

5.4 Extent of Remediation

Given the remediation approach to be adopted for the Site, the RAP stated that the estimated extent of remediation required was based on the identified presence of free tar and tar-impacted materials at the Site as summarised in Table 2, below.

Table 2: Estimated volumes of materials requiring remediation

Area	Impact	Estimated volume (m ³)
Tar wells	Soil / fill impacted by free tar	1000
	Tar sludge in wells	100
Northern gasholder	Soil / fill impacted by free tar	2100
	Tar sludge in Gasholder	320
	Impacted water	640
	Demolition waste in annulus	1900
Former Gasworks areas	Tarry soils – shallow fill	9225
	Tarry soils – deeper soils	2375
	Tarry soils – TP16 "hotspot"	115
Site surface	Ash and coke gravel	2950
Northern boundary retaining wall	Demolition waste	1765
Pipework	Tar and scrap metals	Unknown
Other hotspots	Fill	340

The RAP stated that the volumes were indicative only and would be affected by the remedial option adopted and the implementation of depth-based remediation criteria during the remediation works. The remediation areas and estimated depth of remediation was presented on Figure 4 of the RAP (Attachment 1).

Auditor's opinion

The Auditor considers that the extent of remediation that would be required to remove the free tar and tar-impacted materials from the Site was appropriately presented within the RAP. However, the Auditor considers that it is difficult to derive accurate estimates of volumes of material requiring remediation when the contamination on the Site has developed in a heterogenous manner and the Auditor is not able to confirm the volumes of materials requiring remediation.

With regard to the Southern Gasholder, the Auditor understands given its heritage status, that no remedial activities will be able conducted beneath or directly surrounding the structure. Consequently, no volume estimates were required to be provided for this area of the Site, however, the Auditor notes that it is likely that free tar and associated contamination would be present beneath and directly surrounding the southern gasholder and will remain on the Site after remediation. Potentially, the remaining contamination will provide an ongoing source of contamination to both soil and groundwater on the Site.

It is the Auditor's opinion that an adequate level of uncertainty is required to be applied to the estimates of volumes of materials requiring remediation at the Site as presented in the RAP.

5.5 Remedial Options

The RAP presented the hierarchy of remediation options listed in the NSW DEC (2006) and stated that a "long-list" of remediation options for the Site were provided in a previous report (CH2MHILL, 2007) and that from this "long-list" a "short-list" of remedial options was determined. A detailed evaluation of the previously short-listed options was provided in Appendix C of the RAP and the consideration of each option as it applied to the Site and the preferred remedial option presented in the RAP is summarised below.

5.5.1 Potential Remedial Options

The remedial options presented in the RAP were described as a "short-list" of options which had been selected from a "long-list" by a screening process and their suitability for application on the Site was discussed in relation to the following criteria:

- Effectiveness;
- Technology risk;
- Timeframe;
- Permissibility;
- Compatibility;
- Health and safety risk;
- Cost; and
- On-going management

The assessment of potential remedial options is summarised in Table 3, below.

Table 3: Summary of remedial options

Remedial Option	Description	Advantages	Disadvantages	Preferred / Not preferred
No action	No remedial action taken	Minimal cost	Does not meet long-term objectives for the site, not acceptable for local community or regulators, does not address groundwater contamination	Not preferred
Institutional controls	EMP, access restrictions	Controls exposure risk to humans and ecological receptors, incorporates a groundwater monitoring programme (GMP), cost effective	Enforcement of management plan is site is divested and difficulty restricting access 24 hours-a-day	Preferred – In combination with other controls

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Remedial Option	Description	Advantages	Disadvantages	Preferred / Not preferred
In-situ physical / chemical treatment	Passive chemical oxidation, soil vapour extraction (SVE), thermal treatment	Controls exposure risks to humans and ecological receptors	SVE and thermal treatment may have limited effectiveness as only targets volatile contaminants, presence of clay in soils may limit effectiveness, SVE does not work in saturated zone	Passive chemical oxidation preferred – In combination with other controls. SVE and thermal treatment not preferred
Ex-situ biological treatment	Biopiles, composting, landfarming	Removes exposure risk to human and ecological receptors, generally cost effective, compatible with GMP	Due to space constraints and sensitivity of surrounding land use an additional site would be required for treatment, transport of hazardous waste, unsuitable for grossly impacted materials (free tar impacts), costly based on required timeframe, landfarming unlikely to be effective on complex PAHs	Not preferred
Ex-situ physical / chemical treatment	Solidification, stabilisation, immobilisation, chemical extraction, segregation	Removes exposure risk to humans and ecological receptors, enables disposal of waste to licensed landfills and transfers liability, generally short timeframe,	Due to space constraints and sensitive surrounding land use a treatment facility could not be established on the Site and an alternative site for treatment would be required. Transport of hazardous waste and pre-treatment of soil required due to high clay content, chemical extraction generates liquid waste	Solidification, stabilisation, immobilisation and segregation preferred – with additional controls Chemical extraction – potential ancillary approach

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Remedial Option	Description	Advantages	Disadvantages	Preferred / Not preferred
Ex-situ thermal treatment	Incineration or co-burning, thermal desorption	Reduces exposure risk to humans and ecological receptors, short timeframe, proven technique for PAHs	Due to space constraints and surrounding land use a treatment facility could not be established on the Site and alternative site for treatment would be required. Pre-treatment required for transport, transport of hazardous waste, may require trials to prove effectiveness.	Incineration – not preferred Thermal desorption preferred – with other controls
Containment	Capping or other on-site containment	Reduces exposure risks, short timeframe, relatively cost effective,	Limits future development, site area would be unlikely to accommodate required containment area, would not address on-going groundwater impacts	Not preferred
Off-site disposal	Disposal at a licensed disposal facility	Short timeframe, reduces exposure risks, compatible with GMP and other preferred remedial approaches,	Requires pre-treatment, alternative site, transport of hazardous waste	Preferred – in combination with other remediation controls
Beneficial re-use / recycling	Re-use / recycling of materials on-site or off-site	Reduces volume of contamination (in combination with other controls), reduce cost associated with importing backfill material, low costs	Some materials unsuitable even after treatment, possible presence of asbestos in fill	Preferred – in combination with other controls

Auditor's opinion

The Auditor considers that the details provided on the consideration of the "short-listed" remedial options as presented in the RAP were appropriate and satisfied the requirements of the previous SAR.

5.6 Preferred Remedial Option

The RAP stated that, based on the assessment of potential remediation options, the preferred remediation option for the Site was one that "primarily affects contamination source removal and implements long-term management of environmental receptors under a site-specific EMP".

The preferred remediation option for the Site was stated to potentially include a combination of the following components:

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- Remediation of liquid wastes/sludge:
 - Collection of liquid wastes/sludge for disposal at a liquid waste facility.
- Remediation of contaminated fill materials and natural soils to the extent practicable by one or more of the following methods:
 - Excavation, organic stabilisation treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility under the NSW EPA General Approval for Immobilisation for coal tar materials (number 2005/14).
 - Excavation, thermal desorption treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility.
 - Excavation and disposal of soil waste at a landfill facility under the NSW EPA General Approval for Immobilisation for ash materials (number 1999/05).
 - Excavation and disposal of asbestos impacted demolition waste at a landfill facility.
 - Excavation and disposal of untreated fill/soil waste at a landfill facility.
- In-situ (passive) chemical oxidation of residual source materials at depth subsequent to remedial activities listed above;
- Beneficial re-use and recycle (including segregation or demolition waste) of suitable materials where appropriate;
- Management of groundwater contamination by:
 - Removal of the contamination source (tar) to the extent practicable as outlined above;
 - Passive application of an oxidising agent at the base of excavations to promote biodegradation of residual organic contamination;
 - A programme of MNA;
 - Inclusion of a groundwater management plan (GMP) in the long term environmental management plan (EMP) for the Site.
- Development of a long-term EMP including a GMP with a MNA approach. It was stated that MNA was considered to be a feasible and appropriate strategy for managing residual groundwater contamination on the Site post-remediation given the following:
 - "MNA would complement the primary remedial strategy of tar removal to the extent practicable";
 - Active remediation of groundwater impacts would be impractical and not cost-effective given the hydrogeological conditions at the Site;
 - Extent of groundwater contamination in both shallow and deep groundwater systems has been defined;
 - Groundwater is not likely to be beneficially re-used at the Site or within down-gradient RailCorp owned land; and
 - Existing data indicated the potential for natural attenuation to occur under both aerobic and anaerobic conditions.

The RAP stated that the proposed components of the preferred remediation option, as listed above, were selected as they provided a remediation strategy for the Site that:

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- Satisfied the objectives of the remediation of the Site;
- Followed the remediation hierarchy presented in NSW DEC (2006), NSW DEC (2007) and ANZECC (1992);
- Used proven remediation techniques;
- Could be applied in a generally short timeframe;
- Accounted for the sensitivity of adjoining properties and provides protection from noise, odours, dust and visual impacts;
- Removed or reduced contamination liability enabling beneficial re-use of the Site for rail related activities; and
- Protected groundwater from on-going impacts.

Given the varying nature and extent of contamination identified across the Site, the RAP stated that the components of the preferred remediation option, as listed above, would be applied in differing combinations across the Site. The Site was divided into "remediation areas" that were presented on Figure 4 of the RAP (Attachment 1) and the preferred remediation option for each area was presented in Table 5.1 of the RAP and is summarised in Table 4 below.

Table 4: Preferred remedial option for specified "remediation areas" on the Site

Area	Impact	Preferred remedial option(s)
Site-Wide	NA	Environmental Management Plan (EMP) Site security fencing Beneficial re-use of fill and natural soils where possible
Tar wells	Soil / fill impacted by free tar	Pre-treatment to improve handling. Treatment (stabilisation or thermal desorption) and disposal to landfill
	Tar sludge in wells	Liquid waste disposal
Northern gasholder	Soil / fill impacted by free tar	Pre-treatment to improve handling. Treatment (stabilisation or thermal desorption) and disposal to landfill
	Tar sludge in Gasholder	Potential pre-treatment to improve handling Liquid waste disposal
	Impacted water	Liquid waste disposal
	Demolition waste in annulus	Pre-treatment to remove free tar or segregate oversize materials Disposal to landfill or recycling
Former Gasworks areas	Tarry soils – shallow fill	Pre-treatment to break down material with high clay content
	Tarry soils – deeper soils	
	Tarry soils – TP16 "hotspot"	Treatment (stabilisation or thermal desorption) and disposal to landfill
Site surface	Ash and coke gravel	Landfill disposal

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Area	Impact	Preferred remedial option(s)
Northern boundary retaining wall	Demolition waste	Pre-treatment to segregate oversize materials Landfill disposal or reuse / recycling
Pipework	Tar and scrap metals	Chemical extraction (or other physical process) to remove tar
Other hotspots	Fill	Landfill disposal or beneficial re-use
Deep excavations proximal to source areas	Residual tar sources (subsequent to source removal)	In-situ (passive) chemical treatment

Potential constraints to the preferred remediation options presented in the RAP were stated to include:

- Onsite odours;
- Handling and transport;
- Regulatory approval and regulatory approval for alternate treatment site;
- Available site area / available alternate treatment site;
- Underground services;
- Aesthetic issues for neighbouring residents;
- Groundwater management during excavations;
- Ground stability during excavations;
- Heritage value of structures;
- Health and safety issues associated with asbestos;
- Unknown extent and quantity of tar materials in pipes; and
- Stiff/hard clay limiting effectiveness of in-site passive treatment.

Auditor's opinion

The Auditor considers that the proposed remedial strategy, including the CUTEP and MNA approaches, is appropriate for the Site given the nature of the identified contamination, the physical constraints of the Site (site area, soil profile etc) and the proposed future use of the Site.

5.7 Regulatory Approvals

The RAP provided a comprehensive discussion of the relevant regulatory controls and planning approvals required for the proposed remediation of the Site. These matters are addressed below.