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4 October 2012

Rocla Quarry Products,
PO Box 36,
GUILDFORD, NSW 2161

Attention: Mr Alex Echt

Dear Alex,

Re: Calga Sand Quarry – Re-testing of Bore CP3

Last Friday, 25 October 2013, I conducted a pumping test on bore CP3, which is the Gazzana Domestic Bore. This testing was carried out in response to observed drawdown impacts attributed to the quarrying activities, as discussed in my 2012 independent audit of the groundwater monitoring data (Dundon Consulting, 2013).

1. Groundwater Impact Assessment Criteria

The Calga Site Water Management Plan (SWMP) lists groundwater impact assessment criteria, the first of which relating to groundwater levels states:

> *"…if at any annual independent audit review, there is a declining trend in groundwater levels which is not attributable to climatic conditions or other factors not related to sand extraction, and if the groundwater level decline at monitoring bores CQ10 or CQ11 deemed due to sand extraction impact exceeds 1.0m, then the adjoining landowners will be approached to arrange re-testing of their existing production bore(s). The test results will be compared to pre-extraction tests, and if it is determined that any bore has suffered a reduction in the pumping yield of greater than 10% then action will be taken as described in the Plan."*

It was reported in the 2012 independent groundwater audit (Dundon Consulting, 2013) that the monitoring results suggested that groundwater levels at CQ11S and CQ11D had declined by up to 1.6m and 1.5m respectively, relative to water levels in other bores to the north of the Rocla Site. This relative decline in water levels was interpreted to be attributable to the quarrying activities.

The testing of bore CP3 at this time was therefore mandated by the occurrence of a drawdown attributable to Rocla's quarrying activities greater than 1.0 m at monitoring bores CQ11S and CQ11D. These bores were installed as part of the monitoring network, and were specifically installed to monitor for potential impact on bore CP3. The locations of these three bores are shown on **Figure 1**.

Note that this trigger relates to water level changes in the two monitoring bores CQ11S and CQ11D, and does not imply any adverse impact on potential yield at the private water supply bore CP3. I concluded in the audit report that the magnitude of water level impact was unlikely to have had any noticeable effect on the yield from CP3.

2. Water Supply Bore CP3

CP3 is a water supply bore located just north of the Rocla Quarry Site. It is a domestic bore which is used to supply water to the house and outbuildings on the property known as the "Gazzana" property. CP3 is among a group of bores located within 500m of the Rocla property which were subjected to hydraulic testing prior to the sand extraction activities approved by Development Consent DA 94-4-2004 ("the Consent"). The results of pre-extraction testing were reported in Aquaterra (2008). Note that CP3 was not tested at that time due to lack of access, as the bore was the only source of domestic water for the property at the time, and could not be freed up for sufficient time to allow testing to take place.

Prior to commencing the pumping test on 25 October 2013, the depth and water level of CP3 were checked. The bore depth was measured as 21.38m, and the standing water level as 8.97m below ground level. The top of the casing was observed to be flush with the concrete floor of the pump shed in which the bore is located.

The bore depth and height of casing are different to the values reported in the pre-extraction testing report (Aquaterra, 2008). Portion of **Table 2.1** from that report is re-produced below with the correct dimensions shown in red. In addition to the corrections relating to bore CP3, the most recent water level measurements from all the private water supply bores on 1 October 2013 are shown as well, also in red.

Table 2.1 Summary of Bore Construction Details – Private Water Supply Bores

Bore	Old Name	Registered Bore No	Bore Licence No	Ground Level	Stickup	Bore Depth	Groundwater Production Interval	Water Level	
				mAHD	m	m	mbgl	mbgl	mAHD
CP1	PB1	GW101409	10BL157058	193.53	0.02	60.9	NR	3.6	189.9
CP2	PB2	GW104887	10BL161724	198.75	0.12	40.0	11-13	6.3	192.6
CP3	Gazzana Domestic Bore	GW104176	10BL141536	215.95	**0.00***	**21.4***	NR	**8.97***	**206.9**
CP4	-	GW066908	10BL141537	est 218	-	44.0	13.9-14.1 27.3-27.7	**9.27****	**~209**
CP5	-	GW067408	10BL156622	est 218	-	76.0	10.1-10.2 20.4-20.5 38.3-38.6 61.2-61.3	**5.93****	**~212**
CP6	-	GW101316	10BL157467	est 215	-	92.0	16.5-16.8 62.7-63.0 76.2-76.5	**8.47****	**~207**
CP7	-	GW037925	10BL141519	est 205	-	76.2	4.8-39.5	**1.53****	**~203**
CP8	-	GW066907	-	est 225	-	?	20.6-20.7 44.3-44.6	**19.82****	**~205**

*** Measured 25 October 2013.**

**** Measured 1 October 2013 (from the latest environmental report on the Rocla Calga website).**

CP3 is much shallower than reported in the 2008 Aquaterra report (76.2m), which is also the depth recorded in the NOW groundwater bore database. I confirmed with Mr Gazzana on 25 October 2013 that the bore depth has always been around 20m, confirming that there has not been any change to the bore depth since Rocla commenced extraction under the 2004 development approval. The depth shown in the 2008 report and in the NSW Office of Water (NOW) groundwater bore database was therefore incorrect.

3. Pumping Test Conducted on 25 October 2013

The pumping test on 25 October 2013 was conducted using the installed pump, at a discharge rate of 20 litres (20L) per 90 seconds, which equates to 0.22 L/s or 19 kL/d (ie 19 m^3/d). The exact depth of the pump inlet is not known, but Mr Gazzana advised that it was set near the bottom of the bore. The discharge rate was controlled by a valve on the outlet pipe.

The test was terminated after 20 minutes, by which time the water level had declined to around 18m, and the pump had started showing signs that it was about to run out of water.

Water level in the bore (CP3) was measured manually through the test period, and through a 50 min recovery period.

The plot of drawdown and recovery data from the test is shown on **Figure 2**.

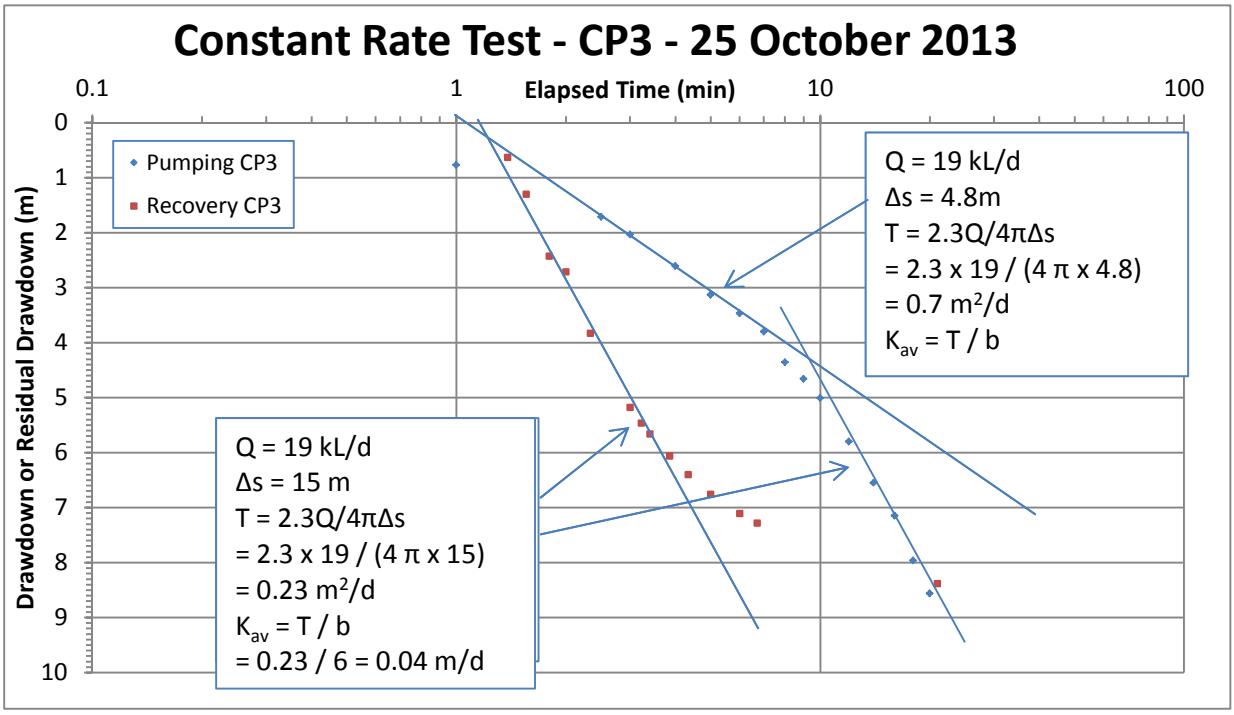

Figure 2: Constant Rate Pumping Test – CP3 – 25 October 2013

The test data were analysed using the Cooper-Jacob method (Cooper and Jacob, 1946) and determined an aquifer transmissivity[1] of 0.7 m^2/d.

The transmissivity value derived from the test, and other recorded data from the date of the test on 25 October 2013, have been compared to the results of testing carried out in 2006, as reported in Aquaterra (2008).

The table below is a partial reproduction of **Table 2.2** from the 2008 Aquaterra hydraulic testing report, including the results of the October 2013 testing of CP3, shown in red. There was no test of CP3 in 2006, so the results can only be compared with the 2006 testing of other private bores in the vicinity.

The value of transmissivity determined for CP3 (0.7 m^2/d) is within the range of values determined at the other bores CP4 to CP7 (0.05 to 5.4 m^2/d), and is exceeded only by CP5.

[1] Transmissivity (in units of m^2/d) is the product of aquifer thickness and average aquifer hydraulic conductivity, ie T (m^2/d) = k (m/d) x D (m).

Table 2.2 Hydraulic Testing Results – Private Water Supply Bores

Bore	Screened Interval	Date of Test	Type of Test	Pumping Rate	Duration	Transmissivity
	mbgl			kL/d	min	m^2/d
CP3	?	**25 Oct 2013**	**Constant Rate**	**19**	**20**	**0.7**
CP4	Open hole	25 Aug 2006	Constant Rate	8	360	0.05
CP5	Open hole	25 Aug 2006	Constant Rate	8	420	5.4
CP6	Open hole	15 Sep 2006	Constant Rate	33	90	0.33
		18 Sep 2006	Constant Rate	16	360	0.15 (early data)
						0.28 (late data)
CP7	Open hole	26 Jul 2006	Constant Rate	12.5	360	0.15

On the basis of this result, it is apparent that CP3's performance is generally similar to the neighbouring private water supply bores (CP4 to CP7). Only CP5 has a higher transmissivity, but CP5 is a deeper bore (76m) than CP3 (21.4m)), and would be able to obtain additional groundwater inflows from horizons deeper than the base of CP3 (ie from between 21m and 76m).

4. Assessment of Performance of CP3

It is assessed that Rocla's quarrying operations have not had an adverse impact on CP3. This is primarily based on the results of the 25 October pumping test, which showed that CP3's current performance is consistent with the nearby private water supply bores.

The monitoring data shows that the water level in CP3 is not low by historical levels, and is actually higher now than during 2006, when the pre-extraction bore testing was undertaken. The water level in the bore immediately prior to the test was 8.97m below ground level which is well within the long-term range of water level fluctuation, and therefore no reduction in performance (ie yield potential) would have been expected to have occurred. This can be seen on **Figure 3**, which shows the CP3 water level hydrograph through the monitoring period from 2006 to 2013.

The interpreted drawdown impact on CP3 was only detectable as a divergence between the CP3 water level and the rainfall residual mass curve, and specifically a divergence between the water levels at CP3 and CP7. CP7 is located further from the quarry than CP3, and has shown no sign of impact from the quarrying operation. Prior to the onset of impact on CP3 coinciding with the period of extraction from cell 3/6 between April and October 2011, CP3 and CP7 generally fluctuated together in response to the seasonal recharge pattern which is related to larger rainfall events.

The pumping test also showed no evidence of damage to the bore or to the aquifer open to the bore. The NOW records indicate that CP3 is only cased to shallow depth, and is open hole through the zone of groundwater inflow.

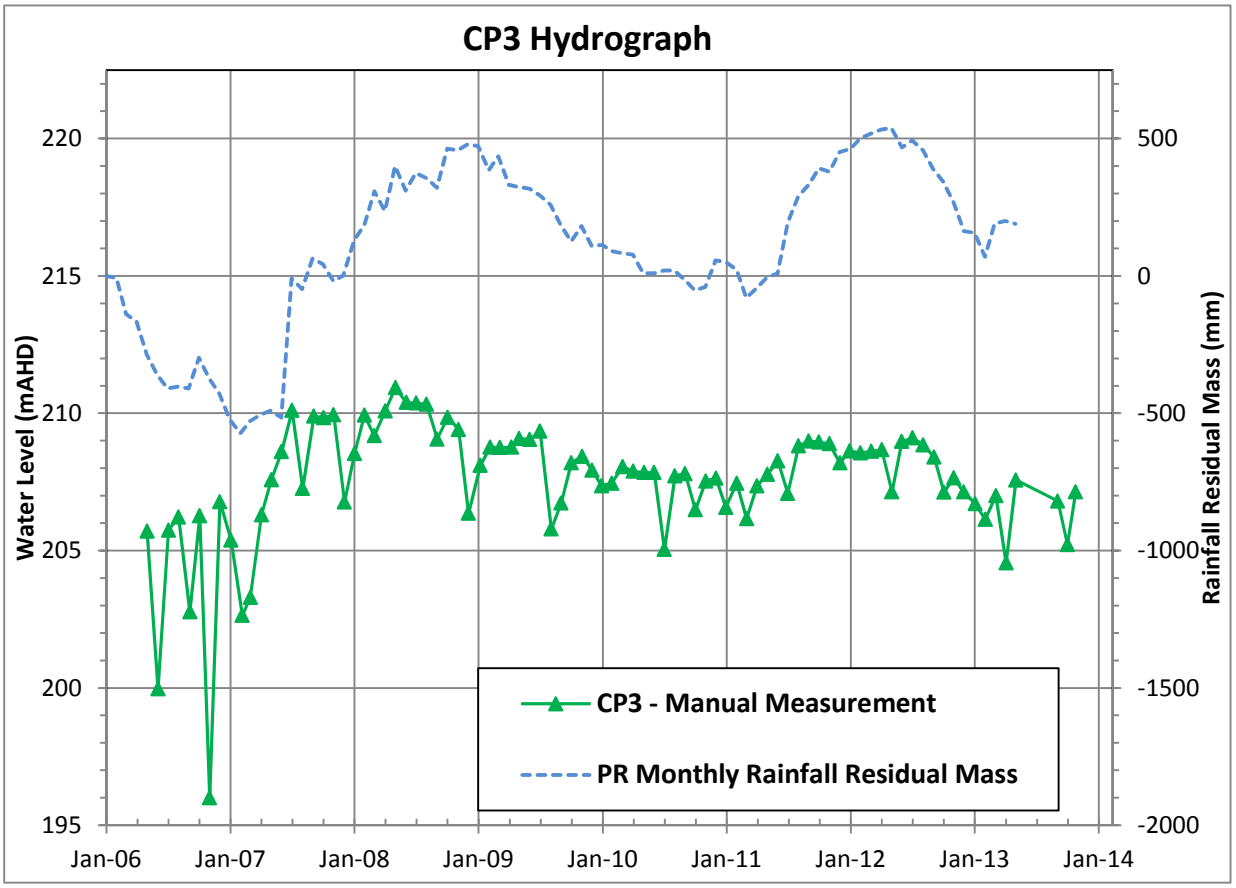

Figure 2: Constant Rate Pumping Test – CP3 – 25 October 2013

5. Conclusion

It is concluded that the quarrying activities have not adversely impacted on the yield potential of bore CP3, the Gazzana domestic bore, based on the following evidence:

- The aquifer trsansmissivity at CP3 is generally similar to the transmissivity values determined at the nearby private wsater supply bores in 2006, prior to commencement of extraction by Rocla under the current DA.
- The water level in bore CP3 is currently within the range of historical water levels, and is actually higher than it was when the pre-extraction hydraulic testing of these bores was undertaken in 2006.
- There was no evidence in the testing of any loss of well efficiency in CP3 as a result of the drawdown impacts attributed to Rocla's extraction activities.
- There is no evidence that the bore has fallen in or suffered any other physical damage.

6. References

Aquaterra Consulting Pty Ltd, 2008. Calga Sand Quarry – Hydraulic Testing Program. Report prepared for Rocla Materials Pty Ltd.

Cooper H H and C E Jacob, 1946. *A generalized graphical method for evaluating formation constants ad summarizing well field history.* Am Geophys Union Trans Vol 27, pp 526-534.

Dundon Consulting Pty Ltd, 2013. Calga Sand Quarry – 2012 Independent Groundwater Audit Report. Report prepared for Rocla Pty Ltd.

Yours faithfully.

Peter Dundon

Dundon Consulting Pty Ltd