



for the duration of time that they had been working on the premises (since November 2003). The gatic cover was lifted and the cap was found to be missing.

MW15S is a shallow monitoring well that records show to have been located on the footpath in Burren adjacent to a residential property (DP79745) but which could not be found by SKM at the time of the site inspection. In the past 2 years this property has been redeveloped and a set of new apartments constructed. It is possible that this well could have been destroyed or covered over during that period.

Table 1 lists the monitoring wells identified during the site inspection, the groundwater levels that were measured in the monitoring wells and the status of the wells.

■ **Table 1 Status of Monitoring Wells from Previous Investigations**

Monitoring Wells	Groundwater Level (mbgl)	Functional	Comments
MW 03S	1.95	Yes	No odour, silty
MW 03D	3.62	Yes	Very strong hydrocarbon odour, very clear water
MW 04S	1.25	Yes	Odour, silty
MW 04D	3.15	Yes	Odour, clear
MW 06S	5.42	Yes	Strong hydrocarbon odour
MW 06D	1.65	Yes	
MW 07S	3.1	-	Well was dry
MW 07D	2.47	Yes	Extreme hydrocarbon odour, clear
MW 08D		No	Bailer or dipper would not go down past 1.5m from top of monument box. May be able to be fixed.
MW 09S		-	Not checked as well located in residential property
MW 10S		-	Not checked as well located in residential property
MW 11S		-	Not checked as well located in residential property
MW 12S	4.5	Yes	Very little water, no odour, bailer stained orange
MW 12D	3.88	Yes	No odour, water relatively clear
MW 13S	3.96	Yes	No odour, water is orange
MW 13D	3.78	Yes	No odour, water relatively clear
MW 14S	2.0	Yes	No odour, water relatively clear
MW 14D	0	Yes	Groundwater relatively clear and flowing out of top of well
MW 15S		No	Could not be located
MW 15D	0	Yes	Groundwater flowing out of top of well, slight hydrocarbon odour. Cap was not on well.
MW 16S	2.04	Yes	Strong sulfur odour, bailer and water very black at bottom of well
MW 16D	0	Yes	Strong sulfur smell, groundwater slowly rising above top of well.



Monitoring Wells	Groundwater Level (mbgl)	Functional	Comments
MW 17S	2.75	Yes	Very silty, orange staining
MW 17D	1.9	Yes	No odour, relatively clear water
MW 18D	3.25	Yes	Orange staining, No odour
MW19S		No	Could not be found
MW 20S	0.7	Yes	Well appears blocked approx. 0.5m below the bottom of the well. Monument stand is loose. Bailer and string stained black. Groundwater black. Slight HC odour.
MW 22S		-	Unable to get dipper or bailer down well. May be able to be fixed
MW 22D	2.08	Yes	No odour, very silty, dark brown
MW X	1.3	Yes	No odour, relatively clear water
MW Y	2.7	Yes	Well depth approx. 3.8m, sulfur odour, orange staining
MW Z	3.36	Yes	Well depth approx. 3.75

5.6 Conceptual Site Contamination Model

5.6.1 Potential Sources of Contamination

The historical, site and contamination data provided by previous investigations at the Macdonaldtown Triangle Area indicate that the potential sources of ground contamination at the Former Gasworks area related to the former use of these areas as a gasworks and railway-related activities. The available data is considered to support the adoption of the following sources and laydown mechanisms for contamination at the Macdonaldtown Triangle Area:

- Dumping of waste materials from the former gasworks operation (eg. ash, spent oxide, coke, tar, ammoniacal liquors);
- Dumping of waste materials from former railway uses (eg. ash);
- Leakage of liquid wastes from pits, tanks and gas holders (eg. tars, phenolic wastes, ammoniacal liquors);
- Spillage of lead-based paint from former structures and train maintenance;
- Spillage of chemicals used for train cleaning (eg. solvents);
- Spillage of oils and greases from former train usage and maintenance;
- Atmospheric deposition of contaminants from the heavy industrial use of the general Erskineville/Macdonaldtown/Redfern area;
- Importation of contaminated fill; and



- Migration of contaminated groundwater from railway operations up-gradient of the site such as at the former Eveleigh railyards.

5.6.2 Potential Contaminants of Concern

Potential contaminants of concern that may be present at the Site, based on the potential contaminant sources listed in the previous section, are summarised in **Table 2**.

■ Table 2 Potential Contaminants of Concern

Contaminant	Areas of Environmental Concern
Fuels, oils, tar and greases	Gasworks waste disposal areas, tanks, former tank locations, pits, pipelines, drums and containers and possibly buried disposal areas, rail activities
Heavy metals	Gasworks waste disposal areas, coal stockpiles, treatment processes, pipes, roof and window flashing (borders / waterproofing), batteries, general refuse
Semi volatile and Volatile organic compounds	Gasworks waste disposal areas, tanks, former tank locations, pits, pipelines, drums and containers and possibly buried disposal areas
PAHs	Gasworks waste disposal areas, coal stockpiles, tanks, former tank locations, waste drums and containers

These analytes correspond to recommendations given in the Contaminated Sites Monograph Series No. 3 (1994) *'Identification and Assessment of Contaminated Land, Improving Site History Appraisal'* and relevant NSW DEC guidelines (eg. service stations and gasworks).

5.6.3 Environmental Media of Concern

Information provided by previous investigations on the Site indicate that the environmental media that need to be targeted are as follows:

- Shallow soils and fill layer (depth generally 0-1.5m);
- Deeper soils comprising predominantly undisturbed, natural soils (depth generally >1.5m);
- Groundwater; and
- Soil-gas.

Ambient air quality was also identified as a potential issue since the previous investigations found some hot-spots and groundwater contaminated with volatile organic hydrocarbons such as benzene and naphthalene.



5.6.4 Potential Receptors

As previously mentioned in **Section 2.1**, it is understood that the site will remain the property of RailCorp and continue to be zoned to allow commercial/industrial land, although it is not known what site activities will occur or if any structures/ buildings will be established on the site.

The potential receptors of ground contamination from the Macdonaldtown Triangle area are expected to be:

- Future commercial/industrial users of the site;
- Future maintenance / construction workers at the Site and surrounding areas;
- The community who live in residential land adjacent to the western boundary of the site (**Figure 4**) and users of any groundwater extracted from wells down-gradient of the site; and
- Freshwater aquatic ecosystems.

Freshwater aquatic ecosystems have been included as a potential receptor even though the nearest water body is the headwaters of Alexandra Canal (Sheas Creek) located some 1.3km to the south of the Site (**Figure 1**). At this location the creek flows would consist of surface water drainage from the Redfern/Alexandria area that would be largely unaffected by tidal influences from the receiving waters in Botany Bay. The subsurface conditions for much of the distance between the Site and the Canal consist of residual clays and shale, and the hydraulic heads are low given the relatively flat, uniform topography. Aquatic ecosystems have been included since there is a risk that extracted/intercepted groundwater could be discharged into the stormwater system that would discharge into Alexandra Canal. An example of such an exposure pathway is the possible interception of contaminated groundwater by drainage systems inside the Eastern Suburbs/Illawarra railway line tunnel that is located approximately 100m from the southern boundary of the Macdonaldtown Triangle area, as shown in **Figure 4**.

5.7 Assessment of Data from Previous Investigations

5.7.1 Assessment of Soil Data

The soils at the Former Gasworks site were extensively investigated by other environmental consultants between 2000 and 2001, with the results of these investigations presented in two reports (CH2MHill, 2000 & 2001). Copies of figures from earlier reports showing all sampling locations at the Gasworks areas are provided in **Appendix G**, together with summary tables of the laboratory data. These figures show that the soil sampling locations are reasonably well spread out across the Former Gasworks site and that the data provided by the previous investigations should be representative of site conditions. The soil sampling locations where contamination was found by previous investigations to exceed the *Investigation Levels* in the fill material and natural soils are shown in **Figure 6** and **Figure 7**, respectively.

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On account of the available data from previous investigations, the SKM investigation conducted as part of this risk assessment has only focused on the collection of a few soil samples required as part of assessments for soil-vapour, as discussed in **Section 5.8**. These few additional data points have been included in the assessment of soil data presented below.

A summary of all laboratory results obtained for soil samples in the Former Gasworks area is provided in **Table B** in **Appendix B**. This table identifies each soil sample that has been tested, the time the sample was collected, its sampling depth, material type and the concentrations for all analytes tested. The soils have been divided into two material types, these being fill and natural undisturbed soils. The total number of soil samples tested for contaminants of concern for each material type are summarised in **Table 2b**. The potential contaminants of concern are as listed in **Section 5.6.2** with the Soil Acceptance Criteria (SAC) for these contaminants discussed in **Section 8.1**.

■ **Table 2b Sampling Frequency for Soils at the Former Gasworks Area**

Potential Contaminant of Concern	Number of Samples Tested		Total
	Fill	Natural Soil	
Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead & zinc)	45	17	62
Heavy metals (mercury)	41	17	58
Total cyanide	12	4	16
BTEX	38	21	59
TPH	24	11	35
PAHs	46	19	65
Total phenols	21	4	25
OCPs	4	0	4
PCBs	3	1	4
VOCs	8	1	9
Asbestos	15	0	15

The NSW EPA (1995) sampling guidelines and the NEPC (1999) guidelines recommend a minimum sampling frequency of 19 samples for a 0.8 ha area. The results indicate that the available data provided by the investigations for the Former Gasworks site meet the NSW DEC minimum sampling requirements as follows:

- Fill layer - heavy metals, BTEX, TPH, PAHs, total phenols.
- Natural soils – BTEX and PAHs



SKM considers the sampling frequencies achieved for the other potential contaminants of concern are acceptable for the purposes of this risk assessment because the concentrations measured for these other analytes were low and well below the soil acceptance criteria. Furthermore, the lower sampling frequencies achieved for the natural soils are considered acceptable since the risk of contamination from these other contaminants is generally lower in these deeper, clayey soils.

All the laboratory soil data for the Former Gasworks Area have been statistically analysed. For each contaminant, the analysis involved the calculation of the average concentration, standard deviation, coefficient of variation (CV) and the estimate of the true average concentration for a 95% Upper Confidence Limit (UCL). The results of the statistical analysis made by the previous investigations are presented in **Tables C and D (Appendix B)** for the fill materials and natural soils, respectively.

The data indicate that the fill layer is mainly contaminated with high levels of PAHs and TPH C10-C36 distributed over much of the site. This is indicated by the 95% UCL estimates of the true mean, which are:

- Total PAHs = 586 mg/kg (SAC = 100 mg/kg)
- Benzo(a)pyrene = 38.7 mg/kg (SAC = 5 mg/kg)
- TPH C10-C36 = 8,010 mg/kg (SAC = 1,000 mg/kg)

Hot-spots are considered to be present at individual sampling locations where the contaminant concentration exceeds 250% of the Investigation Level, as recommended in the NEHF (1998) guidelines. In the fill layer, hot-spots were found to be contaminated by benzene and xylenes in addition to PAHs and TPH C10-C36.

Contamination in the fill layer was found to be highest in samples located near to the former tar tanks and gasholders (SB03, SB04, SB06, SB07), retorts and gas converter (TP44, TPA, BH13, BH15) and the gas scrubbers (SB18), as shown in **Figure 7**.

The data indicate that the natural soils generally have lower levels of contamination compared to the fill layer, with the 95% UCL estimates of the true mean for total PAHs being 329mg/kg, while the 95% UCL values for benzo(a)pyrene and TPH C10-C36 are less than or equal to the SAC. In the natural soils, fewer hot-spots were found compared to the fill layer.

Contamination in the natural soils was found to be highest in samples located near to the former tar tanks and gasholders (SB08, MW33), retorts and gas converter (TP14) and the gas scrubbers (SB12, MW04), as shown in **Figure 8**.



5.7.2 Assessment of Groundwater Data

The groundwater wells that were installed and monitored by previous investigations at the Former Gasworks site comprised wells MW03S, MW04S, MW06S, MW07S, MW12S, MW13S, MW17S, MW20S, (shallow) and MW03D, MW04D, MW06D, MW07D, MW08D, MW12D, MW13D, MW17D, MW18D (deep), as shown in **Figure 5**. As previously mentioned in **Section 5.5**, five monitoring wells were identified at the Former Cleaning Shed Area up-gradient of the site that are not located or mentioned in any of the previous reports. These unknown wells are labelled MWX, MWY, MWZ, MW22S and MW22D in **Figure 5**.

A summary of the groundwater investigations that have been conducted by previous investigations across the Macdonaldtown Triangle area is provided in **Table 3**. The table indicates the groundwater parameters that were tested and the contaminants that were detected above the adopted groundwater *Investigation Levels*. The table indicates that:

- The majority of the groundwater wells have been installed down-gradient of the Former Gasworks Area and in the residential area along the eastern side of Burren Street;
- Exceedances of the groundwater *Investigation Levels* have been detected for dissolved metals, PAHs, phenols, BTEX, particularly around the former retort house, tar well and gasholder area;
- The quality of the groundwater measured at the two wells located up-gradient of the former gasworks site (MW17S & MW17D) complied with the *Investigation Levels* and were considered by the previous investigations to represent background conditions.

A summary of the groundwater data provided by previous investigations conducted at the Macdonaldtown Triangle area is provided in **Tables E** and **F** for the shallow and deep aquifer wells, respectively. Copies of the tables and figures from previous investigation reports are provided in **Appendix G**.

Table 3 Summary of Groundwater Investigations Conducted by Previous Investigations at the Macdonaldtown Triangle Area

Sample	Date	Location	Purpose/ Target	Analysis undertaken	Exceedances observed
MW03S	June 2000	Downgradient of Former Gasworks Site – shallow aquifer	Contaminant concentrations along southern boundary	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Copper, zinc, Iron (II), PAH
MW03D	June 2000	Downgradient of Former Gasworks Site – deep aquifer	Contaminant concentrations along southern boundary	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Copper, Zinc, Iron (II), nickel, Phenols, PAH, Benzene
MW04S	June 2000	Downgradient of Former Gasworks Site – shallow aquifer	Contaminant concentrations along southern boundary	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Chromium, zinc, Iron (II), PAH
MW04D	June 2000	Downgradient of Former Gasworks Site – deep aquifer	Contaminant concentrations along southern boundary	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Copper, Zinc, Iron (II), PAH
MW06S	June 2000	Up gradient of the former gasometer close to the boundary of the former cleaning shed area and coal stacks – shallow aquifer	Contaminant concentrations beneath former coal stacks and Coal Road	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Cadmium, Copper, zinc, Iron (II), Phenols, PAH, Xylene, TPH
MW06D	June 2000	Up gradient of the former gasometer close to the boundary of the former cleaning shed area and coal stacks – deep aquifer	Contaminant concentrations beneath former coal stacks and Coal Road	Phenols, TPH/BTEX, PAH, Heavy Metals, Ferrous Iron, SO ₄ , Nitrate as N, Dissolved Methane, pH, Conductivity	Copper, Zinc, Iron (II), nickel, lead
MW 03S	November 2001	Downgradient of Former Gasworks Site close to former gas purifier – shallow aquifer	Contamination concentrations along southern boundary	Heavy Metals, Cyanide, TPH, BTEX, VOCs, PAHs, Phenols	
MW 03D	November 2001	Downgradient of Former Gasworks Site – deep aquifer	Contamination concentrations along southern boundary	Heavy Metals, Cyanide, TPH, BTEX, VOCs, PAHs, Phenols	Cyanide, TPH, Benzene, Toluene, ethyl benzene, Total phenols, PAH
MW 04S	November 2001	Downgradient of Former Gasworks Site –	Contamination concentrations	Heavy Metals, Cyanide, TPH,	

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