

REPORT NO. 4

Orica Botany Groundwater Remediation Settlement Monitoring

Prepared for

Orica Australia Pty Ltd

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Section 1

Introduction and Purpose

URS Australia Pty Ltd (URS) was engaged by Orica Australia Pty Ltd (Orica) to measure and record changes in the elevation of settlement plates located across the Botany area. The purpose of the monitoring is to identify the occurrence of subsidence (and its magnitude, if present) that may occur as a result of groundwater extraction undertaken by Orica as part of the Botany Groundwater Remediation Project.

This report details the results of the fourth round of monitoring. Details of the first rounds of monitoring program are described in the following reports:

- *Report No. 1: Settlement Monitoring, Orica Botany Groundwater Remediation, URS Australia Pty Ltd, presented to Orica in December 2005;*
- *Report No.2 Settlement Monitoring, Orica Botany Groundwater Remediation, URS Australia Pty Ltd, presented to Orica in March 2007; and*
- *Report No.3 Settlement Monitoring, Orica Botany Groundwater Remediation, URS Australia Pty Ltd, presented to Orica in July 2007.*

The first round of monitoring was conducted to establish baseline elevation data prior to the commencement of full scale groundwater extraction, and the second round to assess effects of extraction from the Secondary Containment Area (SCA) and the Primary Containment Area (PCA). The third round of monitoring was completed to assess the effects of full scale groundwater extraction from the SCA, PCA and the then recently commissioned (end 2006) Botany Industrial Park (BIP) containment lines. The fourth round of monitoring has been completed to further assess the effects of full-scale groundwater extraction on the areas surrounding the BIP containment line only.

This report was prepared in accordance with conditions under Part 5 (Section 116) of the Water Act, 1912 (Reprinted No. 9, 25 July 2000) requiring Orica to install and maintain a settlement monitoring network.

Section 2

Background

In 2005 URS, on behalf of Orica, installed seven permanent survey markers (benchmarks) and twenty one settlement plates at and in the vicinity of the three groundwater containment lines:

- 1) Botany Industrial Park (BIP) containment line.
- 2) Primary Containment Area (PCA) at the Southlands property.
- 3) Secondary Containment Area at Foreshore Road (SCA).

The benchmark and settlement plate locations are shown on Figure 1.0 and the hydraulic containment system in Figure 1.1. The benchmarks and settlement plates were positioned in consultation with the Department of Water and Energy (DWE, formerly the Department of Natural Resources) and nominated by the principal groundwater modeller for the project, Dr Noel Merrick of The University of Technology Sydney (UTS). The location of the groundwater extraction lines, infrastructure near to the extraction lines and the predictions of the model were considered in selecting the location of the settlement plates.

Following installation, the heights and locations of the settlement plates and benchmarks were surveyed by a licensed surveyor, AAMHATCH Pty Ltd (AAMHATCH), under the supervision of URS between September to December 2005. The instrument tolerance reported for this baseline round of monitoring was ± 0.5 mm (0.0005 m), with the exception of the survey of settlement plates Z6 and Z21 (± 1.0 mm or 0.0010 m). The results of the initial survey were provided in *Report No. 1 - Settlement Monitoring, Orica Botany Groundwater Remediation, URS Australia Pty Ltd, December 2005*. It is noted that groundwater extraction had already occurred for approximately 15 months at SCA when the baseline round of monitoring was completed.

Botany has been subject to extensive groundwater extraction for industrial purposes since the 1940's. This pumping (which greatly reduced in magnitude in the late 1980's) was inferred to have caused lowering of the water table in this area of the Botany Basin to levels far greater than will be induced by Orica's groundwater extraction program (A.G Environmental, 1990). This historical pumping is likely to have caused some settlement in the Botany district, and thus further settlement as result of Botany Groundwater Cleanup Project was predicted to be minimal. The three possible settlement outcomes of groundwater extraction were modelled by Dr Noel Merrick as part of the groundwater modelling study and are outlined below:

1. Base Case - where it is assumed that no previous consolidation has occurred.
2. Likely Case - where it is assumed that some previous consolidation has occurred.
3. Worst Case - predictions using more conservative assumptions and which are greater than the Base and Likely Case predictions.

For this report comparisons have been made against the base case scenario, as the amount on settlement caused by previous pumping in the Botany area is unknown. The maximum subsidence in the base case scenario for each of the groundwater extraction lines is as follows:

1. Foreshore Road (SCA): -0.0020 m.
2. Southlands (PCA): -0.0060 m.
3. Botany Industrial Park (BIP): -0.0170 m.

Section 3

Current Assessment

3.1 Operations of Groundwater Extraction Program

In the time since the last settlement monitoring event (May 2007), a program of groundwater extraction has been conducted.

In summary, the extraction program has involved the following:

- The BIP pumps have been fully commissioned and operating. However, the BIP pumps have not been running at full capacity due to issues with the Groundwater Treatment Plant
- An average of 3.8 ML/day was extracted in total from all three containment lines

3.2 Condition of Benchmarks and Settlement Plates

A visual inspection of all Settlement Plates and Benchmarks was conducted by URS, accompanied by Orica before any measurements were undertaken for this round.

Although settlement plates Z6, Z7, Z8, Z9 and Z16 (Plates 1 to 3) were buried beneath sand, gravel and leaves, once uncovered the settlement plates were in good condition.

The benchmarks inspected included B5, B3 and B4. All the benchmarks had water within the casing. B5 was obscured by a light brown mud covering the tip of the benchmark (Plate 4). B3 was completely submerged underwater and the top of the benchmark could not be seen (Plate 5), the concrete surrounding the well cap also appears to have sunk on one side with water only covering half of the well cover (Plate 6).

3.3 Survey Results

The height of the top of the settlement plate rod was surveyed by AAMHATCH, under the supervision of Orica. The survey report indicated that the measurements were made using the same equipment used during the initial September 2005 survey and subsequent surveys in September 2006 and May 2007. Two closed loop double level surveys were performed. The AAMHATCH report, dated May 2008, is included as Appendix A.

The survey results for September 2005, September 2006, May 2007 and May 2008 are presented in Table 1 of this report, including the cumulative 2005 to 2008 results. In addition, a comparison of the various survey results outlining annual variations is presented in Table A1 (Appendix A).

The instrument tolerance for this round of monitoring are comparable to the levels specified for 2005 and 2006.

Section 3

Current Assessment

TABLE 1: SETTLEMENT PLATE AND BENCHMARK SURVEY RESULTS – May 2008

Locality	Monitoring Point	EASTING (MGA)	NORTHING (MGA)	Initial Height September 2005 (mAHD) (± 0.5 mm)	Re-survey Height September 2006 (mAHD) (± 0.5 mm)	Re-survey Height May 2007 (mAHD) (± 0.5mm)	Re-survey Height May 2008 (mAHD) (± 0.5 mm)	Base Case Settlement Prediction (m)
Benchmarks	B1	334589.00	6240682.92	3.7420	3.7420	3.7420	-	NA
	B2	335133.04	6241040.54	3.7330	3.7330	3.7330	-	NA
	B3	335067.26	6241841.95	6.2640	6.2640	6.2640	6.2500	NA
	B4	335391.20	6241463.59	6.8960	6.8960	6.8960	6.8960	NA
	B5	334503.99	6241782.18	12.6960	12.6960	12.6960	12.6960	NA
	B6	334135.59	6241084.71	2.4600	2.4600	2.4600	-	NA
	B7	335687.62	6242478.46	19.9520	19.9520	19.9520	19.9520	NA
BIP	Z4	334548.79	6242072.94	11.0730	11.0725	11.0725	11.0725	-0.0170
	Z5	334942.35	6241999.74	6.0795	6.0845	6.0850	6.0770	-0.0170
	Z6	334827.97	6241998.97	5.9785	5.9775	5.9755	5.9755	-0.0170
	Z7	335098.74	6241800.76	6.4310	6.4340	6.4370	6.4290	-0.0170
	Z8	335236.08	6241633.32	6.5030	6.5055	6.5085	6.5005	-0.0170
	Z9	335290.80	6241667.49	6.8965	6.9000	6.9025	6.8960	-0.0170
	Z10	335495.41	6241459.67	8.1600	8.1590	8.1575	8.1565	-0.0170
	Z11	335375.11	6241431.20	6.6770	6.6770	6.6760	6.6760	-0.0170
	Z16	335810.20	6242161.38	17.6315	17.6330	17.6320	17.6335	-0.0170
	Z17	336082.99	6242433.93	22.3205	22.3215	22.3215	22.3235	-0.0170
Z21	335834.15	6241601.54	14.2925	14.2910	14.2905	14.2925	-0.0170	
Southlands (PCA)	Z3	334409.46	6241507.34	16.1720	16.1720	16.1730	16.1710	-0.0060
	Z12	334809.77	6241099.73	2.9650	2.9670	2.9650	-	-0.0060
	Z13	335012.59	6241064.96	3.7910	3.7895	3.7880	-	-0.0060
	Z14	335201.27	6241036.60	2.9945	2.9940	2.9910	-	-0.0060
	Z15	335361.18	6241001.22	4.0375	4.0380	4.0380	-	-0.0060
Foreshore Road (SCA)	Z1	334297.02	6241003.77	1.6915	1.7185	1.7195	-	-0.0020
	Z2	334120.72	6241097.37	1.5900	1.5920	1.5925	-	-0.0020
	Z18	334810.18	6240651.33	3.5775	3.5775	3.5780	-	-0.0020
	Z19	334610.38	6240678.29	3.5160	3.5160	3.5155	-	-0.0020
	Z20	334266.13	6240793.87	3.4565	3.4570	3.4565	-	-0.002

Notes:

Results provided by AAM Hatch.

MGA = Map Grid Australia

mAHD - Metres above Australian Height Datum

NA - Not Applicable.

(-) Not Surveyed

Section 4

Discussion

4.1 BIP Containment Line

The settlement plates relevant to the BIP containment line were surveyed, including Z3, Z4 to Z11, Z16, Z17 and Z21 were surveyed. Location Z3 is listed in Table A1 as being associated with the PCA but is likely to be influenced by extraction at both PCA and BIP containment lines.

4.1.1 Comparisons to 2007 Monitoring Event

Since the previous monitoring in 2007, the BIP containment line has been fully commissioned and operating, however operation has been less consistent than PCA and SCA due to GTP capacity constraints.

The survey results outlined in Table A1 (Appendix A) indicate the following:

- 1 Settlement plate elevations at Z4, Z6, Z10 and Z11 results were similar to those measured during the 2007 round, and within the instrument tolerance specified by the surveyor (± 0.0005 m to ± 0.0010 m).
- 2 Settlement plate elevations at Z16, Z17 and Z21 appear to have increased slightly when compared to the 2007 round, with the largest increase of 0.0020 m measured at Z17 and Z21.
- 3 Settlement plate elevations at Z5, Z7, Z8 (-0.008 m) and Z9 (-0.0065 m) decreased slightly when compared to the 2007 round.

4.1.2 Comparisons to 2005 Baseline

The survey results from the four monitoring rounds are outlined in Table A1 and indicate the following:

1. The elevations of settlement plates Z16 and Z17 have increased slightly (between 0.0020 m and 0.0030 m) over the monitoring period.
2. The elevations of settlement plates Z4, Z9, Z11 and Z21 have remained stable over the monitoring period and within the instrument tolerance specified by the surveyor (± 0.0005 m to ± 0.0010 m).
3. The elevations of settlement plates Z5 (-0.0025 m), Z6 (-0.003 m), Z7 (-0.002 m), Z8 (-0.0025 m) and Z10 (0.0035 m) have decreased slightly over the monitoring period. The decreases at these settlement plates are, however, within the predicted Base Case scenario of 0.017 m.
4. The elevation change of -0.014 m in benchmark B3 has not been compared to the Base Case scenario as the benchmark had no target level and the change in elevation is due to the instability of this benchmark itself rather than movement due to pumping. The benchmark may have been damaged by heavy vehicles driving over the benchmark, which may have caused the benchmark rod to bend, therefore lowering the elevation.

Section 5**Conclusions and Recommendations**

On the basis of the results of the monitoring conducted during this, and the previous surveys, the following is concluded:

- The changes in elevating of the settlement plates have been relatively minor and are within the base case predicting of the GW model;
- The measured change in elevation at benchmark B3 did not affect the results as the surveyors did not use this location in this survey as a reference for settlement plate elevations during this monitoring round. Any further monitoring of locations Z5, Z7, Z8 and Z9 should be measured off B4, or resurveyed if it is going to be used in future.
- Whilst consistent operations of the entire BIP containment line has not yet occurred, further monitoring of the settlement plates in the proximity of BIP is not considered necessary, since sporadic/opportunistic operation of BIP is likely to be a typical condition (BIP is generally operating only when the GTP capacity allows)

It is recommended that the issue of settlement be revisited should there be significant increases in extraction at any of the three containment lines.

Section 6

References

1. AAM Hatch Settlement Monitoring Survey - Botany (2008) Ref: 14521_01_Report
2. A G Environmental Engineers (May 1990) State Pollution Control Commission - ICI Botany Environmental Survey Stage 1 Preliminary Investigations
3. URS (15 March 2007) Orica Botany Groundwater Remediation - Settlement Monitoring Job No. 43217556
4. URS (8 December 2006) Orica Botany Groundwater Remediation - Settlement Monitoring Round 2 Job No. 43217257
5. URS (16 July 2007) Orica Botany Groundwater Remediation - Settlement Monitoring Round 3 Job No. 43217656
6. Merrick N.P (13 October 2004). Optimal Groundwater Abstraction Rates for Hydraulic Containment of Contaminants Plumes and Source Areas, Botany NSW. AccessUTS Pty Limited, Project Number C04/44/001 13 October 2004.
7. DECC Environmental Protection Licence Number 2148, Department of Environment and Climate Change (formerly Department of Environmental and Conservation [DEC]).

Section 7**Limitations**

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Orica Australia Pty Ltd (Orica) and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared during June and October 2008 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.