

R E P O R T

Settlement Monitoring
Orica Botany Groundwater
Remediation
Report No.1

Prepared for

Orica Engineering Pty Ltd

1 Nicholson Street
Melbourne VIC 3000

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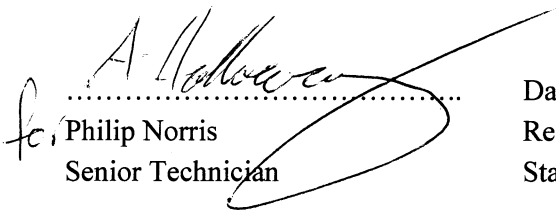
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At the request of Orica Engineering Pty Ltd (Orica), URS Australia Pty Ltd (URS) carried out the installation of seven (7) permanent survey markers (benchmarks) and 21 settlement plates at and in the vicinity of the groundwater containment lines located at the Botany Industrial Park (BIP), Southlands and Foreshore Road. The benchmark and settlement plate locations are shown on Figure 1.

The works are being performed in accordance to the requirements of Orica's Environment Protection Licence. The settlement plate network locations were selected by Noel Merrick of the University of Technology-Sydney, the details of which were provided to the Department of Natural Resources (DNR) prior to installation.

The purpose of the works was to establish:

- Baseline ground elevation data around the three containment lines prior to the commencement of full scale groundwater extraction from these areas; and
- Install infrastructure to allow subsequent monitoring of the ground elevation following commencement of full scale pumping.

The settlement plates were positioned to monitor for subsidence along the extraction line and nearby private and public land, including residential and industrial areas and roadways. The survey benchmarks were positioned about the settlement plates to ensure the survey data which was collected was as accurate as possible. The benchmarks, which were installed and founded on bedrock, were required since existing benchmarks could themselves be subject to subsidence, and therefore would not necessarily provide the accurate information required for the project.

The modelling undertaken by Noel Merrick (2004) indicated that ground subsidence resulting from groundwater extraction would be generally less than 1 mm, which is considered to be negligible and unlikely to cause damage to property. Historic extraction of groundwater from the region was significantly higher than that proposed by Orica's remedial activities. The installation and monitoring undertaken as part of this project aims to quantify the actual subsidence, if any, caused by the groundwater extraction.

2.1 Utilities Search

A Dial Before You Dig search was completed for each benchmark and settlement plate location. A thorough inspection for above and below ground utilities at each area was carried out by URS site personnel together with a URS approved underground service locator.

2.2 Site Access

The appropriate excavation permits and site specific work clearances issued by Orica were read and signed by URS site personnel prior to commencing work.

Permission to work in the areas surrounding BIP was obtained by URS from City of Botany Bay Council (Council), Solvey Interoxm Westfield, Kelloggs and Australand. The appropriate *Application and Permit for Road and Footpath Openings* was obtained from Council for benchmark B6, settlement plates Z1, Z2, Z3 and Z17.

The proposed location for settlement plate Z6 was moved from the Botany to Sydenham Railway Corridor to the carpark (adjacent to the Railway Corridor) located at the end of Swinbourne Street.

At the request of the local community, benchmark B6, settlement plates Z1 and Z2 were moved from Dent Street to Fremlins Road (park area). The location for Benchmark B7 was moved from the corner of Wentworth Avenue and Dension Street to the corner of Wentworth Avenue and Banks Avenue (Westfield Gardens carpark) due to inadequate vehicle access.

2.3 Health and Safety

All URS site personnel and sub-contractors were appropriately site health and safety inducted to work at Orica (BIP, Southlands and Foreshore Road) and adjacent areas (Solvey Interox and Australand).

All URS approved sub-contractors from BCP (excavation), Acclaimed Plant Hire, On Line (service location), Terratest (drilling) and AAM HATCH (surveying) read and signed the URS site specific Safety, Health and Environment Plan, including a Job Safety Analysis specific to settlement plate installation prior to commencing work.

A Daily Safety Task Analysis Worksheet and Daily Toolbox Talk Checklist were completed prior to commencing work.

2.4 Excavated Material

The soil generated by drilling was contained in sealed drums and moved to Southlands by Collex for later disposal by Orica. Soil excavated during the installation of the settlement plates was used as backfill around the settlement plate and settlement plate cover. Any excess surface soil generated by the installation of the settlement plates was spread over the area adjacent to the excavation, where permissible. At the request of the land owner/occupier, excess soil generated by the installation of settlement plates Z1, Z2 and Z6 was also drummed and relocated to Southlands.

3.1 Benchmark Installation

The benchmarks were installed by drilling a borehole to bedrock (Hawkesbury Sandstone) and grouting a 25 mm steel pipe between 1 m and 2 m into competent rock. A 50 mm PVC sleeve was placed around the steel pipe and backfilled with 2 mm graded sand. A steel road box was installed flush with the surface to enable unobstructed pedestrian and vehicle movements.

3.2 Settlement Plate Installation

The settlement plate is a steel plate 0.4 m long x 0.4 m wide x 0.006 m thick with a 0.4 m long x 0.025 mm diameter steel rod welded to the centre of the plate. A Work Method Statement (presented as a Memorandum) attached in Appendix A outlines the method used to install the majority of the settlement plates. The excavation work was undertaken by BCP using hand tools only, supervised by URS. Placement of the chamber sections was carried out by a backhoe with appropriate chain lengths and lifters. The backhoe was not be used for excavation purposes.

An example of the stages of construction/installation, photographed at settlement plate Z14, is presented below in Plates 2.1 to 2.4.



Plate 2.1

Excavation complete, base section of maintenance hole installed.



Plate 2.2

Settlement plate installed and backfilled.



Plate 2.3

Top/lid section of maintenance hole installed.



Plate 2.4

Backfill complete.

A cross section diagram showing the chamber construction and settlement plate orientation is attached in Appendix B.

Due to the heavy vehicles which often cross the Foreshore Road median strip, settlement plates Z18, Z19 and Z20 were placed and backfilled within purpose-designed and engineered concrete chambers of similar specification to the groundwater extraction well housings. Whilst the housing for the settlement plates on Foreshore Road was different to that for the other settlement plates (illustrated in the above plates), the method of installation of the plates themselves was the same.

4.1 Locations

The benchmark and settlement plate locations are detailed below in Table 1 and Table 2 and illustrated in Figure 1.

4.1.1 Benchmarks

Table 1

Benchmark	Location	Area Owner/Occupier/Authority	Date Installed
B1	Foreshore Road	RTA	27 May 2005
B2	Southlands	Orica	24 May 2005
B3	BIP	Orica	31 May 2005
B4	BIP	Orica	7 July 2005
B5	Stephen Road	Nuplex	6 June 2005
B6	Fremlins Road (park area)	Council	8 September 2005
B7	Corner Wentworth Avenue and Banks Avenue	Westfield Eastgardens	1 June 2005

4.1.2 Settlement Plates

Table 2

Settlement Plate	Location	Area Owner/Occupier/Authority	Date Installed
Z1	Fremlins Road (park area)	Council	25 August 2005
Z2	Fremlins Road (park area)	Council	25 August 2005
Z3	Stephen Road	Council	25 August 2005
Z4	Corner Stephen Road and Swinbourne Street	Australand	22 June 2005
Z5	BIP	Orica	28 June 2005

Settlement Plate	Location	Area Owner/Occupier/Authority	Date Installed
Z6	Carpark adjacent to Railway Corridor at end of Swinbourne Street	-	8 September 2005
Z7	BIP	Orica	25 July 2005
Z8	BIP	Orica	25 July 2005
Z9	BIP	Orica	28 June 2005
Z10	BIP	Orica	27 June 2005
Z11	BIP	Orica	27 June 2005
Z12	Macpherson Street	Solvey Interlox	21 June 2005
Z13	Southlands	Orica	21 June 2005
Z14	Southlands	Orica	17 June 2005
Z15	Southlands	Orica	17 June 2005
Z16	BIP	Orica	28 June 2005
Z17	Wentworth Avenue	Westfield Eastgardens	25 August 2005
Z18	Foreshore Road	RTA	17 June 2005
Z19	Foreshore Road	RTA	17 June 2005
Z20	Foreshore Road	RTA	17 June 2005
Z21	Denison Street	Orica	28 June 2005

4.2 Depth of Bedrock

The depth of the bedrock/borehole noted when drilling at each benchmark location is detailed below in Table 3.

Table 3

Benchmark	Depth of Bedrock (m)	Depth of Borehole (m)
B1	33.00	35.00
B2	29.00	31.00
B3	45.20	47.00
B4	22.80	24.80
B5	63.05	65.00
B6	66.00	68.00
B7	52.40	54.50

4.3 Survey

Following installation, the height of the top of the settlement plate rod was surveyed by a licensed surveyor (AAM HATCH), supervised by URS. The base data survey results are presented in Tables 4 and 5; the surveyors report is attached in Appendix C.

Surveying of the majority of the benchmark and settlement plate locations was carried out on 14 to 16 and 20 to 22 September 2005. Due to site access restrictions, surveying the benchmark and settlement plates on Foreshore Road was carried out 25 November 2005 and 1 December 2005.

Re-surveying of the settlement plate locations (to assess if subsidence has occurred as a result of groundwater extraction) will be undertaken approximately 6 months after the commencement of full-scale groundwater extraction, and then on an annual basis thereafter, unless otherwise requested by the relevant consent authorities.

It is noted that URS has estimated the potential thermal expansion of the steel rod (settlement plate) to be in the order of 0.25 mm, which is less than the estimated potential subsidence and likely to be less than the accuracy of the surveying.

Table 4 – Settlement Plate Survey

Settlement	Eastings ¹	Northings ¹	Elevation ²
Z1	334297.02	6241003.77	1.6915 ± 0.5mm
Z2	334120.72	6241097.37	1.5900 ± 0.5mm
Z3	334409.46	6241507.34	16.1720 ± 0.5mm
Z4	334548.79	6242072.94	11.0730 ± 0.5mm
Z5	334942.35	6241999.74	6.0795 ± 0.5mm
Z6	334827.97	6241998.97	5.9785 ± 1.0mm
Z7	335098.74	6241800.76	6.4310 ± 0.5mm
Z8	335236.08	6241633.32	6.5030 ± 0.5mm
Z9	335290.80	6241667.49	6.8965 ± 0.5mm
Z10	335495.41	6241459.67	8.1600 ± 0.5mm
Z11	335375.11	6241431.20	6.6770 ± 0.5mm
Z12	334809.77	6241099.73	2.9650 ± 0.5mm
Z13	335012.59	6241064.96	3.7910 ± 0.5mm
Z14	335201.27	6241036.60	2.9945 ± 0.5mm
Z15	335361.18	6241001.22	4.0375 ± 0.5mm
Z16	335810.20	6242161.38	17.6315 ± 0.5mm
Z17	336082.99	6242433.93	22.3205 ± 0.5mm
Z18	334810.18	6240651.33	3.5775 ± 0.5mm
Z19	334610.38	6240678.29	3.5160 ± 0.5mm
Z20	334266.13	6240793.87	3.4565 ± 0.5mm
Z21	335834.15	6241601.54	14.2925 ± 1.0mm

¹ MGA – Map Grid Australia

² Metres Australian Height Datum (mAHD)

Table 5 – Benchmark Survey

Benchmark	Eastings	Northings	Elevation
B1	334589.00	6240682.92	3.7420
B2	335133.04	6241040.54	3.7330
B3	335067.26	6241841.95	6.2640
B4	335391.20	6241463.59	6.8960
B5	334503.99	6241782.18	12.6960
B6	334135.59	6241084.71	2.4600
B7	335687.62	6242478.46	19.9520

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 Engineering Pty Ltd 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. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 18 March 2005.

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 December 2005 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.

Appendix A

Appendix B

Figures

Appendix C