Rob Lait & Associates PTY LTD
ABN 15 127 209 965

PO Box 788
(27 Scheu Street)
INNISFAIL
Queensland 4860
AUSTRALIA
Phone 617 4061 3103
Fax 617 4061 8094

RL/rl: (Underground Water Rights for Mining of Wynberg deposit)
Project No. 216
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ANALYSIS OF UNDERGROUND WATER RIGHTS

WYNBERG LEASE

EXCO RESOURCES

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1.0 INTRODUCTION

Rob Lait and Associates Pty Ltd (RLA) was requested by Exco Resources Ltd to provide information on underground water rights for their Wynberg lease.

According to The Department of Environment and Heritage Protection Guideline on *Requirements for site-specific and amendment applications – underground water rights*[1], underground water rights provide the tenure holder with a statutory right to take or interfere with underground water in the area of the tenure if the taking or interference with that water is necessarily and unavoidably obtained in the process of extracting the resource.

This document seeks to examine the legislative requirements that may pertain to underground water rights at Wynberg, and to provide technical information that may be required by the administering authority (now the department of Environment and Science [DES]) in relation to those rights.

2.0 LEGISLATIVE REQUIREMENTS

The legislative requirements of the Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016 (EPOLA Act), which amends the Environmental Protection Act (EP Act), and Chapter 3 of the Water Act 2000 (Water Act) pertain to underground water rights. The EPOLA Act details specific methods and information that DES considers necessary for provision to the administering authority, in accordance with section 126A of the EP Act.

Water Act 2000 (QLD)

Section 376

The statutory requirements for the more comprehensive underground water impact reports (UWIRs) as detailed in section 376 of the Water Act 2000 (QLD are transcribed as boxed text below. Many of these requirements pertain to underground water rights and provide guidance in that regard.

Section 376 of the Water Act (2000):

1) An underground water impact report must include each of the following—
   a) for the area to which the report relates—
      i) the quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights; and

      Example for paragraph (a)(i)—

      If the report is prepared by a mining tenure holder before it exercises its underground water rights, the quantity of water produced or taken from the area would be shown in

[1] Department of Environment and Heritage Protection, 6 December 2016. Guideline (Envioronment Protection Act 1994) *Requirements for site-specific and amendment applications – underground water rights*

the report as zero.

ii) an estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period starting on the consultation day for the report;

b) for each aquifer affected, or likely to be affected, by the exercise of the relevant underground water rights—

i) a description of the aquifer; and

ii) an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers; and

iii) an analysis of the trends in water level change for the aquifer because of the exercise of the rights mentioned in paragraph (a)(i); and

iv) a map showing the area of the aquifer where the water level is predicted to decline, because of the taking of the quantities of water mentioned in paragraph (a), by more than the bore trigger threshold within 3 years after the consultation day for the report; and

v) a map showing the area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights, by more than the bore trigger threshold at any time;

Note—

If the underground water impact report or final report is approved, the mapped areas mentioned in subparagraphs (iv) and (v) establish immediately affected and long-term affected areas under section 387.

c) a description of the methods and techniques used to obtain the information and predictions under paragraph (b);

d) a summary of information about all water bores in the area shown on a map mentioned in paragraph (b)(iv), including the number of bores, and the location and authorised use or purpose of each bore;

da) a description of the impacts on environmental values that have occurred, or are likely to occur, because of any previous exercise of underground water rights;

db) an assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights—

i) during the period mentioned in paragraph (a)(ii); and

ii) over the projected life of the resource tenure

e) a program for --

i) conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) and (v); and

ii) giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps;

f) a water monitoring strategy;

g) a spring impact management strategy;

h) if the responsible entity is the office—

i) a proposed responsible tenure holder for each report obligation mentioned in the report; and

ii) for each immediately affected area—the proposed responsible tenure holder or holders who must comply with any make good obligations for water bores within the immediately affected area;

i) other information or matters prescribed under a regulation.

2) However, if the underground water impact report does not show any predicted water level decline in any area of an affected aquifer by more than the bore trigger threshold during the period mentioned in subsection (1)(b)(iv) or at any time as mentioned in subsection (1)(b)(v), the report does not have to include the program mentioned in subsection (1)(e).

3) In this section—

environmental value see the Environmental Protection Act 1994, section 9.

Section 1250S Associated water licence taken to be water licence for particular provisions
New section 1250S provides that an associated water licence is taken to be a water licence for the purposes of several sections of the Water Act 2000, and Mineral Resources Act 1989.

It is necessary to provide that an associated water licence is considered a water licence for the purposes of sections 394A and 369A of the Water Act 2000 to ensure that an associated water licence holder will be exempt from the requirement to prepare an underground water impact report or undertake a baseline assessment in accordance with Chapter 3 of the Water Act 2000 while they continue to take water under the authority of their associated water licence. (Explanatory notes for EPOLA Act).

As Wynberg deposit lies within the Mt Isa mineral zone, **no water licence is required under the Water Act 2000**. The Wynberg deposit is not located over the Great Artesian Basin.

3.0 ASPECTS OF SECTION 376 OF THE WATER ACT 2000 (QLD) THAT PERTAIN TO THE WYNBERG PROJECT

Underground water rights for the Wynberg project will be required to take or interfere with underground water as that water will be necessarily and unavoidably obtained for dewatering purposes of the planned open pits in the process of extracting the resource

The requirements for discussion of underground water rights for the Wynberg project are believed to be constrained to the following aspects:

- The quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights

- Estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period

- Description of the aquifer

- Analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers

- Analysis of the trends in water level change for the aquifer because of the exercise of the rights

- The area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights

- Methods and techniques used to obtain the information and predictions

- Information about all water bores in the area

- Assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights

Each of these aspects will be discussed below. The majority of the information that is presented is sourced from a more comprehensive analysis of the hydrogeological regime undertaken by RLA (March, 2018)[2] and the reader is referred to that document for additional information if required.

The quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights

No groundwater has been produced or taken from the Wynberg area for this mining project to date.

Estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period

Groundwater extraction will be required to assist with dewatering of the open pits at the Wynberg project. The seven proposed open pits at Wynberg deposit have been designated as shown on Figure 1.

2 Rob Lait and Associates Pty Ltd, March 2018. HYDROGEOLOGICAL REGIME WYNBERG LEASE EXCO RESOURCES

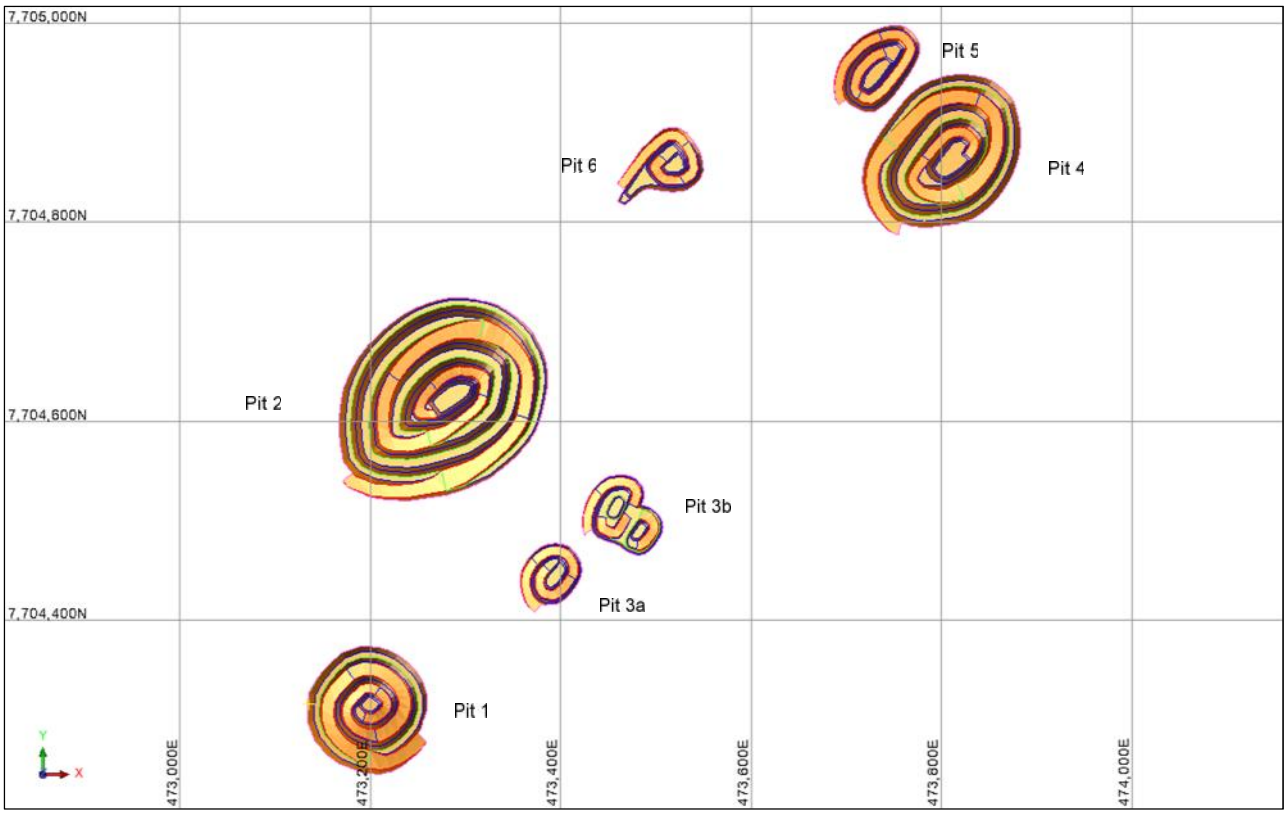

Figure 1: Designations of Open Pits at Wynberg Deposit

RLA[1] has estimated the groundwater inflow to each open pit as shown in Table 1.

TABLE 1: PIT INFLOW ESTIMATES

Pit	Top elevation mAHD	Bottom elevation mAHD	Water table elevation mAHD	Cross-sectional area of saturated aquifer (m^2)	Water table gradient	Hydraulic conductivity k m/s	Total inflow L/s
1	190	145	159	326	0.31	1.27E-06	0.51
2	190	110	150	1430	0.43	1.27E-06	3.12
3a	190	165	148	0		1.27E-06	0.00
3b	185	165	154	0		1.27E-06	0.00
4	180	125	166	1540	0.54	1.27E-06	4.22
5	180	150	160	144	0.27	1.27E-06	0.20
6	180	155	162	111	0.36	1.27E-06	0.20
All							8.26

Note that no groundwater inflow is possible to Pits 3a and 3b as they do not proceed to the depth of the water table.

The main pits that will require dewatering are Pits 2 and 4. The total estimated inflow to Pits 2 and 4 is 7.34L/s.

Groundwater will be taken from existing bore WYNGWMB03 for dewatering during mining of the open pits. Bore WYNGWMB03 is the most productive of the five bores drilled by Exco in the assessment of the hydrogeological regime. It yielded 8L/s on airlift. Subsequent hydraulic testing showed that the black shale aquifer in this bore has the highest hydraulic conductivity of the five bores.

Hence, WYNGWMB03 will be equipped with a pump capable of extracting about 7.34L/s to assist with the dewatering requirements.

Advice received from Exco is that Pit 2 will be mined for 7.5 months and Pit 4 for 2 months. Assuming that WYNGWMB03 is used for that 9.5 month period, the total volume of groundwater to be extracted is about 187ML.

WYNGWMB03 will not be used for dewatering after mining of Pits 2 and 4 ceases.

If required during the dewatering period Exco will consider installing another groundwater monitoring bore in the vicinity of WYNGWMB03 for additional groundwater monitoring during the mining period.

Description of the aquifer

RLA[1] provides a detailed description of the prime aquifer at Wynberg as follows:

"The prime aquifer at Wynberg deposit is comprised of fractured and weathered black shale which occurs at the top of the fresh (i.e. unweathered rock). …

The prime aquifer is confined or at least semi-confined.

There are no reports of water intercepts within the alluvium that overlies the fractured and weathered black shale. It is considered that although alluvium appears to be present from the geological mapping, no alluvial aquifer exists at Wynberg deposit."

Analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers

The most likely mechanism for recharge to the aquifers at Wynberg deposit is *episodic* or *flood recharge*. During a major rainfall event, 80% of water not lost by evaporation may discharge as surface runoff. Deep drainage will occur only as a result of exceptional circumstances.

- Recharge is most likely during the months of January and February – the months in which mean rainfall is the highest.
- Due to the skeletal nature of the soil, the high proportion of runoff and the outcropping lithologies, recharge to the aquifers is probably as low as 1-2% of the aggregate January – February rainfall. This figure, although low, is consistent with similar areas in north western Queensland.

The depths to groundwater in the groundwater monitoring bores at Wynberg deposit are illustrated in Figure 2.

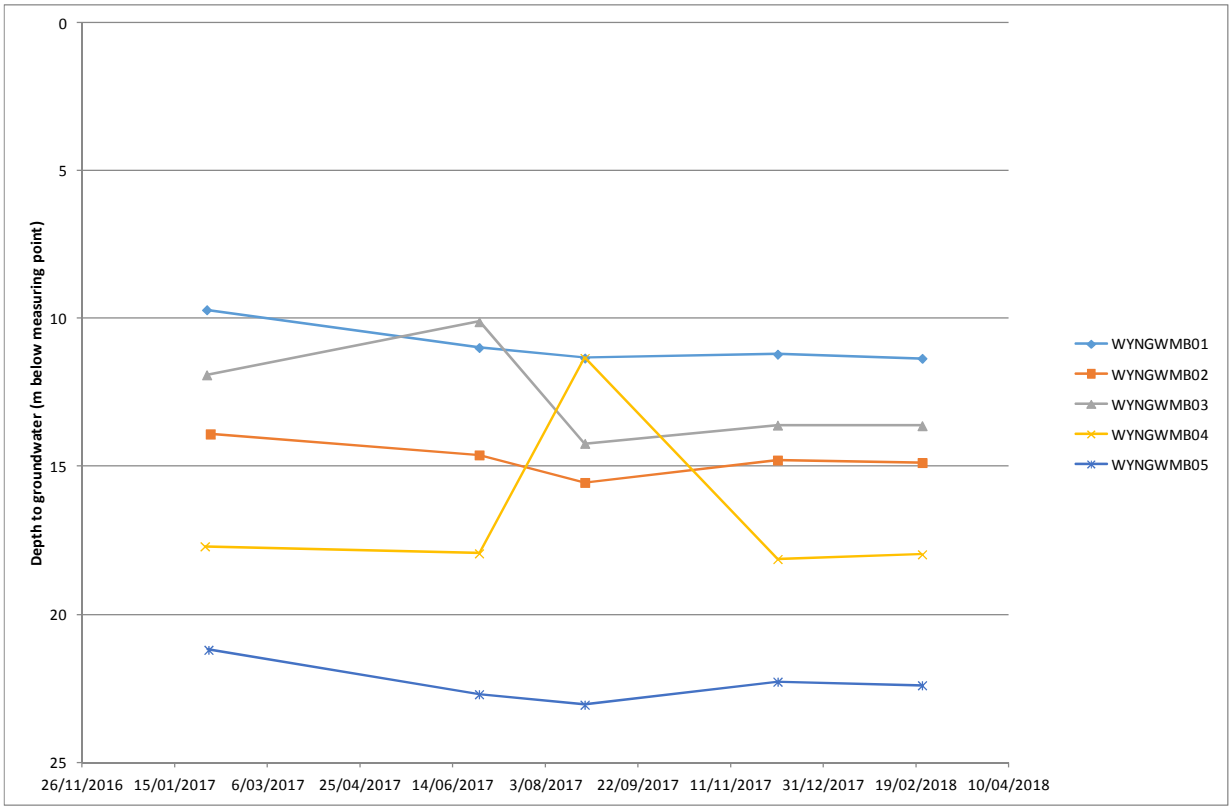

Figure 2: Chart of depth to groundwater in Wynberg deposit groundwater monitoring bores

It can be seen from Figure 2 that the depth to groundwater at Wynberg deposit is a minimum of 10m below ground level and that natural seasonal groundwater level fluctuation may be as much as 3m. In addition to this observation the potentiometric surface contours for the Wynberg project (RLA[1]) show that groundwater flow is away from the major watercourses.

Based on these two facts it is considered that there will be no groundwater – surface water interaction at the Wynberg deposit.

Thus the only possible mechanism for movement of groundwater from the prime aquifer under natural conditions is lateral movement through the aquifer at depth in the direction of groundwater flow i.e. primarily towards the north east.

Analysis of the trends in water level change for the aquifer because of the exercise of the rights

Figure 2 shows the natural fluctuation trends in the hydrogeological regime under pre-mining conditions.

The predicted drawdown resulting from pumping of WYNGWMB03 was analysed using the Theis (1935) method for confined aquifers[3].

The Theis equation is of the form:

$$s = Q (W_u) / 4\Leftrightarrow T$$

Where:	s	=	drawdown
	Q	=	pumping rate in m^3/day
	W_u	=	the well function
	T	=	transmissivity of the aquifer in m^2/day

The well function "W_u" is determined from published tables for this method and is derived from the value of the variable "u" which depends on the distance over which the drawdown effect is to be assessed, the storativity of the aquifer and the time over which the bore will be pumped. The variable "u" is calculated using the following relationship:

$$u = r^2S / 4Tt$$

Where:	r	=	radius from bore at which drawdown is assessed (m)
	S	=	Storativity of the aquifer
	T	=	transmissivity of the aquifer in m^2/day
	t	=	time over which the bore will be pumped (days)

Table 2 shows the predicted drawdown in the prime aquifer in response to pumping of WYNGWMB03 for a period of 300 days (just over 9.5 months). This analysis assumes that groundwater flow to the pits is radially symmetrical which may not necessarily be the case in a structurally controlled area such as the Wynberg deposit

[3] Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

TABLE 2 : THEIS ANALYSIS (DRAWDOWN BY DISTANCE)			
Flowrate	(L/s)	7.34	
	(m^3/day)	634	
	(ML/annum)	231	
Time	(days)	300	
	(years)	0.8	
Transmissivity	(m^2/day)	11.88	
Storativity	(-)	1.00E-03	
Distance	u	w(u)	Drawdown
(m)			(m)
10	7.015E-06	11.2903	47.96
20	2.806E-05	9.9041	42.07
30	6.313E-05	9.0932	38.63
40	1.122E-04	8.5178	36.18
50	1.754E-04	8.0716	34.29
60	2.525E-04	7.7071	32.74
70	3.437E-04	7.3988	31.43
80	4.489E-04	7.1319	30.30
90	5.682E-04	6.8964	29.30
100	7.015E-04	6.6858	28.40
200	2.806E-03	5.3017	22.52
300	6.313E-03	4.4942	19.09
400	1.122E-02	3.9238	16.67
500	1.754E-02	3.4837	14.80
1000	7.015E-02	2.1489	9.13
1500	1.578E-01	1.4209	6.04
2000	2.806E-01	0.9558	4.06
2500	4.384E-01	0.6421	2.73
3000	6.313E-01	0.4269	1.81
3500	8.593E-01	0.2794	1.19
4000	1.122E+00	0.1794	0.76
4500	1.420E+00	0.1127	0.48
5000	1.754E+00	0.0691	0.29

Area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights

Assuming that the amplitude of seasonal groundwater level fluctuation (3m) is taken as a trigger value for drawdown induced by dewatering, the Theis method predicts that, for radial groundwater flow in the prime aquifer, the radius of influence of drawdown of the dewatering bore less than the adopted trigger limit will be of the order of 2.25km.

Figure 3 shows the locations of privately owned stockwatering bores in the vicinity of the Wynberg deposit.

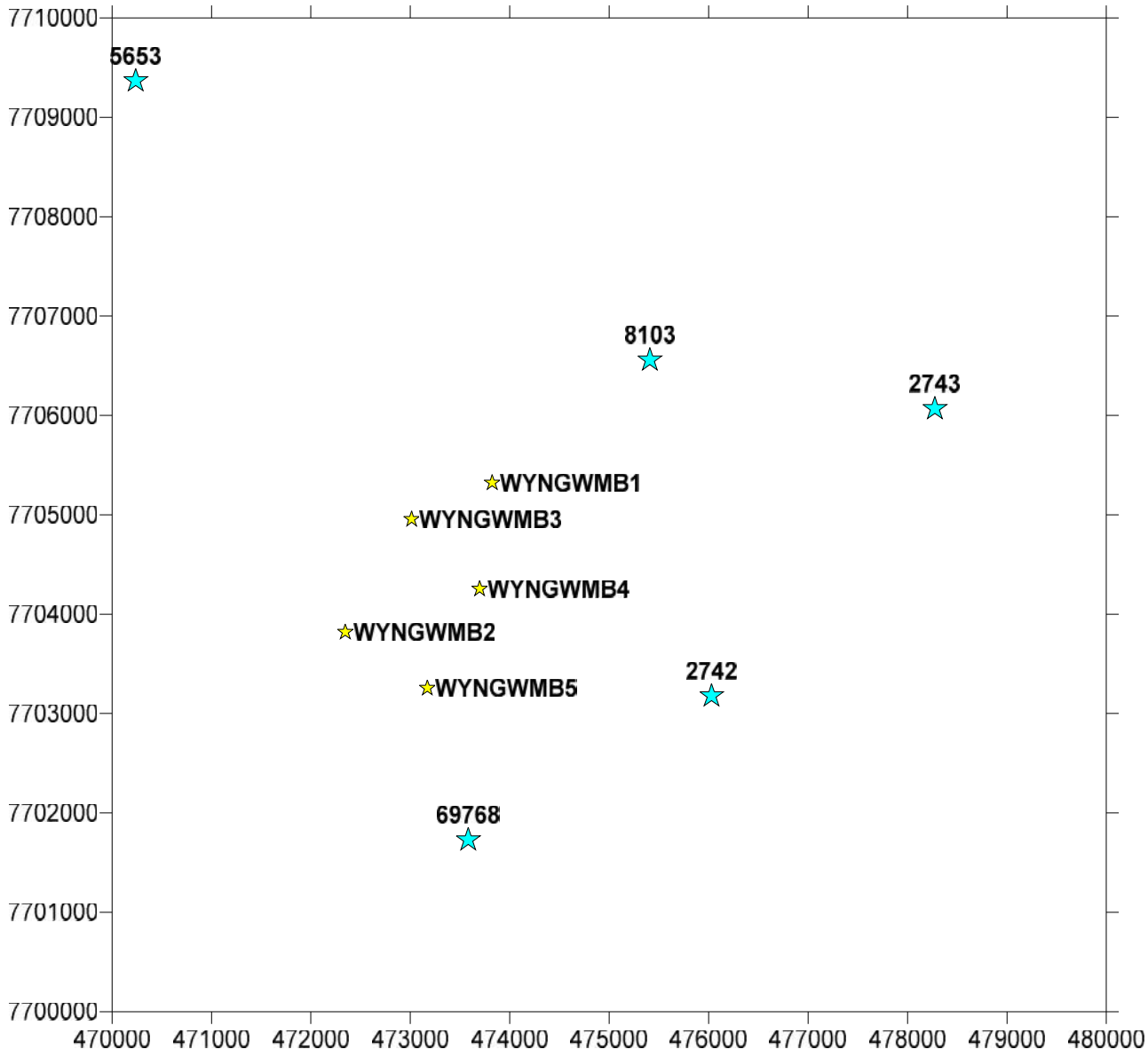

Figure 3: Locations of Wynberg Groundwater Monitoring Bores and Privately Owned Stockwatering Bores

The distances of the privately owned stockwatering bores from WYNGWMB03 are:

RN 2742	3.5km
RN 2743	5.4km
RN5653	5.2km
RN8103	2.9km
RN69768	3.4km

None of these bores falls within the radius of influence of drawdown of the dewatering bore, less than the adopted trigger limit.

Methods and techniques used to obtain the information and predictions

The information used and methodology used for the predictions made in RLA[1] are fully described in that report. The information presented here is, as previously discussed based on RLA[1].

Information about all water bores in the area

A search of the Department of natural Resources, Mines and Energy (DNRME) groundwater database revealed that, other than location details, there are no strata log, casing, groundwater quality or other data for RN 2742, RN 2743, RN5653, RN8103, or RN6978.

Assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights

An environmental value is defined in section 9 of the EP Act 1994 (QLD) to be:

> *a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or*
> *b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.*

The Environmental Protection (Water) Policy 2009 (Qld; EPP Water) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses. Groundwater resources of the Wynberg project area are located within the Cloncurry River catchment.

This area is not listed in Schedule 1 of the EPP Water, therefore, the environmental values listed in section 6(2) of the EPP Water may apply. An analysis of these environmental values is shown in Table 3.

TABLE 3: ANALYSIS OF ENVIRONMENTAL VALUES THAT APPLY TO GROUNDWATER AT WYNBERG		
Criterion	***Applicability***	***Action/s required***
for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;	*Not considered to be applicable*	*None required*
for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;	*Not considered to be applicable*	*None required*
for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree;	*Applicable*	*Ensure that groundwater is not discharged into surface water features unless groundwater quality is considered suitable*
for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters above	*Not considered to be applicable*	*None required*
for waters that may be used for producing aquatic foods for human consumption—the suitability of the water for producing the foods for human consumption;	*Not considered to be applicable*	*None required*
for waters that may be used for aquaculture—the suitability of the water for aquacultural use;	*Not considered to be applicable*	*None required*
for waters that may be used for recreation or aesthetic purposes, the suitability of the water for— *(i) primary recreational use; or* *(ii) secondary recreational use; or* *(iii) visual recreational use;*	*Not considered to be applicable*	*None required*
for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes;	*Applicable. Stockwatering is practised extensively in the Wynberg area*	*Groundwater is used almost exclusively for stockwatering by private bore owners. Ensure groundwater quality is suitable for stock before use*

TABLE 3: ANALYSIS OF ENVIRONMENTAL VALUES THAT APPLY TO GROUNDWATER AT WYNBERG		
Criterion	***Applicability***	***Action/s required***
for waters that may be used for drinking water—the suitability of the water for supply as drinking water;	*Not considered to be applicable*	*None required*
for waters that may be used for industrial purposes—the suitability of the water for industrial use;	*Not considered to be applicable*	*None required*
the cultural and spiritual values of the water.	*No known cultural and spiritual values of the water.*	*None required*

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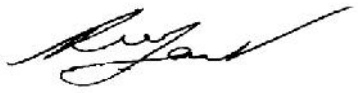

ROB LAIT
Principal Hydrogeologist