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Remediation Options Assessment

Tarago Rail Corridor

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Remediation Options Assessment
Tarago Rail Corridor

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Abbreviations

Measures	Description
%	per cent
µg/L	Micrograms per Litre
µg/m³	Micrograms per Cubic Metre
ha	Hectare
km	Kilometres
m	Metre
mAHD	Metres Australian Height Datum
m bgl	Metres below ground level
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mm	Millimetre
ppm	Parts Per Million
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
CLM Act	NSW Contaminated Land Management Act 1997
COC	Contaminants of Concern
Council	
DA	Development Application
DP	Deposited Plan
DQI	Data Quality Indicator
DQO	Data Quality Objective
EIL	Ecological Investigation Level
EPA	Environment Protection Authority (NSW)
GIL	Groundwater Investigation Level
HIL	Health Investigation Level
LEP	Local Environment Plan
LOR	Limit of Reporting
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury
ML	Management Limits
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OEH	Office of Environment and Heritage
PCOC	Potential Contaminant of Concern
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
ROA	Remedial Options Assessment
SAQP	Sampling Analysis and Quality Plan
SWL	Standing Water Level
TV	Trigger Value
UCL	Upper Confidence Limit
-	On tables is "not calculated", "no criteria" or "not applicable"

Executive Summary

Ramboll Australia Pty Ltd (Ramboll) was commissioned by Transport for NSW (TfNSW) on behalf of the Transport Asset Holding Entity (TAHE or the client) to prepare a Remediation Options Assessment (ROA) for contamination within or originating from the Goulburn – Bombala rail corridor at Tarago, NSW. The rail corridor at Tarago is shown on **Figure 1**, **Appendix 1** and is here-in referred to as the site and includes a section of rail corridor and the property 106 Goulburn Street also known as the former Station Masters Cottage (SMC).

Eleven remediation options were identified as potentially applicable to the general type and scale of contamination. These options were screened based on permissibility and feasibility and eight options, all considered to be permissible and feasible were carried through to detailed assessment.

Detailed assessment comprised scoring the options to describe their performance compared to each other. Options with higher scores were preferred over options with lower scores.

Detailed assessment occurred via workshops coordinated by Ramboll and attended by TfNSW subject matter experts in community engagement, environmental management, rail operations and rail engineering specifically relevant to the NSW Country Regional (rail) Network (CRN). The assessment was framed through SURE by Ramboll; an interactive online platform providing multicriteria comparison for assessment of remedial options based on sustainability. This approach is based on comparison of remediation options through qualitative assessment against indicators grouped under domains of economic, environmental and social sustainability. Specific aspects of the workshops included:

- Defining sustainability indicators that were specifically relevant to contamination at the site. A total of 26 indicators were adopted with eight under the environmental domain, ten under social domain and eight under the economic domain.
- Assigning weightings to each sustainability indicator to reflect their comparative importance
- Assigning scores against each remediation option for each sustainability indicator

Overall scores were then calculated by multiplying the weighting for each indicator by the corresponding scores for each option. Theses weighted scores were then added together to give overall scores.

The overall scores are summarised in **Figure 1** below where a higher score indicates a preferred option.

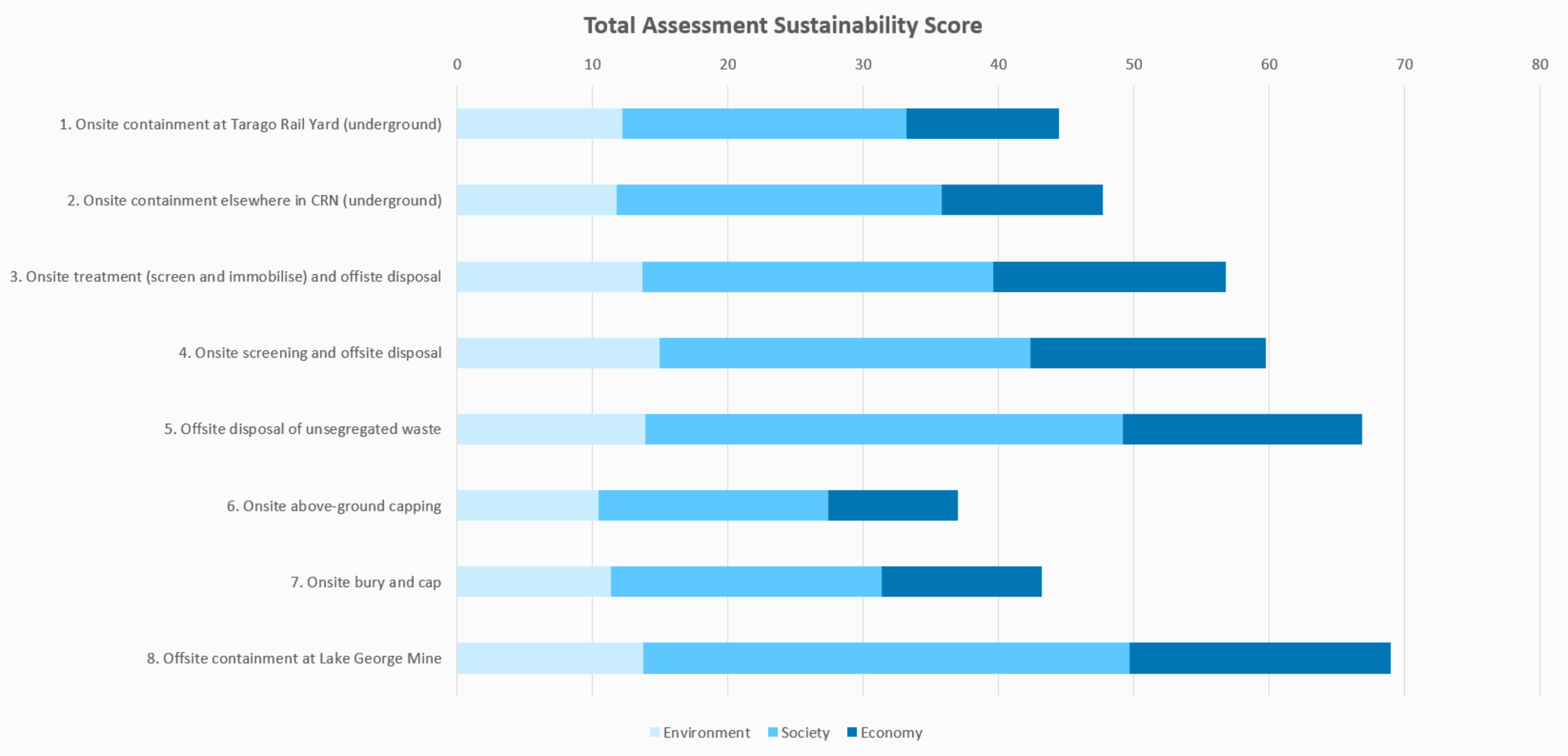

Figure 1: Remediation Options Assessment Scoring Summary

Offsite containment of contaminated soils at the Lake George Mine is identified as the most sustainable option based on the assessment completed. This option comprises:

- Excavation of contaminated materials from the redundant Woodlawn Siding and areas adjacent the rail formation.
- Road transportation of contaminated materials to the Lake George (legacy) Mine which Legacy Mines is preparing for rehabilitation
- Placement of contaminated materials in a containment cell being constructed as part of mine site rehabilitation works
- Recontouring of the final landform onsite to address any potential impacts of the proposed excavation on rail operations with specific regard for site hydrology
- Management of remnant contamination in the in the operational rail formation and at depth around the former loadout facility under an LTEMP.

Based on preliminary estimates prepared to inform comparison of the options the cost for this option is estimated at approximately $2M. It is noted however that cost estimates sourced during procurement of a remediation contractor (after detailed design is complete) may vary considerably.

Following finalisation of the selected remediation option a detailed design package should be prepared to facilitate licencing and approvals, tendering to remediation contractors, refined assessment of cost (through responses from contractors) and completion of remediation.

1. Introduction

Ramboll Australia Pty Ltd (Ramboll) was commissioned by Transport for NSW (TfNSW) on behalf of the Transport Asset Holding Entity (TAHE or the client) to prepare a Remediation Options Assessment (ROA) for contamination within or originating from the Goulburn – Bombala rail corridor at Tarago, NSW. The rail corridor at Tarago is shown on **Figure 1**, **Appendix 1** and is here-in referred to as the site. The site includes a section of rail corridor and the property known as 106 Goulburn Street, a former station masters cottage at 106 Goulburn Street Tarago (here-in referred to as the SMC). SMC was found to be impacted by contamination originating from the rail corridor and is therefore included in the site.

1.1 Background

Ramboll has assisted TfNSW to date in the assessment and management of site contamination including assessment of risks to human health and ecological receptors within and surrounding the site.

In November 2019 the portion of rail corridor was notified to the NSW Environment Protection Authority (EPA) under Section 60 of the *Contaminated Land Management Act 1997* (CLM Act) and on 25 March 2020 the NSW EPA declared the portion of rail corridor to be significantly contaminated under Section 11 of the CLM Act (Declaration Number: 20201102; Area Number 3455). The portion of rail corridor was published on the EPA's list of notified sites as "contamination is regulated by the EPA under the CLM Act". The declaration defines the substance of concern in soil ("the Contaminant") to be lead described as follows:

- Lead concentrations in soil within the rail corridor (Lot 22 DP1202608) exceed national guideline values for the protection of human health and the environment.
- Lead contamination has impacted adjacent land at 106 Goulburn Street, Tarago (Lot 1 DP816626), with soil found to contain lead at concentrations exceeding national guideline values for the protection of human health and the environment.
- There are complete exposure pathways to lead for occupants of 106 Goulburn Street, as well as potentially complete exposure pathways for persons working within the rail corridor and;
- There are potentially complete exposure pathways for onsite and offsite ecological receptors.

An Action Plan (Ramboll 2022) was prepared defining interim management measures and verification monitoring to be implemented until completion of remediation.

A voluntary management proposal (VMP) was prepared to define how the Contaminant and associated risks would be managed and this was approved by the NSW EPA on 28 May 2020.

Principal features of the VMP that relate to assessment of remediation options are:

P8. Assess remediation options to address risks from the Contaminant on, or originating from, the Site.

P9. Select a preferred remediation option integrating consultation with the community and other stakeholders.

1.2 Objective

The objective for this ROA is to assess appropriate and feasible remediation options to enable TfNSW to make an informed decision regarding a remediation strategy for the site.

1.3 Regulatory Framework and Guidelines

This document has been prepared with reference to the following legislation and codes of practice:

- NSW Work Health and Safety Act 2011.
- NSW Work Health and Safety Regulation 2017.
- Protection of the Environment Operations Act 1997.
- Environmental Planning and Assessment Act 1979.
- Protection if the Environment Operations (Waste) Regulation 2014.
- Contaminated Land Management Act 1997.
- SafeWork NSW Lead Guidance.
- SafeWork Australia Code of Practice: Managing Risks of Hazardous Chemicals in the Workplace.
- NSW EPA LeadSmart – Work Smart: Tradespeople and Mining Industry Workers.
- NHMRC Managing Individual Exposure to Lead in Australia – A Guide for Health Practitioners 2016.
- SafeWork NSW Workplace Exposure Standards for Airborne Contaminants.
- NSW EPA Site Auditor Scheme Guidelines 3rd Edition 2017.
- NSW EPA Contaminated Sites Sampling Design Guidelines 2022.
- National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) 2013.
- NSW EPA Guidelines for consultants reporting on contaminated land 2020.
- NSW EPA Guidelines for the Assessment of On-Site Containment of Contaminated Soil 1999.

Additionally, regulations and guidelines relevant to interstate transport and disposal of waste will be applicable.

2. Site Description

2.1 Site Identification

The site locality is shown in **Figure 1, Appendix 1**. A site features plan is presented as **Figures 2a – 2e**, **Appendix 1**.

The site details are presented in **Table 2-1.**

Table 2-1: Site Identification

Information	Description
Street Address:	Accessed from Stewart Street and Goulburn Street Tarago NSW
Identifier:	Part Lot 22 DP1202608 Lot 1 DP816626 (the SMC)
Site Area:	Approximately 7.9 ha
Local Government:	Goulburn Mulwaree Shire
Owner:	Transport Asset Holding Entity (TAHE)
Current Site Use:	Forms part of the Goulburn to Bombala rail line and the Country Regional rail Network (CRN)

2.2 Land Use

The site comprises part of the Goulburn – Bombala rail corridor, including Tarago Station and Carpark and the SMC at 106 Goulburn Street adjacent the rail corridor at Tarago. Review of satellite imagery and site inspection identified land use within the surrounding environment including:

- A residence with a dam that receives waters from the site (during surface water flow), located adjacent (east of) the northern end of site.
- Tarago Public School approximately 120 m east of the northern end of site.
- Residences approximately 70 m west of the south end of site and east of Goulburn Street.
- Tarago Recreation Area approximately 300 m east of site.

3. Site History

Site history previously presented in the *Tarago Rail Corridor and Tarago Area Detailed Site Investigation Addendum* (Ramboll 2021) is summarised below as **Table 3-1**.

Table 3-1: Site History Summary

Site	Description
Zoning	The site is currently zoned RU2 Rural Landscape under the Goulburn Mulwaree Local Environmental Plan (LEP).
Council Records	Council held records identified as relevant to the former load-out complex were limited to the Woodlawn Project Environmental Impact Statement (Jododex Australia 1976). The following excerpts from the EIS (Section 8.11 Transport of Concentrates) are considered relevant to the type and distribution of contamination associated with the former loadout complex: *The Woodlawn project will market four products. These are a zinc concentrate, a lead concentrate and two different copper concentrates, one from the 'complex ore' and one from the 'footwall copper ore'.* *The zinc concentrate consists mainly of sphalerite (zinc sulphide), the lead concentrate of galena (lead sulphide) and both copper concentrates of chalcopyrite (copper iron sulphide). Each of the concentrates contain various proportions of the other base metal sulphides and pyrite (iron sulphide) as the main contaminants…* *Separate storages for the various types of concentrates would be provided in the shed and a passageway between concentrate stockpiles and the railway spur line will allow trucks to enter and depart from opposite ends of the building. The tipped concentrates will be pushed up by front end loader to make best possible use of the available storage space. The amount of storage capacity provided at Tarago will not be large as it is anticipated that there will be frequent dispatches of concentrates by rail from Tarago. The average quantity of material involved will be about 775 wet tonnes per day, requiring about 35 truck movements.*
Mine Owner (Heron Resources Limited) Records	Review of records accessible from the website of Heron Resources Limited (the mine owner) (SRK 2015) indicate the Woodlawn deposit was discovered in 1970 and mined by open-pit and underground methods between 1978 and 1998. Additionally, the SRK report references a rail siding in Tarago that was historically used to rail concentrates to smelters in Newcastle and Port Kembla and to a concentrate berth at Port Kembla.
Dangerous Goods	A search of the SafeWork NSW Dangerous Goods register has not been completed as previous inspection of the site indicates all infrastructure associated with the former load-out complex (except the rail formation) has been removed.
Licenses, Permits and Approvals	A search of the NSW Environment Protection Authority (EPA) Public Register (www.epa.nsw.gov.au/prpoeoapp) was undertaken on 13 January 2020 and identified John Holland Rail (JHR) operated the CRN under EPL 13421. EPL 13421 includes environmental limits for pollution of waters, noise, blasting, odour and dust as well as requirements for notification of environmental harm.

Site	Description
EPA Records	The portion of rail corridor was notified to the NSW EPA under section 60 of the Contaminated Land Management Act in November 2018.
Historical Aerial Photographs	Historical aerial photographs were obtained and reviewed for the years 1960, 1976, 1985, 1991, 1997 and 2005. Review indicates the load-out complex was located approximately 20 m north of Tarago Station adjacent/over the west side of the rail formation. Loadout complex infrastructure appears to have included a loop road for truck access from the south, a truck dumping station, a conveyor from the dumping station to a larger square building and an undercover rail loading point extending over part of the rail formation (the former Woodlawn siding). The load-out complex appears to have been constructed between 1976 and 1985 with demolition between 1997 and 2005. Evidence of the load-out complex in satellite imagery after demolition appears limited to remnants of the haul road for truck access from the south. The loadout complex is identified as the main potential source of site contamination.
Interview of loadout complex employee	Key points from interview of a former employee of the load-out complex (and long-term resident of Tarago) are summarised below: a. The load-out complex floor elevation was approximately the same elevation as the remnant Woodlawn Siding. The current elevation across the area of the load-out complex footprint is approximately one meter higher. This is a result of soil that was imported to cap the area after demolition of the buildings. b. During operation, ore was transported to the load-out complex by truck, tipped at a dump station, transported via conveyor into the main building and loaded onto rail cars using a front-end loader. c. The tail gates of trucks that used to haul ore from the mine to the corridor banged all the way down Stewart Street as they drove off and the road was green from the ore. d. Movement of sediment from the former ore concentrate load-out complex occurred during high rainfall weather events. A flood occurred in the early 1980s which washed through the load-out complex and knocked over the fences to 106 Goulburn Street. Sediment was transported down Wallace Street and possibly across Boyd Street through the tennis courts to the Mulwaree River.
Historical Title Search	A historical title search was not completed based on the longstanding use of the site as a rail corridor.

4. Geology and Hydrogeology

A summary of the geology and hydrogeology is detailed in **Table 4-1**.

Table 4-1: Summary of Geology and Hydrogeology

Site	Details
Geology	Review of the Australian Geoscience Information Network (AUSGIN) portal (http://portal.geoscience.gov.au/ accessed 8/1/2020) identified regional geology including channel and flood plain alluvium (gravel, sand and clay) locally formed as calcrete overlying quaternary sedimentary rock (including some of low metamorphic grade).
Excavation Logs	Excavation logs reviewed to assess site geology included a registered onsite groundwater well, one test pit west of the rail formation opposite Tarago Station and nine test pits through the rail formation. The bore log from the registered bore identified fill from surface to 0.6 mbgl overlying clay to 7 mbgl overlying sand to 12.2 mbgl (depth of bore). The test pit west of the rail formation identified silty gravel fill to 0.4 mbgl overlying clay to 0.8 mbgl (depth of test pit) The nine test pits within the rail formation identified a profile consistent with expected layers of ballast, capping and base formation materials. These included silty gravel (ballast) from surface generally to 0.5 mbgl overlying black gravelly clay (capping) and grey / brown gravelly clay to depth of test pits (generally 0.7 mbgl).
Location and Extent of Fill	Fill was identified progressively through site assessments (Ramboll 2019a – e and Ramboll 2021) broadly across the site including in the former load-out complex, the rail formation and adjacent the eastern side of the rail formation. At the load-out complex a maximum of approximately 1 m of fill (battered to the road to the west, rail to the east and stormwater drain to the north) was observed during targeted test pitting (Ramboll 2020b) consistent with anecdotal account of application of clay 'capping' following demolition of buildings. Localised stockpiles were identified east and west of the rail formation and north of Tarago Station. These stockpiles were present on an historic survey plan before loop extension works. Stockpiles of contaminated spoil (approx. 750m^3 of fouled ballast and approx. 100m^3 of timber sleepers) were also created west of the rail formation and opposite Tarago Station. during construction.
Onsite Wells	One registered groundwater well and five unregistered monitoring wells (MW1 – MW5) are present onsite. Review of the NSW Department of Planning Industry Environment MinView portal identified well ref: GW053976 was installed in 1984 to a depth of 12.2 mbgl with a water bearing zone in sands from 7 mbgl. No other wells were identified onsite. Records indicate the well was constructed using 0.15 m diameter steel casing with 2 mm wide vertical screen slots. Locations of MW1 – MW5 are presented on **Figure 4, Appendix 1** and reported a water bearing zone in gravelly clay from 5 to 6.5 mbgl (Ramboll 2020a).

Site	Details
Groundwater Bore Search	Review of the NSW Department of Planning Industry Environment MinView portal (https://minview.geoscience.nsw.gov.au/) identified 12 wells within a 500 m radius from the site.
Depth to Groundwater Flow	Review of drilling and construction details for registered wells indicates the shallowest regional aquifer is present in gravel layers from 5.5 – 18.6 mbgl with deeper aquifers present in fractures of underlying shale, siltstone and limestone from 50 – 74 mbgl.
Groundwater Usage	Assessment of groundwater usage has occurred including: 1. A search for registered groundwater bores (described above). 2. A groundwater usage survey delivered by JHR in February 2020 to 94 letter boxes in Tarago. A total of 17 responses were received. 3. Discussion with 43 private property owners during assessments of discrete properties. Integrated findings of the groundwater usage survey and discussions with property owners included: 1. 20 properties were identified where groundwater bores had been installed. 2. At all properties groundwater use included (or was assumed to include) watering gardens. 3. At three properties groundwater was reported to include drinking and washing. 4. At two properties groundwater use was reported for agriculture. 5. At one property groundwater was reported to be used for filling a pool. 6. At two properties groundwater use remained unclear.
Direction and Rate of Groundwater Flow	It is considered likely that the shallower aquifer flows toward the Mulwaree River approximately 550 m east of site.
Direction of Surface Water Runoff	Regional surface water runoff is expected to flow toward the Mulwaree River approximately 500 m east of site.
Background Water Quality	Review of drilling and construction details indicates groundwater salinity is low.
Preferential Water Courses	Review of satellite imagery identified the Mulwaree River as the main water course close to site. Three culverts direct surface water beneath the rail formation onsite and then offsite to the east. Each culvert receives water from contaminated areas of site via cess drains on the west side of and running parallel to the rail line as described below: 1. The southernmost culvert is located at CH 262.660 and directs a local water course through the rail corridor. This water course is an unnamed tributary to the Mulwaree River. Water discharging from site flows (after high rainfall events only) under the Goulburn Street bridge and through agricultural land before discharging to the Mulwaree River. 2. The middle culvert is located at CH 262.354 and directs water to a shallow pond within the corridor and then offsite through a causeway on Boyd Street. From the Boyd Street causeway surface water is partly directed into a drain along the eastern side of Boyd Street and partly discharges into an adjacent paddock.

Site	Details
	The northern culvert is located at CH 262.040 and directs water along an informal flow path to a dam on an adjacent agricultural property.

5. Site Condition and Surrounding Environment

Site details are consolidated in **Table 5-1**.

Table 5-1: Site Condition and Surrounding Environment

Site	Description
Topography	Review of Google Earth satellite imagery identifies site elevation of approximately 688 mAHD and slopes down to the east. The rail formation, former load-out complex and unsealed access roads along the west side of the rail formation were observed to be free of vegetation. Some trees were observed west of the rail formation along Stewart Street and east of the rail line to the south of Tarago Station. Grass was generally observed across the remainder of the site. Some vegetative stress was observed though across the site and in the surrounding offsite areas of assessment (Goulburn Street footpaths and Tarago Public School) though appeared consistent with the surrounding environment and with stress that could be expected from recent drought conditions.
Conditions at Site Boundary	Evidence of contamination was identified at several locations near the eastern site boundary and is summarised on **Figures 2a – 2e, Appendix 1**. The site was observed to be fenced on the western boundary and partially fenced on the eastern boundary. Access remained feasible from Tarago Station and the Goulburn Street level.
Visible Signs of Contamination	Visible evidence of contamination was observed as green and orange staining of silt within fouled ballast in the areas of lead impact identified on **Figures 2a – 2e, Appendix 1**. Potential relationship between stressed vegetation and contamination was most notable along the haul route from the mine to the corridor. Vegetative stress was observed along localised areas of road verge compared to the road verge generally which was vegetated with grass. Within the corridor areas of contamination (e.g.: rail formation, adjacent soils, cess drains) generally align with areas where routine maintenance would include removal of vegetation. An exception to this was the former load-out complex where little vegetation was observed. Historic assessment of this area however identified low contaminant concentrations and the absence of vegetation is likely associated with low organic carbon content within the clay surface soils, recent trafficking by heavy machinery and low rainfall over the longer term. Additionally, stress to trees and shrubs at 106 Goulburn Street observed in December 2019 (i.e.: in soils impacted by the Contaminant) appeared consistent with other areas of Tarago (not impacted by the Contaminant). Based on these observations vegetative stress is not considered a reliable indicator of impact from the Contaminant.

6. Assessment Criteria

6.1 Soil

The criteria proposed for the assessment of soil contamination were sourced from the following references:

- National Environment Protection Council (NEPC), National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (NEPM, 2013).
- 'Tarago Loop Extension Preliminary Human Health Risk Assessment Ramboll' dated 17 October 2019 by Ramboll (Ramboll 2019d).

The NEPM (2013) provides health-based soil investigation levels (HILs) and ecological-based investigation levels (EILs) for various land uses. Based on the current and future use of the site, and the surrounding land, the guidelines adopted for the ROA are as follows:

- HIL A – Health investigation level for residential use including residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, (no poultry), also includes children's day care centres, preschools and primary schools. HIL A is applicable to 106 Goulburn Street, Tarago.
- HIL D – Health investigation level for commercial/industrial such as shops, offices, factories and industrial sites. The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of 3 m below the surface for industrial use. HIL D is applicable to the rail corridor including the Train Station.
- EIL for urban residential and public open space and EIL for commercial/ industrial use – ecological investigations levels applicable for assessing risk to terrestrial ecosystems. EILs depend on specific soil physicochemical properties and generally apply to the top 2 m of soil.

Ramboll (2019d) determined a site-specific trigger level (SSTL) for lead protective of current and future onsite workers of 2,200 mg/kg and a site-specific EIL for lead of 1,800 mg/kg.

The human health and ecological criteria adopted for the ROA are provided in **Table 6-1**.

Table 6-1: Soil Assessment Criteria – Human Health and Ecological Investigation Levels (mg/kg)

Contaminant	HIL A – Low density residential	HIL D – Commercial/ Industrial	EIL – Urban Residential and Public Open Space	EIL -Commercial/ Industrial
Aluminium	-	-	-	-
Arsenic	100	3,000	100	160
Barium	-	-	-	-
Beryllium	60	500		
Cadmium	20	900	-	-
Chromium	100[a]	3,600[a]	430[b,c]	710[b,c]
Cobalt	100	4,000	-	-
Copper	6,000	240,000	110[c]	160[c]
Iron	-	-	-	-
Lead	300	2,200[d]	1,100	1,800
Manganese	3,800	60,000	-	-
Mercury	40[e]	730[e]	-	-
Nickel	400	6,000	200[c]	340[c]
Zinc	7,400	400,000	250[c]	370[c]

[a] HIL for chromium (VI).

[b] EIL for chromium (III).

[c] Site specific EIL (calculated during Ramboll 2019d).

[d] SSTL for lead (Ramboll 2019d).

[e] HIL for inorganic mercury.

6.2 Groundwater and Surface Water

The criteria proposed for the assessment of groundwater and surface water contamination are sourced from the following references:

- National Environment Protection Council (NEPC), National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (NEPM, 2013).
- National Health and Medical Research Council (NHMRC) (2001) National Resource Management Ministerial Council (NRMMC) Australian Drinking Water Guidelines 6, Version 3.5 updated August 2018, (ADWG 2011).
- National Health and Medical Research Council (NHMRC), National Resource Management Ministerial Council (NRMMC) Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).
- Department of Environment and Conservation (DEC) Guidelines for the Assessment and Management of Groundwater Contamination (DEC, 2007).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) (available at www.waterquality.gov.au/anz-guidelines).
- Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

A groundwater usage survey was conducted by JHR in February 2020. Review indicate that respondents are extracting groundwater predominantly for use within the garden, but some respondents also extract groundwater for use within the house, drinking water and refilling swimming pools. Therefore, the beneficial uses and environmental values of the regional aquifer are considered to include:

- Irrigation of produce and stock watering.
- Freshwater ecosystems.
- Irrigation watering of fields.
- Drinking water.
- Recreational use in swimming pools

Assessment criteria adopted for surface water and groundwater are summarised in **Table 6-2**.

Table 6-2: Groundwater and Surface Water Investigation Levels (µg/L)

Contaminant	95% Freshwater (ANZG 2018)	Drinking Water (ADWG 2011)	Irrigation Short-term Trigger Value (ANZECC 2000)	Stock Water (ANZECC 2000)
Heavy Metals				
Aluminium	55[a]	-	20,000	5,000
Arsenic	24[b]	10	2,000	500-5,000
Barium	-	2,000	-	-
Beryllium	-	60	500	-
Cadmium	0.2	2	50	10
Chromium	1.0[c]	50[c]	1,000	1,000
Cobalt	1.4	-	100	1,000
Copper	1.4	2,000	5,000	400-5,000
Iron	-	-	10,000	not sufficiently toxic
Lead	3.4	10	5,000	100
Manganese	1,900	500	10,000	not sufficiently toxic
Mercury	0.06[d, e]	1	2	2
Nickel	11	20	2,000	1,000
Zinc	8	-	5,000	20,000
Inorganics				
Ammonia (as N)	900	-	-	-
Nitrate	-	50,000	-	-
Nitrite	-	-	-	-
Total nitrogen	-	-	25,000-125,000	-
Total phosphate (as P)	-	-	800-12,000	-
BTEXN				
Benzene	950	1	-	-

Contaminant	95% Freshwater (ANZG 2018)	Drinking Water (ADWG 2011)	Irrigation Short-term Trigger Value (ANZECC 2000)	Stock Water (ANZECC 2000)
Heavy Metals				
Toluene	180	800	-	-
Ethylbenzene	80	300	-	-
Total xylenes	75[f]	600	-	-
Naphthalene	16	-	-	-

blank cell denoted with – indicates no criterion available.

[a] Aluminium guidelines for pH > 6.5, based on the pH of groundwater measured at the site and surrounding area.

[b] Guideline value for arsenic (III).

[c] Guideline value for chromium (VI).

[d] Guideline value for inorganic mercury.

[e] 99% species protection level DGV has been adopted to account for the bioaccumulating nature of this contaminant.

[f] Guideline value for m-xylene. Guideline values also exist for both o-xylene and p-xylene as per ANZG (2018). The default guideline value for m-xylene guideline has been adopted as it is the most conservative.

6.3 Dam, Drainage Line and River Sediment

The criteria proposed for the assessment of sediments are sourced from the default guideline values in ANZG (2018). The adopted assessment criteria for sediment are summarised in **Table 6-3**.

Table 6-3: Sediment Ecological Investigation Criteria (mg/kg)

Contaminant	Sediment DGV	GV-High
Aluminium	-	-
Arsenic	20	70
Barium	-	-
Beryllium	-	-
Cadmium	1.5	10
Chromium	80	370
Cobalt	-	-
Copper	65	270
Iron	-	-
Lead	50	220
Manganese	-	-
Mercury	0.15	1.0
Nickel	21	52
Zinc	200	410

The Default Guideline Value (DGV) was derived using a ranking of both observed field and laboratory ecotoxicity-effects and represents the 10th percentiles of that data distribution.
Guideline Value (GV)-high represents the median of that data distribution to provide an upper guideline value. Effects on sediment biota are rarely seen for concentrations below the DGV, while effects are more frequently evident above the GV-high value.

6.4 Rainwater Tank Water and Sediment

The criteria proposed for the assessment of rainwater tank water and rainwater tank sediment contamination are sourced from the following references:

- National Environment Protection Council (NEPC), National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (NEPM, 2013).
- National Health and Medical Research Council (NHMRC) (2001) National Resource Management Ministerial Council (NRMMC) Australian Drinking Water Guidelines 6, Version 3.5 updated August 2018, (ADWG 2011).

Assessment criteria adopted for rainwater tank water and sediment are summarised in **Table 6-4**. Rainwater tank sediment criteria are based on reuse of sediment on the site however are also protective of incidental sediment consumption in drinking water.

Table 6-4: Rainwater Tank Water and Sediment Assessment Criteria

Contaminant	Rainwater Tank Water (ADWG 2011) (µg/L)	Rainwater Tank Sediment (mg/kg)	
		HIL A – Low density residential	HIL C – Recreational/ Public Open Space
Lead	10	300	600

6.5 Dust

The preliminary screening criteria proposed for the assessment of dust contamination are sourced from the following references:

- USEPA (2020) Protect your family from lead in your home. US Environmental Protection Agency – January 2020.
- AS 4361.2-1998 Guide to lead paint management - Residential and commercial buildings.

The dust results are to be presented as lead loadings (µg lead/m^2). Where dust samples were collected by vacuum, the lead loading was calculated using the following equation:

$$\textit{Lead loading } (\mu g/m^2) = \frac{\textit{lead concentration (mg/kg) x dust sample mass (g)}}{\textit{sample area } (m^2)}$$

Where samples were collected by swab, the lead loading was calculated using the following equation:

$$\textit{Lead loading } (\mu g/m^2) = \frac{\textit{total lead } (\mu g)}{\textit{sample area } (m^2)}$$

Assessment criteria adopted for lead dust contamination are summarised in **Table 6-5**.

Table 6-5: Lead Dust Assessment Criteria (µg/m^2)

	Residential Property (including childcare centres)	Commercial Property
Dust interior – hard floors	108	1,000
Dust interior – windowsills and shelves	1,076	5,000

7. Results

7.1 Review of Historic Assessments

Previous investigations reviewed to inform CSM for the site and requirement for remediation comprised:

- *Tarago NSW August 2019 - June 2023 Surface Water Monitoring* (Ramboll 2019a – 2023a).
- *Tarago Rail Corridor Environmental Site Assessment* (Ramboll 2019b).
- *Tarago Rail Corridor and Tarago Area Detailed Site Investigation* (Ramboll 2020a).
- *Tarago Rail Corridor and Tarago Area Detailed Site Investigation Addendum* (Ramboll 2020b).
- *Lead Investigation Report 106 Goulburn Street Tarago* (Ramboll 2020c).
- *Tarago Air Quality Monitoring Reports April 2020 – February 2021* (Ramboll 2020d - 2022a).

Results from previous investigations is summarised in the following sub-sections.

7.1.1 Vertical Delineation of the Contaminant at the site

Results from previous assessments informed delineation of the Contaminant within the rail formation and adjacent soils across an area of approximately two hectares and to a maximum depth of 0.5 mbgl. Concentrations of lead were observed to be highest in shallow soils and generally decreased below assessment criteria from 0.5 mbgl. Continued reduction in lead concentrations was observed from 0.5 – 4.5 mbgl. Exceptions to this vertical extent were noted around the former Load-out Complex where lead exceeded assessment criteria at depths of around 1 mbgl. The elevated concentrations reported occurred in material including asphalt and ballast; and are indicative of the site surface during operation of the Load-out Complex (i.e.: before historic application of capping).

Qualitative assessment indicates a relationship between concentrations of lead and other metals such as copper and zinc.

Assessment of the vertical extent of lead in site soil is summarised on **Figures 2a** – **2e**, **Appendix 1.**

7.1.2 Additional Assessment of Site Surface Soils

Visual evidence of ore concentrate was observed in surface soils adjacent a drainage line upstream of the middle culvert in June 2020 as shown on **Figure 2b**, **Appendix A**. These impacts may have occurred during the rail loop extension as this evidence was not observed during previous assessment of the area. Assessment by field portable X-ray fluorescence (fpXRF) identified concentrations of the Contaminant and other metals above assessment criteria for the site and reported concentrations that adversely impact the receiving environment for downstream surface waters.

Soils were analysed surrounding the siding (excluding rail formation) at 0.1 mbgl at three locations where concentrated lead was reported at the surface (PIA2, PIA4, PIA5 – **Figure 2b**, **Appendix A**). Metals concentrations were observed to be much lower at 0.1 mbgl compared to the surface and this supports conclusion that the observed impacts are limited to surface soils.

This area of surface soil contamination is presented on **Figure 2b**, **Appendix 1**. The extent of the Contaminant onsite (including at the former Load-Out Complex) has been delineated and is described by red shading on **Figures 2a** – **2e**, **Appendix 1**.

7.1.3 Load-Out Complex

Assessment of soils within the footprint of the former Load-Out Complex was completed on 19 August 2020 and comprised the advancement of a further six test pits (LO_TP01 to LO_TP06) to supplement existing locations. Results relevant to vertical delineation of elevated lead around the former Load-Out Complex are summarised in **Table 7-1** below.

Table 7-1: Summary of Vertical Delineation of Lead in Site Soils

Depth (mbgl)	0-0.1	0.1 - <0.5	0.5	1	1.5	2.5	3.5	4.5
Number of samples (n)	9	9	15	12	4	4	4	4
Detections	9	9	15	12	4	4	4	4
Minimum (mg/kg)	51	12	7.4	6.7	16	15	15	22
Maximum (mg/kg)	29000	184000	390	3600	540	200	140	42
Mean (mg/kg)	4600	25300	90	360	150	70	50	30
n > Site specific human health guideline (2,200 mg/kg)	3	5	0	1	0	0	0	0
n > Site specific ecological guideline (1,800 mg/kg)	4	5	0	1	0	0	0	0

Lead concentrations were reported above human health and ecological guideline values at three locations as follows:

- LO_TP02 at 1.1 mbgl (5,700 ppm) and 1.3 m bgl (6,900 ppm).
- LO_TP03 at 1.6 mbgl (3,662 ppm).
- MW2_1.0 at 1.0 mbgl (3,600 mg/kg), sampling completed by Ramboll 18 May 2020.

Results indicate that lead contamination is present at depth beneath a clay capping layer approximately 1 m thick. During test pitting completed in August 2020, foreign material (i.e. plastic, metal, wire and glass) was noted at LO_TP03 at depths consistent with elevated lead concentrations. The highest lead concentration was reported at LO_TP02 at 1.3 mbgl. The extent of the contaminant is described by red shading on **Figure 2ci, Appendix 1**.

7.2 Groundwater

Metals concentrations were reported below drinking water guidelines in all bores tested.

Lead concentrations in groundwater were reported above the adopted criteria protective of freshwater ecosystems (95% species protection) in registered bore GW053976 located within the rail corridor. All other dissolved lead concentrations were reported below the 95% freshwater ecosystem criteria. This well is located approximately 300m south and cross-gradient of the most concentrated soil contamination. Based on the unknown history of GW053976 and the absence of lead in groundwater above adopted assessment criteria in any of the purpose-built monitoring wells, lead reported at GW053976 is considered an anomaly. This discussion supports conclusion that the Contaminant has not impacted groundwater.

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Generally, lead, and other heavy metal concentrations were low and all were reported below relevant assessment criteria protective of human health. This is consistent with the vertical profile of contaminants in site soils described in **Section 7.1.1** which indicates that potential for impacts from site soil contamination to groundwater is limited. Concentrations of zinc and cobalt exceeded ecological criteria up and down gradient of the site. Copper, lead, and chromium were observed in groundwater onsite down gradient of site contamination.

In the closest downgradient offsite well (MW6), all contaminant concentrations were reported below ecological and human health criteria. Cobalt was reported above ecological criteria in the nearest well to the Mulwaree River (MW7) however based on the presence of cobalt in groundwater upgradient of site contamination and the absence of cobalt immediately downgradient of site, the observed cobalt concentrations in groundwater are considered indicative of regional conditions unrelated to the site.

Dissolved metal concentrations, indicative of contaminant migration are low and indicate a low potential for impacts in the receiving body of Mulwaree River and the community use of the aquifer.

7.3 Surface Water and Sediment

Surface water and sediment monitoring completed during the *Tarago Rail Corridor and Tarago Area Detailed Site Investigation* (Ramboll 2020a) identified lead and co-located metals in surface water and sediment above human health and ecological criteria on site upstream and/or downstream of the three rail culverts.

Monitoring results since 2019 indicate no evidence of offsite migration of contaminants in surface water and no increasing trends in concentrations that would represent an unacceptable human health risk, with no reported exceedances in the adopted human health criteria for the contaminants of concern (Ramboll 2019a – 2023a).

Similarly, monitoring results indicate no evidence of offsite migration of contaminants in surface water and no increasing trends in concentration that would represent an unacceptable risk to ecology. Concentrations of copper and zinc observed in the Mulwaree River are consistent with background concentrations and do not indicate impacts from the site (Ramboll 2019a – 2023a).

7.4 Public Spaces

The results of the public space investigation by fpXRF indicated lead concentrations in surface soil in most areas assessed are below the adopted assessment criteria indicating that widespread impacts from the lead ore within rail corridor have not occurred. However, there are three areas identified with elevated concentrations as follows:

- In areas along the haul route between the mine and the rail corridor.
- On Mulwaree Street and in the roadside drain downstream.
- On an overland flow path from the rail corridor adjacent the SMC and across Boyd Street.

Items 1 and 2 are considered unrelated to lead within the rail corridor for the following reasons:

- The Contaminant has been delineated onsite except for localised offsite migration through surface water and dust. This includes delineation of the Contaminant onsite and elevated lead concentrations on Stewart Street (the closest part of the haul route).
- Historic practices are known to have occurred along the haul route (transport of ore by truck) and on Mulwaree Street that could have resulted in lead contamination.
- The haul route and Mulwaree Street are elevated above the site such that movement of the Contaminant via surface water is not feasible; and
- The degree of contamination in the haul route and on Mulwaree Street exceeds the degree of impacts linked to dust by an order of magnitude.

Item 3 is related to the migration of lead ore from the rail corridor by surface water and further investigation was completed by enRiskS in 2021 (enRiskS 2021a). The risk assessment was in relation to exposure and risks to human health and the environment identified on land outside of the rail formation in publicly accessible areas, such as road verges and drainage lines, including the areas around Boyd Street. Site-specific criteria for human (commercial / industrial) and ecological exposure were defined for surface water and soil/sediment. Comparison of the available data to the site-specific criteria found that existing risks to be low and acceptable.

7.5 Waste Classification

The results from previous investigations were assessed to provide an indicative waste classification assessment of the materials onsite. The results indicate that lead is the key contaminant driving waste classification. Assessment of lead concentrations against Contaminant Thresholds (CT), Specific Contaminant Concentration (SCC) and Toxicity Characteristic Leachate Procedure (TCLP) supports segregation of contaminated soil into the following three types:

- Ballast fines from the Woodlawn Siding as Hazardous Waste
- Ballast from the Woodlawn Siding as General Solid Waste
- Soils adjacent the rail formation as Restricted Solid Waste
- Soils from SMC as General Solid Waste

Complete waste classifications have not yet been prepared and will be where wastes are to be taken offsite under the preferred remediation option.

7.6 Contaminant Distribution in Fouled Ballast by Particle Size

Further assessment of contaminant distribution by particle size within Woodlawn Siding ballast was completed to refine consideration of remedial requirements. This included:

- Collection of five bulk samples (approx. 20 kg).
- Particle Size Distribution (PSD) analyses.
- Crushing and analyses of the >19 mm fraction for lead.
- Analyses of total lead in ballast (excluding fines) as described below.

Total lead was analysed in 18 sub-samples collected from eight bulk samples. Bulk samples were collected to provide targeted assessment of ballast (excluding fines) within the Woodlawn Siding around the historic loader and systematic assessment of ballast (excluding fines) within the remainder of the Woodlawn Siding. Sampling locations (TP3a, TP5a, TP6a and BAL_01 – BAL_05) are presented on **Figures 2a – 2e**. Assessment of lead concentrations against the SSTL and 95% UCL calculations are summarised in **Table 7-2**.

Table 7-2: Lead in Woodlawn Siding Ballast (excluding fines)

No. of Samples	Minimum	Maximum	No. > criteria[1]	Average	St Dev	95% UCL
18	13	2,800	1	546	756	1,041

[1]The site specific criterion for lead protective of human health (2200 mg/kg) was adopted.

The maximum lead concentration in Woodlawn Siding ballast (excluding fines) was 2,800 mg/kg (< 250% of the guideline) and the standard deviation was 756 mg/kg (< 50% of the guideline). The 95% UCL was therefore considered relevant and was calculated at 1,041 mg/kg and below HIL D site assessment criteria.

Assessment of lead in Woodlawn Siding ballast (excluding fines) indicates this material would be suitable for reuse in the rail corridor following separation of fines.

The arithmetic mean percentage of >20 mm and <20 mm fractions were calculated at 54% and 46% respectively and support volume estimates for material types projected for remediation (see waste volume projections presented in **Section 9.**[1]

7.7 The SMC

Results of sampling of soil, tank water and internal dust at the SMC are replicated from Ramboll 2020c in **Table 7-3**. Results shown in bold exceeded criteria protective of human health in a residential setting.

[1] Projections of ballast and fines proportions are based on limited data and presented to provide an indication of potential volumes only.

Table 7-3: Summary lead concentration results for human health risk

Type	Guideline	Sample Number / Result						
Soil	300 (mg/kg)[1]	SS136 **1,200**	SS137 **1,100**	SS138 210	SS139 **800**	SS140 **660**	SS141 **390**	SMC_HA01_ 0.0 **1,100**
		SMC_HA01_ 0.2 19	SMC_HA01_ 0.5 12	SMC_HA02_ 0.0-0.05 **610**	SMC_HA02_ 0.2 **440**	SMC_HA02_ 0.4 34	SMC_HA03_ 0.0-0.05 **1,200**	SMC_HA03_ 0.2 49
		SMC_HA03_ 0.4 110	SMC_HA04_ 0.0 240	SMC_HA04_ 0.2 34	SMC_HA02_ 0.4 19	SMC_HA05_ 0.0-0.05 **490**	SMC_HA05_ 0.25 **1,100**	SMC_HA05_ 0.4 240
		SMC_HA06_ 0.0 **760**	SMC_HA06_ 0.2 **520**	SMC_HA06_ 0.4 20	SMC_HA07_ 0.0 **3,800**	SMC_HA07_ 0.2 93	SMC_HA07_ 0.4 14	SMC_HA08_ 0.0-0.05 **840**
		SMC_HA05_ 0.2 260				SMC_HA05_ 0.45 280		
Rainwater tank water	0.01 (mg/L)[2]	SMC_TW1 0.004						
Dust Interior – Floors	108 $(\mu g/m^2)$[3]	DSWAB-BE(SMC) **2,111**			DSWAB-FE(SMC) **2,222**		DVAC-LR(SMC) **1,774**	
Dust Interior – Windowsills and Shelves	1,076 $(\mu g/m^2)$[3]	SWAB19 **8,333**			SWAB20 **17,778**		SWAB21 588	
Dust Interior – Grab Samples[4]	(mg/kg)[4]	DVAC-WH(SMC) 11,000				DGRAB-MH(SMC) 5,100		
Dust Exterior	4,300 $(\mu g/m^2)$[5]	SWAB16 **20,000**			SWAB17 **4,556**		SWAB18 **10,000**	
	300 (mg/kg)[1]	DVAL-CP(SMC) **1,100**				DVAL-KYAK(SMC) **1,000**		

[1] NEPM (2013) Schedule B1: Guideline on investigation levels for soil and groundwater. National Environment Protection (Assessment of Site Contamination) Measure 1999. Federal Register of Legislative Instruments F2013C00288 (HIL A - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools).
[2] NHMRC, NRMMC (2011 updated 2018) Australian Drinking Water Guidelines (ADWG) Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
[3] USEPA (2020) Protect your family from lead in your home. US Environmental Protection Agency – January 2020.
[4] These samples were collected to inform quantification of contributions of ore concentrate and house paint to lead in dust and the results will be communicated separately.
[6] NSW EPA Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices. A Guide for Councils 2003.

Results of groundwater sampling at the SMC are replicated from Ramboll 2020c in **Table 7-4**. Concentrations were reported below criteria protective of livestock, irrigation and potable use.

Table 7-4: Summary of lead concentration results for groundwater

Type	Guideline	Result
Water as pumped for livestock	0.1 (mg/L)[1]	0.002
Water as pumped for irrigation	2 (mg/L)[1]	0.002
Water for drinking once settled	0.01 (mg/L)[2]	<0.001

[1] Australia and New Zealand Environment and Conservation Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
[2] NHMRC, NRMMC (2011 updated 2018) Australian Drinking Water Guidelines (ADWG) Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Results of tank sediment sampling at the SMC are replicated from Ramboll 2020c in **Table 7-5**. Concentrations were reported below criteria protective of human health in a residential setting.

Table 7-5: Summary of lead concentration results for tank sediment

Type	Guideline	Result
Rainwater tank sediment	300 (mg/kg) [1]	240

[1] NEPM (2013) Schedule B1: Guideline on investigation levels for soil and groundwater. National Environment Protection (Assessment of Site Contamination) Measure 1999. Federal Register of Legislative Instruments F2013C00288 (HIL A - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools)

8. Conceptual Site Model

A Conceptual Site Model (CSM) is a site-specific qualitative description of the source(s) of contamination, the pathway(s) by which contaminants may migrate through the environmental media, and the populations (human or ecological) that may potentially be exposed. This relationship is commonly known as a Source-Pathway-Receptor ("SPR") linkage. Where one or more elements of the SPR linkage are missing, the exposure pathway is considered to be incomplete, and no further assessment is required. Where this linkage is found to be complete, it does not indicate that health or environmental risk is present, but rather triggers either a more detailed investigation or exposure controls. The findings of all assessments referenced here-in are considered in the exposure pathway assessment presented below.

CSM figures are presented **Sections A1 – A2** and **B1 – B2**, **Appendix 1** and support the following discussion of SPR linkages.

8.1 Sources of the Contaminant

The primary source of the Contaminant was identified as the ore concentrate from the former Load-Out Complex that has been deposited within the rail formation and adjacent shallow soils. Concentrations of the contaminant have been identified requiring remediation across approximately 23,500 m^2 as presented on **Figure 2a** – **2e**, **Appendix 1.** Further detail is provided under **Section 9**.

Sources of contamination at SMC are a result of lead dust deposition from the ore concentrate from the former Load-Out Complex as well as lead-based paints on the buildings and forms part of the 23,500 m^2 above.

8.2 Receptors

The receptors identified in this CSM were based on a current and future use of the site and surrounding land, which currently includes residential and a range of community uses as per the zoning as well as commercial/industrial for the rail formation (including the train station and carpark).

The human receptors identified were:

- Onsite workers (including intrusive maintenance and construction workers).
- Users of Tarago Train Station.
- Agents working on behalf of the owners of SMC (TAHE).
- Offsite residents.
- A range of offsite community facilities including the Public School, Preschool and Townhall.
- Workers in adjacent public road reserves.

The ecological receptors identified were:

- Onsite ecology.
- Offsite ecology including crops and livestock.
- Ecological receptors in the Mulwaree River.

8.3 SPR Linkages

An assessment of the SPR linkages for the Contaminant onsite (including the former Load-Out Complex) is summarised in **Table 8-1**.

Table 8-1: Exposure Assessment Summary

Exposure Route	Onsite Workers	Onsite Ecology	Residents	Community Activities	Offsite Workers	Aquatic receptors in the Mulwaree River	Irrigation and Livestock	Justification
					Potentially Complete SPR? (Y / N / P)			
			Onsite Soil and Sediment					
Direct Contact	P	P	P[1]	N	N/A	N/A	N/A	Concentrations in soils exceed onsite assessment criteria however management measures have been defined to mitigate risks to onsite workers (Ramboll 2019f). Potential remains for impacts to onsite ecology. Ecological risks are low due to the rail corridor holding little to no ecological significance.
Inhalation	P	P	P[1]	N	N/A	N/A	N/A	
Incidental Ingestion	P	P	P[1]	N	N/A	N/A	N/A	
Root Uptake	N/A	P	N/A	N/A	N/A	N/A	N/A	Contamination in soils at depth within the footprint of the former Load-Out Complex exceed human health and ecological criteria however are unlikely to present a risk to human health or ecology as located beneath clay capping.
			Offsite Soil and Sediment					
Direct Contact	N/A	N/A	P	N	N	P	N	Tier 2 human health and ecological risk assessment indicates Contaminant concentrations in soil and sediment offsite are low and acceptable.
Inhalation	N/A	N/A	P	N	N	P	N	
Incidental Ingestion	N/A	N/A	P	N	N	P	N	
Root Uptake	N/A	N/A	N/A	N/A	N/A	P	N	SMC has been acquired by TAHE and is no longer occupied as a residence. Potential remains however for elevated Contaminant concentrations to be present at private residences not tested.
			Surface Water					
Direct Contact	N	Y	N	N	N	N	N	Contaminant concentrations in surface waters onsite exceed ecological criteria. Contaminant concentrations in receiving waters from the site are low and acceptable
Incidental Ingestion	N	Y	N	N	N	N	N	
Root Uptake	N/A	Y	N/A	N/A	N/A	N	N	
Migration to groundwater	N	N	N	N	N	N	N	
			Groundwater					
Potable use including drinking	N	N/A	N	N	N	N/A	N/A	Concentrations of metals in groundwater were reported below human health criteria. Some metals exceeded ecological criteria onsite though not defined offsite and do not appear to discharge to the receiving Mulwaree River so ecological exposure is considered unlikely.
Direct Contact	N	N	N	N	N	N	N	
Incidental Ingestion	N	N	N	N	N	N	N	
Root Uptake	N/A	N	N/A	N/A	N/A	N	N	
			Dust					
Direct Contact	N	N/A	P	N	N	N/A	N/A	Elevated concentrations of lead in internal dust were identified in close proximity to the site indicating limited offsite migration of contaminants in air borne dust had occurred. Dust monitoring is ongoing and data suggests migration of lead in dust from the site has been low since the Tarago Lead Management Action Plan was implemented. Elevated lead in dust has been remediated where identified though potential remains for elevated lead in dust to be present in other residences. The SMC has been acquired by TAHE and is no longer occupied as a residence.
Inhalation	N	N/A	P	N	N	N/A	N/A	
Incidental Ingestion	N	N/A	P	N	N	N/A	N/A	
			Rain Tank Water					
Potable use including drinking	N/A	N/A	N	N	N/A	N	N	Rain tank water reported contaminant concentrations below criteria. The SMC has been acquired by TAHE and is no longer occupied as a residence.
Direct Contact	N/A	N/A	N	N	N/A	N	N	
Incidental Ingestion	N/A	N/A	N	N	N/A	N	N	
Root Uptake	N/A	N/A	N	N	N/A	N	N	
			Rain Tank Sediment					

Exposure Route	Potentially Complete SPR? (Y / N / P)							
	Onsite Workers	Onsite Ecology	Residents	Community Activities	Offsite Workers	Aquatic receptors in the Mulwaree River	Irrigation and Livestock	Justification
Direct Contact	N/A	N/A	P	N	N/A	P	N	Elevated lead in rainwater tank sediment has been remediated where identified though potential remains for elevated lead in rainwater tank sediment to be present in other tanks[2]. The SMC has been acquired by TAHE and is no longer occupied as a residence.
Inhalation	N/A	N/A	P	N	N/A	P	N	
Incidental Ingestion	N/A	N/A	P	N	N/A	P	N	

[1]Potentially complete exposure pathways between the Contaminant in soil and offsite residents are limited to approved (though not current) use of one residential property.

[2]Risks associated with contaminant migration via airborne dust and subsequent accumulation as sediment in rainwater tanks and/or as dust in houses has been addressed under the Action Plan (Ramboll 2022) and is not considered further.

9. Remediation Extent

Concentrations of the Contaminant were identified above criteria and require remediation or management. The extent of remediation is shown on **Figures 2a – 2e**, **Appendix 1** and is defined as:

- 32,100 m^2 of lead impacted ballast and soils including the soils at SMC, and land to the west of the site comprising:
  - 20,800 m^2 of contamination to remain below the existing rail formation to an estimated depth of 0.5 mbgl. This equates to an estimated volume of 10,400 m^3.
  - 11,300 m^2 of ballast and soils could practically be excavated from the site and SMC.
    - Excavation is proposed to a depth of 0.3 mbgl in lead impacted area surrounding the siding (excluding all rail formation)– defined as orange spotted shading in **Figures 2a – 2e, Appendix 1 .**
    - The Redundant Woodlawn Siding excavated to a depth of 0.5 mbgl – defined as red hatched shading in **Figures 2a – 2e, Appendix 1**.
    - The SMC (excluding house footprint) excavated to a depth of 0.25 mbgl.
- In addition, 100 m^3 of railway sleepers, classified as GSW will be incorporated in the remediation.

Estimate volumes of materials requiring excavation based on area and estimated depths are shown in **Table 9-1.** The combined volume retained and remediated is 14,640 m^3 and the extent of disturbance for the works of 11,300 m^2, both parameters are below the triggers for scheduled activity outlined in the *Protection of the Environment Operations Act* 1997.

Table 9-1: Volume projections for remediation materials

Location on Site	Area (m^2)	Depth (mbgl)	Volume (m^3)
Redundant Woodlawn siding proposed excavation	4,000	0.5	2,000
Lead impact area surrounding the siding	6,300	0.3	1,890
SMC (excluding house)	1,000	0.25	250
Railway sleepers – GSW[1]			100
Total	11,300		4,240

[1]Lead concentrations in rail sleepers do not consistently exceed site assessment criteria however offsite disposal was adopted during previous works and aesthetics may drive offsite disposal again.

10. Remediation Options Assessment

10.1 Remediation Goal

The chosen remediation strategy is to make the sites suitable for:

- Rail operations in the rail corridor; and
- Residential use, in accordance with the current zoning, at the SMC.

10.2 Hierarchy of Options

A hierarchy of remediation options has been adopted from the NEPM (NEPC 2013) and is presented as follows:

- On-site treatment of the contamination so that it is destroyed, or the associated risk is reduced to an acceptable level; and
- Off-site treatment of excavated soil, so that the contamination is destroyed, or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or,

if the above are not practicable,

- Consolidation and isolation of the soil onsite by containment with a properly designed barrier; and
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material;

or,

- Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.

In consideration of the above hierarchy, technology to destroy the contaminants present is not currently available. Technology to chemically reduce the mobility of contaminants is available however as outlined in **Section 8.3**, mobility of the contaminant is already limited and further mobility reduction is not warranted. Therefore options to destroy and reduce contaminant concentrations are not considered.

10.3 Site Constraints and Opportunities

The Goulburn to Bombala rail line, Tarago Loop line and Tarago Railway Station remain operational at the site. As such, impacted soils within the operational rail formation are not able to be removed and must be retained. These soils are therefore excluded from this options assessment. These soils will be managed through the current Action Plan (Ramboll 2022) and can later be incorporated in a Long-Term Environmental Management Plan. This approach is considered reasonable given:

- Contaminant concentrations within the main Goulburn - Bombala line and the Tarago Loop line are lower than in the former Woodlawn Siding and it is feasible that contaminant risks could be adequately reduced without removing contaminants from operational rail lines.
- Surface water monitoring at the site has identified no impacts off site from contaminants on site indicating action to mitigate off site risks is not required, refer **Section 7.3**.

SMC and the rail corridor land are currently zoned for different land use, with the later comprising a less sensitive use. As such, some impacted soils on the SMC site are suitable for reuse in the rail corridor and could be excavated and relocated. Each of the remediation options considered later in this report incorporate this approach.

10.4 Preliminary Screening of Remediation Options

Methodologies with potential to address the extent of remediation required were considered in a preliminary options screening according to the regulated hierarchy of options (**Section 10.2**) and within site constraints (**Section 10.3**) based on permissibility and feasibility. A summary of the preliminary screening of remediation options is presented as **Table 10-1**.

Remediation options are ordered in **Table 10-1** according to the hierarchy of options described in **Section 10.2**.

Table 10-1 Preliminary Screening of Remedial Options

Option Type	Option	Detail	Permissibility	Feasibility
Consolidation and isolation of the soil onsite by containment with a properly designed barrier	On-site containment at Tarago Rail Yard (underground)	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials as required to consolidate in one location. 3. Clay fill historically applied across the footprint of the former Loadout Complex would be excavated to a depth approaching the former site surface level verified through fpXRF during excavation to ensure contamination from the former site surface is not mixed with the clay fill. Low reliability estimation of 1,500 m^3 clay fill to be won onsite based on apparent elevated surface area of approximately 2,000 m^2. This clay fill would be reused as capping over the containment cell. 4. Contaminated material within and around the footprint of the former Loadout Complex (currently beneath clay fill) would then be excavated and consolidated with other contaminated materials referred to above. The volume of this material remains TBC though for this ROA is estimated at 1,000 m^3. 5. Construction of containment cell across an area of approximately 5,000 m^2 (25 m E-W x 200 m N-S) to the west of the Woodlawn Siding. The maximum depth of the containment cell would be the current depth of contaminated materials currently capped around the former Load Out Complex. Containment cell parameters considered for this option include: a. Welded 2 mm thick High-Density Polyethylene (HDPE) geomembrane at the base, sides and top of the cell with a 750 gm geofabric cushion layer inside the HDPE b. Placement of topsoil with minimum thickness of 0.2 m c. Placement of geofabric marker layer d. Placement of clay capping to achieve minimum total thickness of cap including topsoil of 0.5 m and final surface designed to minimise erosion potential (estimated 0.3 x 5,000 = 1,500 m^3) c. Vegetation to mitigate erosion of capping or application of a durable surface layer d. A 100-year design life is projected as a required parameter for engineering design. 6. Contamination remaining onsite in the containment cell and in the operational rail formation would remain subject to management under an LTEMP. Based on projected volume of contaminated material of 4,240 m^3 plus the 1,000 m^3 assumed to be present beneath clay fill around the loadout complex and a 0.5 m cap, the total depth of the containment cell is estimated at 1.5 m and the total gross cell volume (including capping) is estimated at 7,740 m^3. Based on this the total minimum total excavation depth over the 5,000 m^2 cell area is estimated at 1.5 m. The total surplus of clean excavation spoil is estimated at 5,240 m^3 and is based on the 4,240 m^3 of contaminated material to be excavated from outside the containment cell footprint plus the 1,000 m^3 of topsoil to be placed as the upper 0.2 m of containment cell capping.	Permissible	Feasible
	Onsite containment elsewhere in CRN (underground)	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials as required to consolidate in one location. 3. Transport by road to a suitable location elsewhere in the CRN (50 km radius assumed). 4. Excavation of approximately 7,740 m^3 (per cell design volume projection above) to facilitate containment cell construction resulting in a final landform consistent with the existing landform. 5. Construction of containment cell. Parameters considered for this option include: a. Welded 2 mm thick High-Density Polyethylene (HDPE) geomembrane at the base, sides and top of the cell with a 750gm geofabric cushion layer inside the HDPE b. Import and placement of clay cap with minimum thickness of 0.2 m c. Placement of geofabric marker layer d. Placement of additional clay to achieve minimum total thickness of cap of 0.5 m and final surface designed to minimise erosion potential c. Vegetation to mitigate erosion of capping or application of a durable surface layer d. A 100-year design life is projected as a required parameter for engineering design. 6. Management of contamination remaining onsite in the containment cell and in the operational rail formation under two separate LTEMPs.	Permissible	Feasible

Option Type	Option	Detail	Permissibility	Feasibility
	Consolidation and isolation beneath capping onsite (underground)	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials as required to consolidate in one location. As chemical immobilisation is not proposed, mechanical screening to remove ballast is not required. Similarly, excavation of contaminated material is not required where capping is to be applied (e.g. beneath existing capping around the former Load Out Complex or within the Woodlawn Siding. 3. Clay fill historically applied across the footprint of the former Loadout Complex would be excavated to a depth approaching the former site surface level verified through fpXRF during excavation to ensure contamination from the former site surface is not mixed with the clay fill. Low reliability estimation of 1,500 m^3 clay fill to be won onsite based on apparent elevated surface area of approximately 2,000 m^2. This clay fill would be reused as capping over the containment cell. 4. Placement of contaminated materials over an area of approximately 5,000 m^2 across the footprint of the former loadout facility and the surrounding area west of the rail formation. 5. Construction of capping over contaminated materials. Capping design contemplated includes a high visibility geotextile marker layer, a minimum 0.5 m clean clay and minimum 0.1 m topsoil to achieve a final surface that minimises erosion potential. The final surface will be finished with vegetation or application of a durable surface layer to mitigate erosion of capping. 6. Management of contamination remaining onsite beneath capping and in the operational rail formation under an LTEMP. Based on projected volume of contaminated material of 4,240 m^3 plus the 1,000 m^3 assumed to be present beneath clay fill around the loadout complex and a 0.5 m cap, the total depth of the capped material is estimated at 1.5 m below current surface level. The total surplus of clean excavation spoil is estimated at 5,240 m^3 and is based on the 4,240 m^3 of contaminated material to be excavated from outside the capping footprint plus the 1,000 m^3 of topsoil to be placed as the upper 0.2 m of capping.	Permissible	Feasible
	Consolidation and isolation beneath capping onsite (above ground)	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials as required to consolidate in one location. 3. Clay fill historically applied across the footprint of the former Loadout Complex would be excavated to a depth approaching the former site surface level verified through fpXRF during excavation to ensure contamination from the former site surface is not mixed with the clay fill. Low reliability estimation of 1,500 m^3 clay fill to be won onsite based on apparent elevated surface area of approximately 2,000 m^2. This clay fill would be reused as capping over the containment cell. Excavation of contaminated material beneath existing clay fill is not proposed. 4. Placement of contaminated materials over an area of approximately 5,000 m^2 across the footprint of the former loadout facility and the surrounding area west of the rail formation. 5. Construction of capping over contaminated materials. Capping design contemplated includes a high visibility geotextile marker layer, a minimum 0.5 m clean clay and minimum 0.1 m topsoil to achieve a final surface that minimises erosion potential. The final surface will be finished with vegetation or application of a durable surface layer to mitigate erosion of capping. 6. Management of contamination remaining onsite beneath capping and in the operational rail formation under an LTEMP. The final landform elevation relative to existing is estimated based on: 1. Projected volume of contaminated material of 4,240 m^3 plus a 0.6 m cap (projected at a volume of 3,000 m^3). On this basis the total volume of capping and underlying contaminated material is estimated at 7,240 m^3. 2. An estimated 1,500 m^3 clean clay within the existing landform will be removed and then reused in capping. As a result, the net volume is estimated at will be removed from Noting depth of the containment cell is estimated at 1.5 m and the total gross cell volume (including capping) is estimated at 5,740 m^3. Applied over an area of 5,000 m^2 this will result in an average increase in landform surface elevation of 1.1 m and a maximum increase in elevation of approximately 1.5 m.	Permissible	Feasible

Option Type	Option	Detail	Permissibility	Feasibility
Removal of contaminated soil to an appropriate facility	Onsite screening, onsite chemical immobilisation of lead in fines and disposal as immobilised GSW at an appropriately licensed facility.	A treatability trial has been completed and a specific immobilisation approval from the EPA granted to allow for chemical immobilisation. Within this context this option would then include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW 2. Mechanical screening of remaining contaminated materials to remove >20 mm fraction 3. Reuse of >20 mm fraction onsite (preliminary testing indicates suitability for this purpose though further validation sampling would be required) 4. Chemical immobilisation of <20 mm fraction and soils adjacent the rail formation onsite prior to offsite disposal as GSW 5. Management of contamination remaining onsite in the operational rail formation under an LTEMP.	Permissible	This option is generally considered feasible though potential for mobilisation of dust in air is identified and may cause delays during windy conditions which are common in the area.
	Return of contaminated soils to the Woodlawn Mine	Return of ore impacted materials to the mine could occur for beneficial reuse including ore recovery through hydraulic mining and tailings dam stabilisation works. This would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW 2. Confirmation with Heron Resources that it will receive ore impacted materials and any limitations associated with receipt (e.g.: chemical or geotechnical properties) 3. Application for a Resource Recovery Exemption and Order to be submitted to the NSW EPA 4. Excavation and cartage of ore impacted materials to the Woodlawn Mine 5. Beneficial reuse 6. Management of contamination remaining onsite in the operational rail formation under an LTEMP.	Potentially permissible subject to site specific RRE/RRO	No longer considered feasible as Heron Resources has indicated it will not receive the material.
	Offsite treatment and disposal.	A pathway for offsite disposal exists through amendment to the Environment Protection license (EPL) of the local landfill (Woodlawn Veolia) to allow treatment (where lead concentrations warrant treatment) as a precursor to disposal as General Solid Waste. A treatability trial has been completed and a specific immobilisation approval from the EPA granted to allow for chemical immobilisation. Within this context this option would then include: 1. Offsite disposal of timber railway sleepers (approx. 100 m3) as GSW 2. Amendment to Woodlawn Veolia waste facility to allow chemical immobilisation at the facility 3. Excavation of contaminated materials from Woodlawn Siding and areas adjacent the rail formation and transport by road to Woodlawn Veolia 4. Sieving to remove oversize material 5. Mixing of soils with immobilising reagents 6. Stockpiling to allow confirmatory sampling to assess success of immobilisation. 7. Confirmation of the waste classification for oversize materials sieved out to allow treatment 8. Management of contamination remaining onsite in the operational rail formation under an LTEMP.	Potentially permissible though subject to EPL amendment.	Not considered feasible as local landfills identified were limited to Woodlawn Veolia and this facility cannot receive the waste would exceed maximum volume truck movements allowed under development consent conditions.
	Offsite disposal of unsegregated waste.	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation and cartage of ore impacted materials to the nominated facility (assumed Western Sydney). 3. Disposal as RSW or Hazardous Waste depending on the classification without immobilisation. 4. Contamination remaining onsite in the operational rail formation would be managed under an LTEMP.	Permissible	Feasible
	Onsite screening followed by offsite disposal of contaminated soil as Hazardous Waste at an appropriately licensed facility.	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials from the Woodlawn Siding and surrounding shallow soils. 3. Mechanical screening onsite to remove ballast for beneficial reuse onsite and transport of fines for disposal as Hazardous Waste at an appropriately licensed facility. 4. Management of remnant contamination in the operational rail formation and at depth around the former loadout facility under an LTEMP.	Permissible	This option is generally considered feasible though potential for mobilisation of dust in air is identified and may cause delays during windy conditions which are common in the area.

Option Type	Option	Detail	Permissibility	Feasibility
	Offsite containment at the Lake George Legacy Mine.	This option would include: 1. Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW. 2. Excavation of contaminated materials from the Woodlawn Siding and surrounding shallow soils. 3. Road transport for placement in a containment cell which is being constructed as part of rehabilitation works at the Lake George Mine in Captains Flat, NSW. It is noted that this option would results in an increase in the volume of contaminated material that is to be otherwise placed in the containment cell and result in a proportionate increase in remedial works (material handling, chemical stailisation etc.) at the Lake George Mine. 4. Management of remnant contamination in the in the operational rail formation and at depth around the former loadout facility under an LTEMP.	Permissible. It is understood the NSW EPA has provided written consent for waste to be received in the containment cell from outside the mine site.	Feasible.
Implementation of an appropriate management strategy	Ongoing management to mitigate contaminant exposure risks.	This option would include: 1. Management of all contaminated material under an LTEMP. 2. Definition of controls to prevent unintentional disturbance of contaminated materials and to mitigate potential exposure risks during intentional disturbance (similar to current Lead Management Action Plan). 3. Review of ongoing monitoring requirements toward reducing monitoring to weather events not captured by existing monitoring.	Permissible	This option would require periodic active remediation controls (e.g.: application of polymer sealant) in perpetuity and so is not considered suitable for the project.

Return of contaminated materials to the Woodlawn Mine, offsite treatment at a landfill and ongoing management without active remediation were each considered not feasible however the remaining eight options were considered both permissible and feasible and were compared further through detailed assessment.

10.5 Detailed Assessment of Remediation Options

The eight remediation options can be summarised as follows and are referred to in **Appendix 2.**

- Option 1 – Onsite containment at the Tarago Rail Yard (underground).
- Option 2 – Onsite containment elsewhere in the CRN (underground).
- Option 3 - Onsite treatment (screen and immobilise) and offsite disposal.
- Option 4 - Onsite screening and offsite disposal.
- Option 5 – Offsite disposal of unsegregated waste.
- Option 6 – Onsite capping (above ground).
- Option 7 – Onsite bury and cap.
- Option 8 – Offsite containment at the Lake George Mine.

The assessment of the eight remediation options above occurred through workshops co-ordinated by Ramboll and attended by TfNSW subject matter experts in community engagement, environmental management, rail operations and rail engineering. The assessment was framed and documented according to a process defined under SURE by Ramboll; an interactive online platform for stakeholder communication and collaboration. The SURE tool inputs were 26 sustainability indicators described below.

Remediation option evaluation is calculated by:

- selecting sustainability indicators that reflect economic, environmental and social parameters relevant to the proposed remediation .
- assigning weighting (1 – 5) to each indicator that reflects the comparative importance of each.
- assigning a score (1 – 5) to describe the performance of each remediation compared to the other options against each indicator.
- multiplying a score (1 - 5) for each indicator under by the weighting for each indicator
- summing the resultant values for each option and
- normalising to present final scores against a maximum score of 100.

In the first workshop TfNSW selected indicators from a pre-set list recognised by the Sustainable Remediation Forum United Kingdom (SuRF UK) and additionally defined two social sustainability indicators specifically relevant to the Tarago project that were not otherwise captured under the pre-set list. They were 'Community Optics' and 'Delivery of the Remediation Program'. A total of 26 indicators were selected under domains of environmental, social and economic sustainability. The TfNSW subject matter experts in attendance then workshopped and agreed on weightings to represent the comparative importance of each indicator.

In the second workshop TfNSW scored the performance of each option compared to the other options against each indicator.

The higher scores represent more preferrable options. Further detail on the assessment process is presented in **Appendix 3**.

Eight indicators were adopted under the environmental domain. A description of each is outlined below:

- Greenhouse Gases – Semi-quantitative evaluation based on diesel consumption for each option. Options assessed on amount of diesel consumed only as information about overall project consumption, equipment and plant required and materials to be used is limited.
- Soil Functionality – A qualitative evaluation of the likely alterations in physical, biological, and chemical properties (particularly topsoil) that may affect flora, fauna, and beneficial soil microbia.
- Soil Erosion – A qualitative evaluation based on an assessment of the risk of soil erosion for each option and potential contaminant exposure.
- Water Uses – A qualitative evaluation based on an assessment of the long-term risk to water users from each option.
- Water Movement – A qualitative evaluation of potential temporary or permanent alterations in natural or existing water movement processes.
- Flora, fauna and food chains – A qualitative evaluation based on expected effects of each remedial option on species via functional changes in habitat quality (e.g., effects on soil or water), habitat removal (e.g., site clearing), and/or habitat alteration (e.g., introduction or acceleration of the spread of alien species, alteration of stand age structure, etc.).
- Impacts, Benefits for Land Re-use – A qualitative evaluation based on the assessment of constraints from each option on future land use due to contamination present onsite.
- Primary Resource and Waste – Semi-quantitative evaluation and option assumptions based on an assessment of consumption of fuel and amount of construction materials used for each option.

Ten indicators were adopted under the social domain. A description of each is outlined below:

- Long-Term Risk Management – A qualitative evaluation based on an assessment of the long-term management requirements for each option.
- Risk Management Performance – A qualitative evaluation based on capacity to manage identified risks and control hazards arising from ancillary operations, such as fugitive emissions, particulates and aerosols.
- Human health impacts – A qualitative evaluation based on relative ability to improve human health and well-being both from a physical and mental perspective.
- Intergenerational Equity – A qualitative evaluation based on the of duration and the extent to which contamination is addressed contamination within a relatively short period, or is passed on for future generations to deal with.
- Community Optics – A qualitative evaluation based on existing community concerns (as understood by TfNSW) regarding contamination remaining on-site and potential health and socio-economic impacts.
- Nuisance Impacts – A qualitative evaluation based on options in terms of their impact on the neighbourhood and locality through the various nuisance issues identified.
- Delivery of the Remediation Program – A qualitative evaluation based on impacts to the neighbourhood related to the complexity and duration of remediation program including remediation planning phase, remediation and validation phases.
- Local Culture and Vitality – A qualitative evaluation of the differences between remedial options in terms of contribution to local culture or vitality and/or alleviation of stigma to community by being associated with contaminated site (e.g. ,difficulty in selling/valuation property).
- Degree of Uncertainty - A qualitative evaluation of the options with particular regard for performance, reliability and comparability of monitoring data and environmental/ social/ economic impacts and/or success criteria.

- Validation and Verification Requirements – A qualitative comparison of the options in terms of the extent and ease of satisfying the verification/validation requirements associated with each option. Of particular relevance for ex situ versus in situ approaches.

Eight indicators were adopted the economic domain. A description of each is outlined below:

- Direct Costs – A semi-quantitative evaluation based on a number of direct costs associated with each option.
- Long-Term Management Costs – A quantitative evaluation based on a 100-year lifespan for cap and contain options and a 2-year lifespan for offsite disposal options (post-remediation monitoring requirements).
- Corporate Reputation – A qualitative evaluation of the options in terms of their potential to have unacceptable financial consequences and/or impact upon corporate reputation.
- Project Lifespan and Flexibility – A qualitative evaluation of the options in terms of the relative length of time over which they remain effective in terms of mitigating the risk, how long before the control measure comes into effect / duration of the remediation works before the site comes into beneficial use.
- Chance of Success – A qualitative evaluation of options in terms of their relative vulnerability to issues that militate against a successful outcome.
- Flexibility to Change in Circumstances – A qualitative evaluation of the options capacity to respond to changing circumstances (e.g. increased volume of contaminated material).
- Resilience to Climate Change – A qualitative evaluation of the options in terms of their resilience to all relevant direct and indirect effects of global warming, especially changes in water regimes, temperature and socio-economic issues (e.g., land use).
- Ongoing Institutional Controls – A qualitative evaluation of the options in terms of how long any institutional controls must remain in place for each option.

The contribution of each indicator to the assessment is SURE evaluation metrics are described in **Table 10-2** below.

Table 10-2: Contribution of Sustainability Indicators to the Tarago Remediation Options Assessment

Domain	Assessment proportion of Domain	Indicator	Weight	Contribution to Assessment
Environment	25%	Greenhouse gases	2	3%
		Soil functionality	2	3%
		Soil erosion	2	3%
		Water uses	2	3%
		Water movement	2	3%
		Flora, fauna and food chains	1	1%
		Impacts/benefits for land reuse	3	4%
		Primary resource & waste	3	4%
Society	51%	Long term risk management	4	6%
		Risk management performance	4	6%
		Human health impacts	3	4%
		Intergenerational equity	4	6%
		Community optics	5	7%
		Nuisance impacts	2	3%
		Delivery of remediation program	4	6%
		Local culture and vitality	4	6%
		Degree of uncertainty	3	4%
		Validation/verification requirements	2	3%
Economy	24%	Direct costs/benefits	2	3%
		Allocation of finances	2	3%
		Corporate reputation	2	3%
		Duration/timing of benefit	2	3%
		Chances of success	2	3%
		Flexibility to change in circumstances	2	3%
		Resilience to climate change	2	3%
		Ongoing institutional controls	2	3%
Total	100%			100%

Scoring of the eight remediation options against each evaluation metric is presented in **Appendix 2**. The outcomes are summarised in **Figure 2** and **Table 10-3** below.

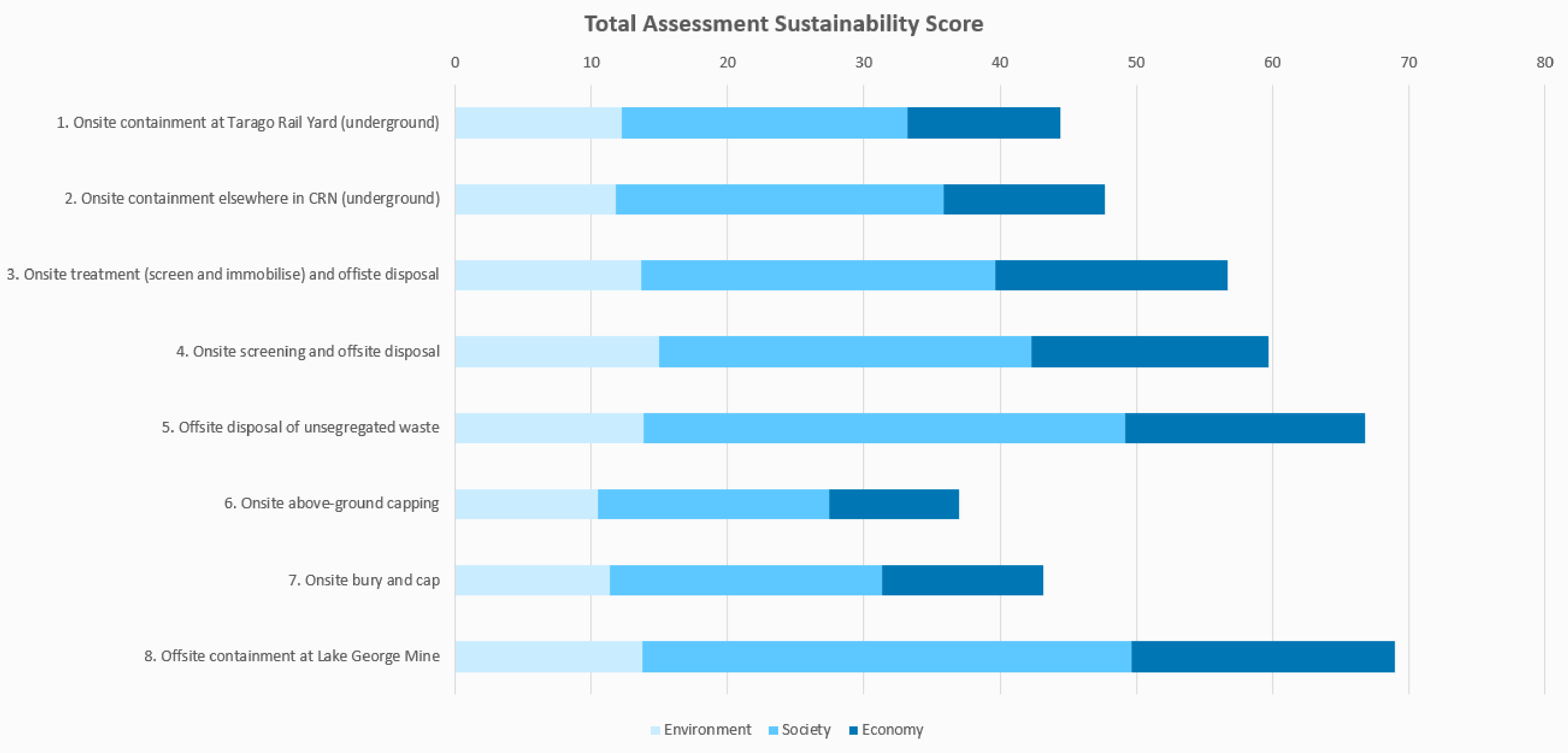

Figure 2: Remediation Options Assessment Scoring Summary

Table 10-3: Remediation Options Assessment Scoring Summary

Options	Environment	Society	Economy	Total Scores
1. Onsite containment at Tarago Rail Yard (underground)	12.2	20.9	11.3	**44**
2. Onsite containment elsewhere in CRN (underground)	11.8	24.1	11.9	**48**
3. Onsite treatment (screen and immobilise) and offsite disposal	13.7	25.9	17.1	**57**
4. Onsite screening and offsite disposal	14.9	27.4	17.4	**60**
5. Offsite disposal of unsegregated waste	13.9	35.3	17.7	**67**
6. Onsite above-ground capping	10.4	17.0	9.6	**37**
7. Onsite bury and cap	11.4	20.0	11.8	**43**
8. Offsite containment at Lake George Mine	13.8	35.9	19.4	**69**

10.6 Remediation Options Assessment Summary

The assessment of remediation options presented above comprised of:

- Preliminary screening based on feasibility and permissibility that was completed with regard for a hierarchy of remediation options presented under **Section 10.2**
- Comparison of the sustainability of permissible and feasible options through detailed assessment against economic, environmental and social indicators specifically relevant to the site.

Both the hierarchy of remediation options and the assessment of economic, environmental and social sustainability are recommended under relevant national guidance (NEPC 2013).

Offsite containment of contaminated soils at the Lake George Mine is identified as the most sustainable option based on the assessment completed.
This option comprises:

- Offsite disposal of timber railway sleepers (approx. 100 m^3) as GSW.
- Excavation of contaminated materials from the Woodlawn Siding and surrounding shallow soils.
- Road transport for placement in the Lake George Mine containment cell.
- Management of remnant contamination in the in the operational rail formation and at depth around the former loadout facility under an LTEMP.

Preliminary estimates for this option indicate costs of approximately $2M. It is noted however that cost estimate sourced during procurement of a remediation contractor (after detailed design is complete) may vary considerably.

11. Conclusions and Recommendations

Remediation of the Contaminant at the site is required due to concentrations of lead above site criteria. A comparative assessment of remediation options was completed against indicators grouped under domains of economic, environmental and social sustainability.

Offsite containment of contaminated soils at the Lake George Mine is identified as the most sustainable option based on the assessment completed. This option comprises:

- Excavation of contaminated materials from the redundant Woodlawn Siding and areas adjacent the rail formation.
- Road transportation of contaminated materials to the Lake George (legacy) Mine which Legacy Mines is preparing for rehabilitation.
- Placement of contaminated materials in a containment cell being constructed as part of mine site rehabilitation works.
- Recontouring of the final landform onsite to address any potential impacts of the proposed excavation on rail operations with specific regard for site hydrology.
- Management of remnant contamination in the in the operational rail formation and at depth around the former loadout facility under an LTEMP.

Following finalisation of the selected remediation option a detailed design package should be prepared to facilitate licencing and approvals, tendering to remediation contractors, refined assessment of cost (through responses from contractors) and completion of remediation.

12. Limitations

This report is produced by Ramboll at the request of the client for the purposes detailed herein. This report and accompanying documents are intended solely for the use and benefit of the client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party and shall not be liable for any loss, damage or expense of whatsoever nature which is caused by their reliance on the information contained in this report.

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Ramboll (2019b) Corridor Environmental Site Assessment

Ramboll (2020a) Tarago Rail Corridor and Tarago Area Detailed Site Investigation

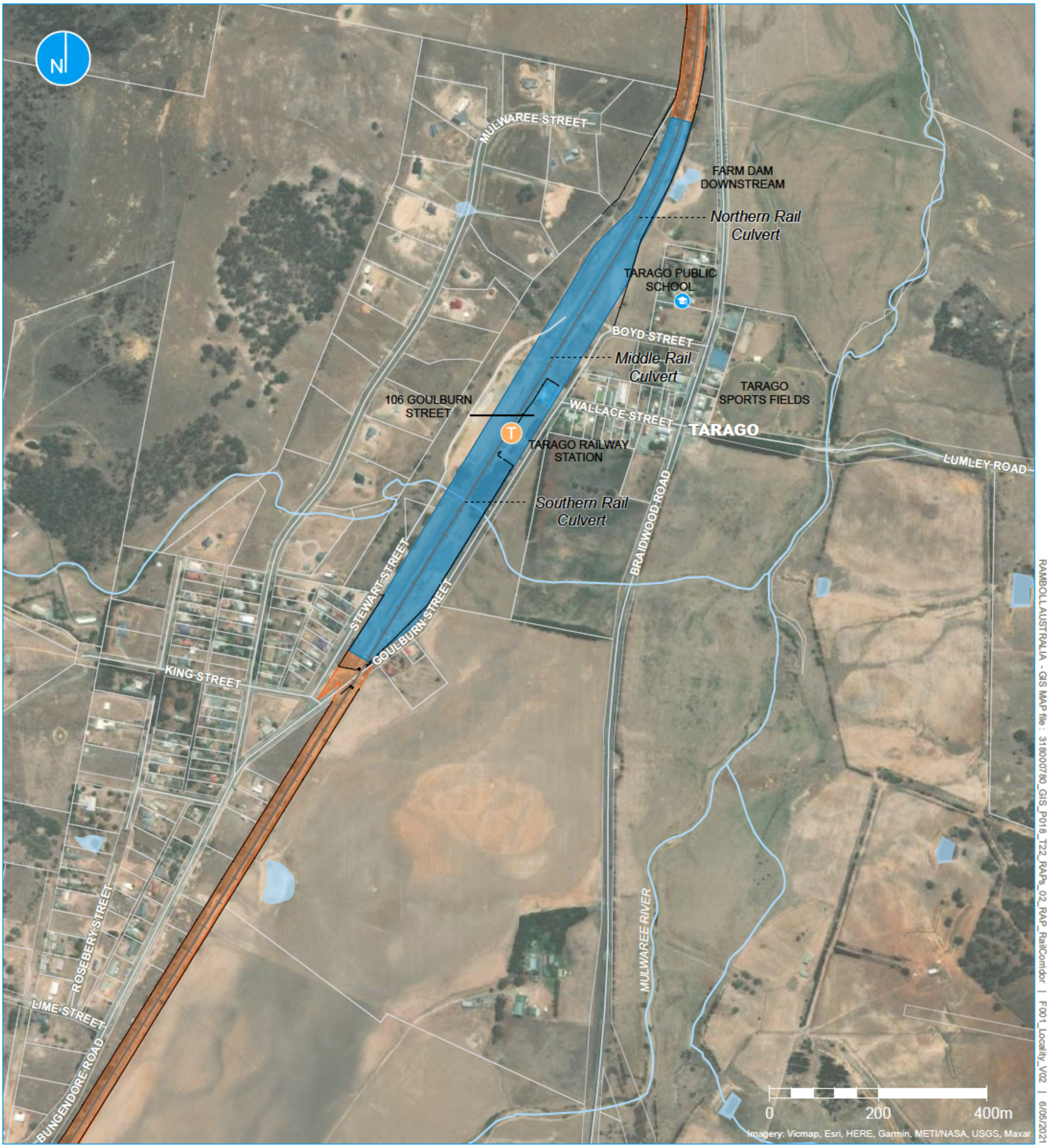
Ramboll (2020b) Tarago Rail Corridor and Tarago Area Detailed Site Investigation Addendum

Ramboll (2020c) Lead Investigation Report 106 Goulburn Street Tarago

Ramboll (2020d - 2022a) Tarago Air Quality Monitoring Reports April 2020 – February 2021

Ramboll (2023b) Tarago Former Station Masters Cottage Detailed Site Investigation

Appendix 1
Figures

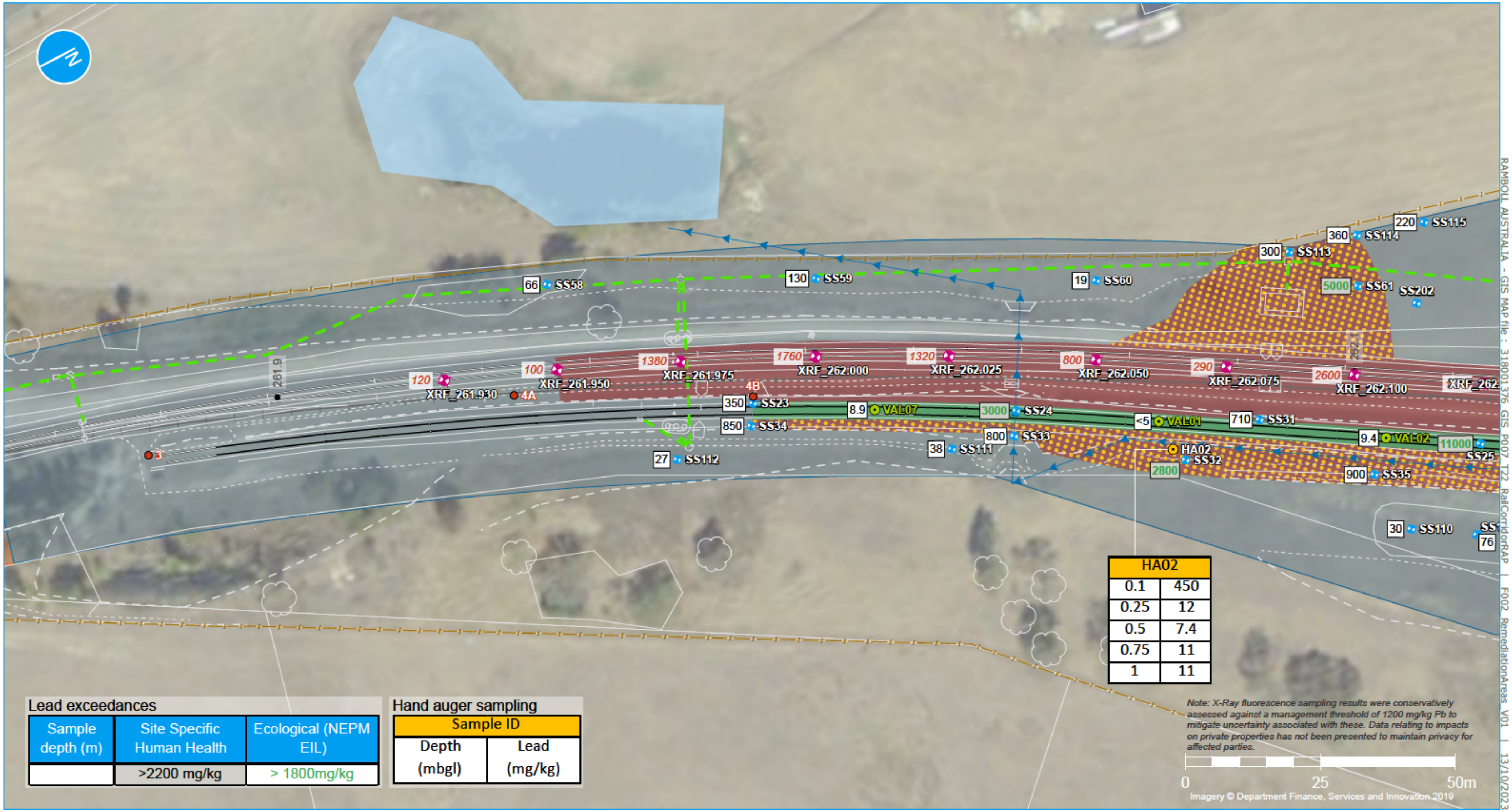


Legend

- Site boundary
- Rail corridor
- Rail corridor fence

A4
1:10,000

Figure 1 | Locality Plan



Legend

Site boundary
0.1km chainage point
Surface water flow (indicative)

Survey lines
Rail track
Top of bank
Bottom of bank
Signal trench
Rail corridor fence
Other elements

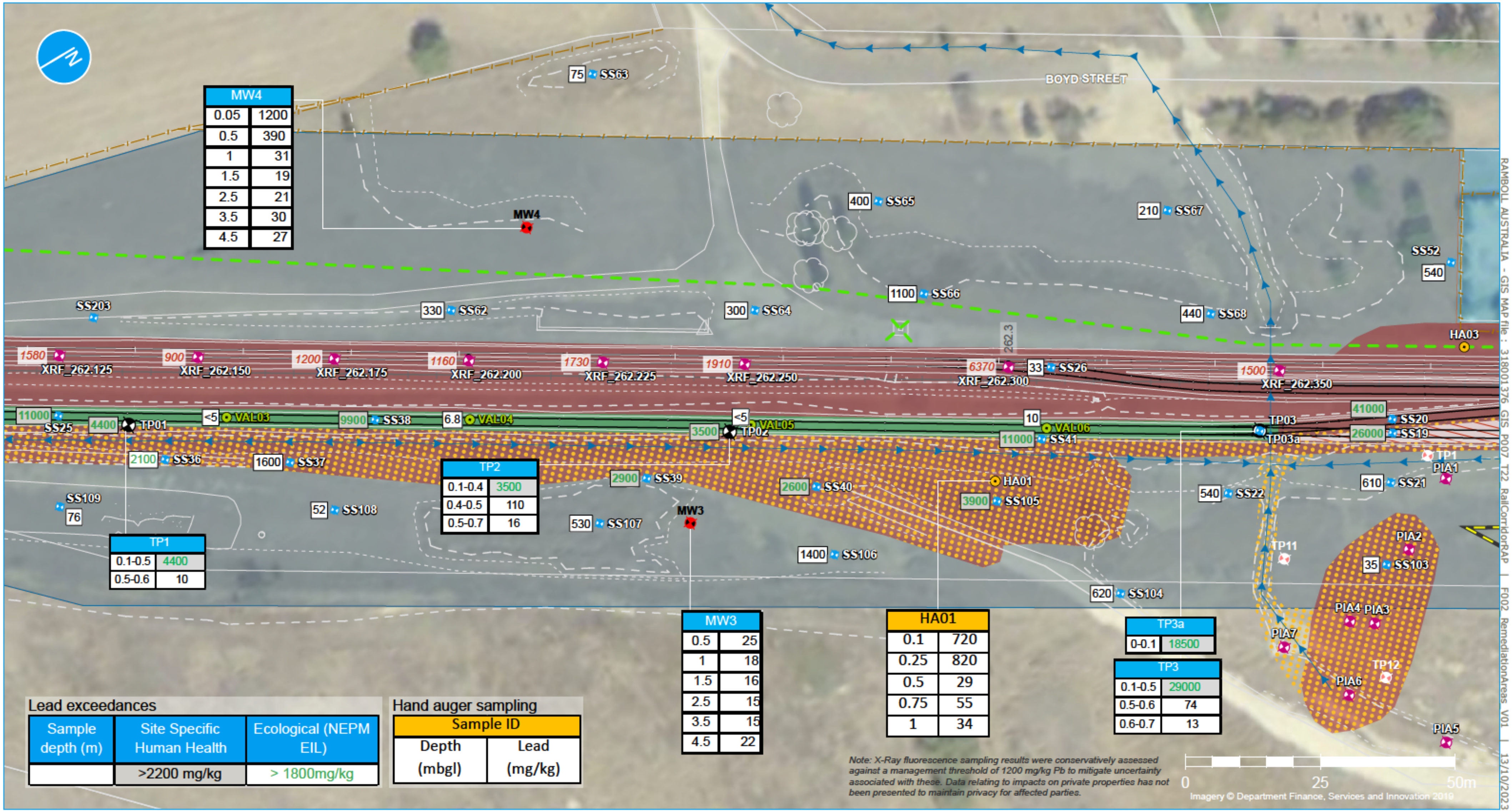
X-Ray fluorescence sampling (Ramboll 2019, 2020)
Previous sampling location (McMahon)
Shallow soil (Ramboll 2019)
Hand auger (Ramboll 2019)
1200 Lead concentration for XRF sample (mg/kg)
Validation sample (Ramboll 2019)

Lead impacted area to remain
Lead impacted area surrounding the siding (excluding all rail formation) - proposed excavation depth 0.3 mbgl
Area of excavation during loop extension (no further excavation proposed)

A4
1:1,000

Location

Figure 2a | Site Plan



MW4	
0.05	1200
0.5	390
1	31
1.5	19
2.5	21
3.5	30
4.5	27

TP1	
0.1-0.5	4400
0.5-0.6	10

TP2	
0.1-0.4	3500
0.4-0.5	110
0.5-0.7	16

MW3	
0.5	25
1	18
1.5	16
2.5	15
3.5	15
4.5	22

HA01	
0.1	720
0.25	820
0.5	29
0.75	55
1	34

TP3a	
0-0.1	18500

TP3	
0.1-0.5	29000
0.5-0.6	74
0.6-0.7	13

Lead exceedances

Sample depth (m)	Site Specific Human Health	Ecological (NEPM EIL)
	>2200 mg/kg	> 1800mg/kg

Hand auger sampling

Sample ID	
Depth (mbgl)	Lead (mg/kg)

Legend

- Site boundary
- 0.1km chainage point
- Surface water flow (indicative)
- Former loadout road (approximate)

Survey lines
- Rail track
- Top of bank
- Bottom of bank
- Signal trench
- Rail corridor fence
- Other elements

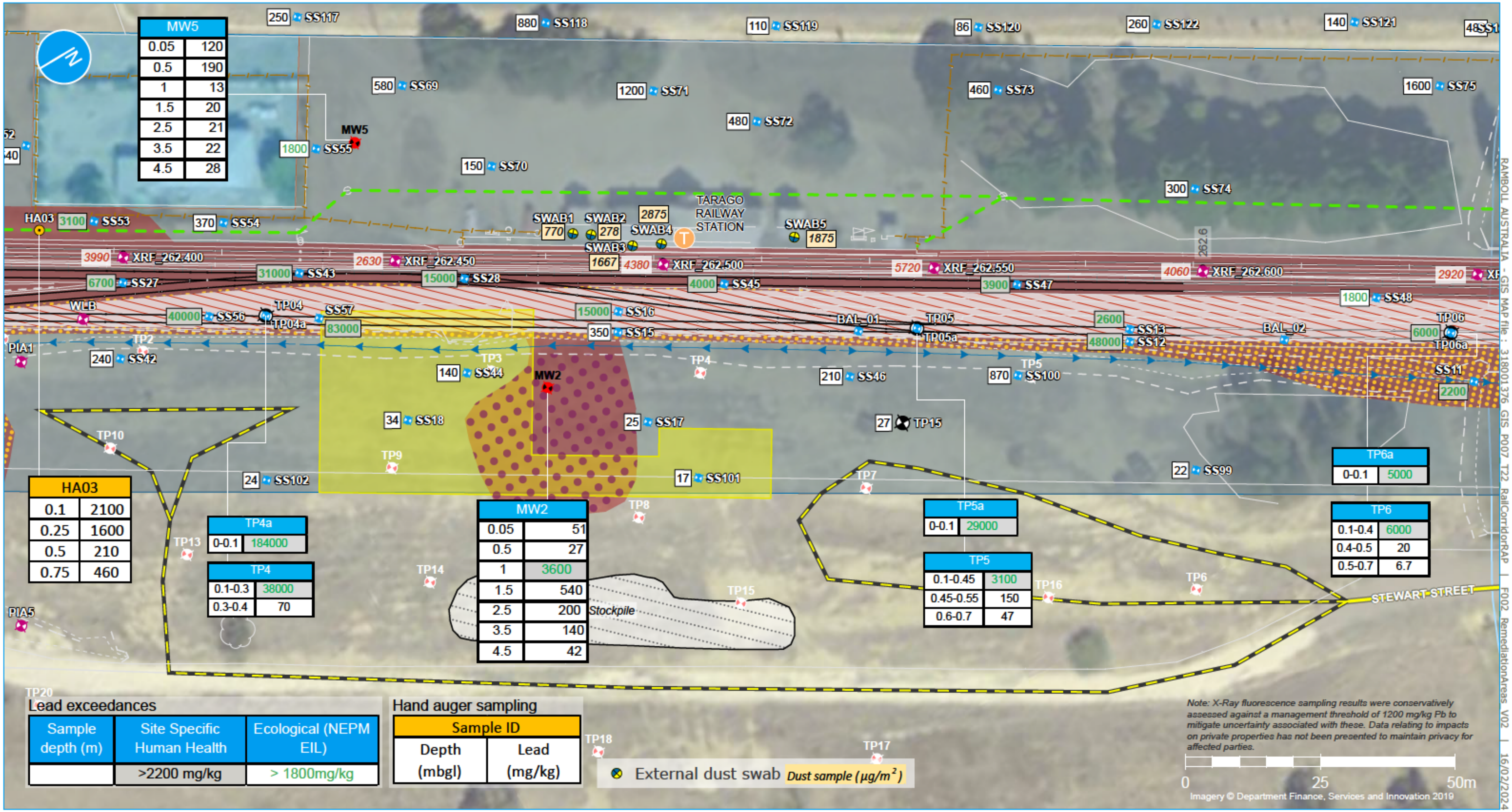
- X-Ray fluorescence sampling (Ramboll 2019, 2020)
- Shallow soil (Ramboll 2019)
- Test pit (Ramboll 2019)
- Hand auger (Ramboll 2019)
- 1200 Lead concentration for XRF sample (mg/kg)
- Validation sample (Ramboll 2019)
- Groundwater monitoring location
- Test pit (loadout complex)

- Lead impacted area to remain
- Redundant Woodlawn siding - propopsed excavation depth 0.5 mbgl
- Lead impacted area surrounding the siding (excluding all rail formation) - proposed excavation depth 0.3 mbgl
- Area of excavation during loop extension (no further excavation proposed)

A4 1:1,000

Location

Figure 2b | Site Plan



Legend

- Site boundary
- 0.1km chainage point
- Surface water flow (indicative)
- Former loadout road (approximate)
- Former loadout complex building footprint
- Lead impacted area to remain at depth beneath existing capping

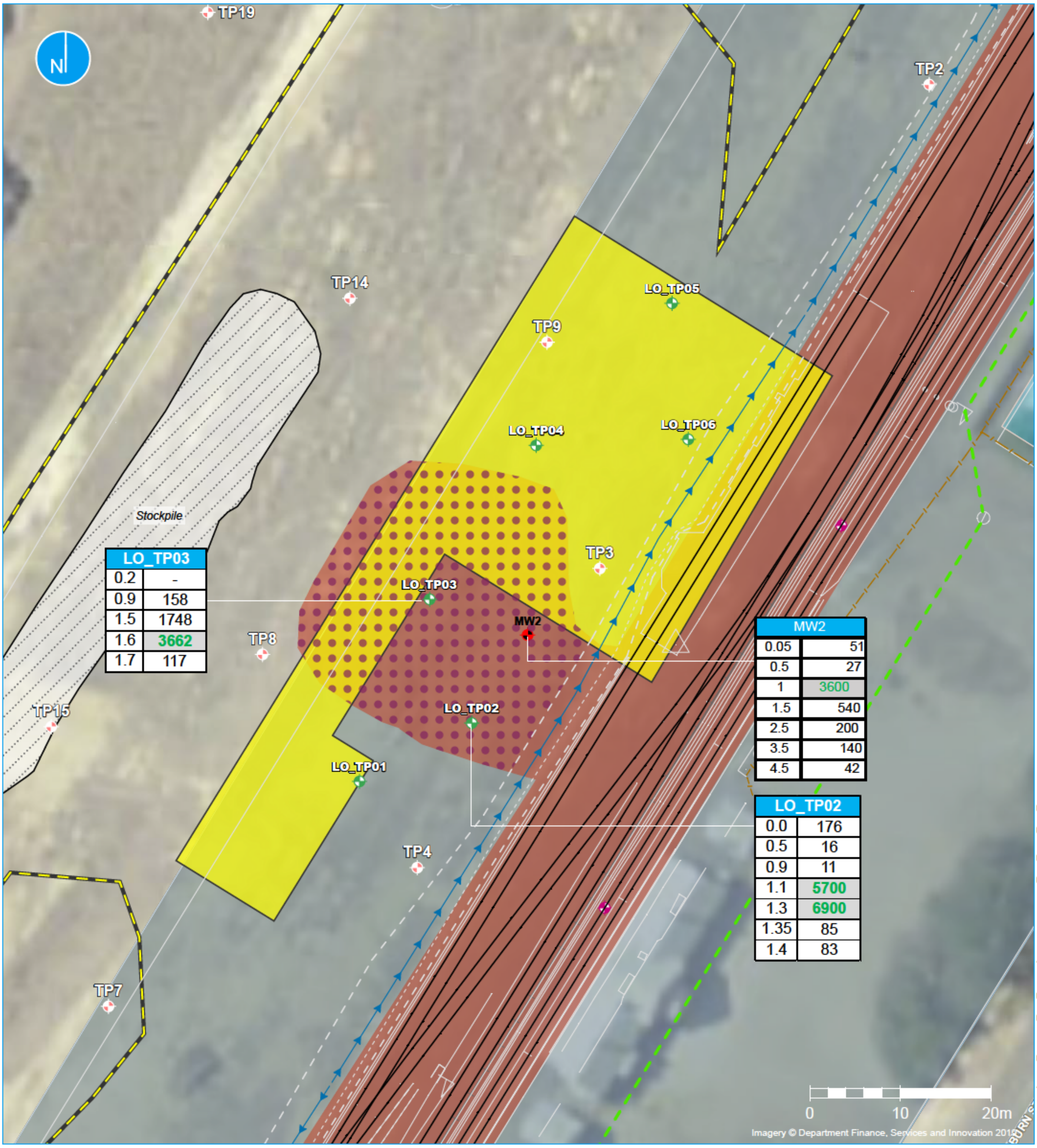
Survey lines
- Rail track
- Top of bank
- Bottom of bank
- Signal trench
- Rail corridor fence
- Other elements

- X-Ray fluorescence sampling (Ramboll 2019, 2020)
- Shallow soil (Ramboll 2019)
- Test pit (Ramboll 2019)
- Hand auger (Ramboll 2019)
- 1200 Lead concentration for XRF sample (mg/kg)
- Groundwater monitoring location
- Test pit (loadout complex)

- Lead impacted area to remain
- Redundant Woodlawn siding - propopsed excavation depth 0.5 mbgl
- Lead impacted area surrounding the siding (excluding all rail formation) - proposed excavation depth 0.3 mbgl
- Haul route

A4
1:1,000

Figure 2c | Site Plan



LO_TP03	
0.2	-
0.9	158
1.5	1748
1.6	3662
1.7	117

MW2	
0.05	51
0.5	27
1	3600
1.5	540
2.5	200
3.5	140
4.5	42

LO_TP02	
0.0	176
0.5	16
0.9	11
1.1	5700
1.3	6900
1.35	85
1.4	83

RAMBOLL AUSTRALIA - GIS MAP file : 318001376_GIS_P007_T22_RailCorridorRAP | F001_TPs_Loadout_V02 | 16/02/2024

A4
1:600

Legend

- Former loadout complex building footprint
- Former loadout road (approximate)
- Site boundary
- Surface water flow (indicative)
- Lead impacted area
- Lead impacted area to remain at depth beneath existing capping
- Loadout complex testpit (March 2020)
- Loadout complex testpit (August 2020)
- Groundwater monitoring location

Survey lines
- Rail track
- Top of bank
- Bottom of bank
- Signal trench
- Rail corridor fence
- Other elements

Lead exceedance criteria

Sample depth (m)	Site Specific Human Health	EIL Commercial/Ind. (NEPM 2013)
	>2200 mg/kg	>1800 mg/kg

Location

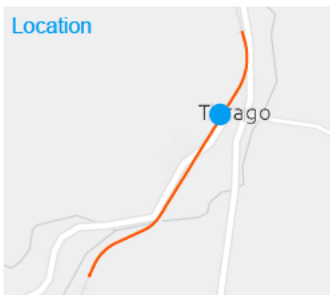
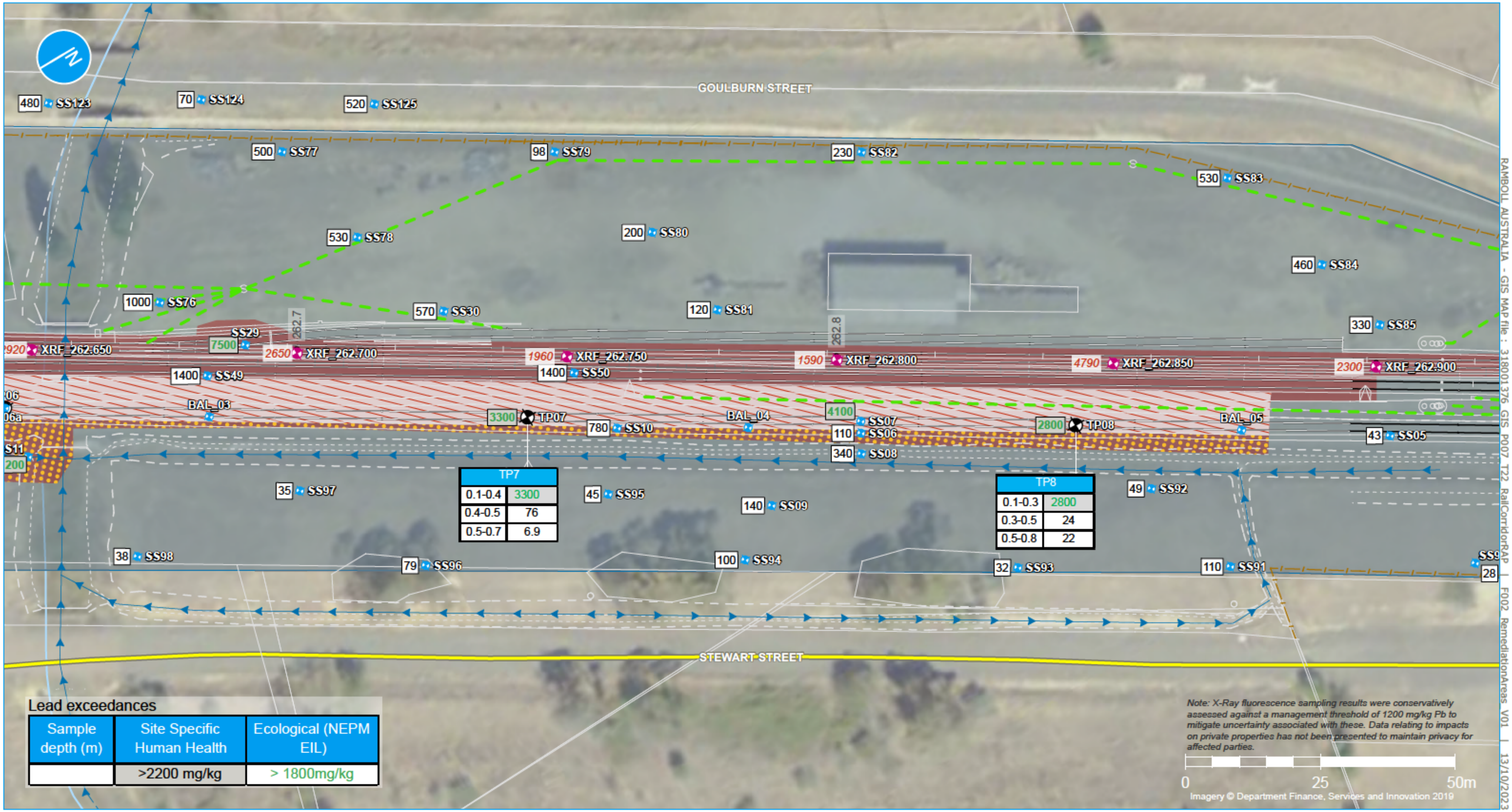


Figure 2ci | Loadout complex sampling locations



Legend

Site boundary
0.1km chainage point
Surface water flow (indicative)

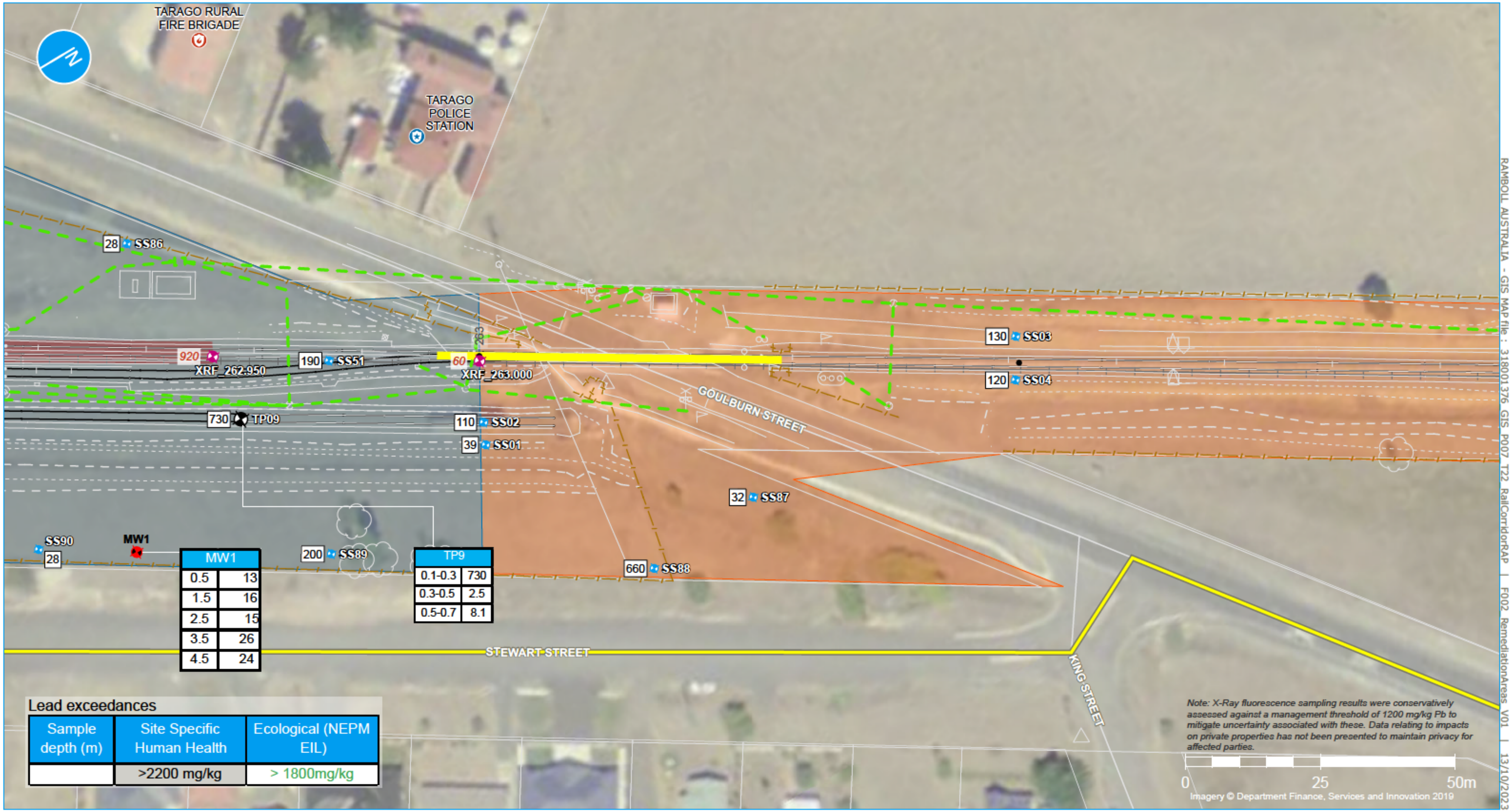
Survey lines
Rail track
Top of bank
Bottom of bank
Signal trench
Rail corridor fence
Other elements

X-Ray fluorescence sampling (Ramboll 2019, 2020)
Shallow soil (Ramboll 2019)
Test pit (Ramboll 2019)
1200 Lead concentration for XRF sample (mg/kg)

Lead impacted area to remain
Redundant Woodlawn siding - propopsed excavation depth 0.5 mbgl
Lead impacted area surrounding the siding (excluding all rail formation) - proposed excavation depth 0.3 mbgl
Haul route

A4
1:1,000

Figure 2d | Site Plan



MW1	
0.5	13
1.5	16
2.5	15
3.5	26
4.5	24

TP9	
0.1-0.3	730
0.3-0.5	2.5
0.5-0.7	8.1

Lead exceedances

Sample depth (m)	Site Specific Human Health	Ecological (NEPM EIL)
	>2200 mg/kg	> 1800mg/kg

RAMBOLL AUSTRALIA - GIS MAP file : 318001376_GIS_P007_T22_RailCorridorRAP | F002_RemediationAreas_V01 | 13/10/2023

Legend

- Site boundary
- 0.1km chainage point
- Goulburn Street level crossing

Survey lines
- Rail track
- Top of bank
- Bottom of bank
- Signal trench
- Rail corridor fence
- Other elements

- X-Ray fluorescence sampling (Ramboll 2019, 2020)
- Shallow soil (Ramboll 2019)
- Test pit (Ramboll 2019)
- 1200 Lead concentration for XRF sample (mg/kg)
- Groundwater monitoring location

- Lead impacted area to remain
- Haul route

A4
1:1,000

Location

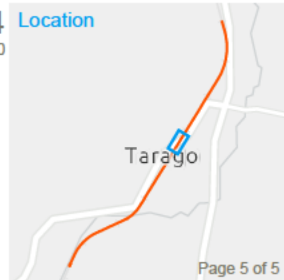
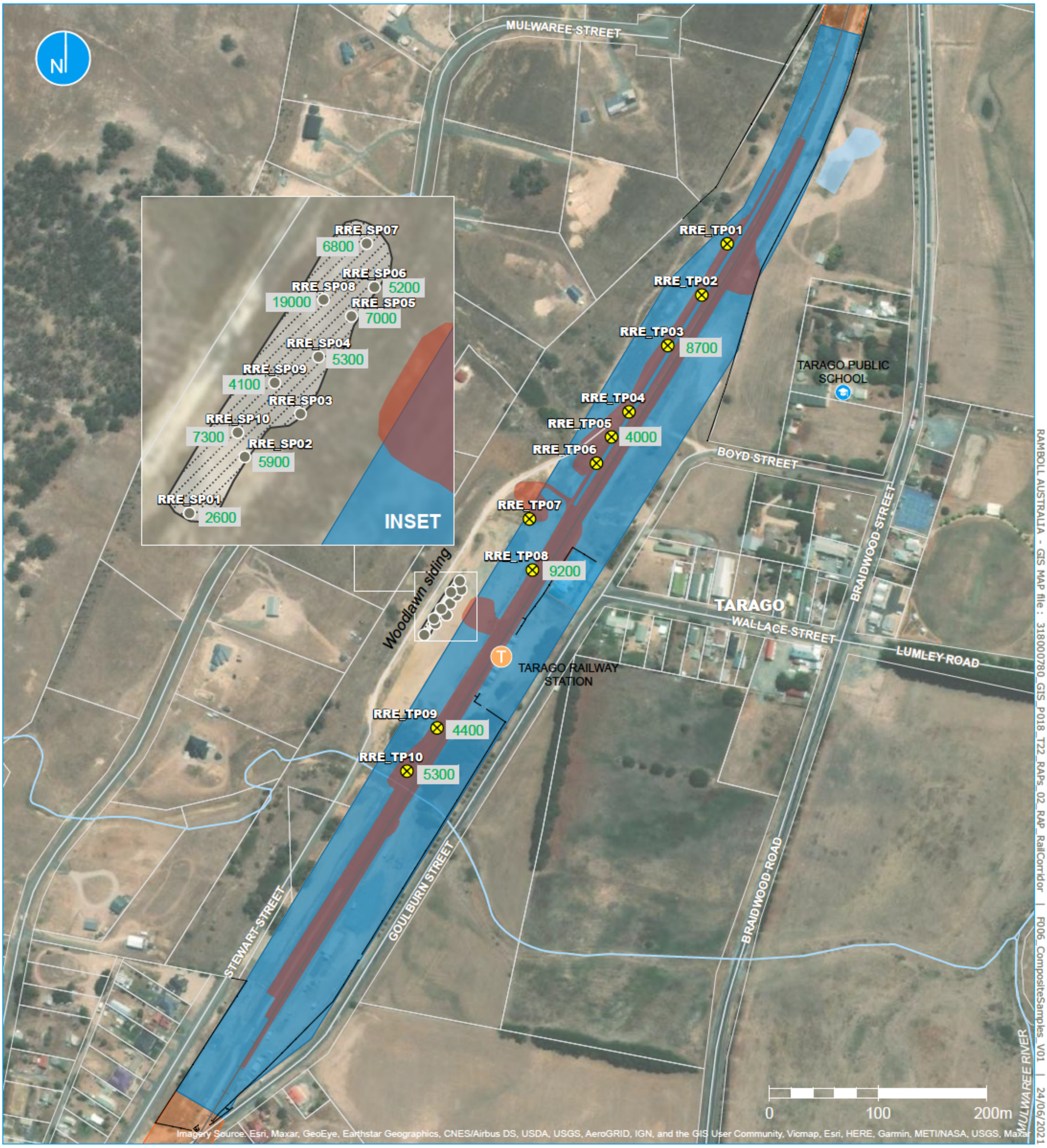


Figure 2e | Site Plan



Legend

A4
1:5,000

- Site boundary
- Rail corridor
- Rail corridor fence
- Lead impacted area
- Stockpile (JHR)

Composite sampling (Ramboll 2020)

- Stockpile sample
- Test pit
- 400 Lead (mg/kg)

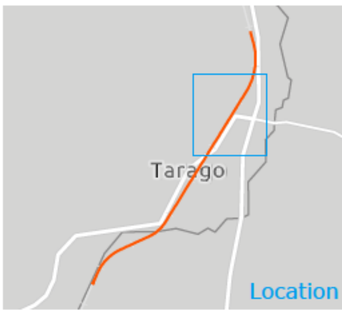


Figure 3 | Soil Sampling for the Resource Recovery Exemption

Legend

- Groundwater monitoring location
- Site boundary
- Rail corridor
- Rail corridor fence
- Lead impacted area

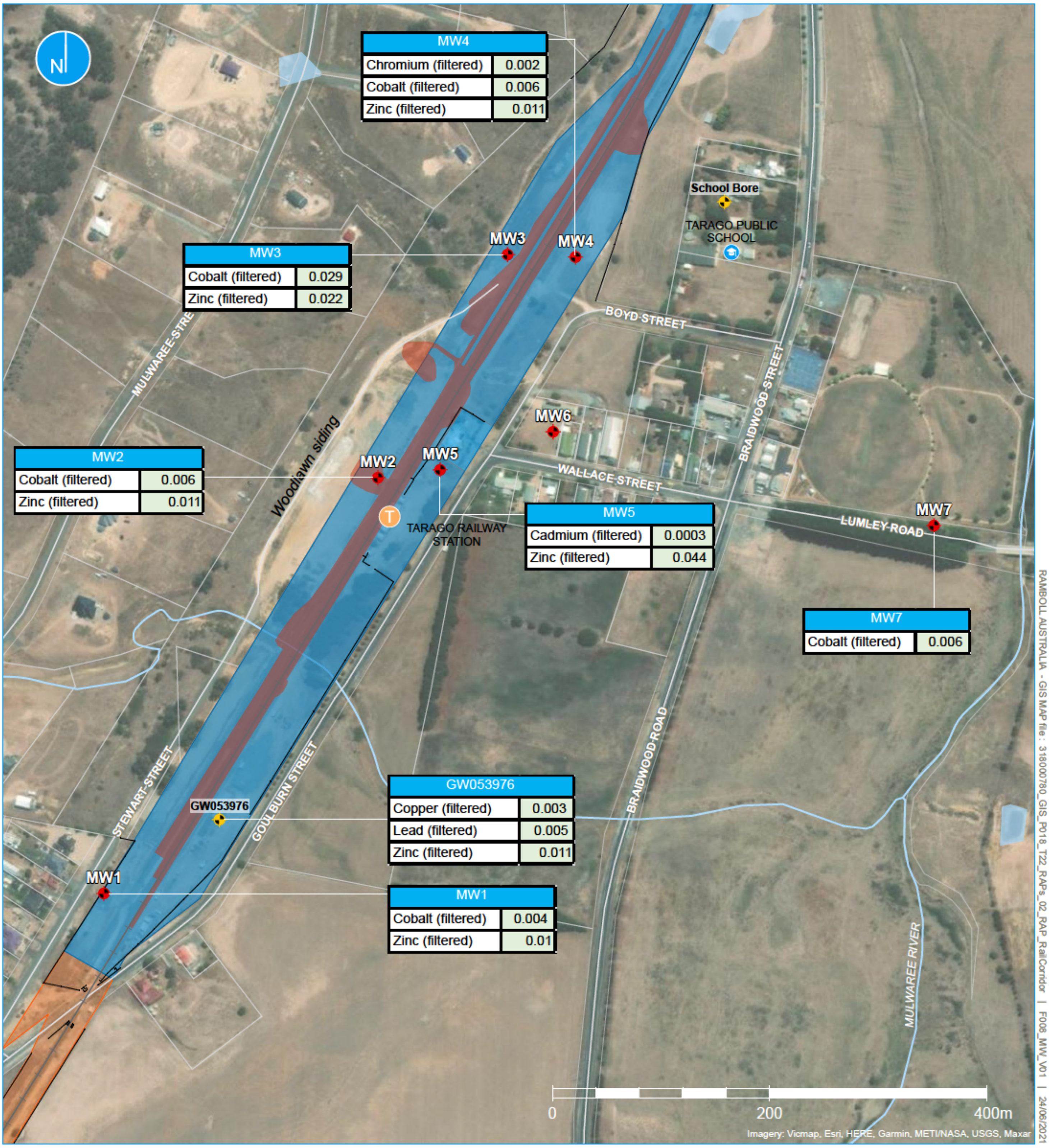
Groundwater contours

- 1m contour
- 0.25m contour
- 0.05m contour

Note: MW1 has been excluded from contouring as groundwater is likely to be influenced by the nearby tributary to the Mulwaree River.

A4
1:5,000

Figure 4 | Groundwater contours



Legend

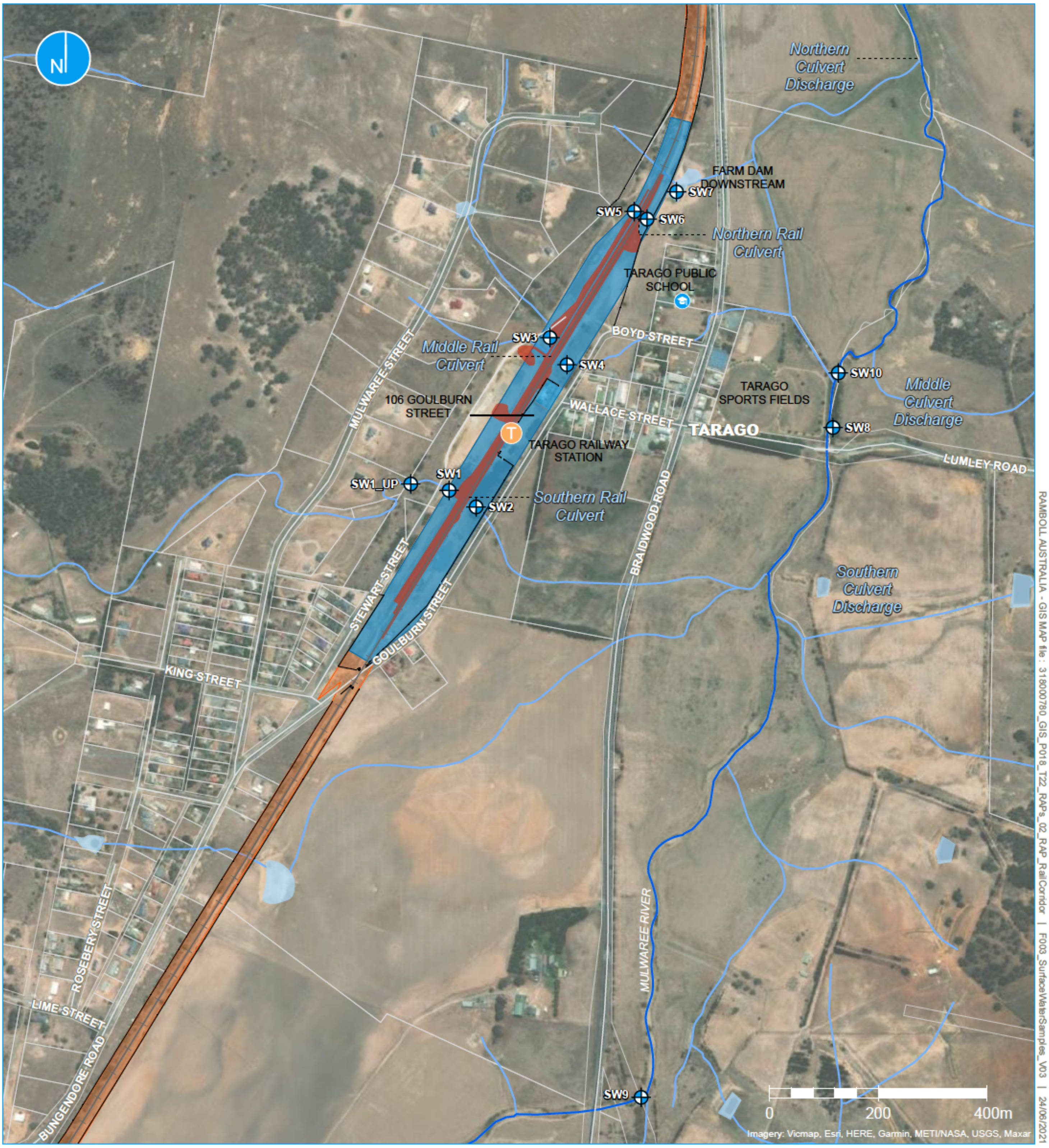
- Groundwater monitoring location
- Groundwater monitoring location (registered, approximate location)
- Site boundary
- Rail corridor
- Rail corridor fence
- Lead impacted area

Exceedances

Contaminant (mg/L)	> ANZG 2018 Freshwater Ecosystems
Cadmium (filtered)	0.0002
Chromium (filtered)	0.001
Cobalt (filtered)	0.0014
Lead (filtered)	0.0034
Zinc (filtered)	0.008

A4
1:5,000

Figure 5 | Groundwater monitoring well locations



Legend

- Surface water sampling location
- Rail corridor
- Rail corridor fence
- Lead impacted area
- Indicative surface water flow path (ie: not ephemeral)
- Indicative ephemeral surface water flow path

A4
1:10,000

Figure 6 | Surface Water Monitoring

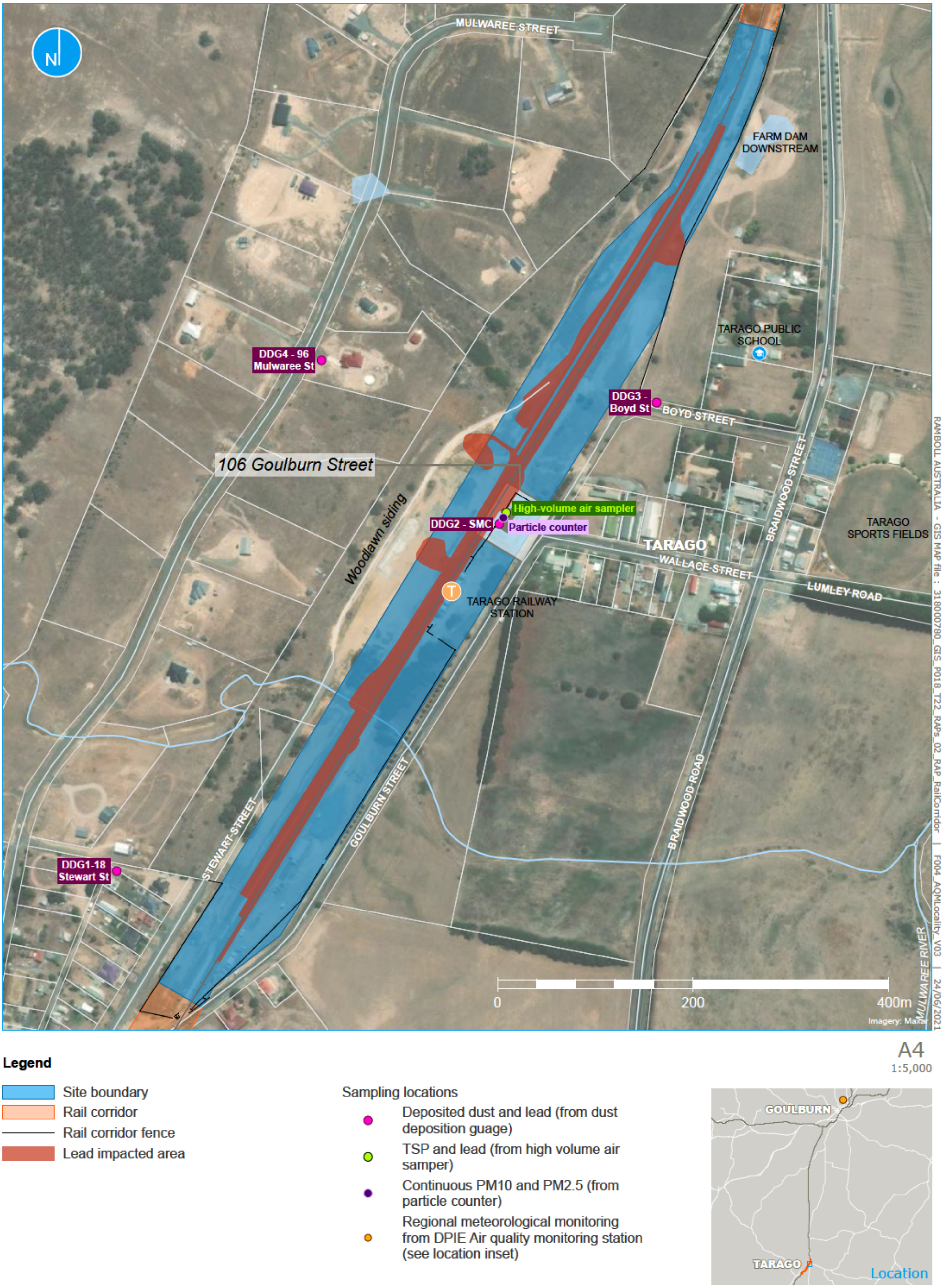


Figure 7 | Air quality monitoring locations

Appendix 2
Remediation Option Scoring

Appendix 2
Table 1: Greenhouse gas emissions

RAMBOLL

Domain	Environment
Indicatory Category	Emissions to air
Indicator	Greenhouse gases
Description:	Consider emissions of greenhouse gases (e.g., carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and certain synthetic chemicals) associated with each remedial option
How to compare:	Compare remedial options in terms of relative energy intensity and/or likely carbon footprint, potential for carbon sequestration and/or production of renewable energy, potential avoidance of current and/or future GHG emissions. Depending on the boundary conditions designated in the project framing, consider also GHG emissions associated with the manufacture and use of materials for each remedial option. Generally, remedial options which result in higher levels of emissions should receive a lower score

Remediation Options	Scope and assumptions for quantitative assessment	Specifications	Total diesel consumption (L)	Carbon dioxide equivalent of total diesel consumption (kg CO2-e) [2]	CO2 emissions relative to highest emissions output (%)	GHG as a % of highest option	SURE score
1. On-site containment at Tarago Rail Yard (underground)	Excavator – 500 hrs Dump Truck – 500 hrs Dozer – 250 hrs Roller – 250 hrs Watercart – 500 hrs Truck and Dogs – 50 hrs	*assume excavator diesel consumption based on specifications for Volvo EC200E 20 t excavator of 15.1 L/hr * assume dump truck diesel consumption 15 L/hr *assume dozer diesel consumption based on specifications for a Caterpilar D7 of 26.5 L/hr *assume roller diesle consumption based on specifications for a CA602D vibratory roller of 22.3 L/hr *assume mobile screen diesel consumtpion based on Sandvik QE341 scalping screen of 15 L/hr *assume pugmill diesel consumption of 40 L/hr *assume front end loader diesel consumption based on specification of a Cat 950H wheel loader of 13 L/hr *assume watercart diesel consumption of 15 L/hr *assume truck and dog fuel consumption of 20 L/hr *emission factor from DISER - NGAF 2021 and converted to kg CO2-e /kL 2	35750	2.7	96525	**57**	**3**
2. Onsite containment elsewhere in CRN	Excavator – 500 hrs Dump Truck – 500 hrs Dozer – 250 hrs Roller – 250 hrs Watercart – 500 hrs Truck and Dogs – 560 hrs (based on 30t loads. 1.8t / m3 and 1 hr drive time each way)		45950	2.7	124065	**73**	**2**
3. Onsite treatment (screen and immobilise) and offsite disposal	Excavator – 850 hrs Dump Truck – 600 hrs Dozer – 300 hrs Roller – 300 hrs Mobile Screen – 150 hrs Front End Loader – 250 hrs Pugmill – 100 hrs Watercart – 600 hrs Truck and Dogs – 50 hrs		59975	2.7	161932.5	**96**	**1**
4. Onsite screening and offsite disposal	Excavator – 300 hrs Dump Truck – 150 hrs Mobile Screen – 150 hrs Front End Loader – 150 hrs Watercart – 300 hrs Truck and Dogs – 1,200 hrs		39480	2.7	106596	**63**	**3**
5. Offsite disposal of unsegregated waste	Excavator – 500 hrs Dump Truck – 500 hrs Dozer – 250 hrs Watercart – 500 hrs Truck and Dogs – 1,680 hrs (based on 30t loads. 1.8t / m3 and 3 hr drive time each way)		62775	2.7	169492.5	**100**	**1**
6. Onsite, above-ground capping	Excavator – 400 hrs Dump Truck – 400 hrs Dozer – 200 hrs Roller – 200 hrs Watercart – 400 hrs Truck and Dogs – 50 hrs		28800	2.7	77760	**46**	**3**
7. Onsite bury and cap	Excavator – 600 hrs Dump Truck – 600 hrs Dozer – 400 hrs Roller – 300 hrs Watercart – 600 hrs Truck and Dogs – 50 hrs		45350	2.7	122445	**72**	**2**
8. Offsite containment at Lake George Mine	Excavator – 500 hrs Dump Truck – 500 hrs Dozer – 250 hrs Watercart – 500 hrs Truck and Dogs – 1,120 hrs (based on 30t loads. 1.8t / m3 and 2 hr drive time each way)		51575	2.7	139252.5	**82**	**1**

[1] Options assessed on amount of diesel consumed only as information about overall project consumption, equipment and plant required and materials to be used is limited.

[2] Emissions factor (kg CO2-e/L) calculated by multiplying energy content factor 38.6GJ/KL for diesel oil and it's emission factor of 69.9 kg CO2-e/GJ divided by 1000 (ML to L). Therefore, emissions factor for CO2 for diesel use = 2.70 kg CO2-e/L

Domain	Environment
Indicatory Category	Soil and ground conditions
Indicator	Soil functionality
Description:	Consider likely alterations in physical, biological, and chemical properties (particularly topsoil) that may affect flora, fauna, and beneficial soil microbia, including potential changes in fertility (biological turnover of nutrients in soil), structure (porosity, retention, and ability to support root growth), pH, nutrient and pH buffering. This indicator is particularly important for areas destined for landscaping, gardens, agriculture/agroforestry, or natural areas.
How to compare:	Compare remedial options in terms of expected positive and negative effects on soil functionality (e.g., thermal treatment would strip organic matter, addition of biochar for bioremediation may promote fertility, etc.). Generally, remedial options which result in higher levels of contaminant reduction and positive effects on soil functionality should receive a higher score.

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	Additional disturbance footprint of the containment cell may be somewhat negated by the requirements to rehabilitate (to an extent) the area above the cap. Therefore, some soil functionality may be restored following cover soil layer and seeding completion above the cap. Imported material would be used to backfill excavation of lead impacted soils. The rehabilitation of the former lead impact area with clean soils and revegetation (where permitted; not within track or operational area) would have a positive impact on soil functionality as contaminants have been removed.	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material. However, this option proposes to disturb additional area within the Tarago Rail Yard for the construction of a containment cell. Therefore, this option has a higher impact of soil functionality due to increased disturbance footprint.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
2. Onsite containment elsewhere in CRN	Additional disturbance footprint of the containment cell may be somewhat negated by the requirements to rehabilitate (to an extent) the area above the cap. Therefore, some soil functionality may be restored following cover soil layer and seeding completion above the cap. Imported material would be used to backfill excavation of lead impacted soils. The rehabilitation of the former lead impact area with clean soils and revegetation (where permitted; not within track or operational area) would have a positive impact on soil functionality as contaminants have been removed.	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material. However, this option proposes to disturb additional area within the CRN for the construction of a containment cell. Therefore, this option has a higher impact of soil functionality due to increased disturbance footprint.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
3. Onsite treatment (screen and immobilise) and offsite disposal	This option does not require additional disturbance for the construction of an on-site containment cell. Therefore, an slight overall reduction to soil functionality impacts. However, when considering the off-site impacts of the off-site disposal location - a licensed waste premises - then it's likely that impacts to soil functionality are similar or worse (assuming that an off-site facility has a larger footprint than an onsite containment cell).	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
4. Onsite screening and offsite disposal	This option does not require additional disturbance for the construction of an on-site containment cell. Therefore, an slight overall reduction to soil functionality impacts. However, when considering the off-site impacts of the off-site disposal location - a licensed waste premises - then it's likely that impacts to soil functionality are similar or worse (assuming that an off-site facility has a larger footprint than an onsite containment cell).	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
5. Offsite disposal of unsegregated waste	This option does not require additional disturbance for the construction of an on-site containment cell. Therefore, an slight overall reduction to soil functionality impacts. However, when considering the off-site impacts of the off-site disposal location - a licensed waste premises - then it's likely that impacts to soil functionality are similar or worse (assuming that an off-site facility has a larger footprint than an onsite containment cell).	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
6. Onsite, above-ground capping	Additional disturbance footprint of the capped mound may be somewhat negated by the requirements to rehabilitate (to an extent) the area above the cap. Therefore, some soil functionality may be restored following cover soil layer and seeding completion above the cap. Imported material would be used to backfill excavation of lead impacted soils. The rehabilitation of the former lead impact area with clean soils and revegetation (where permitted; not within track or operational area) would have a positive impact on soil functionality as contaminants have been removed.	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material. However, this option proposes to disturb additional area for the mounded impacted soil and capping. Therefore, this option has a higher impact of soil functionality due to increased disturbance footprint.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
7. Onsite bury and cap	Additional disturbance footprint of the buried and capped material may be somewhat negated by the requirements to rehabilitate (to an extent) the area above the cap. Therefore, some soil functionality may be restored following cover soil layer and seeding completion above the cap. Imported material would be used to backfill excavation of lead impacted soils. The rehabilitation of the former lead impact area with clean soils and revegetation (where permitted; not within track or operational area) would have a positive impact on soil functionality as contaminants have been removed.	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material. However, this option proposes to disturb additional area for the buried and capped impacted soil. Therefore, this option has a higher impact of soil functionality due to increased disturbance footprint.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
8. Offsite containment at Lake George Mine	Additional disturbance footprint of the containment cell may be somewhat negated by the requirements to rehabilitate (to an extent) the area above the cap. Therefore, some soil functionality may be restored following cover soil layer and seeding completion above the cap. Imported material would be used to backfill excavation of lead impacted soils. The rehabilitation of the former lead impact area with clean soils and revegetation (where permitted; not within track or operational area) would have a positive impact on soil functionality as contaminants have been removed.	All remedial options propose to excavate the same quantity of material therefore options cannot be differentiated by disturbance footprint of excavated the impacted material. However, this option proposes to disturb additional area within the Tarago Rail Yard for the construction of a containment cell. Therefore, this option has a higher impact of soil functionality due to increased disturbance footprint.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**

[1] Certified Professional in Erosion and Sediment Control

Domain	**Environment**
Indicatory Category	Soil and ground conditions
Indicator	Soil erosion
Description:	Consider the potential for changes in soil erosion, particularly those that may affect surrounding drainage networks, surface water/sediment quality, and sediment transport (e.g., debris flow following fire).
How to compare:	Compare remedial options in terms of potential positive and negative effects on soil erosion (e.g., thermal treatment would strip organic matter which can accelerate soil erosion, while an approach involving revegetation may reduce erosion risks). Generally, remedial options which reduce erosion or erosion risks should receive a higher score.

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-s te containment at Tarago Rail Yard	It is assumed that all options requiring on-s te excavat on and earthworks will complete re-vegetation after the remedial work. The targeted revegetation following soil remediation may improve eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. This option proposes additional excavat on for the construction of a containment cell and therefore introduces additional eros on potential. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book.	**3**	3	3	3	3	3	3	3	**3**
2. Onsite containment elsewhere in CRN	It is assumed that all options requiring on-s te excavat on and earthworks will complete re-vegetation after the remedial work. The targeted revegetation following soil remediation may improve eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. This option proposes additional excavat on for the construction of a containment cell and therefore introduces additional eros on potential. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book.	**3**	3	3	3	3	3	3	3	**3**
3. Onsite treatment (screen and immobilise) and offsite disposal	This option has a reduced disturbance footprint (no on-s te containment cell construction) and therefore a slightly lower eros on potential. There will be a reduced disturbance footprint on-site as there will be no on-site containment cell included in this opt on.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book. Although the on-site disturbance footprint is reduced, considerat on should be given to the off-site disposal locat on eros on potential (i.e. off-s te containment or disposal facil ties would also need to manage erosion and sediment risks as part of their operat ons.	**3**	3	3	3	3	3	3	3	**3**
4. Onsite screening and offsite disposal	This option has a reduced disturbance footprint (no on-s te containment cell construction) and therefore a slightly lower eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book. Although the on-site disturbance footprint is reduced, considerat on should be given to the off-site disposal locat on eros on potential (i.e. off-s te containment or disposal facil ties would also need to manage erosion and sediment risks as part of their operat ons.	**3**	3	3	3	3	3	3	3	**3**
5. Offsite disposal of unsegregated waste	This option has a reduced disturbance footprint (no on-s te containment cell construction) and therefore a slightly lower eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book. Although the on-site disturbance footprint is reduced, considerat on should be given to the off-site disposal locat on eros on potential (i.e. off-s te containment or disposal facil ties would also need to manage erosion and sediment risks as part of their operat ons.	**3**	3	3	3	3	3	3	3	**3**
6. Onsite, above-ground capping	It is assumed that all options requiring on-s te excavat on and earthworks will complete re-vegetation after the remedial work. The targeted revegetation following soil remediation may improve eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. This option proposes additional earthworks for the construction of an above-ground capped mound. The above-ground capped mound may also introduce steep gradients to the s te. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book.	**1**	1	1	1	1	1	1	1	**1**
7. Onsite bury and cap	It is assumed that all options requiring on-s te excavat on and earthworks will complete re-vegetation after the remedial work. The targeted revegetation following soil remediation may improve eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. This option proposes additional excavat on to bury impacted soil and therefore introduces additional eros on potential. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book.	**2.6**	3	3	3	2	2.5	2	2.5	**2.6**
8. Offsite containment at Lake George Mine	This option has a reduced disturbance footprint (no on-s te containment cell construction) and therefore a slightly lower eros on potential.	All remedial opt ons propose similar soil excavation methodologies and therefore have similar erosion potentials. Material imported may need to be temporarily stockpiled and therefore increases the erosion potential of the site for the duration of stockpiling. The overall disturbance footprint will be vulnerable to erosion until revegetation reaches 70% cover as per NSW Blue Book. Although the on-site disturbance footprint is reduced, considerat on should be given to the off-site disposal locat on eros on potential (i.e. off-s te containment or disposal facil ties would also need to manage erosion and sediment risks as part of their operat ons.	**2.9**	3	3	2	3	3	3	3	**2.9**

[1] Certified Professional in Erosion and Sediment Control

Domain	Environment
Indicatory Category	Groundwater and surface water
Indicator	Water uses
Description:	Consider short-term and long-term effects on the suitability of water for potable or other uses, including changes in contaminant levels and other water quality factors (e.g., taint, dissolved/suspended solids, redox conditions, pH, nutrients, dissolved metals, etc.).
How to compare:	Compare remedial options in terms of expected levels of contaminant reduction, as well as the anticipated stability of those levels and potential for rebound. Also compare positive and negative effects on water quality within and beyond the project area, as applicable. Generally, remedial options which result in higher levels of contaminant reduction and positive effects on water quality should receive a higher score.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	Encapsulation/containment of contaminated soil will disrupt the migrat on pathway to off-site surface water receptors at downstream locations. Immediate downstream receptors such as agricultural dams/retention basins may have improved water quality from reduced metal concentrat ons and therefore reduced risks to terrestrial and aquat c consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. Risks to public health from contaminated surface water in drainage lines in the township of Tarago will be reduced as a result of the reduced metal concentrations in surface waters draining through the town.	This remedial option will require ongoing management to uphold effectiveness. W thout ongoing management to maintain the containment system, there is a risk of containment failure which may negate the positive impacts of reduced metal in surface water from site. Containment failure may result in contaminant migration to groundwater wh ch is known to be used as potable water.	**2.8**	2.5	3	3	3	3	2	3	**2.8**
2. Onsite containment elsewhere in CRN	Encapsulation/containment of contaminated soil will disrupt the migrat on pathway to off-site surface water receptors at downstream locations. Immediate downstream receptors such as agricultural dams/retention basins may have improved water quality from reduced metal concentrat ons and therefore reduced risks to terrestrial and aquat c consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. Risks to public health from contaminated surface water in drainage lines in the township of Tarago will be reduced as a result of the reduced metal concentrations in surface waters draining through the town.	This remedial option will require ongoing management to uphold effectiveness. W thout ongoing management to maintain the containment system, there is a risk of containment failure which may negate the positive impacts of reduced metal in surface water from site. Containment failure may result in contaminant migration to groundwater wh ch is known to be used as potable water.	**3**	3	3	3	3	3	3	3	**3**
3. Onsite treatment (screen and immobilise) and offs te disposal	Excavation and off-site disposal ill disrupt the migration pathway to off-s te surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. There will be no ongoing management measures at the site to ensure effectiveness of the remedial opt on. Immobilisation of the contaminants will reduce the ongoing management requirements at the disposal location.	Cons derat on should be given to the potential impacts of the receiving s te's / licensed waste facility's ongoing water management to ensure no off-set impacts. Off-s te disposal of the impacted material will still require ongoing management by the waste receiver to ensure contamination does not migrate from the disposal site.	**4**	4	4	4	4	4	4	4	**4**
4. Onsite screening and offsite disposal	Excavation and off-site disposal ill disrupt the migration pathway to off-s te surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. There will be no ongoing management measures at the site to ensure effectiveness of the remedial opt on.	Cons derat on should be given to the potential impacts of the receiving s te's / licensed waste facility's ongoing water management to ensure no off-set impacts. Off-s te disposal of the impacted material will still require ongoing management by the waste receiver to ensure contamination does not migrate from the disposal site.	**4**	4	4	4	4	4	4	4	**4**
5. Offs te disposal of unsegregated waste	Excavation and off-site disposal ill disrupt the migration pathway to off-s te surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. There will be no ongoing management measures at the site to ensure effectiveness of the remedial opt on.	Cons derat on should be given to the potential impacts of the receiving s te's / licensed waste facility's ongoing water management to ensure no off-set impacts. Off-s te disposal of the impacted material will still require ongoing management by the waste receiver to ensure contamination does not migrate from the disposal site.	**4**	4	4	4	4	4	4	4	**4**
6. Onsite, above-ground capping	Capping of contaminated soil will disrupt the migrat on pathway to off-site surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. Risks to public health from contaminated surface water in drainage lines in the township of Tarago will be reduced as a result of the reduced metal concentrations in surface waters draining through the town.	This remedial option will require ongoing management to uphold effectiveness. W thout ongoing management to maintain the capping, there is a risk of failure which may negate the positive impacts of reduced metal in surface water from site. Capping failure may result in contaminant migrat on to groundwater which is known to be used as potable water.	**2.4**	2	2	2	2	3	3	3	**2.4**
7. Onsite bury and cap	Capping of contaminated soil will disrupt the migrat on pathway to off-site surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. Risks to public health from contaminated surface water in drainage lines in the township of Tarago will be reduced as a result of the reduced metal concentrations in surface waters draining through the town.	This remedial option will require ongoing management to uphold effectiveness. W thout ongoing management to maintain the capping, there is a risk of failure which may negate the positive impacts of reduced metal in surface water from site. Capping failure may result in contaminant migrat on to groundwater which is known to be used as potable water. As impacted material is buried and therefore closer to the groundwater, the risk of contaminants reaching groundwater is greater.	**2.3**	2	2	2	3	2	3	2	**2.3**
8. Offs te containment at Lake George Mine	Excavation and off-site disposal ill disrupt the migration pathway to off-s te surface water receptors at downstream locat ons. Immediate downstream receptors such as agr cultural dams/retention basins may have improved water quality from reduced metal concentrations and therefore reduced risks to terrestrial and aquatic consumers/users. Although impacts to the Mulwaree River are nil, the risks of metal contamination of the Mulwaree River will be further reduced. There will be no ongoing management measures at the site to ensure effectiveness of the remedial opt on.	Cons derat on should be given to the potential impacts of the receiving s te's / licensed waste facility's ongoing water management to ensure no off-set impacts. Off-s te disposal of the impacted material will still require ongoing management by the waste receiver to ensure contamination does not migrate from the disposal site.	**3.9**	4	4	3	4	4	4	4	**3.9**

Domain	**Environment**
Indicatory Category	Groundwater and surface water
Indicator	Water movement
Description:	Consider short-term and long-term effects on movement of groundwater and/or surface water (e.g., changes in flow regime, ponding, flooding risks, etc.).
How to compare:	Compare remedial options in terms of potential temporary or permanent alterations in natural or existing water movement processes, noting in particular effects of options involving hydraulic containment and/or pump & treat schemes. Generally, remedial options which are likely to negatively affect water movement should receive a lower score.

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
2. Onsite containment elsewhere in CRN	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
3. Onsite treatment (screen and immobilise) and offsite disposal	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
4. Onsite screening and offsite disposal	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
5. Offsite disposal of unsegregated waste	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
6. Onsite, above-ground capping	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted. The additional surface area and potentially steep gradients may introduce additional site drainage requirements.	**1.7**	1	2	2	2	2	1	2	**1.7**
7. Onsite bury and cap	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.4**	2.5	2.5	2	2.5	2.5	2.5	2.5	**2.4**
8. Offsite containment at Lake George Mine	Existing drainage lines will be reconstructed following excavation and will be an opportunity for drainage and flow optimisation.	Existing drainage lines within the corridor will be excavated and temporarily disrupted.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**

Domain	Environment
Indicatory Category	Ecology
Indicator	Flora, fauna and food chains
Description:	Consider the degree of protection conferred to flora, fauna, and beneficial microbia including the stability and probability of recovery of species particularly as it pertains to protected or sensitive species. Consider also the effect of remediation on biodiversity, unique or rare habitats, sites of special scientific interest (SSSIs), and the introduction/increase of alien or invasive species.
How to compare:	Compare expected effects of each remedial option on species via functional changes in habitat quality (e.g., effects on soil or water), habitat removal (e.g., site clearing), and/or habitat alteration (e.g., introduction or acceleration of the spread of alien species, alteration of stand age structure, etc.). Include any ecological benefits that remedial options may confer. Some options may have both positive and negative effects depending on circumstances (e.g., phytoremediation). Generally, remedial options which result in greater negative effects on flora, fauna, and beneficial microbia should receive a lower score.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	On-site containment will disrupt migration pathways via airborne dust and surface water runoff and therefore reduce contaminants entering the food chain. On-site containment will require additional land disturbance however the additional land will be within the rail corridor which is typically low ecological value. The long-term impacts of having a containment area within the rail corridor will be prohibition of deep-rooted vegetation (large shrubs and trees) in the capped area that may offer habitat in future. However, the likelihood of large shrubs and trees being permitted within the rail corridor (where they do not currently exist) is low.	On-site containment will require ongoing management to maintain effectiveness. The positive impacts (disruption of migration pathways) may be negated but cap breaches and improper cap management. In this circumstance, the area will have undergone some vegetation clearing and prevention of deep-rooted vegetation growth without the positives of preventing contaminant migration into the food chain. This remedial solution won't offer value to flora and fauna with the exception of removing the source contaminants from the food chain.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
2. Onsite containment elsewhere in CRN	On-site containment will disrupt migration pathways via airborne dust and surface water runoff and therefore reduce contaminants entering the food chain. On-site containment will require additional land disturbance however the additional land will be within the rail corridor which is typically low ecological value. The long-term impacts of having a capped area within the rail corridor will be prohibition of deep-rooted vegetation (large shrubs and trees) in the capped area that may offer habitat in future. However, the likelihood of large shrubs and trees being permitted within the rail corridor (where they do not currently exist) is low.	On-site containment will require ongoing management to maintain effectiveness. The positive impacts (disruption of migration pathways) may be negated but cap breaches and improper cap management. In this circumstance, the area will have undergone some vegetation clearing and prevention of deep-rooted vegetation growth without the positives of preventing contaminant migration into the food chain. This remedial solution won't offer value to flora and fauna with the exception of removing the source contaminants from the food chain. However, if the remedial solution fails, the impacted soil may migrate into the environment at the new location of containment elsewhere in the CRN.	**2**	2	2	2	2	2	2	2	**2**
3. Onsite treatment (screen and immobilise) and offsite disposal	Contaminant removal will remove the source of the contamination from site and therefore be protective of the food chain.	There is some land disturbance and land clearing required to achieve this remedial option. Consideration should be given to the disposal location's flora, fauna and food chains. By immobolsing the contaminant there is a reduced risk of the contaminant entering the food chain and causing harm. However, there are still physical impacts to the environment and therefore flora and fauna that come with landfills.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
4. Onsite screening and offsite disposal	Contaminant removal will remove the source of the contamination from site and therefore be protective of the food chain.	There is some land disturbance and land clearing required to achieve this remedial option. Consideration should be given to the disposal location's flora, fauna and food chains and that by transporting the contamination to another location for disposal, there may still be risks to flora and fauna elsewhere.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
5. Offsite disposal of unsegregated waste	Contaminant removal will remove the source of the contamination from site and therefore be protective of the food chain.	There is some land disturbance and land clearing required to achieve this remedial option. Consideration should be given to the disposal location's flora, fauna and food chains and that by transporting the contamination to another location for disposal, there may still be risks to flora and fauna elsewhere.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
6. Onsite, above-ground capping	On-site capping will disrupt migration pathways via airborne dust and surface water runoff and therefore reduce contaminants entering the food chain. On-site capping will require additional land disturbance however the additional land will be within the rail corridor which is typically low ecological value. The long-term impacts of having a capped area within the rail corridor will be prohibition of deep-rooted vegetation (large shrubs and trees) in the capped area that may offer habitat in future. However, the likelihood of large shrubs and trees being permitted within the rail corridor (where they do not currently exist) is low.	On-site capping will require ongoing management to maintain effectiveness. The positive impacts (disruption of migration pathways) may be negated but cap breaches and improper cap management. In this circumstance, the area will have undergone some vegetation clearing and prevention of deep-rooted vegetation growth without the positives of preventing contaminant migration into the food chain. This remedial solution won't offer value to flora and fauna with the exception of removing the source contaminants from the food chain.	**2.6**	2.5	2.5	3	2.5	2.5	2.5	2.5	**2.6**
7. Onsite bury and cap	On-site capping will disrupt migration pathways via airborne dust and surface water runoff and therefore reduce contaminants entering the food chain. On-site capping will require additional land disturbance however the additional land will be within the rail corridor which is typically low ecological value. The long-term impacts of having a capped area within the rail corridor will be prohibition of deep-rooted vegetation (large shrubs and trees) in the capped area that may offer habitat in future. However, the likelihood of large shrubs and trees being permitted within the rail corridor (where they do not currently exist) is low.	On-site capping will require ongoing management to maintain effectiveness. The positive impacts (disruption of migration pathways) may be negated but cap breaches and improper cap management. In this circumstance, the area will have undergone some vegetation clearing and prevention of deep-rooted vegetation growth without the positives of preventing contaminant migration into the food chain. This remedial solution won't offer value to flora and fauna with the exception of removing the source contaminants from the food chain.	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	**2.5**
8. Offsite containment at Lake George Mine	Contaminant removal will remove the source of the contamination from site and therefore be protective of the food chain.	There is some land disturbance and land clearing required to achieve this remedial option. Consideration should be given to the disposal location's flora, fauna and food chains and that by transporting the contamination to another location for disposal, there may still be risks to flora and fauna elsewhere.	**2.6**	3	3	2.5	2.5	2.5	2.5	2.5	**2.6**

Domain	Environment
Indicatory Category	Natural resources and waste
Indicator	Impacts/benefits for land reuse
Description:	Consider the effects of changes in the landscape and its multifunctionality on land re-use, particularly in the case of longer-term projects.
How to compare:	Compare remedial options in terms of their potential to achieve a wider range of land use beyond the specific remediation objectives for the project and/or overall impact on the landscape. Generally, remedial options which result in higher levels of beneficial multifunctionality should receive a higher score.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway of the contaminants results in reduced risk of contamination of the adjacent and downstream properties therefore reducing limitations of nearby land.	An on-site containment cell will introduce limitations to the site for as long as the on-site containment cell exists. Effects on land use will likely include spatial limits on infrastructure construction and/or upgrades, and ongoing regulatory requirements for maintenance, monitoring and management of on-site containment system.	**1.6**	1	1	1	2	2	2	2	**1.6**
2. Onsite containment elsewhere in CRN	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway of the contaminants results in reduced risk of contamination of the adjacent and downstream properties therefore reducing limitations of nearby land.	An on-site containment cell will introduce limitations to the site for as long as the on-site containment cell exists. Effects on land use will likely include spatial limits on infrastructure construction and/or upgrades, and ongoing regulatory requirements for maintenance, monitoring and management of on-site containment system.	**2**	2	2	2	2	2	2	2	**2**
3. Onsite treatment (screen and immobilise) and offsite disposal	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway by removing the source of contamination from the site and therefore no ongoing management measures required to u[hold effectiveness.	Although the future land reuse options for the site will be improved, consideration should be given for the off-site land reuse options, particularly for the site/location receiving and storing the impacted soil waste. Land reuse option at the off-site disposal location will not be improved by this remedial option and therefore this remedial option still negatively impacts land reuse.	**4**	4	4	4	4	4	4	4	**4**
4. Onsite screening and offsite disposal	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway by removing the source of contamination from the site and therefore no ongoing management measures required to uphold effectiveness.	Although the future land reuse options for the site will be improved, consideration should be given for the off-site land reuse options, particularly for the site/location receiving and storing the impacted soil waste. Land reuse option at the off-site disposal location will not be improved by this remedial option and therefore this remedial option still negatively impacts land reuse.	**4**	4	4	4	4	4	4	4	**4**
5. Offsite disposal of unsegregated waste	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway by removing the source of contamination from the site and therefore no ongoing management measures required to uphold effectiveness.	Although the future land reuse options for the site will be improved, consideration should be given for the off-site land reuse options, particularly for the site/location receiving and storing the impacted soil waste. Land reuse option at the off-site disposal location will not be improved by this remedial option and therefore this remedial option still negatively impacts land reuse.	**4**	4	4	4	4	4	4	4	**4**
6. Onsite, above-ground capping	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway of the contaminants results in reduced risk of contamination of the adjacent and downstream properties therefore reducing limitations of nearby land.	On-site capping will introduce limitations to the site for as long as the on-site containment cell exists. Effects on land use will likely include spatial limits on infrastructure construction and/or upgrades, and ongoing regulatory requirements for maintenance, monitoring and management of on-site capping.	**1.9**	2	2	1	2	2	2	2	**1.9**
7. Onsite bury and cap	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway of the contaminants results in reduced risk of contamination of the adjacent and downstream properties therefore reducing limitations of nearby land.	On-site capping will introduce limitations to the site for as long as the on-site containment cell exists. Effects on land use will likely include spatial limits on infrastructure construction and/or upgrades, and ongoing regulatory requirements for maintenance, monitoring and management of on-site capping.	**1.9**	2	2	1	2	2	2	2	**1.9**
8. Offsite containment at Lake George Mine	The future intended land use of the site will remain the same as an operational rail corridor. However this remedial option will reduce contamination such that the site will be suitable for it's intended commercial/industrial land use. This remedial option will also disrupt the migration pathway by removing the source of contamination from the site and therefore no ongoing management measures required to uphold effectiveness.	Although the future land reuse options for the site will be improved, consideration should be given for the off-site land reuse options, particularly for the site/location receiving and storing the impacted soil waste. Land reuse option at the off-site disposal location will not be improved by this remedial option and therefore this remedial option still negatively impacts land reuse.	**4**	4	4	4	4	4	4	4	**4.0**

Domain	Environment
Indicatory Category	Natural resources and waste
Indicator	Primary resources & waste
Description:	Consider the use and substitution of primary material resources within the project or external to it. Consider also the extent of recycling, rates of legacy waste generation (landfilling), use of recycles (and whether they are locally sourced), and opportunities for the use of and/or generation of renewables.
How to compare:	Compare remedial options in terms of relative water demand intensity, requirements for abstraction, and potential for re-use during remediation. Generally, remedial options which are likely to require greater water use and/or result in increased volumes of water requiring subsequent treatment and/or disposal should receive a lower score.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	There is an opportunity to reuse the on-site material won from the excavation of the containment cell. However, reuse of site won material will depend on suitability for reuse depending on proposed reuse.	Construction of on-site containment cell increases the overall footprint of this remedial option. During construction, additional water will be required for dust suppression. There will be a requirement for imported materials for: * general fil * subsoil/topsoil * capping No sorting based on particle size is proposed for this remedial option and therefore ballast cannot be segregated and reused. Overall, this option diverts waste from commercial landfills but doesn't minimise overall waste generated and requiring disposal. The excavated impacted soil in full will require disposal at an on-site containment cell.	**2.2**	1.5	2	2.5	2.5	2.5	2	2.5	**2.2**
2. Onsite containment elsewhere in CRN	There is an opportunity to reuse the on-site material won from the excavation of the containment cell. However, reuse of site won material will depend on suitability for reuse depending on proposed reuse. This option diverts waste from commercial landfills.	Construction of on-site containment cell increases the overall footprint of this remedial option. During construction, additional water will be required for dust suppression. There will be a requirement for imported materials for: * general fil * subsoil/topsoil * capping No sorting based on particle size is proposed for this remedial option and therefore ballast cannot be segregated and reused. Overall, this option diverts waste from commercial landfills but doesn't minimise overall waste generated and requiring disposal. The excavated impacted soil in full will require disposal at an on-site containment cell.	**2**	1.5	2	2.5	2	2	2	2	**2**
3. Onsite treatment (screen and immobilise) and offsite disposal	There is an opportunity to reuse the on-site material won from the excavation of the containment cell. However, reuse of site won material will depend on suitability for reuse depending on proposed reuse. This option has the potential to segregate and reuse ballast which has been shown to be free of contamination once fines are screens and removed. However, there is no confirmation that ballast will be reused and therefore this option has only been assessed based on the potential for this reuse to occur.	Earthworks for the excavation of impacted soil will require some natural resource such as water for dust suppression, and the use of fossil fuels for machines. There will be a requirement for imported materials for: * general fil * subsoil/topsoil This option relies on disposal of impacted soil at a waste facility which is a negative impact in terms of legacy waste generation (landfilling).	**2**	1.5	2	2	2.5	2	2	2	**2**
4. Onsite screening and offsite disposal	There is an opportunity to reuse the on-site material won from the excavation of the containment cell. However, reuse of site won material will depend on suitability for reuse depending on proposed reuse. This option has the potential to segregate and reuse ballast which has been shown to be free of contamination once fines are screens and removed. However, there is no confirmation that ballast will be reused and therefore this option has only been assessed based on the potential for this reuse to occur.	Earthworks for the excavation of impacted soil will require some natural resource such as water for dust suppression, and the use of fossil fuels for machines. There will be a requirement for imported materials for: * general fil * subsoil/topsoil This option relies on disposal of impacted soil at a waste facility which is a negative impact in terms of legacy waste generation (landfilling).	**2.1**	1.5	2	2.5	2.5	2	2	2	**2.1**
5. Offsite disposal of unsegregated waste	There is an opportunity to reuse the on-site material won from the excavation of the containment cell. However, reuse of site won material will depend on suitability for reuse depending on proposed reuse. This option has the potential to segregate and reuse ballast which has been shown to be free of contamination once fines are screens and removed. However, there is no confirmation that ballast will be reused and therefore this option has only been assessed based on the potential for this reuse to occur.	Earthworks for the excavation of impacted soil will require some natural resource such as water for dust suppression, and the use of fossil fuels for machines. There will be a requirement for imported materials for: * general fil * subsoil/topsoil This option relies on disposal of impacted soil at a waste facility which is a negative impact in terms of legacy waste generation (landfilling).	**2.2**	2.5	2	2.5	2.5	2	2	2	**2.2**
6. Onsite, above-ground capping	This option diverts waste from commercial landfills.	Construction of on-site containment cell increases the overall footprint of this remedial option. During construction, additional water will be required for dust suppression. There will be a requirement for imported materials for: * general fil * subsoil/topsoil * capping No sorting based on particle size is proposed for this remedial option and therefore ballast cannot be segregated and reused. Overall, this option diverts waste from commercial landfills but doesn't minimise overall waste generated and requiring disposal. The excavated impacted soil in full will require disposal in the form of an on-site capped landfill.	**2.2**	2	2	2.5	2	2.5	2	2.5	**2.2**
7. Onsite bury and cap	This option diverts waste from commercial landfills.	Construction of on-site containment cell increases the overall footprint of this remedial option. During construction, additional water will be required for dust suppression. There will be a requirement for imported materials for: * general fil * subsoil/topsoil * capping No sorting based on particle size is proposed for this remedial option and therefore ballast cannot be segregated and reused. Overall, this option diverts waste from commercial landfills but doesn't minimise overall waste generated and requiring disposal. The excavated impacted soil in full will require disposal in the form of an on-site capped landfill.	**2.3**	2	2	2.5	2.5	2.5	2	2.5	**2.3**
8. Offsite containment at Lake George Mine	This option diverts waste from commercial landfills.	earthworks for the excavation of impacted soil will require some natural resource such as water for dust suppression, and the use of fossil fuels for machines. There will be a requirement for imported materials for: * general fil * subsoil/topsoil This option relies on disposal of impacted soil at a waste facility which is a negative impact in terms of legacy waste generation (landfilling).	**2.2**	2.5	2	2.5	2.5	2	2	2	**2.2**

Appendix 2

Table 9: Long-term risk management

Domain	Society
Indicatory Category	Human health and safety
Indicator	Long term risk management
Description:	Consider risk management performance of the remedial option (long term) in terms of mitigation of unacceptable human health risks (both chronic and acute), taking into account degree of contaminant reduction, stability of effect & chance of rebound and/or requirement for any other institutional controls.
How to compare:	Compare remedial options in terms of the reduction in risk to human health receptors and the extent of their reliance on additional institutional controls such as restrictions on use. Assess degree of additional health and safety benefits conferred by each remedial option over and above specific project objectives.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	This option proposes to remediate all soils which exceed the adopted human health criteria.	This option proposes to retain the contaminated material on-site in a containment cell. Therefore there is a residual risk to human and ecological receptors if the containment cell is not maintained and managed appropriately.	**2.1**	2	2	2	2.5	2	2.5	2	**2.1**
2. Onsite containment elsewhere in CRN	This option proposes to remediate all soils which exceed the adopted human health criteria.	This option proposes to retain the contaminated material on-site in a containment cell. Therefore there is a residual risk to human and ecological receptors if the containment cell is not maintained and managed appropriately.	**2.1**	2	2	2	2.5	2	2.5	2	**2.1**
3. Onsite treatment (screen and immobilise) and offsite disposal	This option proposes to remediate all soils which exceed the adopted human health criteria. The contaminated soil will be exported from site and disposed of at a waste facility leaving no residual risk for the proposed future land use.	Consideration should be given to risks associated with the contaminated soil at the disposal location. The risks are reduced by the immobolisation of the contaminants before disposal.	**4**	4	4	4	4	4	4	4	**4**
4. Onsite screening and offsite disposal	This option proposes to remediate all soils which exceed the adopted human health criteria. The contaminated soil will be exported from site and disposed of at a waste facility leaving no residual risk for the proposed future land use.	Consideration should be given to risks associated with the contaminated soil at the disposal location. The risks are reduced by the immobolisation of the contaminants before disposal.	**4**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	This option proposes to remediate all soils which exceed the adopted human health criteria. The contaminated soil will be exported from site and disposed of at a waste facility leaving no residual risk for the proposed future land use.	Consideration should be given to risks associated with the contaminated soil at the disposal location. The risks are reduced by the immobolisation of the contaminants before disposal.	**4**	4	4	4	4	4	4	4	**4.0**
6. Onsite, above-ground capping	This option proposes to remediate all soils which exceed the adopted human health criteria.	This option proposes to retain the contaminated material on-site beneath a low permeability cap. Therefore there is a residual risk to human and ecological receptors if the cap is not maintained and managed appropriately.	**1.4**	1.5	1.5	1	1.5	1.5	1	1.5	**1.4**
7. Onsite bury and cap	This option proposes to remediate all soils which exceed the adopted human health criteria.	This option proposes to retain the contaminated material on-site beneath a low permeability cap. Therefore there is a residual risk to human and ecological receptors if the cap is not maintained and managed appropriately.	**1.9**	2	2	1.5	2	2	2	2	**1.9**
8. Offsite containment at Lake George Mine	This option proposes to remediate all soils which exceed the adopted human health criteria. The contaminated soil will be exported from site and disposed of in a customised containment cell leaving no residual risk for the proposed future land use. The containment cell is being constructed for a larger volume of similar waste and inclusion of Tarago waste is unlikely to increase risks.	Consideration should be given to risks associated with the contaminated soil at the disposal location. The risks are reduced by the immobolisation of the contaminants before disposal.	**3.6**	4	4	4	4	3	3	3	**3.6**

Domain	Society
Indicatory Category	Human health and safety
Indicator	Risk management performance
Description:	Consider the risk management performance of remediation activities and ancillary operations (including control of process emissions such as bioaerosols, allergens, PM10, etc.).
How to compare:	Compare remedial options in terms of their capacity to manage identified risks and control hazards arising from ancillary operations, such as fugitive emissions, particulates and aerosols.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	There will be less handling of contaminanted material as the long-term containment cell is located on-site (i.e. no need for loading, unloading for off-site transport).	The footprint of this remedial option is larger than most other options due to the additional area required for the construction of the containment cell. This may increase the risk of dust generation during remedial works. The additional area of earthworks may also increase the risk that sediment laden or contaminated surface water is generated and discharged to off-site receivers. In order to maintain risk reduction at the site, ongoig management and maintenance of the containment cell is required.	**2.1**	2	2	3	2	2	2	2	**2.1**
2. Onsite containment elsewehre in CRN	Depending on the location within the CRN, there will be slightly less handling of contaminanted material as the long-term containment cell is location within the CRN. There may be potential to transport the contaminated material via rail (less impactful than transpot via the road and a reduced risk spatially if confined to corridor) and potential to locate within the CRN where there are minimal nearby sensitive receivers.	The footprint of this remedial option is larger than most other options due to the additional area required for the construction of the containment cell. This may increase the risk of dust generation during remedial works. The additional area of earthworks may also increase the risk that sediment laden or contaminated surface water is generated and discharged to off-site receivers. In order to maintain risk reduction at the site, ongoig management and maintenance of the containment cell is required.	**2.1**	2	2	2.5	2	2	2	2	**2.1**
3. Onsite treatment (screen and immobilise) and offsite disposal	The footprint of the earthworks requird is much less than other remedial options and therefore less risk of generating sediment laden and/or contaminated surface water.	This option has a high potential for generating dust due to the nature of the remedial option. Transport via roads is also required to transport impacted material to the off-site disposal location. If not managed properly, off-site transport using trucks presents some risk of tracking material (contaminanated or not) ontp public roads presenting a sediment issue or potentially spreading contamination beyond the site boundaries.	**1**	1	1	1	1	1	1	1	**1**
4. Onsite screening and offsite disposal	The footprint of the earthworks requird is much less than other remedial options and therefore less risk of generating sediment laden and/or contaminated surface water.	This option has a high potential for generating dust due to the nature of the remedial option. Transport via roads is also required to transport impacted material to the off-site disposal location. If not managed properly, off-site transport using trucks presents some risk of tracking material (contaminanated or not) ontp public roads presenting a sediment issue or potentially spreading contamination beyond the site boundaries. Consideration should also be given for the relocation of the contaminated material to another location where with it potential for furhter contamination if no managed appropriately.	**1**	1	1	1	1	1	1	1	**1.0**
5. Offsite disposal of unsegregated waste	The footprint of the earthworks requird is much less than other remedial options and therefore less risk of generating sediment laden and/or contaminated surface water. This option has the least risk of generating dust due to the reduced earthworks footprint and no requirement to process material on-site.	Transport via roads is required to transport impacted material to the off-site disposal location. If not managed properly, off-site transport using trucks presents some risk of tracking material (contaminanated or not) ontp public roads presenting a sediment issue or potentially spreading contamination beyond the site boundaries. Consideration should also be given for the relocation of the contaminated material to another location where with it potential for furhter contamination if no managed appropriately.	**2.6**	3	2	3	2	2.5	3	2.5	**2.6**
6. Onsite, above-ground capping	There will be less handling of contaminanted material as the long-term capped area is located on-site (i.e. no need for loading, unloading for off-site transport).	The footprint of this remedial option is larger than most other options due to the additional area required for the construction of the above-ground mound and capping. This may increase the risk of dust generation during remedial works. The additional area of earthworks may also increase the risk that sediment laden or contaminated surface water is generated and discharged to off-site receivers. In order to maintain risk reduction at the site, ongoig management and maintenance of the containment cell is required.	**2.2**	2.5	2	2.5	2.5	2	2	2	**2.2**
7. Onsite bury and cap	There will be less handling of contaminanted material as the long-term capped area is located on-site (i.e. no need for loading, unloading for off-site transport).	The footprint of this remedial option is larger than most other options due to the additional area required for the construction of the capped area. This may increase the risk of dust generation during remedial works. The additional area of earthworks may also increase the risk that sediment laden or contaminated surface water is generated and discharged to off-site receivers. In order to maintain risk reduction at the site, ongoig management and maintenance of the containment cell is required.	**1.9**	2	2	1.5	2	2	2	2	**1.9**
8. Offsite containment at Lake George Mine	The footprint of the earthworks requird is much less than other remedial options and therefore less risk of generating sediment laden and/or contaminated surface water. This option has the least risk of generating dust due to the reduced earthworks footprint and no requirement to process material on-site.	Transport via roads is required to transport impacted material to the off-site disposal location. If not managed properly, off-site transport using trucks presents some risk of tracking material (contaminanated or not) ontp public roads presenting a sediment issue or potentially spreading contamination beyond the site boundaries.	**2.6**	3	2	2.5	3	2.5	3	2.5	**2.6**

Domain	**Society**
Indicatory Category	Human health and safety
Indicator	Human health impacts
Description:	Consider general effects on human health and well-being such as provision of positive amenities or adverse health impacts such as fears over release of contamination especially asbestos.
How to compare:	Compare remedial options in terms of their relative ability to improve human health and well-being both from a physical and mental perspective.

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	The remedial option will remediate the site to a condition where human health is protected under limited/restricted conditions (i.e. ongoing management measures required to maintain effectiveness).	The remedial option is unlikely to improve the mental health of the community as it is understood that the community would prefer no residual contamination at the site regardless of whether the contamination is contained within an engineered containment cell.	**2.1**	2	2	2	2.5	2	2	2	**2.1**
2. Onsite containment elsewhere in CRN	The remedial option will remediate the site to a condition where human health is protected under limited/restricted conditions (i.e. ongoing management measures required to maintain effectiveness). The remedial option is likely to improve the mental health of the community adjacent to the site as the remedial option proposes no residual contamination at the site.	Depending on the disposal location and proximity to sensitive receivers, the mental health of the community be negatively impacted due to the stigma associated with a containment cell housing contaminated soil.	**2.7**	2.5	2.5	3	2.5	2.5	3	3	**2.7**
3. Onsite treatment (screen and immobilise) and offsite disposal	The remedial option will remediate the site to a condition where human health is protected for the proposed future land use without long-term restrictions (i.e. no long-term management required). This remedial option is likely to improve the mental health of the community as there will be no residual contamination exceeding criteria for the proposed future land use.	Depending on the disposal location and proximity to sensitive receivers, the mental health of the community be negatively impacted due to the stigma associated with contaminated soil. This stigma is likely to be lower though for disposal at a licensed facility compared to other options.	**2.4**	1.5	2.5	3.5	3	2.5	2.5	1	**2.4**
4. Onsite screening and offsite disposal	The remedial option will remediate the site to a condition where human health is protected for the proposed future land use without long-term restrictions (i.e. no long-term management required). This remedial option is likely to improve the mental health of the community as there will be no residual contamination exceeding criteria for the proposed future land use.	Depending on the disposal location and proximity to sensitive receivers, the mental health of the community be negatively impacted due to the stigma associated with contaminated soil. This stigma is likely to be lower though for disposal at a licensed facility compared to other options.	**2.6**	2.5	2.5	3.5	3	2.5	2.5	2	**2.6**
5. Offsite disposal of unsegregated waste	The remedial option will remediate the site to a condition where human health is protected for the proposed future land use without long-term restrictions (i.e. no long-term management required). This remedial option is likely to improve the mental health of the community as there will be no residual contamination exceeding criteria for the proposed future land use.	Depending on the disposal location and proximity to sensitive receivers, the mental health of the community be negatively impacted due to the stigma associated with contaminated soil. This stigma is likely to be lower though for disposal at a licensed facility compared to other options.	**3.7**	4	4	4	3	3	4	4	**3.7**
6. Onsite, above-ground capping	The remedial option will remediate the site to a condition where human health is protected under limited/restricted conditions (i.e. ongoing management measures required to maintain effectiveness).	The remedial option is unlikely to improve the mental health of the community as it is understood that the community would prefer no residual contamination at the site regardless of whether the contamination is contained within an engineered containment cell.	**1.2**	1	1	1	2	1.5	1	1	**1.2**
7. Onsite bury and cap	The remedial option will remediate the site to a condition where human health is protected under limited/restricted conditions (i.e. ongoing management measures required to maintain effectiveness).	The remedial option is unlikely to improve the mental health of the community as it is understood that the community would prefer no residual contamination at the site regardless of whether the contamination is contained within an engineered containment cell.	**2**	1.5	2	2	2.5	2	2	2	**2.0**
8. Offsite containment at Lake George Mine	The remedial option will remediate the site to a condition where human health is protected for the proposed future land use without long-term restrictions (i.e. no long-term management required). This remedial option is likely to improve the mental health of the community as there will be no residual contamination exceeding criteria for the proposed future land use.	The mental health of the community nearby the disposal location may be negatively impacted by the stigma associated with a containment cell housing contaminated soil. Given a large volume of similarly contaminated soil will also be disposed at this location the potential for mental health impacts is considered to be limited.	**3.9**	4	4	3.5	3.5	4	4	4	**3.9**

Domain	**Society**
Indicatory Category	Ethics & equality
Indicator	Intergenerational equity
Description:	Consider whether there are issues of intergenerational equity (e.g., avoidable transfer of contamination impacts to future generations) when taking into account the duration of remedial options, including implementation and ongoing monitoring/ maintenance.
How to compare:	Compare remedial options in terms of duration and the extent to which contamination is addressed contamination within a relatively short period, or is passed on for future generations to deal with (e.g., landfill, extended pump and treat scheme, PRB).

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Housing contaminants in an engineered containment cell with an expected lifetime will inevitably transfer contaminants to future generations to deal with. There is also long-term maintenance and monitoring associated with this remedial option.	**2.1**	2	2	2.5	2.5	2	2	2	**2.1**
2. Onsite containment elsewhere in CRN	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Housing contaminants in an engineered containment cell with an expected lifetime will inevitably transfer contaminants to future generations to deal with. There is also long-term maintenance and monitoring associated with this remedial option.	**2.2**	2	2	3	2.5	2	2	2	**2.2**
3. Onsite treatment (screen and immobilise) and offsite disposal	The contaminants will be immobilised which may reduce the risks in future management.	Given the material will be disposed of at an off-site waste facility or landfill, it is expected that there will be future management costs associated with the operation and closure of the landfill.	**3.1**	4	3	2.5	3	3	3	3	**3.1**
4. Onsite screening and offsite disposal	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Given the material will be disposed of at an off-site waste facility or landfill, it is expected that there will be future management costs associated with the operation and closure of the landfill.	**2.8**	4	3	2.5	3	2	3	2	**2.8**
5. Offsite disposal of unsegregated waste	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Given the material will be disposed of at an off-site waste facility or landfill, it is expected that there will be future management costs associated with the operation and closure of the landfill.	**2.2**	2	2	2.5	3	2	3	1	**2.2**
6. Onsite, above-ground capping	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Housing contaminants beneath an engineered cap with an expected lifetime will inevitably transfer contaminants to future generations to deal with. There is also long-term maintenance and monitoring associated with this remedial option.	**1.9**	1.5	1.5	2.5	2	2	2	2	**1.9**
7. Onsite bury and cap	There are few positive impacts for this remedial option when compared against the scope of this indicator.	Housing contaminants beneath an engineered cap with an expected lifetime will inevitably transfer contaminants to future generations to deal with. There is also long-term maintenance and monitoring associated with this remedial option.	**2.1**	2	2	2.5	2.5	2	2	2	**2.1**
8. Offsite containment at Lake George Mine	The contaminants will be immobilised which may reduce the risks in future management.	Housing contaminants in an engineered containment cell with an expected lifetime will inevitably transfer contaminants to future generations to deal with. There is also long-term maintenance and monitoring associated with this remedial option.	**3.4**	3	4	4	4	2.5	3	3	**3.4**

Domain	Society
Indicatory Category	Ethics & equality
Indicator	Community optics
Description:	Assess community perception of remedial options.
How to compare:	Based on existing community concerns (as understood by TfNSW) regarding contamination remaining on-site and potential health and socio economic impacts.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	Based on community feedback, it is unlikely that the community will perceive any positive impact from this remedial option.	This remedial option will likely be perceived by the community as an option that leaves residual risk at the site. Based on community feedback, the community will likely not be accepting of contaminated soil remaining on-site.	**1.6**	1.5	2	1.5	2.5	1	1.5	1	**1.6**
2. Onsite containment elsewhere in CRN	Based on community feedback, it is unlikely that the community will perceive any positive impact from this remedial option.	This remedial option will likely be perceived by the community as an option that leaves residual risk at the site. Based on community feedback, the community will likely not be accepting of contaminated soil remaining on-site.	**2.6**	2	2	3	3	2.5	3	3	**2.6**
3. Onsite treatment (screen and immobilise) and offsite disposal	Based on community feedback, it is likely that this option will satisfy the expectations of the community as the contaminated soil will be transported off-site. Therefore, the community will likely perceive that this option is overall safer leaving no residual risk.	The community may perceive the environmental impacts during the remedial works (dust, traffic, noise) as a risk to the community.	**2.3**	2	2	3	2.5	3	2.5	1	**2.3**
4. Onsite screening and offsite disposal	Based on community feedback, it is likely that this option will satisfy the expectations of the community as the contaminated soil will be transported off-site. Therefore, the community will likely perceive that this option is overall safer leaving no residual risk.	The community may perceive the environmental impacts during the remedial works (dust, traffic, noise) as a risk to the community.	**2.6**	2	3	3	2.5	3	2.5	2	**2.6**
5. Offsite disposal of unsegregated waste	Based on community feedback, it is likely that this option will satisfy the expectations of the community as the contaminated soil will be transported off-site. Therefore, the community will likely perceive that this option is overall safer leaving no residual risk.	The community may perceive the environmental impacts during the remedial works (dust, traffic, noise) as a risk to the community.	**3.9**	4	4	4	3	4	4	4	**3.9**
6. Onsite, above-ground capping	Based on community feedback, it is unlikely that the community will perceive any positive impact from this remedial option.	This remedial option will likely be perceived by the community as an option that leaves residual risk at the site. Based on community feedback, the community will likely not be accepting of contaminated soil remaining on-site.	**1**	1	1	1	1	1	1	1	**1.0**
7. Onsite bury and cap	Based on community feedback, it is unlikely that the community will perceive any positive impact from this remedial option.	This remedial option will likely be perceived by the community as an option that leaves residual risk at the site. Based on community feedback, the community will likely not be accepting of contaminated soil remaining on-site.	**1.6**	1.5	2	1.5	2	1	1.5	2	**1.6**
8. Offsite containment at Lake George Mine	Based on community feedback, it is likely that this option will satisfy the expectations of the community as the contaminated soil will be transported off-site. Therefore, the community will likely perceive that this option is overall safer leaving no residual risk.	The Tarago community may perceive the environmental impacts during the remedial works (dust, traffic, noise) as a risk. The Captains Flat community may perceive that receipt of Tarago waste into the containment cell may limit the capacity of the containment cell to receive waste from the surrounding community. The period over which waste can be received at the cell (understood to be 1 -2 years) and limitations on the type of contaminated material (predominantly lead and co-located metals) may present greater limitations on the feasibility of placing community waste in the containment cell however and for these reasons receipt of Tarago waste is considered unlikely to have negative impacts.	**3.6**	3.5	4	3.5	4	3	4	3	**3.6**

Domain	Society
Indicatory Category	Neighbourhood and locality
Indicator	Nuisance impacts
Description:	Consider effects from dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night-time/weekend operations.
How to compare:	Compare remedial options in terms of their impact on the neighbourhood and locality through the various nuisance issues identified.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	On-site management of contaminated material will reduce traffic impacts on the community.	Due to the additional time required on-site to complete this remedial option, there will likely be more of a risk of dust generation and noise impacts on the community.	**1.9**	1.5	2	2.5	2	1.5	2	1.5	**1.9**
2. Onsite containment elsewhere in CRN	On-site management of contaminated material will reduce traffic impacts on the community.	Due to the additional time required on-site to complete this remedial option, there will likely be more of a risk of dust generation and noise impacts on the community.	**2.2**	1.5	2	2.5	2.5	2.5	2	2.5	**2.2**
3. Onsite treatment (screen and immobilise) and offsite disposal	As this is potentially the most impactful option when compared with the other remedial options, there are no positive impacts to describe. However, during remedial works there may be opportunities to reduce impacts on the community (scheduling of works for less sensitive hours of the day, community notifications, engineering controls for dust minimisation during material processing etc.)	Due to the on-site processing of the material followed by off-site disposal, this option is potentially the most impactful option in terms of dust generation, noise and traffic.	**1.4**	1	1	2	2	1.5	1	1	**1.4**
4. Onsite screening and offsite disposal	As this is potentially the most impactful option when compared with the other remedial options, there are no positive impacts to describe. However, during remedial works there may be opportunities to reduce impacts on the community (scheduling of works for less sensitive hours of the day, community notifications, engineering controls for dust minimisation during material processing etc.)	Due to the on-site processing of the material followed by off-site disposal, this option is potentially the most impactful option in terms of dust generation, noise and traffic.	**1.5**	1	1	2	2	1.5	1	2	**1.5**
5. Offsite disposal of unsegregated waste	This option may be slightly less noisy than other remedial options. This option is also likely to require less time to complete.	This option has the potential to impact the community from dust generation during excavation and loading of trucks, as well as traffic and noise impacts from the load-out/off-site transport component.	**2.9**	2.5	3	2.5	3	3	3	3	**2.9**
6. Onsite, above-ground capping	On-site management of contaminated material will reduce traffic impacts on the community.	Due to the additional time required on-site to complete this remedial option, there will likely be more of a risk of dust generation and noise impacts on the community.	**1.7**	2	1.5	2.5	1.5	1.5	2	1	**1.7**
7. Onsite bury and cap	On-site management of contaminated material will reduce traffic impacts on the community.	Due to the additional time required on-site to complete this remedial option, there will likely be more of a risk of dust generation and noise impacts on the community.	**1.6**	1.5	1.5	1.5	2	1.5	2	1	**1.6**
8. Offsite containment at Lake George Mine	This option may be slightly less noisy than other remedial options. This option is also likely to require less time to complete.	This option has the potential to impact the community from dust generation during excavation and loading of trucks, as well as traffic and noise impacts from the load-out/off-site transport component.	**2.8**	2.5	3	2	3	3	3	3	**2.8**

RAMBOLL

Domain	Society
Indicatory Category	Neighbourhood and locality
Indicator	Delivery of the remediation program
Description:	Complexity and duration of remediation program including remediation planning phase, remediation and validation phases
How to compare:	

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	No positive impacts determined.	There is added complexity in the delivery of this remedial option due to the skilled labour and materials required to construct the containment cell.	**2.1**	1.5	2	3	2	2	2	2	**2.1**
2. Onsite containment elsewhere in CRN	No positive impacts determined.	There is added complexity in the delivery of this remedial option due to the skilled labour and materials required to construct the containment cell.	**1.9**	1.5	2	1.5	2	2	2	2	**1.9**
3. Onsite treatment (screen and immobilise) and offsite disposal	This remedial option if comparatively less complex and anticipated to require less time than other remedial options proposing on-site management.	No negative impacts determined.	**1.7**	2	2	2	2	2	1	1	**1.7**
4. Onsite screening and offsite disposal	This remedial option if comparatively less complex and anticipated to require less time than other remedial options proposing on-site management.	No negative impacts determined.	**2.6**	2	3	4	3	2	2	2	**2.6**
5. Offsite disposal of unsegregated waste	This remedial option if comparatively less complex and anticipated to require less time than other remedial options proposing on-site management.	No negative impacts determined.	**4.1**	4	4	5	4	4	4	4	**4.1**
6. Onsite, above-ground capping	No positive impacts determined.	There is added complexity in the delivery of this remedial option due to the skilled labour and materials required to construct the on-site capping.	**2.3**	2	2	3	3	2	2	2	**2.3**
7. Onsite bury and cap	No positive impacts determined.	There is added complexity in the delivery of this remedial option due to the skilled labour and materials required to construct the on-site capping.	**2**	1.5	2	2.5	2	2	2	2	**2.0**
8. Offsite containment at Lake George Mine	This remedial option if comparatively less complex and anticipated to require less time than other remedial options proposing on-site management.	No negative impacts determined.	**4.3**	5	5	4	4	4	4	4	**4.3**

Domain	Society
Indicatory Category	Communities and community involvement
Indicator	Local culture and vitality
Description:	Consider effects of the project on local culture and vitality. This indicator is particularly important for sites used for recreational activities such as parks and urban gardens.
How to compare:	Compare differences between remedial options in terms of contribution to local culture or vitality and/or alleviation of stigma to community by being associated with contaminated site (e.g. ,difficulty in selling/valuation property).

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-s te containment at Tarago Rail Yard	There is a chance that by communicating the remedial option effectively to the commun ty and broader community that the stigma of being associated with contaminated land may be alleviated.	This option is less likely than other remedial options to alleviate the stigma to the commun ty by being associated with contaminated land as the perception may be that the contaminat on remains on-site and therefore there is a risk to adjoining properties.	**2.4**	2.5	2	2	3	2.5	3	2	**2.4**
2. Ons te containment elsewhere in CRN	There is a chance that by communicating the remedial option effectively to the commun ty and broader community that the stigma of being associated with contaminated land may be alleviated.	This option is less likely than other remedial options to alleviate the stigma to the commun ty by being associated with contaminated land, particularly if nearby communities misunderstand the remediation concept and perceive the remedial option as simply relocated the contaminated elsewhere in the corr dor rather than addressing the contamination.	**3.3**	2.5	4	3	3	2.5	4	4	**3.3**
3. Ons te treatment (screen and immobilise) and offs te disposal	There is a higher likelihood that this remedial option will alleviate the stigma of the town/community being located adjacent to contaminated land as this remedial option proposes to remove the contamination from site.	The community nearby the proposed disposal locat on may be stigmatised for being located near a facility which is accepting contaminated soil.	**4**	4	4	4	4	4	4	4	**4.0**
4. Ons te screening and offsite disposal	There is a higher likelihood that this remedial option will alleviate the stigma of the town/community being located adjacent to contaminated land as this remedial option proposes to remove the contamination from site.	The community nearby the proposed disposal locat on may be stigmatised for being located near a facility which is accepting contaminated soil.	**4**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	There is a higher likelihood that this remedial option will alleviate the stigma of the town/community being located adjacent to contaminated land as this remedial option proposes to remove the contamination from site.	The community nearby the proposed disposal locat on may be stigmatised for being located near a facility which is accepting contaminated soil.	**4**	4	4	4	4	4	4	4	**4.0**
6. Ons te, above-ground capping	There is a chance that by communicating the remedial option effectively to the commun ty and broader community that the stigma of being associated with contaminated land may be alleviated.	This option is less likely than other remedial options to alleviate the stigma to the commun ty by being associated with contaminated land as the perception may be that the contaminat on remains on-site and therefore there is a risk to adjoining properties.	**1.1**	1	1	1	1.5	1.5	1	1	**1.1**
7. Ons te bury and cap	There is a chance that by communicating the remedial option effectively to the commun ty and broader community that the stigma of being associated with contaminated land may be alleviated.	This option is less likely than other remedial options to alleviate the stigma to the commun ty by being associated with contaminated land as the perception may be that the contaminat on remains on-site and therefore there is a risk to adjoining properties.	**2.3**	2.5	2.5	2	2.5	2.5	2	2	**2.3**
8. Offsite containment at Lake George Mine	There is a higher likelihood that this remedial option will alleviate the stigma of the town/community being located adjacent to contaminated land as this remedial option proposes to remove the contamination from site.	The community nearby the proposed disposal locat on may be stigmatised for being located near a facility which is accepting contaminated soil from the surrounding reg on. The potential for this is cons dered limited however as the containment cell is primarily being constructed to receive similar waste from its immediate surroundings.	**3.9**	4	4	3.5	4	4	4	4	**3.9**

Domain	Society
Indicatory Category	Uncertainty and evidence
Indicator	Degree of uncertainty
Description:	How options differ in their intrinsic levels of uncertainty: to include considerations of e.g., release of fugitive emissions from excavation and screening, reliability and comparability of monitoring and verification data, depth and period of monitoring data, etc.
How to compare:	Compare options according to degree of uncertainty particularly regarding performance, reliability and comparability of monitoring data and environmental/ social/ economic impacts and/or success criteria.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	There is no dependency on off-site waste facil ty capac ties, pricing or regulation.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. This will impact the timing of this remedial option as the capacity of the containment cell will be unknown until excavation is completed w th validation showing complete contaminant removal. This will then introduce to problem of temporary stockpiling of contaminated material - stockpiling area, temp stockpile controls (namely erosion & sed controls).	**1.9**	1.5	2	2.5	2.5	1.5	1.5	2	**1.9**
2. Onsite containment elsewhere in CRN	There is no dependency on off-site waste facil ty capac ties, pricing or regulation.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. This will impact the timing of this remedial option as the capacity of the containment cell will be unknown until excavation is completed w th validation showing complete contaminant removal. This will then introduce to problem of temporary stockpiling of contaminated material - stockpiling area, temp stockpile controls (namely erosion & sed controls).	**1.9**	1.5	2	1.5	2.5	2	2	2	**1.9**
3. Onsite treatment (screen and immobilise) and offs te disposal	The uncertainties associated with design and construct on of on-site containment or capping systems (i.e. spatial requirements, scheduling of works, sourcing su table materials for containment etc.) are eliminated by disposing of material off-site.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. Therefore, the exact cost of disposal will be unknown until validation confirms complete contaminant removal. Therefore, there will need to be contingencies to allow for extra material in order to avoid budget exceedance. This processing aspects of this remedial option may also be restricted to mild weather conditions (i.e. low speed wind) due to the excessive handling of soil and increased likelihood to generate dust.	**1.9**	1	1	3	3	2	1	2	**1.9**
4. Onsite screening and offsite disposal	The uncertainties associated with design and construct on of on-site containment or capping systems (i.e. spatial requirements, scheduling of works, sourcing su table materials for containment etc.) are eliminated by disposing of material off-site.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. Therefore, the exact cost of disposal will be unknown until validation confirms complete contaminant removal. Therefore, there will need to be contingencies to allow for extra material in order to avoid budget exceedance.	**1.9**	1	1	3	3	2	1	2	**1.9**
5. Offs te disposal of unsegregated waste	The uncertainties associated with design and construct on of on-site containment or capping systems (i.e. spatial requirements, scheduling of works, sourcing su table materials for containment etc.) are eliminated by disposing of material off-site.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. Therefore, the exact cost of disposal will be unknown until validation confirms complete contaminant removal. Therefore, there will need to be contingencies to allow for extra material in order to avoid budget exceedance.	**3.3**	3	3	4	3	3	4	3	**3.3**
6. Onsite, above-ground capping	There is no dependency on off-site waste facil ty capac ties, pricing or regulation.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. This will impact the timing of this remedial option as the capacity of the capped area will be unknown until excavation is completed with validation showing complete contaminant removal. This will then introduce to problem of temporary stockpiling of contaminated material - stockpiling area, temp stockpile controls (namely erosion & sed controls). There will also be uncertainty around the amount of capping required.	**2.1**	2	2	2.5	2	2	2	2	**2.1**
7. Onsite bury and cap	There is no dependency on off-site waste facil ty capac ties, pricing or regulation.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. This will impact the timing of this remedial option as the capacity of the capped area will be unknown until excavation is completed with validation showing complete contaminant removal. This will then introduce to problem of temporary stockpiling of contaminated material - stockpiling area, temp stockpile controls (namely erosion & sed controls). There will also be uncertainty around the amount of capping required.	**1.9**	1.5	2	2	2.5	1.5	1.5	2	**1.9**
8. Offs te containment at Lake George Mine	The uncertainties associated with design and construct on of on-site containment or capping systems (i.e. spatial requirements, scheduling of works, sourcing su table materials for containment etc.) are eliminated by disposing of material off-site.	All remedial opt ons share a common uncertainty of not knowing the exact volume of contaminated material to be excavated. Therefore, there is uncertainty in knowing if the Lake George Mine containment cell will have capacity to accept all of the excavated contaminated soil.	**3.1**	3	3	2.5	3	3	4	3	**3.1**

Domain	Society
Indicatory Category	Uncertainty and evidence
Indicator	Validation/verification requirements
Description:	The verification/validation requirements that would have to be met by the implementation of a particular option.
How to compare:	Compare the extent and ease of satisfying the verification/validation requirements associated with each option. Of particular relevance for ex situ versus in situ approaches.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-s te containment at Tarago Rail Yard	Although there are additional validation/verificat on requirements with this remedial opt on, they are not expected to be complex requirements.	All options will require progressive validation of contaminant excavat on during the remedial works. Additionally, there will be verification/validation requirements associated with demonstrating the effectiveness if the on-site containment cell as-built. As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**2.1**	2	2	2.5	2	2	2	2	**2.1**
2. Ons te containment elsewhere in CRN	Although there are additional validation/verificat on requirements with this remedial opt on, they are not expected to be complex requirements.	All options will require progressive validation of contaminant excavat on during the remedial works. Additionally, there will be verification/validation requirements associated with demonstrating the effectiveness if the on-site containment cell as-built. As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**2.1**	2	2	2.5	2	2	2	2	**2.1**
3. Ons te treatment (screen and immobilise) and offs te disposal	As de from validation testing which is common across all remedial options, there will be no validation or verification requirements for this option.	As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**2.9**	3	2	3.5	3	2.5	3	3	**2.9**
4. Ons te screening and offsite disposal	As de from validation testing which is common across all remedial options, there will be no validation or verification requirements for this option.	As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**3**	3	3	3.5	3	2.5	3	3	**3.0**
5. Offsite disposal of unsegregated waste	As de from validation testing which is common across all remedial options, there will be no validation or verification requirements for this option.	As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**3.1**	3	3	3.5	3	3	3	3	**3.1**
6. Ons te, above-ground capping	Although there are additional validation/verificat on requirements with this remedial opt on, they are not expected to be complex requirements.	All options will require progressive validation of contaminant excavat on during the remedial works. Additionally, there will be verification/validation requirements associated with demonstrating the effectiveness if the on-site capping cell as-built. As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**1.9**	1.5	2	2	2	2	2	2	**1.9**
7. Ons te bury and cap	Although there are additional validation/verificat on requirements with this remedial opt on, they are not expected to be complex requirements.	All options will require progressive validation of contaminant excavat on during the remedial works. Additionally, there will be verification/validation requirements associated with demonstrating the effectiveness if the on-site capping cell as-built. As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**2.1**	2	2	2.5	2	2	2	2	**2.1**
8. Offsite containment at Lake George Mine	As de from validation testing which is common across all remedial options, there will be no validation or verification requirements for this option.	As w th all remedial options, there is some uncertainty around the extent of contamination and excavat on required therefore the validation may take more time.	**3.1**	3	3	3.5	3	3	3	3	**3.1**

Domain	Economic
Indicatory Category	Direct economic costs and benefits
Indicator	Direct costs
Description:	Direct financial costs and benefits of remediation / management for or
How to compare:	Compare relative performance of the various options in terms of direct and capital gains outcomes, against the overall benefit achieved.

Direct Costs — 1. On-site containment at Tarago Rail Yard

	Unit	Budget Rate	Estimated Qty	Estimated Total
Detailed design, planning and approvals	Item	$ 200,000.00	1	$ 200,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment	Item	$ 20,000.00	1	$ 20,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	10	$ 300,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of clay capping	m^3	$ 25.00	1,500	$ 37,500.00
Excavation of contaminated material on the west s de of the rail corridor	m^3	$ 25.00	3,650	$ 141,250.00
Excavation of contaminated material east of the rail lines and transport via publ c roads to the west s de.	m^3	$ 25.00	1,000	$ 25,000.00
Loading, transport and offsite reuse of surplus VENM	m^3	$ 80.00	4140	$ 331,200.00
Construction of containment cell lining	m^2	$ 30.00	12,500	$ 375,000.00
Placement of contaminated materials	m^3	$ 30.00	4,650	$ 139,500.00
Supply and place geofabric maker layer	m^2	$ 4.00	5,000	$ 20,000.00
Placement of geofabr c marker layer	m^2	$ 4.00	5,000	$ 20,000.00
Appl cat on of 0.3 m clay capping	m^3	$ 40.00	1,500	$ 60,000.00
Appl cat on of 0.2 m topsoil	m^3	$ 50.00	1,000	$ 50,000.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	10	$ 150,000.00
Remediat on Supervision and Validat on	Item	$ 132,000.00	1	$ 132,000.00
Demobilisation	Item	$ 20,000.00	1	$ 20,000.00
Verif cation mon toring	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 2,508,950.00	1	$ 2,508,950.00
Total excluding LTEMP implementation	**$**			**2,598,950.00**
Capital Expenditure cost relative to most costly option (%)		42%		
SURE Score for CAPEX		**3**		
LTEM implementation cost relative to most costly option (%)		86%		
SURE Score for LTEM Costs		**1**		

Direct Costs — 2. Onsite containment elsewhere in CRN

	Unit	Budget Rate	Estimated Qty	Estimated Total
Detailed design, planning and approvals	Item	$ 200,000.00	1	$ 200,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment excluding mechan cal screen and pugmill	Item	$ 20,000.00	1	$ 20,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	10	$ 300,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of clay capping	m^3	$ 25.00	1,500	$ 37,500.00
Excavation of contaminated material on the west s de of the rail corridor	m^3	$ 25.00	3,650	$ 141,250.00
Excavation of contaminated material east of the rail lines and transport via publ c roads to the west s de.	m^3	$ 25.00	1,000	$ 25,000.00
Excavation and cartage to alternate location in the CRN	m^3	$ 47.00	4,650	$ 218,550.00
Loading, transport and offsite reuse of surplus VENM	m^3	$ 80.00	4140	$ 331,200.00
Excavation of soils to allow cell construction to achieve a final landform consistent w th existing	m^3	$ 25.00	7,740	$ 193,500.00
Construction of containment cell lining	m^2	$ 30.00	12,500	$ 375,000.00
Placement of contaminated materials	m^3	$ 30.00	4,650	$ 139,500.00
Supply and place geofabric maker layer	m^2	$ 4.00	5,000	$ 20,000.00
Placement of geofabr c marker layer	m^2	$ 4.00	5,000	$ 20,000.00
Appl cat on of 0.3 m clay capping	m^3	$ 40.00	1,500	$ 60,000.00
Appl cat on of 0.2 m topsoil	m^3	$ 50.00	1,000	$ 50,000.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	10	$ 150,000.00
Remediat on Supervision and Validat on	Item	$ 132,000.00	1	$ 132,000.00
Demobilisation	Item	$ 20,000.00	1	$ 20,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
Verif cation mon toring at alternate CRN location	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	2	$ 15,000.00
LTEMP implementat on costs	Item	$ 983,000.00	1	$ 2,928,500.00
Total excluding LTEMP implementation	**$**			**3,458,500.00**
Cost relative to most costly option (%)		56%		
SURE Score for CAPEX		**3**		
LTEM cost relative to most costly option (%)		100%		
SURE Score for LTEM Costs		**1**		

Direct Costs	3. Onsite treatment (screen and immobilise) and offsite disposal.			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 150,000.00	1	$ 150,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment including mechan cal screen and pugmill	Item	$ 30,000.00	1	$ 30,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	12	$ 360,000.00
Excavation of clay capping	m^3	$ 25.00	1,500	$ 37,500.00
Excavation of soils adjacent the rail lines and from 106 Goulburn Street followed by transport and disposal as GSW	m^3	$ 610.00	1,000	$ 610,000.00
Offs te disposal of soils adjacent the rail formation as RSW	m^3	$ 935.00	2,100	$ 1,963,500.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of fouled ballast	m^3	$ 25.00	2,050	$ 101,250.00
Mechan cal screening of fouled ballast	m^3	$ 75.00	2,050	$ 153,750.00
Onsite chemical immobilisation of fines	m3	$ 300.00	950	$ 285,000.00
Loading transport and offsite disposal of immobilised ballast fines as General Solid Waste (in Sydney)	m^2	$ 1,000.00	950	$ 950,000.00
Replacement of clay capping	m^3	$ 25.00	1,500	$ 37,500.00
Appl cat on of 0.1 m topsoil	m^3	$ 50.00	300	$ 15,000.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	12	$ 180,000.00
Remediat on Supervision and Validat on	Item	$ 150,000.00	1	$ 150,000.00
Demobilisation	Item	$ 25,000.00	1	$ 25,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 440,000.00	1	$ 100,000.00
Total excluding LTEMP implementation	**$**			**5,626,000.00**
Cost relative to most costly option (%)		90%		
SURE Score for CAPEX		**1**		
LTEM cost relative to most costly option (%)		3%		
SURE Score for LTEM Costs		**5**		

Direct Costs	4. Onsite screening and offsite disposal			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 150,000.00	1	$ 150,000.00
Preliminaries and Management Plans	Item	$ 10,000.00	1	$ 10,000.00
Mobilisation and site establishment including mechan cal screen	Item	$ 10,000.00	1	$ 10,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 25,000.00	6	$ 150,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of lower impact soils adjacent the rail lines and from 106 Goulburn Street followed by transport and disposal as GSW	m^3	$ 610.00	1,000	$ 610,000.00
Offs te disposal of soils adjacent the rail formation as RSW	m^3	$ 935.00	2,100	$ 1,963,500.00
Excavation of fouled ballast	m^3	$ 25.00	2,050	$ 101,250.00
Mechan cal screening of fouled ballast	m^3	$ 75.00	2,050	$ 153,750.00
Loading transport and offsite disposal of ballast fines as Hazardous Waste (in Sydney)	m^2	$ 1,300.00	950	$ 1,235,000.00
Dust controls through durat on of project	Week	$ 15,000.00	6	$ 90,000.00
Remediat on Supervision and Validat on	Item	$ 110,000.00	1	$ 110,000.00
Demobilisation	Item	$ 10,000.00	1	$ 10,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 440,000.00	1	$ 100,000.00
Total excluding LTEMP implementation	**$**			**5,121,000.00**
Cost relative to most costly option (%)		82%		
SURE Score for CAPEX		**1**		
LTEM cost relative to most costly option (%)		3%		
SURE Score for LTEM Costs		**5**		

Direct Costs	5. Offsite disposal of unsegregated waste			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 50,000.00	1	$ 50,000.00
Preliminaries and Management Plans	Item	$ 10,000.00	1	$ 10,000.00
Mobilisation and site establishment including mechan cal screen	Item	$ 10,000.00	1	$ 10,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 25,000.00	4	$ 100,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of lower impact soils adjacent the rail lines and from 106 Goulburn Street followed by transport and disposal as GSW	m^3	$ 610.00	1000	$ 610,000.00
Offs te disposal of soils adjacent the rail formation as RSW	m^3	$ 935.00	2100	$ 1,963,500.00
Excavation of fouled ballast	m^3	$ 25.00	2050	$ 101,250.00
Loading transport and offsite disposal of unsegregated ballast as Hazardous Waste (in Sydney)	m^2	$ 1,300.00	2050	$ 2,665,000.00
Dust controls through durat on of project	Week	$ 15,000.00	4	$ 60,000.00
Remediat on Supervision and Validat on	Item	$ 110,000.00	1	$ 110,000.00
Demobilisation	Item	$ 10,000.00	1	$ 10,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 440,000.00	1	$ 100,000.00
Total excluding LTEMP implementation	**$**			**6,217,250.00**
Cost relative to most costly option (%)		100%		
SURE Score for CAPEX		**1**		
LTEM cost relative to most costly option (%)		3%		
SURE Score for LTEM Costs		**5**		

Direct Costs	6. Onsite, above-ground capping			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 200,000.00	1	$ 200,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment excluding including mechanical screen and pugmill	Item	$ 20,000.00	1	$ 20,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	8	$ 240,000.00
Excavation of clay capping	m^3	$ 25.00	1,500	$ 37,500.00
Excavation of contaminated material on the west s de of the rail corridor	m^3	$ 25.00	3,650	$ 141,250.00
Excavation of contaminated material east of the rail lines and transport by public road to the west s de.	m^3	$ 25.00	1,000	$ 25,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Placement of excavated materials	m^3	$ 30.00	4,650	$ 139,500.00
Supply and place geofabric maker layer	m^2	$ 4.00	5,000	$ 20,000.00
Import of addit onal clay for capping	m^3	$ 80.00	2,500	$ 200,000.00
Appl cat on of 0.5 m clay capping	m^3	$ 40.00	1,000	$ 40,000.00
Appl cat on of 0.1 m topsoil	m^3	$ 50.00	500	$ 25,000.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	8	$ 120,000.00
Remediat on Supervision and Validat on	Item	$ 125,000.00	1	$ 125,000.00
Demobilisation	Item	$ 20,000.00	1	$ 20,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 983,000.00	1	$ 2,165,750.00
Total excluding LTEMP implementation	**$**			**1,930,750.00**
Cost relative to most costly option (%)		31%		
SURE Score for CAPEX		**4**		
LTEM cost relative to most costly option (%)		74%		
SURE Score for LTEM Costs		**1**		

Direct Costs	7. Onsite, bury and cap			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 200,000.00	1	$ 200,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment excluding including mechanical screen and pugmill	Item	$ 20,000.00	1	$ 20,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	8	$ 240,000.00
Excavation of clay capping	m^3	$ 25.00	1500	$ 37,500.00
Excavation of contaminated material at depth (underlying clay capping)	m^3	$ 25.00	1200	$ 30,000.00
Excavation of clay underlying contamination at depth	m^3	$ 25.00	1162	$ 29,050.00
Excavation of contaminated material on the west s de of the rail corridor	m^3	$ 25.00	3650	$ 141,250.00
Excavation of contaminated material east of the rail lines and transport by public road to the west s de.	m^3	$ 25.00	1000	$ 25,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Placement of excavated materials	m^3	$ 30.00	5812	$ 174,360.00
Supply and place geofabric maker layer	m^2	$ 4.00	5000	$ 20,000.00
Import of addit onal clay for capping	m^3	$ 80.00	2500	$ 200,000.00
Appl cat on of 0.5 m clay capping	m^3	$ 40.00	1000	$ 40,000.00
Appl cat on of 0.1 m topsoil	m^3	$ 50.00	500	$ 25,000.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	8	$ 120,000.00
Remediat on Supervision and Validat on	Item	$ 125,000.00	1	$ 125,000.00
Demobilisation	Item	$ 20,000.00	1	$ 20,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 983,000.00	1	$ 1,934,660.00
Total excluding LTEMP implementation	**$**			**2,024,660.00**
Cost relative to most costly option (%)		33%		
SURE Score for CAPEX		**4**		
LTEM cost relative to most costly option (%)		66%		
SURE Score for LTEM Costs		**2**		

Direct Costs	8. Offsite containment at Lake George Mine			
	Unit	**Budget Rate**	**Estimated Qty**	**Estimated Total**
Detailed design, planning and approvals	Item	$ 200,000.00	1	$ 200,000.00
Preliminaries and Management Plans	Item	$ 30,000.00	1	$ 30,000.00
Mobilisation and site establishment excluding mechan cal screen and pugmill	Item	$ 20,000.00	1	$ 20,000.00
Project Management Inc. remediation contractor PM, site supervis on, labor, accommodation and labor	Week	$ 30,000.00	10	$ 300,000.00
Offs te disposal of railway sleepers as GSW	m^3	$ 800.00	100	$ 80,000.00
Excavation of clay capping	m^3	$ 25.00	1500	$ 37,500.00
Excavation of contaminated material on the west s de of the rail corridor	m^3	$ 25.00	3650	$ 141,250.00
Excavation of contaminated material east of the rail lines and transport via publ c roads to the west s de.	m^3	$ 25.00	1000	$ 25,000.00
Cartage to Lake George Mine	m^3	$ 85.00	4650	$ 395,250.00
Chem cal immobilisat on of contaminated material	m^3	$ 75.00	4,650	$ 348,750.00
Nominal provision for native revegetat on and landscaping	Item	$ 20,000.00	1	$ 20,000.00
Dust controls through durat on of project	Week	$ 15,000.00	10	$ 150,000.00
Remediat on Supervision and Validat on	Item	$ 132,000.00	1	$ 132,000.00
Demobilisation	Item	$ 20,000.00	1	$ 20,000.00
Verif cation mon toring at Tarago	Year	$ 220,000.00	2	$ 440,000.00
LTEMP amendment / preparat on	Item	$ 7,500.00	1	$ 7,500.00
LTEMP implementat on costs	Item	$ 440,000.00	1	$ 100,000.00
Total excluding LTEMP implementation	**$**			**2,347,250.00**
Cost relative to most costly option (%)		38%		
SURE Score for CAPEX		**4**		
LTEM cost relative to most costly option (%)		3%		
SURE Score for LTEM Costs		**5**		

Notes:
Net present value costs for LTEMP implementation have been projected based on 100 year design life

All options include a nominal provision of $50,000 for removal of remnant concrete infrastructure (approx. 20m x 3m x 2m) in the Woodlawn Siding rail line at the former Loadout Complex.

Domain	Economic
Indicatory Category	Indirect economic costs and benefits
Indicator	Allocation of finances
Description:	Internal to the site owner: ability to allocate resources to other interests, impact of costs on debt financing.
How to compare:	Assess options accordingly, giving consideration e.g., to spread of costs over time (i.e., amortization).

1. On-site containment at Tarago Rail Yard

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-2 158 950																																																																																																							
Verification Monitoring		-220000	-220000																																																																																																			
Long Term Maintenance and Monitoring																																																																																																								
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																	
Periodic cap repair											-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000
Recontainment at 100 years																																																																																																							-2 158 950
Initial Capital Expenditure	-2,158,950																																																																																																									
Verification Monitoring Net Present Value (NPV)	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-2,508,950	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-2,188,950
Total costs NPV	-5,107,900																																																																																																											

2. Onsite containment elsewhere in CRN

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-2 578 500																																																																																																										
Verification Monitoring at Tarago		-220000	-220000																																																																																																						
Verification Monitoring elsewhere in the CRN		-220000	-220000																																																																																																					
Long Term Maintenance and Monitoring																																																																																																							
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Periodic cap repair											-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000
Recontainment at 100 years																																																																																																						-2 578 500
Initial Capital Expenditure	-2,578,500																																																																																																										
Verification Monitoring Net Present Value (NPV)	-880,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-2,928,500	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-2,608,500
Total costs NPV	-6,387,000																																																																																																											

3. Onsite treatment (screen and immobilise) and offsite disposal

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-5 186 000																																																																																																										
Verification Monitoring		-220000	-220000																																																																																																					
Long Term Maintenance and Monitoring																																																																																																									
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Initial Capital Expenditure	-5,186,000																																																																																																										
Verification Monitoring Net Present Value (NPV)	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-100,000	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000
Total costs NPV	-5,726,000																																																																																																									

4. Onsite screening and offsite disposal

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	681 000																																																																																																									
Verification Monitoring		-220000	-220000																																																																																																						
Long Term Maintenance and Monitoring																																																																																																									
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Initial Capital Expenditure	4,681,000																																																																																																										
Verification Monitoring Net Present Value (NPV)	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-100,000	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000
Total costs NPV	4,141,000																																																																																																										

5. Offsite disposal of unsegregated waste

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-5 777 250																																																																																																										
Verification Monitoring		-220000	-220000																																																																																																						
Long Term Maintenance and Monitoring																																																																																																									
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Initial Capital Expenditure	-5,777,250																																																																																																										
Verification Monitoring Net Present Value (NPV)	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-100,000	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000
Total costs NPV	-6,317,250																																																																																																										

6. Onsite, above-ground capping

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-1 90 750																																																																																																										
Verification Monitoring		-220000	-220000																																																																																																						
Long Term Maintenance and Monitoring																																																																																																									
Inspection and reporting						-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000					-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																			
Periodic cap repair						-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000					-25000					-25 000
Replacement of cap at 100 years																																																																																																						-25 000
																																																																																																						-1 90 750
Initial Capital Expenditure	-1,490,750																																																																																																										
Verification Monitoring Net Present Value (NPV)	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-2,165,750	-10,000	-10,000	-10,000	-10,000	-40,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-30,000	0	0	0	0	-1,545,750
Total costs NPV	-4,096,500																																																																																																										

7. Onsite, bury and cap

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-1 58 660																																																																																																									
Verification Monitoring		-220000	-220000																																																																																																							
Long Term Maintenance and Monitoring																																																																																																									
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Periodic cap repair											-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000										-25 000
Replacement of cap at 100 years																																																																																																				-1 58 660
Initial Capital Expenditure	-1,584,660																																																																																																										
Verification Monitoring NPV	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-1,934,660	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-30,000	0	0	0	0	0	0	0	0	0	-1,614,660
Total costs NPV	-3,959,320																																																																																																									

8. Offsite containment at Lake George Mine

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Initial Capital Expenditure	-1 907 250																																																																																																										
Verification Monitoring		-220000	-220000																																																																																																						
Long Term Maintenance and Monitoring																																																																																																									
Vegetation maintenance		-10000	-10000	-10000	-10000	-10000																																																																																																		
Inspection and reporting											-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000										-5000
Initial Capital Expenditure	-1,907,250																																																																																																											
Verification Monitoring NPV	-440,000																																																																																																										
Long Term Maintenance and Monitoring NPV	-100,000	-10,000	-10,000	-10,000	-10,000	-10,000	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000	0	0	0	0	0	0	0	0	0	-5,000
Total costs NPV	-2,447,250																																																																																																									

Domain	Economy
Indicatory Category	Indirect economic costs / benefits
Indicator	Corporate reputation
Description:	Financial consequences of impact on corporate reputation / brand value.
How to compare:	Assess options for their potential to have unacceptable financial consequences and/or impact upon corporate reputation.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	On-site management of contaminated material instead of off-site disposal may be perceived by the broader community as being more sustainable and therefore may improve corporate reputation.	There is an increased financial and/or reputational risk with remedial options that retain contaminated material on-site due to the small potential that the on-site containment will fail and may result in reputational damage and financial consequence.	**2.4**	2	2	2.5	3	2	3	2	**2.4**
2. Onsite containment elsewhere in CRN	On-site management of contaminated material instead of off-site disposal may be perceived by the broader community as being more sustainable and therefore may improve corporate reputation.	There is an increased financial and/or reputational risk with remedial options that retain contaminated material on-site due to the small potential that the on-site containment will fail and may result in reputational damage and financial consequence.	**2.7**	2	2	3	3	3	3	3	**2.7**
3. Onsite treatment (screen and immobilise) and offsite disposal	As contaminated material is proposed to be taken to an off-site waste facility, the risk of reputational damage posed by the dissatisfaction of the neighbouring communities is greatly reduced. Additionally, the risk of regulatory action for pollution due to failed on-site management is reduced by removing the contamination source (contaminated soil) therefore remedial options that propose off-site disposal to a licensed waste facility are inherently less likely to encounter reputational and financial consequence.	Off-site disposal may be perceived by the broader community as contributing to landfill rates and therefore unsustainable which may negatively impact corporate reputation.	**4.0**	4	4	4	4	4	4	4	**4.0**
4. Onsite screening and offsite disposal	As contaminated material is proposed to be taken to an off-site waste facility, the risk of reputational damage posed by the dissatisfaction of the neighbouring communities is greatly reduced. Additionally, the risk of regulatory action for pollution due to failed on-site management is reduced by removing the contamination source (contaminated soil) therefore remedial options that propose off-site disposal to a licensed waste facility are inherently less likely to encounter reputational and financial consequence.	Off-site disposal may be perceived by the broader community as contributing to landfill rates and therefore unsustainable which may negatively impact corporate reputation.	**4.0**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	As contaminated material is proposed to be taken to an off-site waste facility, the risk of reputational damage posed by the dissatisfaction of the neighbouring communities is greatly reduced. Additionally, the risk of regulatory action for pollution due to failed on-site management is reduced by removing the contamination source (contaminated soil) therefore remedial options that propose off-site disposal to a licensed waste facility are inherently less likely to encounter reputational and financial consequence.	Off-site disposal may be perceived by the broader community as contributing to landfill rates and therefore unsustainable which may negatively impact corporate reputation.	**3.9**	4	4	4	3.5	3.5	4	4	**3.9**
6. Onsite, above-ground capping	On-site management of contaminated material instead of off-site disposal may be perceived by the broader community as being more sustainable and therefore may improve corporate reputation.	There is an increased financial and/or reputational risk with remedial options that retain contaminated material on-site due to the small potential that the on-site containment will fail and may result in reputational damage and financial consequence.	**1.9**	1.5	2	2	2	2	2	2	**1.9**
7. Onsite bury and cap	On-site management of contaminated material instead of off-site disposal may be perceived by the broader community as being more sustainable and therefore may improve corporate reputation.	There is an increased financial and/or reputational risk with remedial options that retain contaminated material on-site due to the small potential that the on-site containment will fail and may result in reputational damage and financial consequence.	**2.3**	2	2	2.5	2.5	2	3	2	**2.3**
8. Offsite containment at Lake George Mine	As contaminated material is proposed to be taken to an off-site waste facility, the risk of reputational damage posed by the dissatisfaction of the neighbouring communities is greatly reduced. Additionally, the risk of regulatory action for pollution due to failed on-site management is reduced by removing the contamination source (contaminated soil) therefore remedial options that propose off-site disposal to a licensed waste facility are inherently less likely to encounter reputational and financial consequence.	Off-site disposal may be perceived by the broader community as contributing to landfill rates and therefore unsustainable which may negatively impact corporate reputation.	**4.0**	4	4	4	4	4	4	4	**4.0**

Domain	Economy
Indicatory Category	Project Lifespan and Flexibility
Indicator	Duration / timing of benefit
Description:	Duration of the risk management (remediation) benefit, e.g., time-limited for a containment system vs. permanency of benefit from destructive technologies; also, length of time taken for beneficial effects to become apparent.
How to compare:	Compare options for the relative length of time over which they remain effective in terms of mitigating the risk, how long before the control measure comes into effect / duration of the remediation works before the site comes into beneficial use.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	Positive impacts are limited as the remedial option does not propose to destroy the contaminant. Therefore, contaminated material must be managed long-term introducing an element of ensuring effectiveness over the length of time material will be managed for (indefinitely).	The remedial solution is time-limited. Over its projected lifetime, the remedial option will require maintenance and at the end of its projected lifetime will require reconstruction or at least major maintenance and renewal.	**2.6**	2.5	2	2.5	3	2.5	3	2.5	**2.6**
2. Onsite containment elsewhere in CRN	Positive impacts are limited as the remedial option does not propose to destroy the contaminant. Therefore, contaminated material must be managed long-term introducing an element of ensuring effectiveness over the length of time material will be managed for (indefinitely).	The remedial solution is time-limited. Over it's projected lifetime, the remedial option will require maintenance and at the end of it's projected lifetime will require reconstruction or at least major maintenance and renewal.	**2.6**	2.5	2	2.5	3	2.5	3	2.5	**2.6**
3. Onsite treatment (screen and immobilise) and offsite disposal	All remedial options have time-limited elements within the scope. However, there may be some benefit in disposal at larger waste accepting facilities as the contaminated material is concentrated at one location amongst other waste streams rather than storing on-site in what will practically be a new, small landfill.	Consideration should be given to the duration and timing benefit of the off-site disposal location. It is likely that off-site disposal facilities will be subject to similar time limitations. By contributing to the disposal facility or landfill, the remedial option is still indirectly time-limited with regard to remedial effectiveness.	**4**	4	4	4	4	4	4	4	**4.0**
4. Onsite screening and offsite disposal	All remedial options have time-limited elements within the scope. However, there may be some benefit in disposal at larger waste accepting facilities as the contaminated material is concentrated at one location amongst other waste streams rather than storing on-site in what will practically be a new, small landfill.	Consideration should be given to the duration and timing benefit of the off-site disposal location. It is likely that off-site disposal facilities will be subject to similar time limitations. By contributing to the disposal facility or landfill, the remedial option is still indirectly time-limited with regard to remedial effectiveness.	**4**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	All remedial options have time-limited elements within the scope. However, there may be some benefit in disposal at larger waste accepting facilities as the contaminated material is concentrated at one location amongst other waste streams rather than storing on-site in what will practically be a new, small landfill.	Consideration should be given to the duration and timing benefit of the off-site disposal location. It is likely that off-site disposal facilities will be subject to similar time limitations. By contributing to the disposal facility or landfill, the remedial option is still indirectly time-limited with regard to remedial effectiveness.	**4**	4	4	4	4	4	4	4	**4.0**
6. Onsite, above-ground capping	Positive impacts are limited as the remedial option does not propose to destroy the contaminant. Therefore, contaminated material must be managed long-term introducing an element of ensuring effectiveness over the length of time material will be managed for (indefinitely).	The remedial solution is time-limited. Over it's projected lifetime, the remedial option will require maintenance and at the end of it's projected lifetime will require reconstruction or at least major maintenance and renewal.	**1.6**	1.5	1.5	2	2	1.5	1.5	1.5	**1.6**
7. Onsite bury and cap	Positive impacts are limited as the remedial option does not propose to destroy the contaminant. Therefore, contaminated material must be managed long-term introducing an element of ensuring effectiveness over the length of time material will be managed for (indefinitely).	The remedial solution is time-limited. Over it's projected lifetime, the remedial option will require maintenance and at the end of it's projected lifetime will require reconstruction or at least major maintenance and renewal.	**2.2**	2	2	2.5	2.5	2.5	2	2	**2.2**
8. Offsite containment at Lake George Mine	All remedial options have time-limited elements within the scope. However, there may be some benefit in disposal at larger waste accepting facilities as the contaminated material is concentrated at one location amongst other waste streams rather than storing on-site in what will practically be a new, small landfill.	Consideration should be given to the duration and timing benefit of the off-site disposal location. It is likely that off-site disposal facilities will be subject to similar time limitations. By contributing to the disposal facility or landfill, the remedial option is still indirectly time-limited with regard to remedial effectiveness.	**4**	4	4	4	4	4	4	4	**4.0**

Domain	Economy
Indicatory Category	Project Lifespan and Flexibility
Indicator	Chance of success
Description:	Factors affecting chances of success of the remediation / management works and issues that may affect works, including community, contractual, environmental, procurement and technological risks.
How to compare:	Compare options for their degree of vulnerability to issues that militate against a successful outcome (refer to examples).

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	There are some positive impacts to retaining contaminated material on-site which is that there is more control over project scheduling following procurement of contractor/s and material/s and less reliability on third party conditions (i.e. disposal facility licensed volumes for accepting waste, timing etc.).	The community will likely protest this remedial option as it proposes to retain contaminated material on-site where the community perceives it to be an ongoing risk to their safety. As the scope includes construction of on-site containment, there is added uncertainty in being able to procure a suitable contractor and materials within the required timeframe.	**2.8**	2.5	2.5	2.5	3	3	3	3	**2.8**
2. Onsite containment elsewhere in CRN	There are some positive impacts to retaining contaminated material on-site which is that there is more control over project scheduling following procurement of contractor/s and material/s and less reliability on third party conditions (i.e. disposal facility licensed volumes for accepting waste, timing etc.).	The community will likely protest this remedial option as it proposes to retain contaminated material on-site where the community perceives it to be an ongoing risk to their safety. As the scope includes construction of on-site containment, there is added uncertainty in being able to procure a suitable contractor and materials within the required timeframe.	**2.8**	2.5	2.5	2.5	3	3	3	3	**2.8**
3. Onsite treatment (screen and immobilise) and offsite disposal	There are less on-site risks of issues that may affect the remedial option progress and therefore more control over the duration of nuisance impact on the adjacent community. There is also a reduced technological risk as this remedial option relies less on specialist construction and materials for a successful outcome.	There are additional factors which may reduce chances of success due to the inherent reliance on third party waste facilities to lawfully accept contaminated material in a timely manner.	**3.3**	3.5	3.5	3.5	3.5	3	3	3	**3.3**
4. Onsite screening and offsite disposal	There are less on-site risks of issues that may affect the remedial option progress and therefore more control over the duration of nuisance impact on the adjacent community. There is also a reduced technological risk as this remedial option relies less on specialist construction and materials for a successful outcome.	There are additional factors which may reduce chances of success due to the inherent reliance on third party waste facilities to lawfully accept contaminated material in a timely manner.	**3.5**	3.5	3.5	3.5	3.5	3.5	3.5	3.5	**3.5**
5. Offsite disposal of unsegregated waste	There are less on-site risks of issues that may affect the remedial option progress and therefore more control over the duration of nuisance impact on the adjacent community. There is also a reduced technological risk as this remedial option relies less on specialist construction and materials for a successful outcome.	There are additional factors which may reduce chances of success due to the inherent reliance on third party waste facilities to lawfully accept contaminated material in a timely manner.	**3.9**	3.5	4	3.5	4	4	4	4	**3.9**
6. Onsite, above-ground capping	There are some positive impacts to retaining contaminated material on-site which is that there is more control over project scheduling following procurement of contractor/s and material/s and less reliability on third party conditions (i.e. disposal facility licensed volumes for accepting waste, timing etc.).	The community will likely protest this remedial option as it proposes to retain contaminated material on-site where the community perceives it to be an ongoing risk to their safety. As the scope includes construction of on-site capping, there is added uncertainty in being able to procure a suitable contractor and materials within the required timeframe.	**2**	2	2	2	2	2	2	2	**2.0**
7. Onsite bury and cap	There are some positive impacts to retaining contaminated material on-site which is that there is more control over project scheduling following procurement of contractor/s and material/s and less reliability on third party conditions (i.e. disposal facility licensed volumes for accepting waste, timing etc.).	The community will likely protest this remedial option as it proposes to retain contaminated material on-site where the community perceives it to be an ongoing risk to their safety. As the scope includes construction of on-site containment, there is added uncertainty in being able to procure a suitable contractor and materials within the required timeframe.	**2.6**	2.5	2.5	2.5	2.5	2.5	2.5	3	**2.6**
8. Offsite containment at Lake George Mine	There are less on-site risks of issues that may affect the remedial option progress and therefore more control over the duration of nuisance impact on the adjacent community.	There are additional factors which may reduce chances of success due to the inherent reliance on third party waste facilities to lawfully accept contaminated material in a timely manner.	**3.9**	3.5	4	3.5	4	4	4	4	**3.9**

Domain	**Economy**
Indicatory Category	Project Lifespan and Flexibility
Indicator	Flexibil ty to change in circumstances
Description:	Abil ty of opt on to respond to changing circumstances, including discovery of addit onal contaminat on, different soil materials, or timescales. Important for both long-term issues (e.g., changes arising from global warming) but also for sites where s te investigat on data is constrained, e.g., because of buildings or uncertainties associated w th work of prev ous incumbents, so condit ons may not be as ant cipated.
How to compare:	Compare opt ons for their abil ty to change according to these examples (where relevant) and to any other circumstances.

Remediation Options	**Qualitative Evaluation**		**SURE Score**	**Subject Matter Expert Scores**							**Average**
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	The magnitude of financial consequence and impact to project scheduling is less likely to be as great as other remedial options and there would still be capacity to continue with some of the remedial scope while awaiting additional materials or labour in the event that more contaminated material was excavated than originally planned for.	The extent of contaminated material to be excavated has not been completely determined. The impact of oversupply of contaminated material in this remedial option is that the materials and labour procured for the on-site containment cell may not be sufficient to contain the actual quantity of contaminated material. This may introduce large time delays and financial consequence and therefore there is less flexibility to change in circumstances.	**2.3**	2.5	2.5	2.5	2.5	2	2	2	**2.3**
2. Onsite containment elsewhere in CRN	The magnitude of financial consequence and impact to project scheduling is less likely to be as great as other remedial options and there would still be capacity to continue with some of the remedial scope while awaiting additional materials or labour in the event that more contaminated material was excavated than originally planned for.	The extent of contaminated material to be excavated has not been completely determined. The impact of oversupply of contaminated material in this remedial option is that the materials and labour procured for the on-site containment cell may not be sufficient to contain the actual quantity of contaminated material. This may introduce large time delays and financial consequence and therefore there is less flexibility to change in circumstances.	**2.6**	2.5	2.5	2.5	2.5	2.5	3	3	**2.6**
3. Onsite treatment (screen and immobilise) and offsite disposal	The likelihood that an off-site waste facility would need to discontinue services mid-project is low.	There is a reliance on the continual, unrestricted ability of the off-site waste facility to accept contaminated material as required. If this ability of the waste acceptor was disrupted, this may introduce large financial consequences due to the increase duration of the remedial option and procured labour.	**3.7**	4	3	3.5	4	3.5	4	4	**3.7**
4. Onsite screening and offsite disposal	The likelihood that an off-site waste facility would need to discontinue services mid-project is low.	There is a reliance on the continual, unrestricted ability of the off-site waste facility to accept contaminated material as required. If this ability of the waste acceptor was disrupted, this may introduce large financial consequences due to the increase duration of the remedial option and procured labour.	**4**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	The likelihood that an off-site waste facility would need to discontinue services mid-project is low.	There is a reliance on the continual, unrestricted ability of the off-site waste facility to accept contaminated material as required. If this ability of the waste acceptor was disrupted, this may introduce large financial consequences due to the increase duration of the remedial option and procured labour.	**4.1**	4	4	4.5	4	4	4	4	**4.1**
6. Onsite, above-ground capping	The magnitude of financial consequence and impact to project scheduling is less likely to be as great as other remedial options and there would still be capacity to continue with some of the remedial scope while awaiting additional materials or labour in the event that more contaminated material was excavated than originally planned for.	The extent of contaminated material to be excavated has not been completely determined. The impact of oversupply of contaminated material in this remedial option is that the materials and labour procured for the on-site capping may not be sufficient to cap the actual quantity of contaminated material. This may introduce large time delays and therefore there is less flexibility to change in circumstances.	**2.2**	2	2.5	2.5	2.5	2	2	2	**2.2**
7. Onsite bury and cap	The magnitude of financial consequence and impact to project scheduling is less likely to be as great as other remedial options and there would still be capacity to continue with some of the remedial scope while awaiting additional materials or labour in the event that more contaminated material was excavated than originally planned for.	The extent of contaminated material to be excavated has not been completely determined. The impact of oversupply of contaminated material in this remedial option is that the materials procured for the on-site containment cell may not be sufficient to contain the actual quantity of contaminated material. This may introduce large time delays and therefore there is less flexibility to change in circumstances.	**2.1**	2	2	2	2.5	2	2	2	**2.1**
8. Offsite containment at Lake George Mine	The likelihood that an off-site waste facility would need to discontinue services mid-project is low.	There is a reliance on the continual, unrestricted ability of the off-site waste facility to accept contaminated material as required. If this ability of the waste acceptor was disrupted, this may introduce large financial consequences due to the increase duration of the remedial option and procured labour.	**3.9**	4	4	3	4	4	4	4	**3.9**

Domain	Economy
Indicatory Category	Project Lifespan and Flexibility
Indicator	Resilience to climate change
Description:	Robustness of option to global warming effects.
How to compare:	Compare options in terms of their resilience to all relevant direct and indirect effects of global warming, especially changes in water regimes, temperature and socio-economic issues (e.g., land use).

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	**Negative impacts**		**Project Management**	**Project Management**	**Contaminated Land**	**Community Engagement**	**Environmental Management**	**Rail Engineering**	**Environmental Management / Community Engagement**	
1. On-site containment at Tarago Rail Yard	This option is less likely to impact future land use as the proposed site for containment is within the rail corridor which is likely to be used into the future.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option is bushfire. A bushfire in the area and immediate vicinity would drastically impact the project during construction. A bushfire may also damage the containment cell once constructed.	**2.6**	2.5	2.5	2.5	3	3	2	3	**2.6**
2. Onsite containment elsewhere in CRN	This option is less likely to impact future land use as the proposed site for containment is within the rail corridor which is likely to be used into the future.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option is bushfire. A bushfire in the area and immediate vicinity would drastically impact the project during construction. A bushfire may also damage the containment cell once constructed.	**3.0**	3	3	3	3	3	3	3	**3.0**
3. Onsite treatment (screen and immobilise) and offsite disposal	As the remedial option has not directly considered resilience to climate change, no positive impacts have been determined.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option cannot be properly determined without confirming the disposal location. However, given the disposal location will be a waste facility, the remedial option will negatively impact society's resilience to climate change indirectly due to land usage and the ongoing operational carbon footprint of the waste facility.	**4.1**	4	4	5	4	4	4	4	**4.1**
4. Onsite screening and offsite disposal	As the remedial option has not directly considered resilience to climate change, no positive impacts have been determined.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option cannot be properly determined without confirming the disposal location. However, given the disposal location will be a waste facility, the remedial option will negatively impact society's resilience to climate change indirectly due to land usage and the ongoing operational carbon footprint of the waste facility.	**4.1**	4	4	5	4	4	4	4	**4.1**
5. Offsite disposal of unsegregated waste	As the remedial option has not directly considered resilience to climate change, no positive impacts have been determined.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option cannot be properly determined without confirming the disposal location. However, given the disposal location will be a waste facility, the remedial option will negatively impact society's resilience to climate change indirectly due to land usage and the ongoing operational carbon footprint of the waste facility.	**4.1**	4	4	5	4	4	4	4	**4.1**
6. Onsite, above-ground capping	This option is less likely to impact future land use as the proposed site for containment is within the rail corridor which is likely to be used into the future.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option is bushfire. A bushfire in the area and immediate vicinity would drastically impact the project during construction. A bushfire may also damage the cap by desiccation and possibly cracking/breach of material used once constructed.	**2.0**	2	2	2	2.5	2	1.5	2	**2.0**
7. Onsite bury and cap	This option is less likely to impact future land use as the proposed site for containment is within the rail corridor which is likely to be used into the future.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option is bushfire. A bushfire in the area and immediate vicinity would drastically impact the project during construction. A bushfire may also damage the cap by desiccation and possibly cracking/breach of material used once constructed.	**2.6**	2.5	2.5	2.5	3	3	2	3	**2.6**
8. Offsite containment at Lake George Mine	As the remedial option has not directly considered resilience to climate change, no positive impacts have been determined.	There are no considerations for defence against climate change impacts within the scope of this remedial option. The most likely effect of global warming and climate change to impact the remedial option cannot be properly determined without confirming the disposal location. However, given the disposal location will be a waste facility, the remedial option will negatively impact society's resilience to climate change indirectly due to land usage and the ongoing operational carbon footprint of the waste facility.	**4.1**	4	4	4	4.5	4	4	4	**4.1**

Domain	Economy
Indicatory Category	Project Lifespan and Flexibility
Indicator	Ongoing inst tutional controls
Description:	Requirements for ongoing inst tutional controls for the site or a water source and in some cases the effectiveness of such controls.
How to compare:	Compare how long any inst tutional controls must remain in place for each option -these can relate to monitoring/verif cat on but also issues such as restr ctions on use of a groundwater supply. Compare also the long-term effectiveness of such controls.

Remediation Options	Qualitative Evaluation		SURE Score	Subject Matter Expert Scores							Average
	Positive impacts	Negative impacts		Project Management	Project Management	Contaminated Land	Community Engagement	Environmental Management	Rail Engineering	Environmental Management / Community Engagement	
1. On-site containment at Tarago Rail Yard	No positive impacts determined.	The duration of ongoing controls such as remedial option effectiveness monitoring will likely continue for the projected lifetime of the remedial option (100 years). There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**2.5**	2.5	2.5	2.5	3	2	3	2	**2.5**
2. Onsite containment elsewhere in CRN	No positive impacts determined.	The duration of ongoing controls such as remedial option effectiveness monitoring will likely continue for the projected lifetime of the remedial option (100 years). There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**2.5**	2.5	2.5	2.5	3	2	3	2	**2.5**
3. Onsite treatment (screen and immobilise) and offsite disposal	Duration likely limited to maximum two years of validation and verification monitoring to demonstrate risks related to contamination remaining in operational lines are low and acceptable.	There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**4**	4	4	4	4	4	4	4	**4.0**
4. Onsite screening and offsite disposal	Duration likely limited to maximum two years of validation and verification monitoring to demonstrate risks related to contamination remaining in operational lines are low and acceptable.	There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**4**	4	4	4	4	4	4	4	**4.0**
5. Offsite disposal of unsegregated waste	Duration likely limited to maximum two years of validation and verification monitoring to demonstrate risks related to contamination remaining in operational lines are low and acceptable.	There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**4**	4	4	4	4	4	4	4	**4.0**
6. Onsite, above-ground capping	No positive impacts determined.	The duration of ongoing controls such as remedial option effectiveness monitoring will likely continue for the projected lifetime of the remedial option (100 years). There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**1.6**	1.5	1.5	2	1.5	1.5	1.5	2	**1.6**
7. Onsite bury and cap	No positive impacts determined.	The duration of ongoing controls such as remedial option effectiveness monitoring will likely continue for the projected lifetime of the remedial option (100 years). There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**2.3**	2.5	2.5	2.5	2.5	2	2	2	**2.3**
8. Offsite containment at Lake George Mine	Duration likely limited to maximum two years of validation and verification monitoring to demonstrate risks related to contamination remaining in operational lines are low and acceptable.	There will also be an immediate need for vegetation management to establish vegetation following earthworks which will require short-term watering.	**4**	4	4	4	4	4	4	4	**4.0**

Appendix 3
Calculation of Assessment Results

The assessment process is based on evaluating the selected options according to a list of relevant sustainability indicators. These indicators are grouped into each domain of sustainability (Environment, Society, Economy).

Initially each indicator or domain is assigned a weighting factor (indicator weight) on a scale of 0 to 5. In this assessment the Environment domain was assigned a weighting of 1 while the Society and Economy domains received weightings of 3. These weightings were selected to offset a higher number of indicators under the Environment domain and result in an overall equal distribution of weights across the three domains.

The options to be evaluated are numerically scored, also on a scale of 0 to 5, based on their comparative sustainability with respect to each indicator. Once all weights and scores have been assigned, SURE by Ramboll automatically generates a Results Matrix, which for each Option compiles the products of weights and scores against each indicator, i.e.:

$$\text{Indicator Result Score} = \text{Indicator Weight} \times \text{Indicator Score}$$

To ensure standardization and comparability, the indicator weights are expressed in the reporting as a percentage of the sum of Indicator Weights to generate Sustainability Weights:

$$\text{Sustainability Weight (\%)} = \text{Indicator Weight} / \sum \text{Indicator Weights}$$

The Indicator Result Scores are likewise expressed as a percentage of the sum of maximum Indicator Result Scores (5) to generate Indicator Sustainability Scores:

$$\text{Indicator Sustainability Score} = \text{Result Score} / \sum \text{Maximum Result Scores}$$

The Total Sustainability Score for a given option is then computed as the sum of the individual Indicator Sustainability Scores:

$$\text{Total Sustainability Score} = \sum \text{Indicator Sustainability Scores}$$

A Total Sustainability Score of 100 therefore reflects the ideal option (i.e. one which has received maximum scores for all indicators).