- Former purifier beds, scrubbers and gas meters in the central Site area. Some below ground structures associated with these features were also stated to remain at the Site.

The RAP described the surface of the Site as "hard and gravely" in the central sections and covered by overgrown vegetation near the fencelines. The RAP also stated that small stockpiles of "ballast, decaying vegetation (tree stumps) and spent car tyres" were located on the surface.

Auditor's opinion

It is the Auditor's opinion that the RAP provided an adequate description of the structures known to be present on the Site and of the general layout and current condition of the Site. In addition, given the historical operation of the gasworks and the complexity of the structures identified on the Site, the Auditor considers it likely that further remnant gasworks structures may be present beneath the surface of the Site.

3.3 Surrounding Land Use

The RAP did not contain a detailed description of surrounding land-uses. However, the introduction of the RAP states that the Site is "bound to the north by rail land, to the south and east by rail corridor and to the west by a row of residences on Burren Street".

Auditor's opinion

The Auditor understands from the reports of the previous investigations conducted on the Site that the land to the north is owned by RailCorp and is used for stabling and cleaning operations, while the railway corridor to the south and east is also owned by RailCorp and forms part of the Sydney suburban rail network (Illawarra Line).

The Auditor considers that the RAP should have provided more detail on relevant local sensitive environments and/or receptors and also to have provided some discussion on the potential for the surrounding land uses to contain contaminating activities that may have impacted on the Site.

3.4 Topography and Drainage

The RAP stated that the Site was generally flat with a gentle grade falling to the south-east, but that an embankment fell steeply along the western boundary that adjoins the residential properties, particularly in the southern corner where a surface level difference from the top of the embankment to the base of the embankment, which was noted to be at a similar elevation to the rear backyards of the residential properties, of approximately 4 m.

The surface of the RailCorp property located directly to the north of the Site was stated to be approximately 2 m above the surface level of the Site and the higher surface level was stated to extend into the Site up to 5 m in places, where a retaining wall was present.

Auditor's opinion

It is the Auditor's opinion that the RAP presented a satisfactory understanding of the topography at the Site.

Surface water drainage for the Site was not discussed in the RAP, however, the Auditor understands from previous investigations reports that surface water was considered likely to drain in the direction of the fall of the Site to the south-east and that a concrete-lined open drain present at the western boundary of the Site, at the same level as the adjoining residential properties, was also considered likely to receive minor surface water flows from the Site.

3.5 Geology

The RAP stated that the Site is underlain by the Ashfield Shale of the Wianamatta Group and comprises black to dark grey shales and laminate. The shale bedrock was stated to be overlain by residual clay soils and fill materials.

Based on the results of previous investigations the RAP described five types of fill materials that were identified at the Site, as follows:

- Ash and coke gravels – across the majority of the Site from the surface to approximately 0.5 metres below ground surface (m bgs);
- Reworked clays – between 0.5 to 1.5 m bgs in areas of general filling;
- Sand and gravels – between 0.5 to 1.5 m bgs in the north-east and southern central areas of the Site and in the vicinity of the former gas purifiers;
- Gravely sand and clay with minor ash – to approximately 3.5 m bgs, mainly in the south-west of the Site; and
- Gravel, sand and demolition wastes – in the fill embankment at the northern boundary and in the annulus of the former Northern Gasholder. This material was stated to consist of demolition wastes and rubble including bricks, metal pipes, tiles, fibro-cement sheeting and asbestos containing material in a gravely sand matrix.

The RAP stated that the fill materials were directly underlain by residual soils that were described as silty clay, generally between 1.5 to 2.5 m bgs, and red/grey mottled clay, generally from 2.5 to 4 to 6 m bgs. The red/grey mottled clay was described as being moderately to highly plastic, stiff to very stiff and moist.

The RAP noted that shale bedrock was present underlying the residual clays at depths between approximately 4 to 6 m bgs and was described as extremely weathered to moderately weathered up to depths of 10 m bgs.

3.6 Hydrogeology

The RAP stated that, based on previous investigations undertaken at the Site, "the groundwater system exists as a shallow perched groundwater layer and a deep bedrock layer". Shallow groundwater was stated to be present within the fill and silty clay residual soils and was encountered at depths as shallow as 1 m bgs. The deep groundwater was stated to be present, under semi-confined conditions in the Ashfield Shale.

Based on the results of previous investigations groundwater flow was stated to be towards the south/south-west, for both groundwater systems. The RAP also stated that the groundwater flow direction was likely to be influenced by the presence of underground structures, including gasholder, annuli, underground waste pits and services.

The flow velocities presented in the RAP were stated to be based on the results of a previous investigation (SKM, 2006) that presented hydraulic conductivities that ranged between 6.2 to 13.7 m/year in the shallow groundwater and between 12.2 to 36.5 m/year in the deep groundwater. It was further stated that the flow velocities did not correlate with the observed lateral extent of the groundwater contamination plume identified on the Site.

Auditor's opinion

It is the Auditor's opinion that the RAP presented a satisfactory understanding of the geology and hydrogeology at the Site for the purposes of the RAP. The Auditor requires that further data are collected from the Site prior to remediation to determine hydraulic conductivities that can be relied upon for the purposes of developing a groundwater management plan. This matter is addressed in further detail in Section 7.3 of this SAR.

3.7 Site History

The RAP provided a summary of information collated from previous investigations conducted on the Site. The historical information relating to the Site as presented in the RAP is summarised as follows:

- Site was acquired in 1888 by the NSW State Government railways department;
- Gasworks was constructed in 1892;
- Site operated as a gasworks plant between 1892 and 1958. During this time gas was produced from coal and raw shale products and stored in two gasholders;
- Operation of the gasworks included raw product storage, gas production, waste disposal, filling and storage of tar wastes;
- Facilities and buildings present on the Site during the operation of the gasworks included a retort house, a boiler, condensers, purifier beds, a scrubber, two tar wells, above ground tar tanks, two gasholders, service pipework, raw storage areas, nd other buildings likely to be offices, washrooms and compressors.
- The use of inferior quality coal during the 1950's caused damage to the gasworks plant machinery and as a consequence operations ceased;
- Until 1958, the two gasholders were reportedly used for the storage of gas manufactured at and piped from the Mortlake operations;
- Demolition of the gasworks was completed in 1958, with the exception of the Southern Gasholder;
- The Site was closed down in the 1970's and was no longer used for storage of gas;
- The Southern Gasholder is listed on the State Heritage Register and the Sydney Region Environment Plan 26 (SREP 26) as part of the area known as the Eveleigh Railway Workshops.

Auditor's opinion

It is the Auditor's opinion that the RAP provided an adequate summary of the historical use of the Site the operation of the gasworks and the products produced as a result of the manufacturing processes conducted.

3.8 Previous Investigations

The RAP stated that the results of the following previous investigations were referred to in determining the nature and extent of contamination at the Site:

- Rail Services Australia "Eveleigh Gasworks – Site History" November 1999 (RSA, 1999);
- CH2M HILL Australia "Phase I & II Environmental Site Assessments" June 2000 (CH2M HILL, 2000);
- CH2M HILL Australia "Vegetable, Soil and Sediment Sampling – Letter Report" November 2000 (CH2M HILL, 2000);
- CH2M HILL Australia "Soil & Groundwater Investigations of Former Gasworks Area and Offsite" December 2001(CH2M HILL, 2001);
- Australian railway Historical Society "A Brief History of NSW Railway Gasworks" June 2003 (ARHS, 2003);
- Banksia Heritage and Archaeology "Macdonaldtown Station Works – Archaeological Assessment" April 2004 (Banksia Heritage, 2004);
- GHD "Macdonaldtown Triangle (Former Cleaning Sheds – Delineation and Classification Sampling" September 2005 (GHD, 2005);
- Sinclair Knight Merz "Macdonaldtown Triangle (Former Gasworks Site) – Human Health and Ecological Risk Assessment" April 2006 (SKM, 2006);
- Heritage Concepts "Archaeological Assessment and Remediation Management Strategy" November 2006 (Heritage Concepts, 2006); and
- CH2M HILL Australia "Delineation and Characterisation Sampling and Review of Remedial Options" March 2007 (CH2M HILL, 2007a).

3.9 Chemicals of Concern

The RAP stated that the chemicals of potential concern (COPCs) at the Site were identified based on the "historic site operations and the contaminants detected during the previous site investigations". The COPCs identified in the RAP are summarised in Table 1, below.

Table 1: Summary of COPCs

Soil	Water	Vapour
Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) Polycyclic Aromatic Hydrocarbons (PAH) Petroleum hydrocarbons (TPH) Phenolic compounds Heavy metals (localised) Asbestos	BTEX PAH Phenolic compounds Heavy metals Cyanides	BTEX Naphthalene (PAH compound)

3.10 Areas of concern

The RAP stated that the areas of environmental concern identified by the previous investigations were as follows:

- Tar wells;
- Northern Gasholder and Southern Gasholder;
- Retort and gas purifiers;
- Underground pipework; and
- General fill.

3.11 Proposed future use of the Site

The RAP stated that "the exact future use of the Site is unknown". It was further stated that, given the current zoning and the surrounding land use comprising railway operations, the future use of the Site was anticipated to be "rail related under a commercial/industrial land use scenario".

Auditor's opinion

Given the presence of significant contamination on the Site and the scale of remediation contemplated in the RAP, the Auditor notes that it is likely that the Site will only be suitable for such insensitive use as proposed by RailCorp as defined in the RAP.

4.0 Environmental Condition of the Site

The RAP provided a detailed description of the nature and extent of the soil and groundwater contamination previously identified on the Site. The previous sampling locations were presented on Figure 3 of the RAP (Attachment 1). The analytical results from the previous investigations were included as Tables 1 and 2 of the RAP and have been presented in Attachment 2 of this SAR. The environmental condition of the Site as presented in the RAP is addressed in detail below.

4.1 Soil Conditions

4.1.1 Fill

The RAP stated that a number of COPCs were detected in the majority of fill materials at the Site at concentrations exceeding the adopted commercial/industrial land-use criteria as follows:

- Benzo(a)pyrene (BaP) and PAHs - stated to be directly related to the presence of tar in the fill materials, proximal to source areas including underground tar pipes, the retort area, tar wells and the gas purifier. Another major source of PAH and BaP was stated to be the surface fill layer consisting of ash/coke gravel to approximately 0.5 m bgs;
- Benzene and xylenes (total) - also stated to be directly related to the presence of tar in fill materials and the presence of ash/coke in the surface fill materials;
- TPH ($C_{10} - C_{36}$) - attributable to the presence of PAH, as the laboratory results were stated to show that the main constituents of TPH comprised aromatic compounds;
- Lead – detected at three locations including within the Northern Gasholder annulus and to the south of the Southern Gasholder It was stated that concentrations of the remaining metals and cyanide met the commercial/industrial land use criteria; and
- Asbestos – detected in samples of fibrous cement sheeting observed at the Site and in fill samples from within the Northern Gasholder annulus.

4.1.2 Natural Soil

Concentrations of COPCs detected in natural soils were stated to be generally consistent with those in fill (with the exception of lead and asbestos) and it was further stated that concentrations of volatile organic compounds (VOCs), including benzene, xylene and TPH ($C_6 - C_9$), greater than the land-use criteria were detected in a greater number of samples of natural clay soils than of fill materials. The RAP stated that the presence of higher concentrations of volatile compounds in the natural soils, rather than the fill materials, on the Site may be due to the following:

- "Higher solubility rates of shorter chained hydrocarbons that become mobile with infiltrating water or migrating groundwater;
- Volatilisation of these compounds from shallower fill materials;

- Higher impact from leakage of tarry wastes from deep subsurface storage areas, especially fro the tar wells and gasholders; and
- Vertical fracturing of natural clays and weathered shales, providing preferential pathways into deeper soils".

It was stated that concentrations of PAHs and heavier fraction TPH were relatively lower and met the land-use criteria. It was also stated that concentrations of metals and cyanide in natural soils met the land-use criteria.

4.1.3 Tar Materials

The RAP stated that the tar contamination encountered at the Site was present within the areas of the Site that contained the former gasworks and associated structures, the locations of which were shown on Figure 2 of the RAP (Attachment 1).

The RAP categorised the tar contamination observed at the Site as follows:

- "Free Tar" – stated to consist of black, low viscosity, highly odorous material present in the tar wells and in some of the underground pipes associated with a number of the former gasworks structures;
- "Tar Impacted Materials" – stated to be fill materials or natural soils that contained lenses of "free tar" within the matrix and noted to be present proximal to the tar wells, underground pipes, base of the annulus of the Northern Gasholder and the retort and gas purifier areas; and
- "Dark Stained Impacts" – stated to consist of highly odorous dark brown to black stained soils and weathered shales that did not contain free tar but were contaminated as a result of the presence of tar at the Site and were only encountered underneath the Southern Gasholder.

Concentrations of PAHs, TPH and BTEX within the "free tar" and "tar impacted materials" were stated to be significantly greater than the land-use criteria with the majority of the sampling locations where these materials were encountered reporting concentrations greater than 2.5 times the land-use criteria, In the "dark stained impacted material" sampled from depths between 6 to 10 m bgs beneath the Southern Gasholder, the concentrations of PAHs, TPH and BTEX were significantly less with limited number of samples reported concentrations greater than the land-use criteria. It was noted that no "free tar" or "tar impacted materials" were noted in the sampling locations completed in and surrounding the Southern Gasholder.

The RAP also stated that neutral water leaching tests were conducted on natural soils sampled from depths between 7 to 8.5 m bgs beneath the Southern Gasholder, the Northern Gasholder and the gas purifier area. The results were stated to indicate that BTEX and TPH (C_{10}-C_{14}) present in the natural soils beneath the Northern Gasholder and the gas purifier area were likely to leach under neutral conditions and were unlikely to leach from the natural soils beneath the Southern Gasholder. The RAP stated that these results indicated that the dark stained impacted natural soils present beneath the Southern Gasholder were "unlikely to be providing a contamination source and there is unlikely to be a source of tar material below this gasholder".

Auditor's opinion