

# FINAL REPORT

Remediation Action Plan  
QUIX Service Station  
161 Hume Highway  
Lansvale  
NSW  
(NJ 3565)

*Prepared for*

**Mobil Oil Australia Pty Ltd**

7 JULY 2003

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The logo for URS, consisting of the letters 'URS' in a bold, black, sans-serif font.

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## **Site Identification**

The site is located at 161 Hume Highway, Lansvale, NSW. The site occupies Lot 204 in Deposited Plan 732440 and is currently zoned 4(c) Industrial Special (Handex, January 2002).

The Handex report *Environmental Site Assessment Quix Service Station 161 Hume Highway (Cnr Chadderton Street) Lansvale, NSW (Site No. NJ 3565) (9 January, 2002)* indicated that the site occupies an area of 1 894 m<sup>2</sup>.

## **Objective of Remediation Action Plan**

The objective of this RAP is to:

- Define the remediation goals for the site;
- Determine the most appropriate remediation method to achieve the defined remediation goals; and
- Demonstrate how the remediation goals will be achieved.

## **Site Background**

The site has been an operating service station since approximately 1961. In 1986 the site was refurbished. Prior to this an auto mechanics may also have been present on the site. In the 10 years prior to 1961 the site was vacant land (Handex, January 2002).

Mobil currently lease the site (Lot 204 in D/P 732440) from the owner, Modern Motels Pty. Ltd.

Previous Phase II and Post Phase II site assessments have identified phase separated hydrocarbons and levels of total petroleum hydrocarbons (TPH), benzene, toluene, ethyl benzene and xylene (BTEX) in subsurface soils and groundwater that exceed the relevant NSW EPA approved investigation levels. Elevated concentrations of polynuclear aromatic hydrocarbons (PAHs) were also detected in groundwater. Elevated contaminant concentrations have been detected in groundwater at the southern and eastern site boundaries. Phase separated hydrocarbons (PSH) were detected in the central western portion of the site, adjacent to the underground storage tanks (USTs). URS are currently conducting a Phase I environmental assessment at the site.

Mobil made a notification of the site to the NSW EPA under Section 60 of the Contaminated Land Management Act. The NSW EPA indicated that there is insufficient information to declare the site a significant risk of harm. However, the NSW EPA requested that all PSH are removed from the site, and that additional investigations are conducted to determine the extent of impacts off of the site.

Primary sources that have been identified at the site include four known USTs.

## **Remediation Goals**

Primary and secondary source control are considered to be the most appropriate options for the site remediation. Based on this evaluation, the following remediation goals have been selected for the site:

- Remove all primary sources of potential impact;
- Remove PSH;
- Remediate sub-surface impacted soil to a standard suitable for ongoing commercial/industrial land use;
- Remediate dissolved phase impact to groundwater such that it does not pose an unacceptable risk to human health or the environment (as defined through a quantitative risk assessment, additional off site investigations and/or the NSW EPA's significant risk of harm determination);
- Implement a groundwater monitoring program to measure the effectiveness of the remediation activities. The program should be designed to demonstrate that remediation has effectively removed the potential risks which the impacts may pose, based on the achievement of risk based or NSW EPA determined criteria; and
- Demonstrate that the potential impacts from the residual hydrocarbons (following remediation) are suitably limited and appropriate based on the site and surrounding land uses, contaminant concentrations, retardation rates and exposure pathways.

## **Remediation End Points**

Primary source control involves the removal of all primary sources of site contamination, including leaking USTs, fuel lines, dispensers and interceptor pits. The NEPM HIL Level F guidelines for PAHs in soil are considered appropriate. Given that currently there are no guidelines for assessment of total petroleum hydrocarbon (TPH) and benzene, toluene, ethyl benzene and xylene (BTEX) impacts to soil under a commercial/industrial and/or operation petrol station land use, a quantitative risk assessment is proposed for the derivation of guidelines for TPH and BTEX in soil. A risk-based approach is also proposed for the derivation of guidelines for groundwater. However, final selection of the remediation end points for soil and groundwater at the site will depend on the NSW EPA's assessment of whether the site poses a significant risk of harm risk. The NSW EPA's determination of whether the site poses a significant risk of harm will be based on the results of the proposed quantitative risk assessment and additional on site and off site investigations.

## **Review of Applicable Remediation Technology**

In reviewing the applicable technology for soil remediation, the following factors were considered: the ability to meet regulatory requirements, the remediation goal and remediation end points; the ability to meet site business needs; capital and operating costs; time constraints; waste management requirements; environmental impacts; aesthetic impacts and site amenity. In accordance with the Mobil Specification, a Remediation Technology Review Matrix and a Net Present Value analysis were compiled to evaluate the

# Executive Summary

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viability of various remediation approaches. The remediation approach considered most suitable for the site comprises total fluids pumping (for PSH removal and recovery of impacted groundwater) and possibly a combined soil vapour extraction, air sparging and/or groundwater and/or multi-phase extraction approach for remediation of soil and groundwater under the site, if required.

## **Remediation Strategy**

The remediation strategy will comprise:

- Conducting pilot testing to assess the applicability of the proposed remediation technologies;
- System design and installation;
- Implementation of an environmental management plan and drafting of an operations manual;
- System commissioning and monitoring;
- Conduct quarterly groundwater sampling; and
- System decommissioning once remediation end points have been achieved.

## **Validation Sampling**

Remediation of the site soils will be required if the quantitative risk assessment and/or NSW EPA determine that the concentrations of the contaminants of concern pose a risk to human health and/or the environment. To ensure the remedial works meet the defined remedial goals, validation of the site soils will be required. Validation of the site soils will comprise collection of soil samples on a 10 m grid across the site. Samples will be collected from the surface at 1 m intervals to 1 m beyond the known depth of soil impact at the site. Two samples from within the (known) impacted soil zone, along with other samples exhibiting indicators of hydrocarbon impact (hydrocarbon odours, elevated VOC readings, colour) will be submitted from each validation location for laboratory analysis. All samples (with the exception of trip blanks) will be analysed for: TPH; BTEX; and PAHs.<sup>1</sup>

Quarterly groundwater monitoring events will be conducted throughout the course of the remediation program. The purpose of these events will be to assess the efficacy and progress of the PSH and groundwater remediation systems. Groundwater samples will be collected from all site and off site monitoring wells. PSH will be considered to have been removed when there is an asymptotic recovery, or when the PSH thickness reduces to less than 5 mm in each affected well over three consecutive groundwater monitoring events. Dissolved phase hydrocarbon impacts will be considered to have been removed when groundwater samples collected from three consecutive (quarterly) groundwater monitoring events meet the remediation end points. All samples (with the exception of the trip blanks) will be analysed for: TPH; BTEX; and PAHs.

## 1.1 Preamble

URS Australia Pty Ltd (URS) was engaged by Mobil Oil Australia Pty Ltd (Mobil) to prepare a Remediation Action Plan (RAP) for the QUIX service station located at 161 Hume Highway, Lansvale, NSW (the site) (see Figure 1). The RAP has been prepared to provide a framework for the remediation of the site to a level commensurate with the ongoing commercial industrial land use (zoned 4 (c) Industrial Special). The RAP was prepared following notification of the site by Mobil under Section 60 of the Contaminated Land Management Act (1997), and the subsequent response to this notification by the NSW Environment Protection Authority (NSW EPA), which is attached in Appendix A.

Remediation of the site is required to:

- Fulfill Mobil's obligations under the lease hand back arrangements;
- Remove the risks to human health and the environment which may be posed by the impact identified during the previous site investigations; and
- Meet the NSW EPA requirements, as detailed in the letter of 30 June, 2003 (Appendix A).

## 1.2 Objective

In accordance with the *Environmental Site Assessment Specification Module 6 – Remediation Action Plans (D. Wright, 3 March, 2002)* (Specification), the objective of the RAP is to develop a risk-based, cost effective strategy for implementation of remediation measures that achieve the remedial requirements listed in Section 1.1. The RAP is also used as a basis for preparing the subsequent detailed design of the remediation system, if required.

The objective of this RAP is to:

- Define the remediation goals for the site (using existing data and data from proposed additional investigations);
- Determine the most appropriate remediation method to achieve the defined remediation goals; and
- Demonstrate how the remediation goals will be achieved.

The RAP has been developed based on information from previous assessments and on the requirements of the:

- Specification;
- *Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA November, 1997)*; and
- NSW EPA.

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The Mobil Work Request Form (WRF) and Instruction to Proceed (ITP) are attached in Appendix B.

### 2.1 Site Summary Information

#### 2.1.1 Site Identification

The table below provides a summary of the site identification details.

Item	Description
SITE NAME	QUIX Service Station Lansvale.
SITE NUMBER	NJ3565.
SITE LOCATION	161 Hume Highway, Lansvale, NSW.
REAL PROPERTY DESCRIPTION	Lot 204 in Deposited Plan 732440
SITE AREA	1 894 m <sup>2</sup> (Handex, 9 January 2002).
SITE ZONING	4(c) Industrial Special (Handex, 9 January 2002).
CURRENT OWNERSHIP	Modern Motels Pty Ltd (leased by Mobil Oil Australia Pty Ltd.).
PROPOSED SITE USE	Ongoing commercial/industrial.
LOCAL GOVERNMENT AREA	Fairfield City Council
CURRENT SITE USE	Service Station

#### 2.1.2 Site Layout

The site slopes gently (approximately 1 in 200) towards the northeast. The site is an operating service station comprising the following facilities:

- Four underground storage tanks (USTs) in the south western portion of the site;
- Three fuel dispenser islands in the central portion of the site, and a diesel dispenser in the western portion of the site;
- A salesroom in the eastern portion of the site; and
- Landscaped gardens along the eastern, southern and south western boundaries of the site.

Handex (January, 2002) indicated that the USTs were more than 10 years old. Table 1 (attached) details the capacity and fuel type stored within each UST. The forecourt surface is fully sealed with a 0.15 m-0.2 m concrete slab that has some minor cracks. Surface staining is evident near the diesel dispenser and the central fuel dispenser. Figure 3 illustrates the layout of the site.

### 2.1.3 Surrounding Land Use

A site inspection was performed by URS personnel in February 2003. The land uses adjacent to the site were noted as follows:

- **NORTH:** a vacant lot bounds the site to the north. Commercial/light industrial properties (metal spinning, transport, body repairs and mechanic) are located beyond the vacant lot;
- **SOUTH:** the Hume Highway bounds the site to the south. Commercial/light industrial properties (welder, storage facility and glass manufacturer) are located on the southern side of the Hume Highway;
- **EAST:** the intersection of Chadderton Street and the Hume Highway bounds the site to the east. Commercial/light industrial properties (mechanic, car dealer and welder) are located beyond Chadderton Street; and
- **WEST:** a vacant lot bounds the site to the west. The *Lansdowne Motor Inn* is located beyond the vacant lot.

Figure 2 illustrates the location of the site relative to the surrounding land uses.

## 2.2 Summary of Previous Assessments

### 2.2.1 General

The following assessments have been conducted at the site:

- MassTech Australia Pty Limited, 9 April, 2001, "*UPS Precision Test Report Mobil Quix NJ3565 161 Hume Highway Lansvale NSW 2166*";
- Handex Australia Pty Ltd, 9 January, 2002 "*Environmental Site Assessment Quix Service Station 161 Hume Highway (Cnr Chadderton Street) Lansvale, NSW (Site No. NJ 3565)*";
- MassTech Australia Pty Limited, 6 June 2002 "*UPS Precision Test Report Mobil 161 Hume Highway Lansvale NSW 2166*";
- Handex Australia Pty Ltd, 5 September, 2002 "*Additional Well Installation and Groundwater Monitoring Mobil/Quix Service Station 161 Hume Highway (Cnr Chadderton Street) Lansvale, NSW (Site No. NJ 3565)*";

- Handex Australia Pty Ltd, 21 February, 2003 *Multi-Phase Extraction Summary Report Mobil Service Station 161 Hume Highway, Lansvale, NSW (Site No. NJ 3565)*"; and
- URS Australia Pty Ltd, 26 May, 2003 "*Groundwater Monitoring Event Mobil Service Station Site No. NJ 3565 161 Hume Highway, Lansvale, NSW*".

A Site Summary Information Table is included in Appendix C.

### 2.2.2 Summary of Phase II and Post Phase II Assessment Findings

A summary of the results of the previous assessments are detailed in the following sections:

#### **Site History**

The site has been an operating service station since approximately 1961. In 1986 the site was refurbished. Prior to this an auto mechanics may also have been present on the site. In the 10 years prior to 1961 the site was vacant land (Handex, January 2002).

Mobil currently lease the site (Lot 204 in D/P 732440) from the owner, Modern Motels Pty. Ltd. The site is zoned 4 (c) Industrial Special (Handex, January 2002).

A Phase I environmental site assessment is currently conducted at the site, which aims to gather further information regarding the site history and usage.

#### **Hydrology**

The site is sealed with concrete, with the exception of the landscaped areas which border the site along the eastern, southern and south western boundaries. The site slope gently to the north east. Surface water is likely to collect in the site drains and adjacent street storm water drains. The closest water bodies to the site are Prospect Creek (to the north east) and Chipping Norton Lake (to the south), which are located approximately 400 m and 600 m from the site, respectively (see Figure 2).

#### **Geology**

The 1:100 000 *Penrith Geological Series Sheet 9030 (Department of Mineral Resources, 1991)* indicates that the regional geology underlying the site is comprised of a sequence of Quaternary sand, clay and silt associated with the Georges River Basin.

The generalised geological profile beneath the site is detailed below.

- Concrete – surface to 0.2 m below the ground level (bgl);
- Fill – brown and grey sand with minor clay, silt and gravel, loose and moist (0.2 m bgl to 1 m bgl);

- Sandy Clay and Clay – red/brown, firm, plastic, moist (1 m bgl to 3 m bgl); and
- Sand or Clayey Sand - low-moderate plasticity, light brown, damp, stiff, (3 m bgl to 6 m bgl).

Geological cross sections illustrating the site and surrounding geology are presented as Figures 4a to 4d. These cross sections show spatial variations in the thickness of some of the above described units, along with the presence of lenses of other soil types and facies changes within some units.

The thickness of fill varies from being absent at LMW7, to approximately 1.5 m thick at LMW11. Variations in the fill thickness may be due to leveling works conducted during initial construction of the site.

The thickness of the clay layer underlying the fill varies between 1 m (at LMW10) to approximately 3 m (under several areas of the site). It is also noted that there are facies changes within this unit, with the clay (laterally) grading into sandy clay and clayey sands in the eastern and western portions of the site (see Figures 4a and 4b), and in the northwestern and southwestern portion of the site (see Figure 4c).

The clay unit is variably underlain by sand, or a lens of silty sand, clayey sand or sandy clay. Figure 4a indicates that the layer of silty sand intersected below the clay unit at LMW2 grades laterally (to the east) into sandy clay (at LMW13). This reflects a general increase in the clay content within soils at the eastern end of the site.

### Hydrogeology

Handex Australia Pty Ltd (Handex) installed 14 monitoring wells at the site (see Figure 3). On the basis of the most recent groundwater gauging and recovery test data (URS, 2003), the following table provides a summary of the site groundwater conditions and closest groundwater receptors to the site.

Item	Description
Aquifer Type	Likely to be unconfined or possibly semi-confined.
Depth to Groundwater	3.72 m bgl to 4 m bgl.
Flow Direction	South east, north east and south west.
Groundwater Gradient	0.005.
Hydraulic Conductivity	0.01 m/day to 0.96 m/day.
Seepage Velocity	0.016 m/day, assuming an effective porosity of 0.15 for the sand unit located at approximately 3 m bgl to 6 m bgl (limit of drilling).
Beneficial Groundwater Use	The sampling results indicate the water beneath the site is relatively saline, and may be suitable for irrigation (TDS min 2,532 mg/L).

# Site Background Information

## SECTION 2

Nearest Registered Bore	14 bores within 850 m of site. Uses comprise industrial, irrigation and waste disposal. None known to be domestic.
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Historical groundwater contour plots and the inferred groundwater flow directions are attached in Appendix D.

The most recent round of groundwater monitoring indicated the groundwater at the site has:

- PSH on top of the water table at monitoring wells LMW1 (0.16 m), LMW2 (0.57 m) and LMW4 (0.18 m);
- Slightly acid pH levels (5.55 to 6.71);
- Generally low dissolved oxygen (DO) levels (0.27 mg/l to 2.01 mg/L), which is indicative of reducing conditions;
- Total dissolved solids concentrations (calculated from electrical conductivity readings) of 2 532 mg/L to 5 604 mg/L, which is indicative of brackish to saline conditions; and
- A reduction potential (redox) of -177 mV to 384 mV, which generally is indicative of reducing to slightly oxidising conditions.

The groundwater gauging and field water quality screening results for all of the previous assessments conducted at the site are attached in Appendix E.

As detailed in the above table, there is a large variation in hydraulic conductivities within the aquifer underlying the site. This is a reflection of the variation of soil types within the water bearing strata. Typically, the higher conductivities ( $K > 0.6$  m/day) were measured at monitoring wells installed within portions of the aquifer comprised of sand, while the lower conductivities ( $K < 0.1$ ) were measured in monitoring wells installed within portions of the aquifer which contained varying amounts of clay.

The heterogeneity of the aquifer materials and the variation in conductivities indicate that the aquifer is likely to be moderately, to highly, anisotropic. Consequently, the groundwater flow direction will be influenced both by the gradient (vector) and differences in hydraulic conductivities (flow will preferentially occur along the path of least resistance, ie in the direction of highest hydraulic conductivity).

The degree of anisotropy is reflected in the most recent groundwater contour map (URS Figure 4, Appendix D), which shows the groundwater contours bending around the tank pit area. The tank pit is likely to have been back filled with un-compacted, high permeability materials (sand or pea gravel). Consequently, groundwater flow under the site bends towards (and through) these materials. Groundwater flow (beyond the tankpit) then appears to be towards the south east. However, there also appears to be localised flow to the south west from the unsealed area to the south east of the site (near LMW14); and to the north east in the area of monitoring well LMW5. The south westerly flow

components may be due to mounding in the water table from localised recharge in the unsealed area to the south east of the site.

### Soil Sample Analytical Results

Handex Australia Pty Ltd - 9 January and 5 September, 2002.

Handex Australia Pty Ltd (Handex) drilled 20 boreholes as part of their environmental assessments at the site (9 January and 5 September, 2002). A total of 46 soil samples (including 5 field duplicate samples) were collected from the 20 boreholes. The samples were analysed for:

- Total petroleum hydrocarbons (TPH) – all samples;
- Benzene, toluene, ethyl benzene and xylene (BTEX compounds) – all samples;
- Lead – all samples;
- Total organic carbon (TOC) – 4 samples of natural soils;
- Arsenic, cadmium, chromium, copper, mercury, nickel and zinc – 3 fill samples; and
- Polynuclear aromatic hydrocarbons (PAHs), phenols, organochlorine pesticides (OCs), organophosphorous pesticides (OPs) and volatile chlorinated hydrocarbons (VCH) – 3 fill samples.

Soil sample analytical results were compared with the following investigation levels:

- NSW EPA, 1994 "*Guidelines for Assessing Service Station Sites*" (Service Station Guidelines) - for TPH, BTEX and total PAHs; and
- National Environmental Protection Council, 1999 "*National Environmental Protection Measure Health Based Investigation Levels (Level F – Commercial/Industrial)*" (NEPM HIL F) - for all other compounds.

Soils containing concentrations of TPH C<sub>6</sub>-C<sub>9</sub>, TPH C<sub>10</sub>-C<sub>36</sub> and BTEX above the referenced investigation levels were collected from bore holes LVB3 – LVB7, LVB9 and LMW4 (see Handex Figure 5, Appendix J), which were located in the vicinity of the USTs and the southern-most dispenser island. The impacted soils were detected between 3.2 m bgl and 6 m bgl, within the natural sand and clayey sand unit. The concentrations of all other compounds were below the relevant investigation levels (where available).

The distribution of the impacts to soil is likely to be related both to the:

- Proximity to the probable sources; and
- Inferred groundwater flow directions (predominantly to the south east, as detailed in the above sections).

The historical soil sample analytical results are attached in Appendix F.

### Groundwater Sample Analytical Results

Handex Australia Pty Ltd - 9 January and 5 September, 2002

Handex installed (and sampled) 12 groundwater monitoring wells (LMW1 To LMW12) during their first environmental assessment at the site (9 January, 2002), and a further 2 monitoring wells (LMW13 and LMW14) during their second environmental assessment (5 September, 2002).

The groundwater sample analytical results for these assessments were compared with the following investigation levels:

- Service Station Guidelines *Threshold Concentrations for the Protection of Aquatic Ecosystems (Fresh)* (Threshold Concentrations) for toluene, ethylbenzene, total xylenes and total PAHs; and
- ANZECC / ARMCANZ (2000) *Trigger Values for Fresh Waters (95 % Level of Protection)* for all other compounds (Trigger Values).

The results of groundwater sampling are detailed below:

- Elevated concentrations of C<sub>6</sub>-C<sub>9</sub> TPH were detected in samples collected from monitoring wells LMW3, LMW4, LMW6, LMW7 and LMW9, ranging from 1 100 µg/L (LMW7) to 19 000 µg/L (LMW4);
- Elevated concentrations of C<sub>10</sub>-C<sub>36</sub> TPH were detected in samples collected from monitoring wells LMW3, LMW4, LMW6, LMW7, LMW9 and LMW13, ranging from 456 µg/L (LMW6) to 7 881 µg/L (LMW4);
- Benzene was detected above the investigation level of 950 µg/L in samples collected from monitoring wells LMW3, LMW4, LMW6, LMW7 and LMW9, ranging in concentration from 970 µg/L (LMW6) to 5 800 µg/L (LMW9);
- Toluene was detected above the investigation level of 300 µg/L in samples collected from monitoring wells LMW3, LMW4 and LMW9, ranging in concentration from 1 600 µg/L (LMW3) to 7 400 µg/L (LMW4);
- Ethyl benzene was detected above the investigation level of 140 µg/L in samples collected from monitoring wells LMW3, LMW4 and LMW9, ranging in concentration from 380 µg/L (LMW3) to 800 µg/L (LMW4);
- Total xylene was detected above the investigation level of 380 µg/L in samples collected from monitoring wells LMW3, LMW4, LMW6 and LMW9, ranging in concentration from 2 100 µg/L (LMW6) to 6 500 µg/L (LMW4);
- Total PAHs were detected above the investigation level of 3 µg/L in the sample collected from monitoring well LMW3 (310 µg/L). The only other samples to be analysed for PAHs (other than the

sample from LMW3) were collected from monitoring wells LMW13 and LMW14. The concentrations of total PAHs in these samples ranged from < 1 µg/L (LMW14) to 3 µg/L (LMW13);

- VHCs were not detected above the laboratory detection limit in the only sample (collected from LMW3) analysed for this chemical suite;
- Total arsenic concentrations ranged from 9 µg/L (LMW13) to 16 µg/L (LMW3) and total chromium concentrations ranged from 4 µg/L (LMW13) to 23 µg/L (LMW3). There are no investigation levels for total arsenic and total chromium;
- Cadmium was detected above the investigation level of 0.2 µg/L in the sample collected from monitoring well LMW3 (0.8 µg/L);
- Copper was detected above the investigation level of 1.4 µg/L in samples collected from monitoring wells LMW3, LMW13 and LMW14, ranging in concentration from 3 µg/L (LMW13) to 133 µg/L (LMW3);
- Lead was detected above the investigation level of 3.4 µg/L in the sample collected from monitoring well LMW3 (202 µg/L);
- Nickel was detected above the investigation level of 11 µg/L in samples collected from monitoring wells LMW3 and LMW14, ranging in concentration from 26 µg/L (LMW14) to 43 µg/L (LMW3); and
- Zinc was detected above the investigation level of 8 µg/L in samples collected from monitoring wells LMW3, LMW13 and LMW14, ranging in concentration from 24 µg/L (LMW13) to 312 µg/L (LMW3).

PSH was detected at monitoring wells LMW1 and LMW2, with apparent thickness' of 0.029 m and 0.040 m, respectively. Groundwater samples were not collected from these monitoring wells.

ORC socks were installed at the completion of the second groundwater sampling round in monitoring wells LMW3, LMW4, LMW6, LMW7 and LMW9.

### Handex Australia Pty Ltd – 21 February, 2003

In July 2002, Handex conducted two, one-day multi-phase extraction (MPE) events at the site. The purpose of these MPE events was to remove PSH and facilitate the remediation of hydrocarbon impacted soil and groundwater at the site.

The MPE events were conducted on two separate days and involved the extraction of vapour, groundwater and PSH from monitoring wells LMW1, LMW2, LMW3, LMW4, LMW9 and LMW11 (Event 1), and LMW1, LMW2, LMW3, LMW4, LMW6 and LMW7 (Event 2). Groundwater gauging was conducted prior to and immediately following each of the MPE events. A full round of groundwater gauging and sampling was conducted five weeks after the MPE events in September 2002 to assess the impact of the two MPE events on groundwater quality.

Immediately prior to the MPE events, PSH was detected in monitoring wells LMW1 and LMW2, with apparent thickness' 0.258 m and 0.361 m, respectively. These product thickness' were an order of magnitude greater than those reported in the previous Handex assessments (9 January, 2002 and 5 September, 2002). Immediately following the MPE events, groundwater gauging indicated that PSH had been removed from LMW1, and was reduced to an apparent thickness of 0.002 m in LMW2.

The groundwater gauging and sampling conducted five weeks after the MPE events indicated the following:

- Relative to the pre-MPE gauging results, the apparent PSH thickness in LMW1 had decreased to 0.010 m, and increased in LMW2 to 0.460 m;
- Concentrations of C<sub>6</sub>-C<sub>9</sub> TPH generally fell or remained at similar levels to those found prior to the MPE events. Elevated concentrations of C<sub>6</sub>-C<sub>9</sub> TPH were still present following the MPE events at monitoring wells LMW3 (4 900 µg/L), LMW4 (14 000 µg/L) and LMW9 (11 000 µg/L);
- Concentrations of C<sub>10</sub>-C<sub>36</sub> TPH fell at monitoring wells LMW3, LMW7 and LMW9, increased at monitoring wells LMW4, LMW6 and LMW13, and remained at similar levels to those found prior to the MPE event at the remaining monitoring wells. Elevated concentrations of C<sub>10</sub>-C<sub>36</sub> TPH were still present following the MPE events at monitoring wells LMW3 (1 200 µg/L), LMW4 (9 531 µg/L), LMW6 (1 630 µg/L), LMW9 (1 200 µg/L) and LMW13 (13 969 µg/L). The concentration of C<sub>10</sub>-C<sub>36</sub> TPH in LMW13 increased from 1 728 µg/L (prior to remediation), to 13 969 µg/L following the MPE events;
- Concentrations of benzene generally fell, or remained at similar levels to those found prior to the MPE event. Concentrations of benzene remained above the investigation level, following the MPE event, in samples collected from monitoring wells LMW3 (3 100 µg/L) and LMW9 (4 900 µg/L);
- Concentrations of toluene generally fell, or remained at similar levels to those found prior to the MPE event. Concentrations of toluene remained above the investigation level following the MPE in samples collected from monitoring wells LMW4 (1 700 µg/L) and LMW9 (4 900 µg/L);
- Concentrations of ethyl benzene generally fell, or remained at similar levels to those found prior to the MPE event. Concentrations of ethyl benzene remained above the investigation level following the MPE event in samples collected from monitoring wells LMW4 (810 µg/L) and LMW9 (560 µg/L);
- Concentrations of total xylene generally fell, or remained at similar levels to those found prior to the MPE event. Concentrations of total xylene remained above the investigation level following the MPE event in samples collected from monitoring wells LMW4 (5 900 µg/L) and LMW9 (1 490 µg/L); and
- Concentrations of lead generally fell or remained at similar levels to those found prior to the MPE event. Concentrations of lead were below the investigation level in all samples collected following the MPE event.

Groundwater samples collected from the monitoring wells following the MPE event were not analysed for PAHs, VHCs, arsenic, cadmium, copper, mercury, nickel or zinc.

URS Australia Pty Ltd, 11 March, 2003

A complete round of groundwater gauging and sampling was conducted by URS in February, 2003. The results of this assessment are summarised below:

- The groundwater flow direction is inferred to be predominantly towards the south east, with lesser components to the north east and south west;
- PSH was present in monitoring wells LMW1 (0.16 m), LMW2 (0.57 m) and LMW4 (0.18 m). PSH had not previously been present at LMW4; while the apparent thickness of PSH in LMW1 and LMW2 increased by approximately 0.1 m since the previous assessment (Handex, 21 February, 2003). Baildown tests conducted by URS as part of this assessment indicated that a maximum PSH thickness of 0.05 m was present within monitoring well LMW2;
- An 80 % recovery of the apparent thickness was observed within one hour of removal (of all PSH) in monitoring well LMW2, with 95 % recovery observed within 8 hours. Recovery of PSH in monitoring wells LMW1 and LMW4 was comparably slow, with less than 40 % recovery of the apparent thickness of PSH within one hour of removal. The differences observed in the rate of PSH recovery may be related to the positioning of the monitoring wells with respect to the geometry of the PSH plume, and also reflect differences in intrinsic permeabilities in the aquifer surrounding the tested monitoring wells;
- Elevated concentrations of C<sub>6</sub>-C<sub>9</sub> TPH were detected in groundwater samples collected from monitoring wells LMW3 (1 700 µg/L) and LMW9 (2 300 µg/L). In general, concentrations of C<sub>6</sub>-C<sub>9</sub> TPH fell or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003);
- Elevated concentrations of C<sub>10</sub>-C<sub>36</sub> TPH were detected in groundwater samples collected from LMW3 (1 200 µg/L), LMW6 (1 130 µg/L) and LMW13 (64 160 µg/L). In general, concentrations of C<sub>10</sub>-C<sub>36</sub> TPH fell or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003). The exception is the C<sub>10</sub>-C<sub>36</sub> TPH concentration in the sample collected from LMW13, which increased by approximately 40 000 µg/L since the previous Handex assessment (21 February, 2003);
- Benzene was detected above the investigation level in groundwater samples collected from monitoring wells LMW3 (1 500 µg/L) and LMW9 (1 300 µg/L). In general, concentrations of benzene fell or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003);
- Toluene and ethyl benzene were detected above the relevant investigation levels in the groundwater sample collected from monitoring well LMW9 (350 µg/L and 170 µg/L, respectively). In general,

# Site Background Information

## SECTION 2

concentrations of toluene and ethyl benzene fell or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003);

- Total xylene was not detected above the investigation level in any of the groundwater samples analysed. In general, concentrations of total xylene fell or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003);
- Naphthalene was detected above the investigations level in samples collected from LMW3 (50 µg/L) and LMW13 (840 µg/L). Total PAHs were detected above the investigation levels in samples collected from monitoring wells LMW3 (67 µg/L), LMW7 (3 µg/L), LMW9 (15 µg/L) and LMW13 (866 µg/L). The scope of the previous investigations did not include analysis of groundwater samples for PAHs, with the exception of samples collected from LMW3, LMW13 and LMW14, which were analysed for total PAHs. Comparison of the results from the previous investigations indicates that concentrations of total PAHs have decreased at LMW3, increased at LMW13 and remained similar (non-detect) at LMW14. It is noted that some of the laboratory analytical detection limits were above the relevant investigation levels for individual PAH compounds for this investigation;
- VHCs were not detected above the laboratory detection limit, with the exception of 4 µg/L of chloroform in the sample collected from MW10;
- Total arsenic concentrations ranged from 4 µg/L (LMW10) to 17 µg/L (LMW13) and total chromium concentrations ranged from 2 µg/L (LMW10) to 10 µg/L (LMW13). Concentration of arsenic and chromium have fallen slightly or remained at similar concentrations compared with those detected (where analysed) in the previous Handex assessments (9 January, 2002 and 5 September, 2002). There are no investigation levels for total arsenic and total chromium;
- Barium concentrations ranged from 13 µg/L (LMW14) to 327 µg/L (LMW3). The samples collected during the previous assessments were not analysed for barium. There are no investigation levels for barium;
- Cadmium was not detected above the investigation level. Concentrations of cadmium fell compared with those detected (where analysed) during the previous Handex assessments (9 January, 2002 and 5 September, 2002);
- Copper was detected slightly above the investigation level in samples collected from monitoring wells LMW3 (2 µg/L), LMW5 (6 µg/L), LMW6 (3 µg/L), LMW7 (3 µg/L), LMW8 (3 µg/L) and LMW11 (3 µg/L). Concentrations of copper have fallen slightly compared with those detected (where analysed) in the previous Handex assessments (9 January, 2002 and 5 September, 2002).
- Lead was not detected above the investigation level. In general, concentrations of lead fell, or remained at similar concentrations, compared with those detected during the previous Handex assessment (21 February, 2003);

- Mercury was not detected above the investigation level. Concentrations of mercury fell, or remained at similar concentrations, compared with those detected (where analysed) during the previous Handex assessments (9 January, 2002 and 5 September, 2002);
- Nickel was detected slightly above the investigation level in the sample collected from monitoring well LMW5 (12 µg/L). Concentrations of nickel have fallen slightly compared with those detected (where analysed) in the previous Handex assessments (9 January, 2002 and 5 September, 2002);
- Vanadium concentrations ranged from 1 µg/L (LMW3, LMW5 – LMW10) to 4 µg/L (LMW3). The samples collected during the previous assessments were not analysed for vanadium. There are no investigation levels for vanadium;
- Zinc was detected slightly above the investigation level in samples collected from monitoring wells LMW3 (11 µg/L), LMW5 (32 µg/L), LMW6 (59 µg/L), LMW7 (18 µg/L), LMW8 (17 µg/L), LMW9 (9 µg/L), LMW10 (13 µg/L), LMW11 (35 µg/L), LMW13 (10 µg/L) and LMW14 (49 µg/L). The concentration of zinc has fallen slightly compared with that detected (where analysed) in the previous Handex assessments (9 January, 2002 and 5 September, 2002).

Fingerprinting analysis identified the source of the hydrocarbon impact at the western end of the site as degraded leaded petrol of between 2 and 8 years old. The nature of the hydrocarbon impact at the eastern end of the site (C<sub>10</sub>-C<sub>14</sub> and C<sub>15</sub>-C<sub>28</sub> TPH and naphthalene) indicates a possible diesel related source.

As with soil, the distribution of the hydrocarbon impacts are likely to be related both to the:

- Proximity to the probable sources; and
- Inferred groundwater flow directions (predominantly to the south east, as detailed in the above sections).

The source of impacts to groundwater at LMW13 is not known, but it may to be from a separate source (other than the tank pit).

The historical groundwater analytical results are attached in Appendix G. The figure attached in Appendix H illustrates the most recent groundwater analytical results (URS, 2003).

### **Data Quality**

Review by Handex and URS of the data quality for the respective assessments indicate that it is of an acceptable standard for the purpose of the assessments.

### **UST Integrity Testing**

MassTech Australia Pty Ltd (Mass Tech) conducted two rounds of UST integrity testing. The first round of testing commenced in March 2001, and the second round in June 2002. All four USTs and associated lines present on site were subjected to testing.

Both rounds of testing indicated that the integrity of the USTs and associated lines was satisfactory. However, during testing, a minor water egress was noted in UST number 3 (lead replacement petrol) and a minor water ingress was noted in UST number 4 (diesel). MassTech did not consider these leakages to be significant.

### 2.2.3 Summary of Site Impacts

Compiling the results of the previous assessments conducted at the site, the following can be concluded with respect to the extent and nature of impacts to soil and groundwater.

#### **Soil**

The site soils are impacted with elevated concentrations (above relevant investigation levels) of TPH C<sub>6</sub>-C<sub>9</sub>, TPH C<sub>10</sub>-C<sub>36</sub> and BTEX compounds immediately surrounding and to the south east of the USTs. TPH C<sub>6</sub>-C<sub>9</sub> and BTEX are the predominant organic compounds present within the soils, indicating a petrol source. However, the presence of elevated concentrations of TPH C<sub>10</sub>-C<sub>36</sub>, also suggests that there may be a secondary (diesel or waste oil like) source of impact. The impacted soils are present between 3.2 m bgl and 6 m bgl, within the natural sand and clayey sand unit. This indicates that the impact to soil is present both within the unsaturated and saturated zones. Distribution of the impacts to soil are likely to be related both to the:

- Proximity to the probable sources; and
- Inferred groundwater flow directions (predominantly to the south east, as detailed in the above sections).

#### **Groundwater**

The most recent round of groundwater sampling (URS, 2003) indicates the following impacts to groundwater:

- PSH is present at LMW1, LMW2 and LMW4. These monitoring wells are located immediately adjacent to the site USTs. PSH baildown tests conducted at these monitoring wells showed varying rates of recovery, which is likely to be a reflection of the aquifer anisotropy and distribution of the PSH proximal to these wells. Fingerprinting of the product from these wells indicated the source to be leaded petrol;
- Elevated concentrations of dissolved phase TPH C<sub>6</sub>-C<sub>9</sub> and benzene were detected at monitoring wells LMW3 and LMW9. Elevated concentrations of dissolved toluene and ethyl benzene were also detected at LMW3, while elevated concentrations of TPH C<sub>10</sub>-C<sub>36</sub>, naphthalene, phenanthrene and total PAHs were detected at LMW3, LMW6 (TPH C<sub>10</sub>-C<sub>36</sub> only) and LMW13. The source of TPH C<sub>6</sub>-C<sub>9</sub> and benzene impacts to groundwater at LMW3 and LMW9 is likely to be leaded petrol formerly stored in the site USTs. The source of the TPH C<sub>10</sub>-C<sub>36</sub> and PAH impacts to groundwater is

not known. It is possible that there is a separate (currently unknown) source. However, elevated concentrations of TPH C<sub>10</sub>-C<sub>36</sub> were detected in soil at boreholes LVB3, LVB5 and LVB7, which are located near the site USTs. It is noted that the concentration of TPH C<sub>10</sub>-C<sub>36</sub> in groundwater at monitoring well LMW13 (which is at the north eastern boundary of the site) increased by more than 40 000 µg/L since the previous Handex assessment (21 February, 2003); and

- Slightly elevated concentrations of copper and zinc were present in groundwater under the site. However, since similar (slightly elevated) concentrations of copper and zinc were also detected in the monitoring wells installed upgradient of the site (LMW10 and LMW11), the slightly elevated concentrations of these compounds are considered to be representative of background (ambient) conditions. A slightly elevated concentration of nickel was detected only in monitoring well LMW5, and is therefore not considered to be of concern.

### 2.2.4 Summary of Findings of Qualitative Risk Assessment

The results of the qualitative risk assessments conducted for the site by Handex (9 January, 2002) and URS (2003) are summarised in the following sections.

#### *Primary Sources of Risk*

Primary sources of risk at the site have been identified as the four known USTs and associated transfer lines and dispensers, which store unleaded and diesel fuels (and previously leaded fuels). Table 1 lists fuel storage details for the USTs.

Testing of the tanks and lines was conducted and indicated that the integrity of these was satisfactory. A minor water egress was noted in UST number 3 (lead replacement petrol), and a minor water ingress was noted in UST number 4 (diesel). MassTech did not consider these leakages to be significant. It is therefore concluded that the USTs are not currently impacting (through release of fuel products) on the site soil and groundwater.

It is possible that there are abandoned USTs under the site, associated with the former usage of the site as a mechanics workshop. A search with the Workcover NSW Dangerous Goods Licensing Department is currently being conducted to determine locations of possible former USTs or above ground storage tanks at the site (and the fate of these tanks – ie. whether they have been removed or abandoned).

#### *Secondary Sources of Risk*

Secondary sources of risk identified at the site include impacted sub-surface soils, PSH and impacted groundwater. Impacted sub-surface soils are present within the unsaturated and saturated zones, between 3.2 m bgl and 6 m bgl. Based on the nature and position of the impacts relative to the water table, the impacted soils may act as an ongoing source of vapour and dissolved phase contamination.

PSH is floating on the water table in the area immediately adjacent to the USTs. As for the impacted sub-surface soils, the PSH may act as an on-going source of vapour and dissolved phase impacts.

### ***Transport Mechanisms***

Transport mechanisms for the PSH, sub-surface soil and dissolved phase impacts at the site include:

- Wind and water erosion – this may occur if the impacted soils are exposed by excavation and stockpiling/landfarming on the site surface;
- Volatilisation – impacts at the site include TPH C<sub>6</sub>-C<sub>9</sub> and BTEX compounds, both of which are volatile compounds. Volatilisation of these compounds from the impacted sub-surface soils and PSH may occur. However, vertical (upward) migration of vapour phase impacts under the site is likely to be restricted due to the presence of a low permeability clay layer (which overlies the impacted soils in all areas except the tank pit) and the concrete seal which has been placed across the site surface; and
- Groundwater transport – PSH and dissolved phase impacts (derived from dissolution of free and adsorbed phase PSH) will be transported from primary (if present) and secondary source areas by groundwater flow. Dissolved phase impacts are likely to migrate more quickly than PSH, since the PSH is more viscous (and will therefore flow more slowly) than the groundwater containing dissolved phase impacts.

### ***Potential Exposure Pathways***

Potential exposure pathways to the identified site impacts include dermal contact and ingestion of soil and water and the inhalation of vapour or dust. These are discussed in detail below.

Potential exposure pathways to the impacted soil would be through dermal contact, incidental ingestion or inhalation of dust. Since the impacted soils are located below the concrete sealed site surface at a depth of 3.2 m bgl to 6 m bgl, potential exposure would only occur during removal of the concrete, and excavation and stockpiling of the material at the site surface. A management plan could be developed to ensure that works which would involve excavation of the impacted soils are conducted in such a way to:

- Limit the potential for dermal contact, incidental ingestion and inhalation (by implementing appropriately health and safety, security and dust management plans); and
- Be protective of the environment.

Potential exposure pathways to impacted groundwater are through ingestion and dermal contact. There are fourteen registered bores within a 1.5 km radius of the site. Handex (9 January, 2002) indicated that one bore is used for waste disposal, four for irrigation and nine for monitoring purposes. Abstraction of groundwater for drinking water purposes is considered remote, based on the brackish to saline nature of the groundwater. Therefore, the potential exposure pathway to impacted groundwater is likely to be through dermal contact or incidental ingestion of groundwater abstracted from the site. For abstraction of

groundwater at the site (during tank replacement works or the like), a management plan could be developed to limit the potential for human or environmental exposure.

The lateral extent of the impacts to groundwater to the east and south of the site has not been delineated. Delineation of the extent of impacts to the east and south of the site, combined with an assessment of the attenuation of contaminants, would be required to assess whether an exposure pathway to potentially impacted groundwater abstracted from off site locations currently exists, or will exist in the future.

Potential exposure pathways to impacted surface water would be by dermal contact and incidental ingestion. Impact to the nearby surface waters could occur through:

- Natural discharge of impacted groundwater into the surface water bodies; and
- Discharge of abstracted groundwater to the storm water system.

As with groundwater, to assess the potential for an exposure pathway to contaminants in surface water via natural groundwater discharge would require delineation of the extent of groundwater impacts to the east and south of the site, combined with an assessment of the attenuation of contaminants in groundwater. However, given the distance and direction to the nearest surface water body (400 m to the north east) and the estimated seepage velocities (0.016 m/day), impact to surface water by natural groundwater discharge is considered to be low.

Delineation of the extent of groundwater impacts to the east and south of the site, and an assessment of the attenuation of contaminants in groundwater would also be required to determine whether irrigation water runoff (abstracted from off site locations) into the stormwater system would adversely impact upon the surface water quality (and therefore complete a potential exposure pathway). Discharge of groundwater abstracted from the site to storm water (eg. during site excavations) could also impact upon surface water. The potential for this to occur could be minimised through the implementation of an appropriate management plan.

Exposure to vapour phase contamination would be by inhalation, either indoors or outdoors. Since the impacted soils are predominantly within the saturated zone, are overlain by a low permeability clay (except in the tank pit area), and the site surface sealed with concrete, the potential for exposure under the existing site setting is considered low. This is confirmed by the absence of detectable vapours within nearby utilities pits during the initial Handex site investigation (9 January, 2002).

### **Receptors**

Potential receptors to impacted soil, groundwater, PSH, dust and vapours comprise:

- Site users (under existing conditions);
- On site workers conducting excavations or removing groundwater;
- Off site worker conducting maintenance in utility manholes and trenches;

- Off site users of groundwater for irrigation;
- Off site occupants and workers; and
- Surface water users and habitats.

On the basis of the location, type and concentration of the chemicals of concern, and the potential exposure pathways for these chemicals, the following describes the likelihood of unacceptable health risks for the above listed receptors from the site contaminants:

- Site users (under existing conditions) – the Handex (9 January, 2002) and URS (2003) Tier 1 risk assessments indicate that there is low risk to site users. However, a Tier 2, quantitative risk was recommended to assess the potential risks posed by the presence of PSH;
- On site workers conducting excavations or removing groundwater – potential exists for site workers to be exposed to the impacts during excavation and groundwater abstraction works. However, the potential for exposure can be minimised by the implementation of appropriate management plans;
- Off site workers conducting maintenance in utility manholes and trenches – potential for exposure is considered to be low based on the probable depth of the utilities in relation to the location of the impacts. This appears to be confirmed by monitoring conducted by Handex (9 January, 2002) at nearby utility pits, during which no relevant organic vapours were detected;
- Off site users of groundwater for irrigation – assessment of the potential for exposure and therefore health risk requires delineation of the extent, nature and concentration of the groundwater impacts in site and off site, and assessment of contaminant attenuation rates;
- Off site occupants and workers – assessment of potential exposure and therefore health risk can only be determined once the groundwater quality adjacent to the site is established, along with the landuse of the surrounding properties; and
- Surface water users and habitats – surface water receptors could be impacted by discharge of abstracted impacted groundwater to the storm water system (during site excavation works or irrigation), and the natural discharge of impacted groundwater to the surface water bodies. The potential for surface water receptors to be impacted by groundwater abstracted during site works could be minimised by the implementation of an appropriate management plan. The potential for surface water receptors to be impacted by irrigation waters or natural discharge of groundwater requires assessment of the nature, extent and concentration of off site impacts (if any), and the attenuation of the contaminants in groundwater.

### 2.2.5 Summary of Findings of Quantitative Risk Assessment

A quantitative risk assessment was not conducted at the site. However, due to the presence of PSH, it is considered prudent either to remove the PSH, or conduct a quantitative risk assessment to determine the potential risks posed by the PSH to human health and the environment. Furthermore, determination of

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the extent and concentration of off site soil and groundwater impacts (if any), and assessment of the risks posed by these impacts is also warranted.

A quantitative risk assessment may also be used to develop remediation end points or criteria for the site. However, the remediation criteria may also be driven by the NSW EPA's determination of whether the site poses a SRoH.

### 3.1 Chemicals of Concern

#### 3.1.1 Soil

On the basis of the site history and the results of the previous assessments, URS considers the following as the soil chemicals of concern:

- TPH;
- BTEX; and
- PAHs.

#### 3.1.2 Groundwater

On the basis of the site history and the results of the previous assessments, URS considers the following as the groundwater chemicals of concern:

- TPH;
- BTEX;
- PAHs;

Slightly elevated concentrations of arsenic, (unspeciated), chromium (unspeciated), copper, nickel and zinc were detected in groundwater at the site. However, the concentrations of these chemicals were similar in samples collected from the monitoring wells located upgradient of the site (LMW10 and LMW11). Consequently, the levels of inorganic chemicals detected at the site are considered representative of background conditions and therefore are not considered chemicals of concern.

### 3.2 Remediation Goal Development

The objective of the remediation is to remove the identified hydrocarbon impact to a level commensurate with the ongoing commercial industrial land use (zoned 4 (c) Industrial Special). Remediation of the site is also required to:

- Fulfill Mobil's obligations under the lease hand back arrangements;
- Remove the risks to human health and the environment which may be posed by the impact identified during the previous site investigations;
- Meet NSW EPA's requirements.

# Remediation Goals and Methods Analysis

## SECTION 3

In accordance with the Mobil Specifications, development of the remediation goals initially involves listing of all possible remediation goals that can be used to remove exposure pathways for a given set of site conditions. The first part of this process is to assess goals for the site in each of the following categories:

- Primary and Secondary Source Control;
- Transport Control; and
- Exposure Pathway Control.

The primary and secondary sources of contamination, transport mechanisms, exposure pathways and potential receptors have been identified during the Phase II and Post Phase II Assessments and are discussed in Sections 2.2.3 and 2.2.4. In developing remediation goals, methods of minimising the risk of exposure through source control, transport control, and exposure control have been evaluated for their applicability as remediation options in relation to the following factors:

- Physical and environmental setting and contaminant distribution data;
- Regulatory requirements for land/groundwater contamination (including possible future developments);
- Effect on site operation;
- Amenability to treatment/control; and
- Typical time scale required for control measure implementation.

The initial evaluation of possible remediation goals (source control, transport control, and exposure control) and methods is discussed below.

### 3.2.1 Source Control

Primary sources that have been identified at the site include 4 USTs and associated transfer lines and dispensers. Fuel storage information for the USTs is listed in Table 1. Primary source control would involve the removal of leaking USTs, fuel lines, dispensers and interceptors (if present). Testing of the USTs and associated lines by MassTech indicated that there were no significant leaks in the USTs. However, a water egress and ingress was noted in Tanks 3 and 4, respectively, which suggests there may be a minor leakage point in these tanks. Assessment of the integrity of the site dispensers and interceptors has not been conducted. The previous URS assessment (11 March, 2003) recommended a Dangerous Goods License Search be conducted to determine whether there are any unidentified (to date) USTs present at the site. Should this search identify other USTs at the site, the integrity of these USTs should be assessed and any suspect tanks removed.

Secondary sources that have been identified at the site include PSH and impacted sub-surface soils and groundwater. Secondary source control mechanisms could involve:

# Remediation Goals and Methods Analysis

## SECTION 3

- PSH – removal of PSH by active skimming, enhanced by groundwater abstraction;
- Impacted Soils - excavation of all contaminated soil for treatment or disposal off-site, or the installation of a suitable in-situ treatment system; and
- Impacted Groundwater – should contaminant concentrations continued to exceed the relevant remediation criteria following removal of the primary sources, control mechanisms for contaminated groundwater could involve the installation of an appropriate groundwater treatment system. Alternatively, natural attenuation could be considered as a method of secondary source control. Additional groundwater chemical analyses would be necessary in order to assess the potential for natural attenuation at the site.

Primary and secondary source removal is considered to be a viable method of meeting the remediation objectives for the site.

### 3.2.2 Transport Control

Transport mechanisms for the impacted soils at the site include wind and water erosion (if surface seal is removed and the impacted soils excavated), volatilisation and groundwater transport. In the absence of source removal, control mechanisms for each of these transport mechanisms should be considered. Transport control mechanisms could include:

- PSH – control migration by PSH by altering groundwater flow conditions through groundwater abstraction;
- Impacted Groundwater - control migration of impacted groundwater by altering groundwater flow conditions through groundwater abstraction; and
- Impacted Soils – where impacted soils are exposed by excavation, implement a management plan to minimise the potential for water or wind erosion.

### 3.2.3 Exposure Pathway Control

Methods of limiting human or environmental exposure through exposure pathway control would include drafting a management plan to provide a framework for:

- Guidance to site workers conducting sub-surface excavations and groundwater abstraction such that human and environmental exposure to the impacted soil and groundwater is minimised; and
- Assessment of the presence, rates of migration and retardation of PSH, dissolved and vapour phase impacts such that sensitive receptors are not impacted (through the actions of natural attenuation and remediation, if required).

The viability of exposure pathway control for limiting human and environmental exposure requires:

# Remediation Goals and Methods Analysis

## SECTION 3

- Further assessment of the extent of potential off site impacts to the east and south of the site; and
- Assessment of the natural attenuation rate for the contaminants in the vapour and dissolved phases (to determine whether the impacts will reach the identified sensitive receptors at unacceptable levels).

The viability of exposure pathway control will also be determined by the NSW EPA's determination of whether the site poses a SRoH. The NSW EPA have indicated that assessment of soil and groundwater conditions to the east and south of the site are required to determine whether the site forms a SRoH.

### 3.3 Remediation Goals

The following table provides an assessment of the potential viability of source control, transport control, and exposure control options to form remediation goals.

Contaminant Source Media	Potential Remediation Goals		
	Source Control	Transport Control	Exposure Control
Primary Source	Yes	No	Yes
Sub-surface Soils (3.2 m bgl – 6 m bgl)	Yes	Yes*	Yes
PSH	Yes	Yes	Yes
Dissolved Phase	Yes	Yes	Yes

Yes – Considered to be a possible remediation option

No – Not considered to be a possible remediation option

\* Where soils are excavated, not insitu.

Dependent on the NSW EPA's judgement with respect to the SRoH which the site may, or may not pose, primary and secondary source control, combined with transport and exposure control are considered to be the most appropriate options for the site remediation. Based on this evaluation, the following remediation goals have been selected for the site:

- Remove all primary sources of potential impact;
- Remove PSH;
- Remediate sub-surface impacted soil to a standard suitable for ongoing commercial/industrial land use;

- Remediate dissolved phase impact to groundwater such that it does not pose an unacceptable risk to human health or the environment (as defined through a quantitative risk assessment or the NSW EPA's SRoH determination);
- Implement a groundwater monitoring program to measure the effectiveness of the remediation activities. The program should be designed to demonstrate that the remediation activities have effectively removed the potential risks which the impacts may pose, based on the achievement of risk based or NSW EPA determined criteria; and
- Demonstrate that the potential impacts from the residual hydrocarbons (following remediation) are suitably limited and appropriate based on the site and surrounding land uses, contaminant concentrations, retardation rates and exposure pathways.

### 3.4 Remediation End Points

#### 3.4.1 Primary Source Control

Primary source control involves the removal of all primary sources of site contamination, including leaking USTs, fuel lines, dispensers and interceptor pits. The remediation end point in this case will have been achieved when all potential sources have been inspected and all leaking or suspect sources removed from the site and disposed of properly, or adequately repaired (such that they do not form an ongoing source of impact).

#### 3.4.2 Secondary Source Control

The remediation goal for secondary source control is the removal of PSH and remediation of impacted soil and groundwater to a standard suitable for ongoing commercial/industrial land use, while also ensuring that there are no unacceptable off site impacts (based on the results of a risk assessment or NSW EPA's SRoH determination). The remediation end points for soil and groundwater remediation are detailed in the following sections. These end points are endorsed by the NSW EPA, and are therefore considered appropriate benchmarks to assess whether the remediation objectives listed in Section 3.2 have been achieved.

#### **Soil**

The NEPM HILs have been developed for a range of land use categories. For each land use type, appropriate generic exposure scenarios and relevant generic exposure factors have been considered in developing a range of investigation levels. URS considers the NEPM HIL Level F (commercial/industrial) an appropriate remediation goal for the site based on the current zoning and site land use.

# Remediation Goals and Methods Analysis

## SECTION 3

The use of NEPM HIL Level F as a remediation goal is considered appropriate for the following reasons:

- The assumptions made in deriving the NEPM HIL Level F are conservative; and
- The potential exposure pathways considered in deriving the NEPM HIL Level F guidelines are consistent with those associated with the commercial/industrial land use and the remediation objectives.

The NEPM HIL F guideline concentrations for PAHs are presented in Table 2.

The NEPM provides HILs for some aliphatic and aromatic fractions of TPH. However, since the analysis of these TPH fractions is not by the routine method, the Service Station Guidelines for C<sub>6</sub>-C<sub>9</sub> and C<sub>10</sub>-C<sub>36</sub> TPH fractions are typically used as remediation goals. The Service Station Guidelines also provide remediation goals for BTEX compounds. However, since the Service Station Guidelines have been developed as "*Threshold Concentrations for Sensitive Land Use – Soils*", they are considered overly conservative based on the ongoing commercial/industrial land use at the site. Therefore, URS recommends that a quantitative risk assessment (which takes into account the commercial/industrial usage of the site) be conducted to develop appropriate guidelines for TPH and BTEX compounds.

### Groundwater

Once PSH recovery and soil remediation works are complete (based on achievement of the NEPM HIL F and risk-based guidelines), the initial step in the assessment of groundwater remediation will be a comparison of the post-remediation concentrations of the chemicals of concern in groundwater with the relevant Trigger Values and Threshold Concentrations (ANZECC/ARMCANZ (2000) and NSW EPA (1994)). If the concentrations of the chemicals of concern exceed the Trigger Values and Threshold Concentrations, a risk based approach will be used to develop appropriate remediation end points. This risk-based approach will include an assessment of the fate and transport of impacted groundwater in order to assess whether unacceptable levels of impact will (or will not) reach the identified sensitive receptors. These end points will consider the site and surrounding land uses, depth of the groundwater impact, potential exposure pathways and receptors, and will be developed in accordance with the approach specified in ANZECC/ARMCANZ (2000) and the *Mobil Environmental Site Assessment Specification Module 6 – Remediation Action Plans* (D.Wright, 3 March, 2002).

The ANZECC (2000) Trigger Values and Service Station Threshold Concentrations are presented in Table 3.

### Risk Based Remediation End Points

For chemicals for which there are no Trigger values or Threshold Concentrations (eg TPH), a risk based approach will be used to develop appropriate remediation end points. These end points will consider the site and surrounding land uses, depth of the groundwater impact, potential exposure pathways and receptors, and will be developed in accordance with the approach specified in ANZECC/ARMCANZ

(2000) and the Mobil *Environmental Site Assessment Specification Module 6 – Remediation Action Plans* (D.Wright, 3 March, 2002).

### 3.4.3 Transport and Exposure Pathway Control

The remediation goal for transport and exposure pathway control is to ensure that there are no unacceptable off-site impacts during or following remediation. Control measures, including groundwater abstraction, storm water management, site security, noise, odour, and dust management, and health and safety measures will be addressed in a management plan. Long term transport and exposure pathway control for the migration of impacted groundwater (to sensitive receptors) will require the delineation of the current extent of impacts on site and off site and an assessment of the contaminant retardation (natural attenuation) rates.

The remediation end points for transport and exposure pathway control include the elimination during and following remediation of on and off-site impacts via groundwater, stormwater, dust and vapour, and the successful management of site security, noise, and odours. Achievement of these end points will require the implementation of an appropriate monitoring program during the course of, and following remediation. Section 4.3.6 details the appropriate actions should any of these conditions be in danger of being breached.

### 3.5 Review of Applicable Remediation Technologies

A review of applicable remediation method technologies has been conducted. Selection of the most appropriate remediation technologies was based on the following factors:

- Ability to meet the regulatory requirements;
- Ability to achieve the remediation goals and end points;
- Ability to meet the site business needs;
- Capital and operating cost;
- Time constraints (schedules for lease handback);
- Waste management requirements;
- Environmental impacts - noise, odour and other; and
- Impacts to site and surrounding amenity.

In accordance with the requirements of the Mobil Specification, a Remediation Technology Review Matrix has been compiled to assess the viability and appropriateness of various remediation approaches in achieving the site remediation goals.

In compiling the matrix, each factor of the remediation technology assessment was ranked 1 to 4 (for the unsaturated zone) or 1 to 10 (for the saturated zone), with 1 being the most favoured approach, and 4 or 10 the least. Consequently, the remediation approach with the lowest total score is the most favoured approach. The completed Remediation Technology Review Matrix for the unsaturated and saturated zone is attached in Appendix I.

A Remediation Technology Review Matrix was not compiled for the removal of the primary sources of impact, since the only practical means available to achieve this goal is to assess all existing potential primary sources, and remove/repair or abandon those found to be contributing to impact at the site.

### 3.5.1 Unsaturated Zone Treatment

Remediation options for the unsaturated zone treatment comprise:

- Excavation – removal of impacts through excavation and landfarming/off site disposal. Due to the depth and areal extent of the unsaturated zone impacts, excavation would require:
  - shoring to prevent collapse of the hole; and
  - closure of the service station.
- Soil vapour extraction – removal of hydrocarbon impacts by drawing air through the soils (using a vacuum pump manifolded to dedicated extraction wells), which promotes volatilisation and biodegradation. May also involve the addition of nutrients to further stimulate biological activity. Extracted air which contains volatile contaminants requires treatment prior to discharge to the atmosphere. The success of this approach is dependent on favourable soil permeabilities and the amenability of the contaminant (volatility and ability to be biodegraded);
- Bioventing – similar to soil vapour extraction, except that the primary remedial agent is biodegradation, which is enhanced by the introduction of oxygen through the venting process. As with soil vapour extraction, the success of this approach is dependent on favourable soil permeabilities and the amenability of the contaminant (volatility and ability to be biodegraded); and
- Natural and / or Enhanced Attenuation – using natural biodegradation (aerobic and anaerobic) to remediate impacted soils. This is unlikely to occur where contaminants are at levels which are toxic to bacteria. Process may be enhanced through the addition of nutrients and oxygen to improve biological activity. Effectiveness of approach is dependent on the amenability of the contaminant to bio-degradation, and the rates of biodegradation;

The Handex assessment (9 January, 2002 and 5 September, 2002) indicated that impacts (TPH and BTEX compounds) to soil exceeding the investigation levels were detected between the 3.2 m bgl to 6 m bgl in the vicinity of the USTs and fuel dispenser islands (see Figure in Appendix J). It is not known whether the soils at this depth are also impacted by PAHs (Handex did not analyse for PAHs in samples from these depths during their previous intrusive investigations). The standing water level is approximately 4 m bgl, indicating that only a small thickness (approximately 1 m) of the unsaturated zone is impacted.

