURE 1**


Springs discharging from Shallow Sand Aquifer
EROSION
Bore BHAP6
Aquifer in hardrock
Basalt
Sand
Clay (Aquitard)
Sand/gravel
Sand & Clay
Sand/gravel
'Old' Rock Basement
35m
10m
40m
30m
N
Scale: As shown
FIGURE 2
Hydrogeological Assessment
Lot 24 DP1001312 - 'Ardmore Park'
Schematic Cross Section
Larry Cook Consulting
PO Box 8146
Tumbi Umbi NSW 2261
Ph 02 4340 0193


'A'
'B'
'C'
CHARNWOOD ROAD (572m)
'ARDMORE PARK'
'INVERARY PARK'
Projected Plateau
North of Spring
PHILS SHRINE
ARBH6
DDH1
DDH4
Basalt
Sand
Clay
Geological Contact
SWL 56.2m
Dkts
Oa
CROSS SECTION 'A' 'B' 'C'
HORIZONTAL SCALE
0
500
1000
m
ELEVATION (m AHD)
DEVONIAN METASEDIMENTARY ROCKS
ORDOVICIAN METASEDIMENTARY ROCKS
STANDING WATER LEVEL (below ground)
(following drilling)
Scale: As shown
FIGURE 3
Hydrogeological Assessment
Lot 24 DP1001312 - 'Ardmore Park'
Conceptual Cross Section A-B-C
Larry Cook Consulting
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Tumbi Umbi NSW 2261
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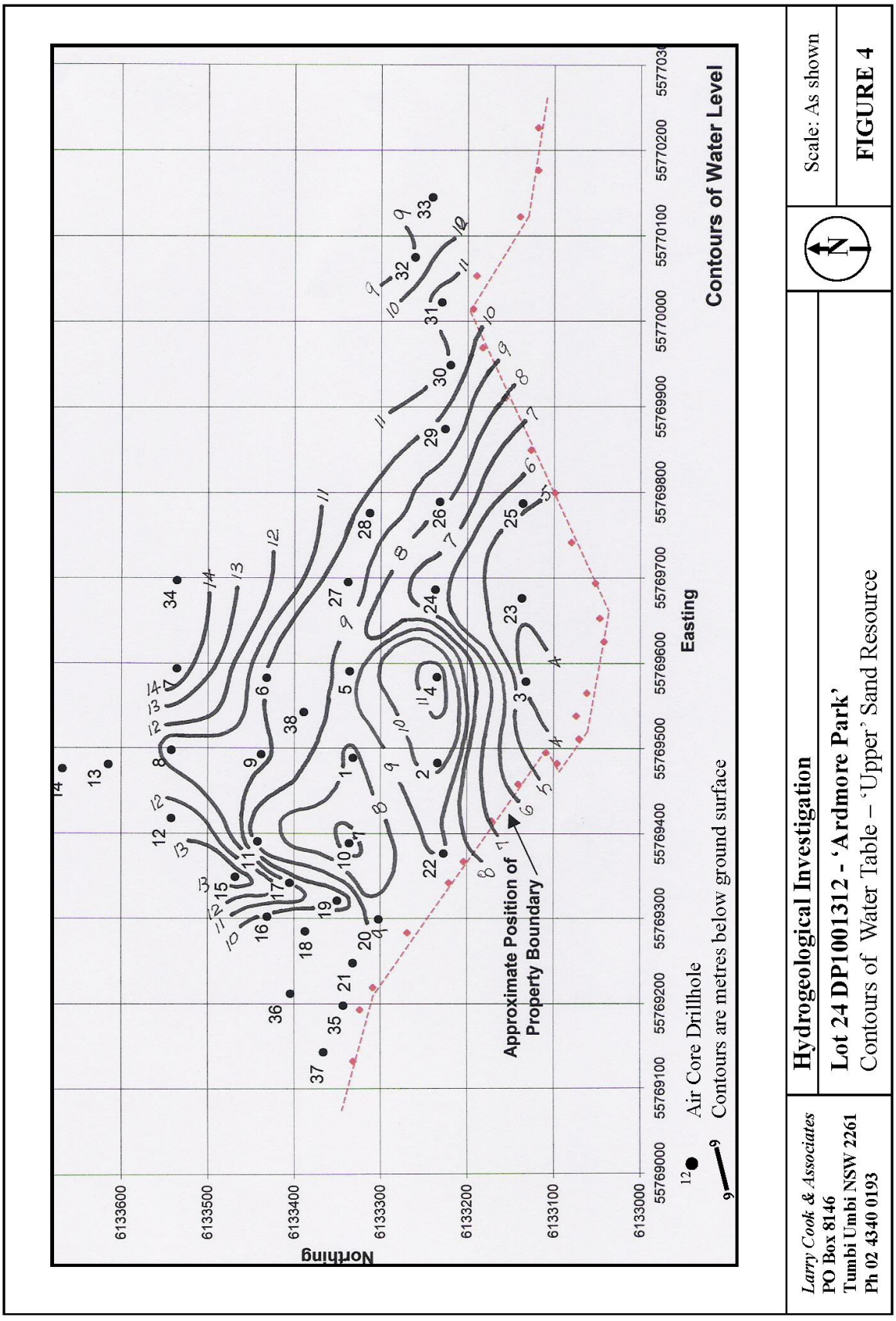
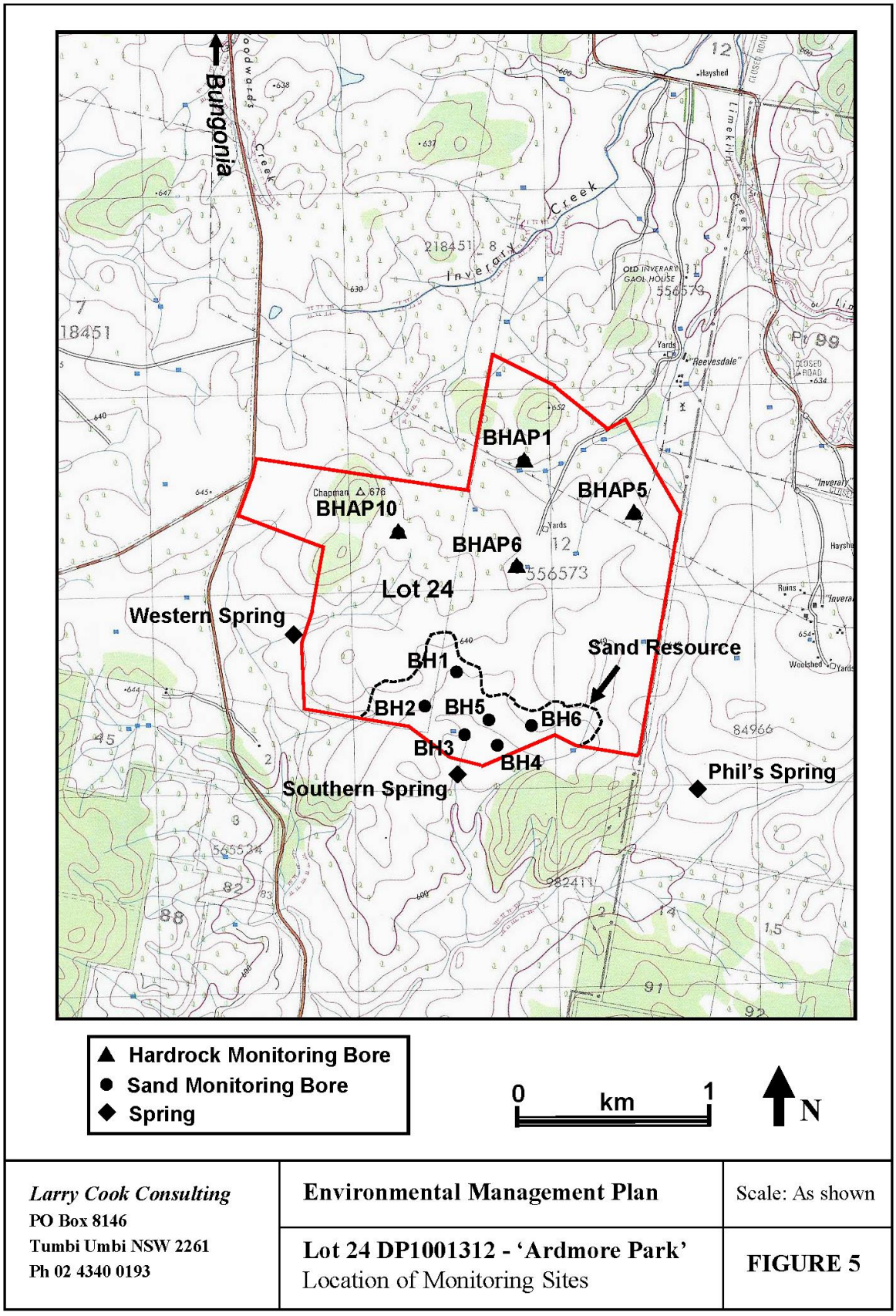
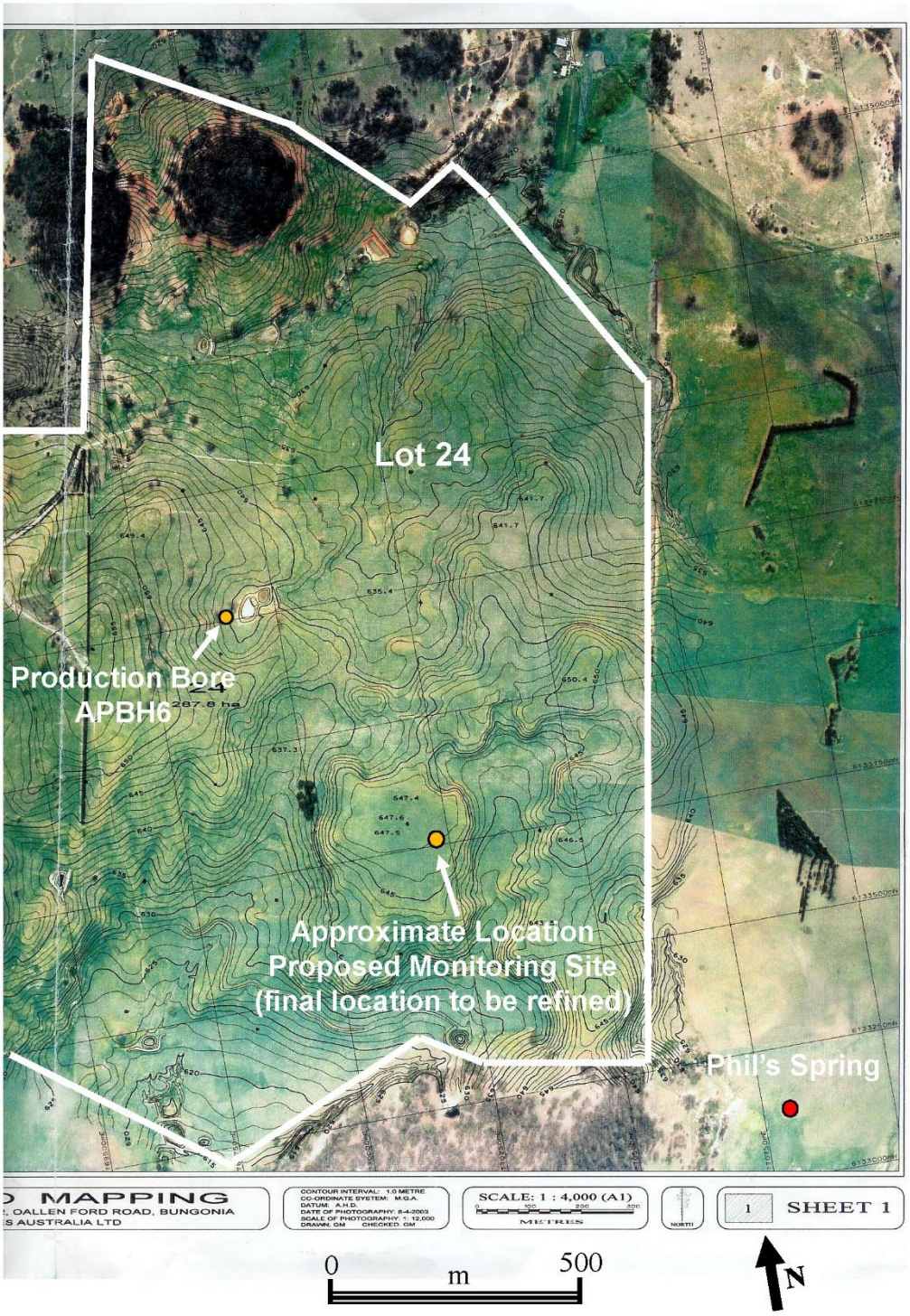

Contours of Water Level
Easting
Northing
Approximate Position of Property Boundary
Air Core Drillhole
Contours are metres below ground surface
Larry Cook & Associates
PO Box 8146
Tumbi Umbi NSW 2261
Ph 02 4340 0193
Hydrogeological Investigation
Lot 24 DP1001312 - 'Ardmore Park'
Contours of Water Table – 'Upper' Sand Resource
Scale: As shown
FIGURE 4



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 5**



Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Ph 02 4340 0193**	**Hydrogeological Assessment**	Scale: As shown
	Lot 24 DP1001312 - 'Ardmore Park' Proposed Monitoring Site	**FIGURE 6**