31 May 2010

CELEBRATING 50 YEARS in 2010

GROUNDWATER TREATMENT PLANT (GTP) QUARTERLY GROUNDWATER AND SURFACE WATER MONITORING REPORT MARCH 2010

Orica Botany Environmental Survey Stage 4 - Remediation

Submitted to:
Orica Australia Pty Ltd
1 Nicholson Street
Melbourne VIC 3000

REPORT

Report Number. 107623038-002-R-RevA-Monitoring Report

A world of capabilities delivered locally

Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report presents the results of groundwater and surface water data collected in March 2010 as part of the Groundwater Treatment Plant (GTP) – Groundwater and Surface Water Monitoring Program. The scope of services of the March 2010 monitoring program fulfils the requirements of a quarterly sampling event as specified in the amended GTP – Groundwater and Surface Water Monitoring Program (URS, 2008c).

Hydraulic Monitoring

Following completion of annual maintenance at the GTP in early December 2009 hydraulic containment was achieved at BIP, PCA and for the shallow and deep aquifers at SCA. Detailed monitoring of the changes to water levels following cleaning (pigging) of pipe lines in May 2010 is required to ensure ongoing achievement of target levels at the western end of the SCA.

Elevated groundwater levels were observed at the SCA in intermediate monitoring wells at the eastern end of the containment line. The increased levels are the result of fouling in the deep extraction wells and a detailed assessment of microbiological and geochemical conditions is currently being undertaken so that an appropriate well rehabilitation program can be implemented. A drilling contractor has been engaged to commence the rehabilitation program in early June 2010.

Chemical Monitoring

The quarterly groundwater chemical monitoring program is focused on collecting data critical to environmental and human health receptors. No samples have been collected from onsite sampling locations (i.e. on BIP or Southlands).

Offsite Monitoring Wells

The assessment of groundwater chemical monitoring data presented in this report focuses on historical maximum concentrations. Historical maximum concentrations were reported for several contaminants at the 0.75 m and 2 m ports of BP01. To determine whether fluctuations in concentrations reported in the December 2009 and March 2010 monitoring rounds represent real changes in concentrations and are not an artefact of a compromised bundle piezometer a replacement well (comprised of several drivepoints) will be installed to serve as an alternative sampling location prior to the next quarterly monitoring round. . Based on the results of sampling at the discharge interface and for surface water in Penrhyn Estuary the elevated concentrations at BP01 are not currently impacting on water quality in the estuary.

Three nested monitoring wells are currently being installed between the SCA and Penrhyn Estuary to further assess contaminant concentrations and hydraulic containment at the SCA. These wells, along with the replacement sample locations at BP01, will provide additional data to aid in determining the cause of the variable concentrations at BP01.

Historical maximum concentrations in the Central Plume area were reported at the 8 m port of BP60 (EDC, PCE and TCE) and at the 20 m port of BP77 (EDC, PCE, TCE and CFM). Similarly, historical maximum concentrations in the Southern Plumes area were also reported at MWF15S (PCE), MWF15I (CFM) and at BP58 (TCE), located in the Northern Plumes area.

The reported historical maximum concentrations, with the exception of concentrations at BP01, are not considered significant as they are similar to concentrations reported previously for the respective sample locations. Slight changes in concentrations may be a function of changes in plume distribution induced by hydraulic containment.

Penrhyn Estuary

The March 2010 groundwater data from Penrhyn Estuary is consistent with data from the previous monitoring rounds, with the concentrations of the chemicals of concern generally decreasing towards the discharge interface.

The concentrations of the key contaminants reported in the March 2010 monitoring round are less than the ANZECC (2000) Trigger values for all samples collected at the discharge interface (0.1 m port). No historical maximum key contaminant concentrations were reported during the March 2010 monitoring round.

Surface Water

Key contaminant concentrations reported in the March 2010 monitoring round continued to be less than the relevant ANZECC (2000) Trigger Values.

Implications for Human Health Risk Assessment

There is no additional data presented in the March 2010 monitoring round that affect the conclusions of the HHRA (URS, 2005e) and its Addendum (URS, 2006b) in relation to the Western margin of the Northern Plumes and with respect to existing commercial/industrial workers in areas above the main plumes. That is, the groundwater contamination within the Northern Plumes near the Western Margin and within the main plumes is not considered to pose an unacceptable risk to human health, assuming groundwater is not extracted and used.

Similarly, based on the data collected up to March 2010, the conclusions presented within the HHRA associated with exposures within the inner and outer estuary remain unchanged. That is, given the conservative nature of the range of assumptions and the safety factors applied to toxicity values, the risks to human health for all exposure scenarios are considered to be low. However, the assessment has identified worst-case exposure scenarios (particularly within the inner estuary where calculated risks exceed the target values). It is noted that the potential for exposure within the inner estuary is effectively eliminated by access restrictions associated with the current Port Botany expansion works.

1.0 INTRODUCTION

In accordance with Notice of Clean Up Action (NCUA) No 1030236, Orica Australia Pty Ltd (Orica) is required to remediate chlorinated hydrocarbon (CHC) groundwater contamination at Botany Industrial Park (BIP) and in areas to the south and west of BIP. In response to condition 3B of the NCUA, Orica prepared a Groundwater Cleanup Plan (GCP) (Orica, 2003b). The GCP included a quarterly monitoring program that was superseded by the Groundwater Treatment Plant (GTP) – Groundwater and Surface Water Monitoring Program (URS, 2005g) which was subsequently amended in January 2007 (URS, 2007a) and June 2008 (URS, 2008c). The amended GTP monitoring program includes three types of monitoring events: quarterly, annual and biennial (in order of sampling program magnitude).

As specified in the amended monitoring program (URS, 2008c) the March 2010 program is a quarterly monitoring event.

1.1 GTP Monitoring Program Methodology

The GTP monitoring program has two distinct groundwater monitoring functions:

- Chemical monitoring of the distribution of the contaminants of concern within surface water and groundwater; and
- Monitoring of hydraulic containment performance.

1.1.1 Chemical Monitoring

The chemical monitoring program (presented in Table 1.1) is based on the following methodology (URS, 2008c):

- Quarterly monitoring ensures that data critical to environmental and human health receptors (refer to URS, 2005e/2006b) is collected. Data proposed to be collected in the Quarterly GTP monitoring program includes:
  - Surface water in Penrhyn Estuary, and Springvale and Floodvale Drains;
  - Pore water at the inter-tidal groundwater discharge zone (i.e. 0.1 m ports at BP42-BP44 and BP64-BP66) located within Penrhyn Estuary; and
  - Groundwater at the top of the water table, which may be relevant to assessing risks presented by vapour migration.
- Annual chemical monitoring focuses on assessing chemical changes in areas where plume migration is expected to occur as well as detailed assessment of data with respect to the assumptions made in the Consolidated Human Health Risk Assessment (CHHRA) (URS, 2005e) and Addendum (URS, 2006b); and
- Biennial chemical monitoring focuses on identifying major changes to plume geochemistry and distribution throughout the Groundwater Extraction Exclusion Area (GEEA).

1.1.2 Hydraulic Monitoring

The strategy selected to achieve hydraulic containment of groundwater contamination was described in the Botany Groundwater Cleanup (BGC) Project Environmental Impact Statement (EIS) (URS 2004i). The hydraulic monitoring approval requirements detailed in the BGC Project EIS can be summarised as a number of specific objectives, including the monitoring of aquifer levels to demonstrate:

- Capture of contaminated groundwater to the three hydraulic containment lines (primary, secondary and BIP); and
- Excessive drawdown does not occur which may result in ground subsidence.

Hydraulic monitoring and regular review of pumping rates is also conducted to minimise the rate of saltwater intrusion at the Secondary Containment Area (SCA), which is undesirable for GTP operation.

The amended hydraulic monitoring program (URS, 2008c) is based on the use of automated data loggers and transducers to enable continuous water level monitoring in the lower GEEA (see Table 1.2 for locations). The methodology for the hydraulic monitoring program is as follows:

- Quarterly hydraulic monitoring to focus on assessing hydraulic containment at the SCA, Primary Containment Area (PCA) and BIP containment lines; and
- Annual and biennial hydraulic monitoring to assess long-term data and the groundwater flow regime within the broader area of the lower GEEA.

1.2 Previous Quarterly Groundwater and Surface Monitoring

Groundwater monitoring has been conducted throughout the Stage 3 and Stage 4 Surveys on a number of occasions. Previous quarterly monitoring programs completed and reported under the GCP and GTP programs are presented in the following table.

Previous GCP and GTP Monitoring Programs

	Year	Month	Reference
GCP Programs	2004	March	URS, 2004d
		June	URS, 2004f
		September	URS, 2004h
		December	URS, 2005a
	2005	March	URS, 2005c
		June	URS, 2005f
GTP Programs	2005	September	URS, 2005h
		December	URS, 2006a
	2006	March	URS, 2006c
		June	URS, 2006g
		September	URS, 2006i
		December	URS, 2007b
	2007	March	URS, 2007d
		June	URS, 2007e
		September	URS, 2007g
		December	URS, 2008a
	2008	March	URS, 2008b
		June	URS, 2008d
		September	URS, 2008f
		December	URS, 2009a
	2009	March	URS, 2009b
		June	URS, 2009c
		September	URS, 2009d
		December	URS, 2010a

The previous biennial GTP monitoring report was September 2009 (URS, 2009d), while the previous interim monitoring report was December 2009 (URS, 2010a).

2.0 SCOPE OF SERVICES

2.1 General

The scope of the March 2010 quarterly monitoring program is summarised in this section. The results of the hydraulic monitoring program are presented and discussed in Section 3. The results of the chemical monitoring program are presented in Section 4, while the results of the Penrhyn Estuary and surface water sampling are presented in Section 5. The implications (if any) of the chemical monitoring program results are discussed in Section 6.

2.2 Hydraulic Containment Water Level Monitoring

A comprehensive water level monitoring program utilising automated data loggers and transducers was undertaken in accordance with the GTP monitoring program (URS, 2008c) as shown in Figure 2.1. The monitoring well locations used for the March 2010 GTP monitoring program are presented in Table 1.2. The program involved the collection and processing of data from 297 continuously logged monitoring and extraction wells.

2.3 GTP Chemical Sampling Program

In accordance with the GTP program (see Table 1.1 and URS, 2008c) the March 2010 sampling program represents a quarterly monitoring event. It includes an analytical program with sampling locations focusing on areas in the vicinity of potential environmental and human health receptors. Due to inaccessible or dry ports at some sampling locations, minor variations to the amended GTP program were made. In most instances, adjacent ports were sampled. The variations to the amended GTP program are presented in the following table.

The groundwater sampling locations are shown on Figure 2.2. Surface water and Penrhyn Estuary groundwater sampling locations are shown on Figure 2.3.

March 2010 GTP Monitoring Program Variations

Plume	Scheduled Program (see Table 1.1)		Completed March 2010 Program		Variations
	Location No.	Sample No.	Location No.	Sample No.	
Southern	5	9	5	8	■ BP115, 3.25 port dry. No other available port.
Central	6	23	6	22	■ BP41, 2 m port dry. Substituted with 6 m port. The 4 m port was sampled as part of the program. ■ BP60, 4 m port dry or blocked, 6 m port and 18 m ports not labelled. Substituted with 8 m and 24 m ports. All other ports were blocked or unlabelled. ■ BP77, 4 m port dry and 18 m port blocked. Substituted with 12 m and 20 m ports, respectively.
Northern	12	12	12	12	■ BP54, 6 m port dry or blocked. Substituted with 9 m port. ■ BP58, 3 m port not labelled. Substituted with 6 m port.
Penrhyn Estuary	5	29	5	29	■ BP43, 2 m port blocked. Substituted with 1 m port.
Surface Water	14	18	13	16	■ SW048 not accessible due to Port Botany expansion construction work.
Total	**42**	**91**	**41**	**87**	

As reported in the September 2008 annual report (URS, 2008f), sampling locations BP44, BP66, BP108 and BP109 were decommissioned as part of the work being undertaken for the Port Botany expansion project. As a result, these sampling locations were not included as part of the March 2010 sampling program.

2.4 Sample Analyses

All groundwater and surface water samples were analysed for a suite of volatile chlorinated hydrocarbons (CHCs). The analytical suite includes the list of compounds specified in the NCUA, and is presented in the table below.

Analytes

Volatile Chlorinated Hydrocarbons	
Carbon Tetrachloride (CTC)	Chloroform (CFM)
Methylene Chloride (DCM)	Chloromethane
Pentachloroethane	1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane (1,1,2,2-TeCA)	1,1,2-Trichloroethane (1,1,2-TCA)
1,1,1-Trichloroethane	1,1-Dichloroethane (1,1-DCA)
1,2-Dichloroethane (EDC)	Chloroethane
Tetrachloroethene (PCE)	Trichloroethene (TCE)
trans-1,2-Dichloroethene (trans-1,2-DCE)	*cis*-1,2-Dichloroethene (cis-1,2-DCE)
Vinyl Chloride (VC)	

A summary of the properties of volatile CHCs is presented in Appendix B.

2.5 Quality Assurance and Quality Control

2.5.1 Quality Assurance Plan

All monitoring well development, sample collection, sample handling and decontamination procedures were performed according to the Stage 2 Groundwater Survey QA Plan and are described in the Stage 2 Contract C3 Report (Woodward-Clyde, 1996).

2.5.2 QA/QC Samples

The analyses of laboratory and field QA/QC samples are mechanisms for checking the accuracy and precision of analytical data in order to ensure that the data quality objectives are being met. The QA/QC samples collected in the field during this sampling round included trip blanks, field duplicates and field triplicates.

In addition to field QA/QC samples, the primary and secondary analytical laboratories (ALS and LabMark, respectively) have used laboratory and batch specific QA/QC processes including laboratory duplicates, laboratory blanks, surrogate spikes, matrix spikes and laboratory control samples.

2.5.3 Data Validation

2.5.3.1 General

To ensure that data of known quality are reported and to identify whether data is suitable to fulfil the overall project objectives, analytical data validation is conducted. The validation process is based upon the following data validation guidance documents:

- NEPC, 1999, National Environment Protection (Assessment of Site Contamination) Measure (NEPC, 1999);
- USEPA, October 2004, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 2004); and
- USEPA, June 2008, USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2008).

The analytical data validation process involves the checking of analytical procedure compliance and the assessment of accuracy, precision and completeness of analytical data.

Analytical data validation summary sheets are presented in Appendix C.

2.5.3.2 Variability in Vinyl Chloride Analytical Results

Vinyl chloride (VC) is a dissolved gas that relative to the other volatile CHCs, is difficult to quantify resulting in a raised Limit of Reporting (LOR) of 10 µg/L. The sources of variability due to the sampling and analytical processes and the strategies used to increase the accuracy in determining VC concentrations have been described in the December 2009 quarterly monitoring report (URS, 2010a). These strategies have been implemented in the March 2010 monitoring program.

2.6 Data Management

Analytical data for the Botany project is stored on a secure SQL server and managed via the EQuIS® 5 Environmental Data Management System (EDMS) offsite. This data is currently being migrated and is expected to be transferred to a secure Golder server within the next quarter.

Warehoused data sets are linked to ArcGIS, a proprietary Geographical Information System (GIS) software that is considered to be the industry standard and is used nationwide by Golder. This GIS is used in the spatial presentation of the site's monitoring locations and the creation of contaminant distribution figures as well as geochemical and hydraulic figures.

3.0 HYDRAULIC MONITORING

3.1 General

The March 2010 monitoring round is a quarterly event and focuses on assessing hydraulic containment at the SCA, PCA and BIP containment lines.

The results of the hydraulic monitoring are presented as follows:

- Historical (from June 2007) and current hydraulic monitoring data are tabulated in Table 3.1;
- Water table elevation (shallow aquifer) and potentiometric surface (deep aquifer) maps, and associated groundwater flow lines are presented in Figures 3.1 and 3.2, respectively;
- The contoured data represents transducer and logger data from 1 January 2010 at 12:00 am and as a result do not account for transient effects of pumping, rainfall and tides (these effects can be assessed by analysis of the hydrographs in Appendix A). While the selected time period is considered representative of conditions during pumping, it is important to note that an extended period of no pumping occurred during the annual shutdown in early December 2009;
- Detailed hydrographs for wells equipped with transducers/loggers are presented in Appendix A (Figures A.01 to A.38). Monitoring well hydrographs for the SCA include a representation of the target water level that is used to assess hydraulic containment;
- During the March 2010 field program water levels were manually measured at each logger location and compared against the logged water level in order to ensure data quality and reliability. A summary of this data is presented in Table 3.2. A number of minor discrepancies were identified and where possible the presented data has been corrected. In cases where the cause of the discrepancy is not clear further assessment will be undertaken during the next monitoring round. The identified discrepancies do not affect interpretation of groundwater flow and the overall data is suitable for assessing hydraulic containment;
- Each hydrograph includes a daily rainfall chart for Sydney Airport. Rainfall during the period was below average in December (60 mm compared with an average of 73 mm), significantly below in January (26 mm compared with an average of 95 mm) and significantly above in February (157 mm compared with an average of 114 mm). The highest daily rainfall (54 mm) occurred on 7 February 2010; and
- A number of faulty pressure transducers and data loggers were identified during the monitoring period. Given the historical data set and extent of monitoring at adjacent locations, the absence of data at the locations below does not affect the quality of the assessment. A program to repair/replace accessible loggers/transducers is currently underway.

3.2 Assessment of Containment Area Groundwater Flow

3.2.1 General Comments

With respect to assessing the flow of groundwater at the three Containment Areas it is important to highlight the following:

- Assessment of groundwater flow and hydraulic containment is by analysis of observed static groundwater levels, interpreted groundwater flow lines, transient water levels and contaminant distribution in the context of the site conceptual model (URS, 2007f);
- While target water levels for the SCA are presented on the hydrographs to aid interpretation, it is important to note that observed levels above these targets do not directly imply hydraulic containment was not achieved. As indicated above, assessment of hydraulic containment requires incorporation and analysis of a number of lines of evidence; and

- The slow migration of groundwater and the potential for increased pumping to recapture groundwater mean that hydraulic containment can still be maintained through extended periods of no, or low, groundwater extraction. An assessment of the maximum time periods that the SCA and PCA containment lines can be off-line before groundwater at the containment line cannot be recaptured was presented in previous GTP monitoring reports (URS, 2007b).

While the focus of the quarterly hydraulic monitoring program is assessment of hydraulic containment, the following comments are made with respect to regional groundwater flow in the lower GEEA:

- With the implementation of hydraulic containment the groundwater flow regime has altered groundwater flow from its previous south westerly path to radially towards the containment lines;
- Large areas of very flat hydraulic gradients (as evidenced by the wide spacing between the 0.5, 1.0, 2.0 and 3.0 mAHD contours on Figures 3.1 and 3.2) have developed between the containment lines. These areas represent zones of very slow groundwater flow and as a result contaminant concentrations in these areas are likely to remain relatively constant for the medium to long term;
- While the observed pattern of groundwater flow in March 2010 is clearly different to that observed during the baseline monitoring in October 2004 (URS, 2005a) it is very similar to that presented in recent monitoring reports (e.g. URS, 2007g, 2008a/b/d/g/h/g, 2009a/b/c/d, 2010a); and
- Monitoring wells located at significant distances from the containment lines (i.e. MWC09/11 and WG200/202/215/216/217/232/235) currently show no discernible water level impact due to hydraulic containment (Table 3.1). This observation highlights the relatively localised effects of the hydraulic containment system and its limited potential to affect infrastructure and licensed groundwater users.

3.2.2 Botany Industrial Park (BIP) Containment Area

The primary purpose of the BIP containment line is to prevent ongoing contaminant migration from source areas located on the BIP. Containment at BIP is considered to be of secondary importance to SCA and PCA and hence pumping at the BIP Containment Area only occurs as GTP capacity allows. The PCA is located downgradient, and there are significant environmental and human health benefits achieved by maintaining pumping at the SCA and PCA compared to the BIP.

The BIP containment line is operated as follows:

- First priority is given to pumps within the vicinity of Springvale Drain in order to minimise shallow groundwater discharge to the drain;
- Second priority is given to pumps on Second Street downgradient of the Central Plume source area with highest contaminant concentrations; and
- Third priority is given to pumps at the north-western end on First Street where contaminant concentrations are significantly lower.

Groundwater extraction flow rates and the consistency of pump operation at the BIP have improved significantly compared to previous monitoring rounds. This improvement is reflected in the current water level monitoring data that shows water levels have decreased to approximately 3 mAHD at the containment line monitoring wells. These water levels are lower than those required for hydraulic containment at the BIP containment line (Laase, 2005). Based on this data, the interpreted groundwater flow at the BIP (Figures 3.1 and 3.2) and the hydrographs presented in Appendix A, hydraulic containment during the monitoring period was achieved for the monitoring period after the completion of the annual maintenance shutdown on 10 December 2010.

3.2.3 Primary Containment Area (PCA)

The PCA has two purposes: mass removal from the central EDC plume; and prevention of ongoing contaminant migration from Block 2, Southlands.

Interpreted deep groundwater flow at the PCA (Figure 3.2) shows deep groundwater was successfully contained at the PCA. Analysis of the hydrographs presented in Appendix A indicates that pumping was consistent following the annual shutdown for extraction wells along McPherson Street although levels at EWB10D and EWB11D were not as low as adjacent PCA extraction wells. However, the water levels at EWB10D/EWB11D were maintained at levels close to, or below 1 mAHD, and levels at the adjacent monitoring wells (MWB03 to MWB05) indicated that containment was largely effected.

Figure A.37 presents hydrographs for shallow monitoring wells at and downgradient of the PCA containment line. The hydrographs in the figure have been grouped together to allow direct assessment of the direction of groundwater flow at the PCA. The hydrographs indicate the following:

- When groundwater extraction is not occurring at PCA, groundwater is inferred to flow slowly from Southlands across McPherson Street;
- During groundwater extraction, water levels in shallow monitoring wells on Southlands (with the exception of MWB02S) are lower than in McPherson Street indicating that groundwater flow reverses during GTP operation. As a result it can be inferred that hydraulic containment of the shallow aquifer at PCA is achieved by operation of the deep pumps; and
- Even though flow at MWB02S may initially be offsite, the reversed hydraulic gradient observed from MWB15S to MWB02S implies that the offsite flow will be recaptured at the PCA containment line.

3.2.4 Secondary Containment Area (SCA)

The primary purpose of the SCA is to prevent migration of groundwater contamination to Botany Bay. Pumping priority is based on contaminant concentrations along the SCA and on that basis the western end has a low pumping priority. Target groundwater levels for SCA monitoring wells are based on subsidence constraints and an assessment of groundwater levels at the discharge point in the intertidal zone. Field studies (Turner et al 1996, Nielsen 1999, Cartwright & Nielsen 2001) have demonstrated the average groundwater elevation in the intertidal zone discharge point is above 0 mAHD. The field studies show that water levels at the discharge point (even in the quiescent conditions of Penrhyn Estuary) could exceed 0.2 mAHD. As a result, a conservative target level of 0.1 mAHD has been adopted for long-term operation of the SCA.

Eastern Portion

Following completion of the annual maintenance program at the GTP in December 2009 groundwater extraction was consistent at the eastern end of the containment line. With the exception of water levels in the intermediate aquifer at the eastern end of the SCA, hydraulic containment was successfully achieved during the monitoring period.

Previous reports (URS, 2010a) have discussed re-occurring issues with intermediate water levels at SCA. Groundwater levels in intermediate monitoring wells east of MWF01 consistently exceeded the target level during the monitoring period. Historically (2005) water levels in the deep and intermediate aquifer responded similarly to changes in groundwater extraction rates in the deep aquifer. However, recent monitoring (including that presented in this report) clearly indicates that this response no longer occurs and extraction now affects the intermediate aquifer less than the deep aquifer. Based on these observations (and the results of previous investigations (Orica, 2009) and recent maintenance works) it is concluded that fouling of the deep extraction well screens is occurring.

A program of microbiological and geochemical sampling is currently underway to identify the cause of the fouling and the most appropriate methodology for rehabilitation of the extraction wells.

At the time of writing the barriers had been moved to allow access to the affected wells and samples had been collected from extraction wells EWF22S/D, EWF24S/D, EWF26S/D, EWF28S/D and monitoring wells MWF12S/I/D to MWF14S/I/D. A drilling company has been engaged to commence preparatory works for cleaning of fouled wells from early June 2010.

Western Portion

Following completion of the annual maintenance program at the GTP on 10 December 2009 groundwater extraction at the western end of the SCA was inconsistent compared to the eastern end of the containment line. The reduced performance at the western end of the containment line is the direct result of elevated pressure in the header pipe restricting pumping rates. Although the groundwater extraction rates were limited, water levels remained at or below the nominated 0.1 mAHD target from late December 2009 through to early February 2010 when significant rainfall resulted in elevated groundwater levels.

In mid May 2010, a program to clean (pig) the header was undertaken by Orica. This resulted in an immediate reduction in pressure on the western end of SCA (approximately 50 kPa) and more uniform pressure across the line. A detailed review of the effects of the pressure change on water levels will be provided in the June 2010 report.

4.0 GROUNDWATER CHEMICAL MONITORING

4.1 General

The quarterly groundwater chemical monitoring program is focused on collecting data critical to environmental and human health receptors. The assessment of chemical changes in shallow groundwater is presented in this section and the discussion of the results with reference to the human health risk assessment is presented in Section 6.

4.2 Description of Groundwater Chemical Monitoring Data

The groundwater chemical monitoring data for the March 2010 GTP monitoring round is presented as follows:

- The locations of monitoring wells and bundle piezometers sampled in March 2010 are shown in Figure 2.2;
- Measured water quality parameters and field observations made during sampling are presented in Table 4.1;
- Analytical results of groundwater volatile CHCs and carbon disulfide are presented in Table 4.2 to 4.4; and
- Historical concentrations, detection limit variations, historical maximums and short-term and long-term trends are presented in Tables 4.5 to 4.10. All available historical data have been used in calculating historical trends, but only data since June 2007 is presented in the tables.

4.3 Assessment of Groundwater Chemical Monitoring Data

Tables 4.5 to 4.10 present the following parameters:

- Locations where a reported contaminant concentration represents a historical maximum (Max Flag);
- A Detection Limit (DL Flag) for locations where the reported detection limit is greater than the reported concentration or detection limit for the previous monitoring round; and
- Parametric tests for selected contaminants to identify short-term (12 month) and long-term (all available data) trends. Where increases (>20%) are observed for both short- and long- term tests the result is represented by ‘double red flags’ in the data table. Conversely, decreases (>20%) are represented by ‘double green flags’.

The assessment of groundwater chemical monitoring data presented in this report focuses on historical maximum concentrations. An assessment of short-term and long-term trends, although presented in the parametric tables, will be conducted in the annual/biennial reports as the additional data collected during these events will provide a more robust interpretation of overall trends.

4.3.1 Historical Maximums

Historical maximum concentrations were reported for the following contaminants and ports at BP01:

- 0.75 m port – EDC (22.5 mg/L), PCE (0.005 mg/L), TCE (5.5 mg/L), VC (2.06 mg/L) and CFM (4.86 mg/L); and
- 2 m port – TCE (25.5 mg/L).

The concentrations reported at these ports were similar to the concentrations reported during the December 2009 monitoring round. However, as part of the December 2009 monitoring round (URS, 2010a), this location was resampled to assess whether the results were representative of the groundwater conditions at this location at that time. The reported concentrations of the second sample, which were used in the interpretation of data for this location during the December 2009 monitoring round, were consistent with historical averages. To determine whether the fluctuations represent real changes in concentrations and are not an artefact of a compromised bundle piezometer a replacement well (comprised of several drivepoints) will be installed to serve as an alternative sampling location prior to the next quarterly monitoring round.

Historical maximum concentrations in the Central Plume area were reported for the following contaminants and locations:

- BP60 (8 m port) – EDC (29.5 mg/L); PCE (0.06 mg/L); TCE (1.13 mg/L); and
- BP77 (20 m port) – EDC (62.8 mg/L); PCE (1.27 mg/L); TCE (3.14 mg/L); CFM (4.6 mg/L).

Historical maximum concentrations in the Southern Plumes area were reported at MWF15S for PCE (0.004 mg/L) and at MWF15I for CFM (32.4 mg/L).

Historical maximum concentrations of TCE (0.007 mg/L) were reported at BP58 located in the Northern Plumes area.

The reported historical maximum concentrations, with the exception of concentrations at BP01, are not considered significant as they are similar to concentrations reported previously for the respective sample locations. Slight changes in concentrations may be a function of changes in plume distribution induced by hydraulic containment.

5.0 PENRHYN ESTUARY AND SURFACE WATER MONITORING

5.1 Penrhyn Estuary Pore Water Monitoring

5.1.1 General

All pore water and surface water samples collected during the March 2010 monitoring round were analysed for volatile CHCs. The results are presented in Table 4.3. Short- and long-term historical trends, detection limit flags and historical maximum concentrations are presented in Tables 5.1 to 5.5. However, the analysis of short- and long-term trends will be conducted in the annual/biennial reports.

In general, March 2010 data is consistent with data from the previous monitoring rounds with the concentrations of the chemicals of concern generally decreasing with the decreasing depth towards the discharge interface.

5.1.2 Discharge Interface Pore Water CHC Concentrations

Concentrations of volatile CHCs at the discharge interface are considered the most relevant in terms of assessing current data against the Consolidated Human Health Risk Assessment (HHRA, URS 2005e) and its Addendum (URS, 2006b) and potential impacts to surface waters within Penrhyn Estuary.

A comparison of concentrations of key contaminants in samples collected from the discharge interface (0.1 m port) and shallow pore water in Penrhyn Estuary during the March 2010 monitoring round compared against the ANZECC (2000) Trigger Values has been conducted. This data is presented in Table 4.3 with concentrations above the ANZECC (2000) Trigger Values indicated by shaded cells.

The concentrations of the key contaminants reported in the March 2010 monitoring round are less than the ANZECC (2000) Trigger values for all samples collected at the discharge interface (0.1 m port).

The only exceedance of an ANZECC (2000) Trigger value was for VC (0.1 mg/L) in the 2 m port of BP42 at both high and low tides (2.6 and 2.92 mg/L, respectively).

5.1.3 Comparison with Historical Pore Water Concentrations

Volatile CHCs concentrations measured in pore water within Penrhyn Estuary are similar to or lower than, historical concentrations. No historical maximum key contaminant concentrations were reported during the March 2010 monitoring round.

5.2 Surface Water Monitoring

Surface water samples were collected at high tide and low tide at Penrhyn Estuary in conjunction with pore water sampling on 17 March 2010. Table 4.4 presents the volatile CHC analytical results for surface water samples as compared against the ANZECC (2000) Trigger values.

Key contaminant concentrations reported in the March 2010 monitoring round were less than the relevant ANZECC (2000) Trigger Values.

6.0 IMPLICATIONS FOR HUMAN HEALTH RISK ASSESSMENT

The Consolidated Human Health Risk Assessment (URS, 2005e) considered risks to human health in the following areas surrounding the BIP: Western Margin of the Northern Plumes; Main Plume; and Penrhyn Estuary. Other relevant reports have also been completed subsequent to the 2005 HHRA. This includes the Addendum to the 2005 HHRA (URS, 2006b) and the Surface Water and Ambient Air Monitoring for Springvale Drain report (URS, 2008g). It is also noted that a revision of the HHRA is currently being undertaken.

The data reviewed as part of the 2005 HHRA and its Addendum, relevant exposure pathways and contaminants of potential concern (COPC) are summarised in previous quarterly monitoring reports (most recently in the December 2009 quarterly monitoring report [URS, 2010a]).

A review of the data collected as part of the March 2010 monitoring program against data previously reported and/or used in the HHRA or its Addendum has been undertaken. This data is relevant to the three main areas identified in the 2005 HHRA. The findings of this review are:

- Western Margin on Northern Plumes - The concentrations of CTC, EDC, PCE, TCE and VC in groundwater taken from the representative bores and depths sampled in the March 2010 program were less than those reported in the HHRA and/or its Addendum;

- Main Plumes – Concentrations of key contaminants from shallow groundwater in relevant areas overlying the main plumes, Botany Golf Course and commercial/industrial areas were less than or similar to those considered when the HHRA was conducted; and

- Penrhyn Estuary – Concentrations of key contaminants from relevant surface water and pore water samples were less than the maximum concentrations assessed in previous reports (including the additional review of data presented in June 2007 [URS, 2007e] and September 2008 [URS, 2008f] quarterly monitoring reports). It is noted that the potential for exposure within the inner estuary is currently affected by access restrictions associated with the Port Botany expansion works (URS, 2010a).

In summary, there is no additional data presented in the March 2010 monitoring round that affects the conclusions of the HHRA (URS, 2005e) and its Addendum (URS, 2006b) in relation to the Western margin of the Northern Plumes and with respect to existing commercial/industrial worked in areas above the main plumes. That is, the groundwater contamination within the Northern Plumes near the Western Margin and within the main plumes is not considered to pose an unacceptable risk to human health, assuming groundwater is not extracted and used.

Similarly, based on the data collected to March 2010, the conclusions presented within the HHRA associated with exposures within the inner and outer estuary remain unchanged. That is, given the conservative nature of the range of assumptions and the safety factors applied to toxicity values, the risks to human health for all exposure scenarios are considered to be low. However, the assessment has identified worst-case exposure scenarios (particularly within the inner estuary where calculated risks exceed the target values). It is noted that the potential for exposure within the inner estuary is effectively eliminated by access restrictions associated with the Port Botany expansion works.

A detailed review of data from Springvale Drain (URS, 2009e) identified a strong relationship between shallow groundwater levels, concentrations of volatile CHCs in surface water and in ambient air adjacent to the drain. This review also identified shallow groundwater conditions (less than 2.3 mAHD at MWB03S) where the potential for inhalation exposures adjacent to the drain were not considered to be high. Review of hydrograph data collected from this location (refer to Figure A.12) indicates that groundwater elevations were below 2.3 mAHD at MWB03S during the entire monitoring period. Based on this observation no significant issues have been identified with respect to inhalation exposures adjacent to Springvale Drain.

7.0 CONCLUSIONS

7.1 Hydraulic Monitoring

Subject to the Limitations in Section 8 and the extended discussion in Section 3, the following conclusions are presented for the hydraulic monitoring:

- The inferred contours and patterns of shallow and deep groundwater flow infer that hydraulic containment was achieved at BIP and PCA during the monitoring period;
- With the exception of water levels in the intermediate aquifer at the eastern end of the SCA, hydraulic containment was successfully achieved during the monitoring period. Detailed monitoring of the changes to water levels following cleaning (pigging) of pipe lines in May 2010 is required to ensure that target levels are achieved at the western end of the containment line;
- Elevated groundwater levels were observed at the SCA in intermediate monitoring wells east of MWF01. The increased levels are the result of fouling in the deep extraction wells. Detailed analysis of the causes (biological/geochemical) of the fouling has been commenced and a drilling contractor will commence cleaning activities in early June 2010. It is anticipated that cleaning of extraction wells will be included as part of the ongoing preventative maintenance program; and
- Water levels at regional monitoring locations show no discernible water level impact due to hydraulic containment thus indicating a limited potential to affect infrastructure and licensed groundwater users.

7.2 Chemical Monitoring

Subject to the Limitations in Section 8 and the extended discussion in Sections 4, 5 and 6, the following conclusions are presented for the chemical monitoring program:

7.2.1 Offsite Monitoring Wells

- Historical maximum concentrations were reported for several contaminants at the 0.75 m and 2 m ports of BP01. To determine whether fluctuations in concentrations reported in the December 2009 and March 2010 monitoring rounds represent real changes in concentrations and are not an artefact of a compromised bundle piezometer a replacement well (comprised of several drivepoints) will be installed to serve as an alternative sampling location prior to the next quarterly monitoring round;
- Historical maximum concentrations in the Central Plume area were reported at the 8 m port of BP60 (EDC, PCE and TCE) and at the 20 m port of BP77 (EDC, PCE, TCE and CFM). Similarly, historical maximum concentrations in the Southern Plumes area were also reported at MWF15S (PCE), MWF15I (CFM) and at BP58 (TCE), located in the Northern Plumes area; and
- The reported historical maximum concentrations, with the exception of concentrations at BP01, are not considered significant as they are similar to concentrations reported previously for the respective sample locations. Slight changes in concentrations may be a function of changes in plume distribution induced by hydraulic containment.

7.2.2 Penrhyn Estuary

- In general, March 2010 data is consistent with data from the previous monitoring rounds with the concentrations of the chemicals of concern generally decreasing with the decreasing depth towards the discharge interface; and
- The concentrations of the key contaminants reported in the March 2010 monitoring round are less than the ANZECC (2000) Trigger values for all samples collected at the discharge interface (0.1 m port). No historical maximum key contaminant concentrations were reported during the March 2010 monitoring round.

7.2.3 Surface Water

- Key contaminant concentrations reported in the March 2010 monitoring round were less than the relevant ANZECC (2000) Trigger Values.

7.2.4 Implications for Human Health Risk Assessment

- There is no additional data presented in the March 2010 monitoring round that affects the conclusions of the HHRA (URS, 2005e) and its Addendum (URS, 2006b) in relation to the Western margin of the Northern Plumes and with respect to existing commercial/industrial worked in areas above the main plumes. That is, the groundwater contamination within the Northern Plumes near the Western Margin and within the main plumes is not considered to pose an unacceptable risk to human health, assuming groundwater is not extracted and used; and

- Similarly, based on the data collected up to March 2010, the conclusions presented within the HHRA associated with exposures within the inner and outer estuary remain unchanged. That is, given the conservative nature of the range of assumptions and the safety factors applied to toxicity values, the risks to human health for all exposure scenarios are considered to be low. However, the assessment has identified worst-case exposure scenarios (particularly within the inner estuary where calculated risks exceed the target values). It is noted that the potential for exposure within the inner estuary is effectively eliminated by access restrictions associated with the current Port Botany expansion works.

8.0 LIMITATIONS

This Document has been provided by Golder Associates Pty Ltd (“Golder”) under the Environmental Consultancy Services Agreement M5739 between Orica Australia Pty Ltd (“Orica”) and Golder and is subject to the following limitations:

This Document has been prepared for the particular purpose outlined in Golder’s proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

The scope and the period of Golder’s Services are as described in Golder’s proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

Conditions may exist which were not detected given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between assessment locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder’s opinions are based upon information that existed at the time the information is collected. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

Any assessments, designs, and advice provided in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any direct legal recourse to, and waives any claim, demand, or cause of action against, Golder’s affiliated companies, and their employees, officers and directors. Rather, Golder accepts full responsibility for the services provided by its subconsultants, including Golder's affiliated companies, and their employees, officers and directors. Golder acknowledges and agrees it is legally liable for the Services provided by the Golder's affiliated companies, and their employees, officers and directors.

This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.

Report Signature Page

GOLDER ASSOCIATES PTY LTD

Beatrice Gomez
Senior Environmental Scientist

Greg Dasey
Principal Environmental Engineer

Colm Molloy
Associate

BG/GD:MU/bg

A.B.N. 64 006 107 857

j:\env\2010\107623038_orica_march 2010 quarterly_botany\project doc\final report\107623038-002-r-reva-monitoring report.docx