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TARAGO RAIL CORRIDOR
REMEDIAL OPTIONS ASSESSMENT

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Revision	Date	Prepared by	Checked by	Approved by	Description
Rev 0 / Draft	20/08/2020	S Maxwell	F Robinson	F Robinson	For client review
Rev 1	6/10/2020	S Maxwell	F Robinson	F Robinson	For client review

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TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

Measures	Description
%	per cent
ha	Hectare
km	Kilometres
m	Metre
mAHD	Metres Australian Height Datum
mbgs	Metres below ground surface
mg/kg	Milligrams per Kilogram
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
CLM Act	NSW Contaminated Land Management Act 1997
Council	Goulburn Mulwaree Council
DP	Deposited Plan
EIL	Ecological Investigation Level
EMP	Environmental Management Plan
EPA	Environment Protection Authority (NSW)
HIL	Health Investigation Level
pH	A measure of acidity, hydrogen ion activity
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
ROA	Remedial Options Assessment
SAQP	Sampling Analysis and Quality Plan
-	On tables is "not calculated", "no criteria" or "not applicable"

EXECUTIVE SUMMARY

Ramboll Australia Pty Ltd was commissioned by John Holland Rail to prepare a Remedial Options Assessment (ROA) for contaminated materials within or originating from the Goulburn – Bombala rail corridor at Tarago NSW.

The objective of the ROA is to identify a range of applicable remedial technologies that would achieve the remedial goal and determine the preferred option based on identified evaluation metrics.

The chosen remedial method as determined by the ROA is then described in detail within a Remedial Action Plan developed specifically for the project.

This ROA has included the following key elements:

1. Summary of information provided in 'Tarago Rail Corrdior and Tarago Area Detailed Site Investigation' (Ramboll, 2020a) including presentation of the conceptual site model describing the need for remediation
2. Definition of the remedial goal
3. Identification of the evaluation metrics to assess the remedial options
4. Brief description of remediation technologies capable of meeting the remedial objective
5. Assessment of remedial options against the identified criteria
6. Conclusion on the preferred remediation method.

The objective for this remedial options assessment has been adopted from the VMP and is to assess remedial options to address risks from the Contaminant on, or originating from, the site.

Remedial options that have been considered generally fall into three categories:

1. Return of ore impacted materials to the mine from which the ore originated for beneficial reuse under a Resource Recovery Exemption
2. Onsite containment
3. Offsite disposal

Return of contaminated material to Woodlawn Mine was identified as the most sustainable option and based on preliminary communication with Heron Resources planning for this option was progressed. Woodlawn Mine activities subsequently shifted from Operational to Care and Maintenance modes and Heron Resources has advised that return of contaminated material to the mine is no longer feasible.

The assessment identified that the second preferred remediation option was containment of impacted soils within the rail corridor however based on the proximity of the surrounding community to contamination in the rail corridor at Tarago and historic migration of this contamination into the surrounding area, it was considered likely that more suitable containment locations could exist within the broader rail corridor outside of Tarago. Additionally, containment at Tarago could provide a constraint to future development of the rail corridor.

Within this context and in consultation with the JHR, the following remediation strategy is proposed:

1. Remediation onsite through insitu retention of contaminated materials beneath active lines and excavation and transport of contaminated materials from other areas for containment within the CRN at a location to be confirmed
2. Remediation of 106 Goulburn Street through return of contaminated materials from other areas of the site to the Woodlawn Mine subject to assessment of additional potential contaminants of concern

3. Remediation of the Braidwood site and the Boyd Street site, if determined to be required is proposed through return of contaminated materials to the Woodlawn Mine subject to assessment of additional potential contaminants of concern.

Key considerations relating to the implementation of the preferred remedial options are:

1. Further risk assessment based on derivation of Site Specific Trigger Values for ecology and agriculture are required to confirm remedial requirements at 2135 Braidwood Road (The Braidwood site) and 16 Wallace Street (The Boyd St site)
2. Remediation of onsite contamination should occur before remediation of 106 Goulburn Street based on potential contaminant migration onto 106 Goulburn Street during remediation onsite.
3. Remediation of 106 Goulburn Street should start with removal or repair of lead based paint to reduce potential for this source to impact soil / dust after remediation has occurred

Resolution of items 1 -2 are limiting factors for preparation to Remedial Action Plans.

1. INTRODUCTION

Ramboll Australia Pty Ltd (Ramboll) was commissioned by John Holland Rail (JHR or the client) to prepare a Remedial Action Plan (RAP) 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.

1.1 Background

Ramboll has assisted JHR to date in the assessment and management of site contamination including assessment of risks to other human health and ecological receptors within and surrounding the site. This previous assessment included identification of data gaps that limited capacity to assess potential risks to users of Tarago Station and sensitive offsite receptors.

In November 2019 the site 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 site to be significantly contaminated under Section 11 of the CLM Act (Declaration Number: 20201102; Area Number 3455). The site 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:

1. lead concentrations in soil within the rail corridor (Lot 22 DP1202608) exceed national guideline values for the protection of human health and the environment
2. 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
3. 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
4. there are potentially complete exposure pathways for onsite and offsite ecological receptors.

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 as relate to assessment of the Contaminant include:

An Action Plan (Ramboll 2020b) was prepared defining interim management measures and verification monitoring to be implemented until completion of remediation.

1.2 Objective

The objective for this remedial options assessment has been adopted from the VMP and is to assess remedial options to address risks from the Contaminant on, or originating from, the site.

The ROA will be used to address the following features of the VMP:

1. Select a preferred remedial option integrating consultation with the community and other stakeholders.
2. Prepare a RAP(s) to define how the selected remedial option will be implemented and validated.

Contamination that has migrated from the site has been observed to include metals other than the Contaminant that present potential risks to ecological receptors downstream and are included in the remedial objective.

1.3 Regulatory Framework and Guidelines

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

1. NSW Work Health and Safety Act 2011
2. NSW Work Health and Safety Regulation 2017
3. Protection of the Environment Operations Act 1997
4. Environmental Planning and Assessment Act 1979
5. Protection if the Environment Operations (Waste) Regulation 2014
6. Contaminated Land Management Act 1997
7. SafeWork NSW Lead Guidance
8. SafeWork Australia Code of Practice: Managing Risks of Hazardous Chemicals in the Workplace
9. NSW EPA LeadSmart – Work Smart: Tradespeople and Mining Industry Workers
10. NHMRC Managing Individual Exposure to Lead in Australia – A Guide for Health Practitioners 2016
11. SafeWork NSW Workplace Exposure Standards for Airborne Contaminants
12. NSW EPA 2017 Site Auditor Scheme Guidelines 3rd Edition
13. NSW EPA Contaminated Sites Sampling Design Guidelines 1995
14. National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) 2013
15. NSW EPA 2020 Guidelines for consultants reporting on contaminated land.

1.4 Scope of Work

This document includes a review of information provided in *'Tarago Rail Corrdior and Tarago Area Detailed Site Investigation'* (Ramboll, 2020a) and assessment of remedial options to meet the remedial objectives.

2. SITE DESCRIPTION

2.1 Site Identification

The site locality is shown in **Figure 1,** Error! Reference source not found., a site features plan is p resented 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
Site Area:	Approximately 7.5 ha
Local Government:	Goulburn Mulwaree Shire
Owner:	Transport for NSW
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 forms part of the Goulburn – Bombala rail corridor. Review of satellite imagery and site inspection identified land use within the surrounding environment including:

1. Tarago Station (onsite).
2. A residence adjacent (east of) the site and adjacent (north of) Tarago Station. This residence is defined as 106 Goulburn Street Tarago (Lot 1 DP816626 - the Station Masters Cottage) and is known to be impacted by the Contaminant
3. A residence with a dam that receives waters from the site (during surface water flow), located adjacent (east of) the northern end of site.
4. Tarago Public School approximately 120 m east of the northern end of site.
5. Residences approximately 70 m west of the south end of site and east of Goulburn Street.
6. 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 Sit Investigation* (Ramboll 2020a) 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 loadout 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 loadout 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 JHR operate 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 site 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 loadout 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 loadout complex appears to have been constructed between 1976 and 1985 with demolition between 1997 and 2005. Evidence of the loadout 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 loadout 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-complex footprint is approximately one meter higher. This is a results of soil that was imported to cap the area after demolition of the buildings. b. During operation, ore was transported to the loadout 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 used to haul ore from the mine to the corridor used to bang 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 the station masters cottage. Sediment was transported down Wallace Street and possibly across Boyd Street through the tennis courts to the 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 mgl (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 2020a) broadly across the site including in the area of the former loadout complex, the rail formation and adjacent the eastern side of the rail formation. At the loadout complex a maximum of approximately one meter 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 (described within this report) 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. The identification of these stockpiles on an historic survey plan indicates presence before loop extension works. Stockpiles of contaminated spoil (approx. 750m^3 of fouled ballast and approx. 50m^3 of timber sleepers) were also created during construction west of the rail formation and opposite Tarago Station.
Onsite Wells	One groundwater well is 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 0.15m diameter steel casing with 2 mm wide vertical screen slots.
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.

Site	Details
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 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 southern most 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 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. 3. 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 loadout 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 (the Station Masters Cottage 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 (eg: 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 loadout 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 (ie: 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.

Sensitive receptors within the surrounding environment were identified including:

1. A residence with a dam receiving waters from the site (during surface water flow) adjacent (east of) the northern end of site.
2. Residences approximately 70 m west of the south end of site.
3. Tarago Station adjacent (east of) the site.
4. Tarago Public School approximately 120 m east of the northern end of site.
5. Tarago Recreation Area approximately 300 m east of site.

6. REMEDIATION CRITERIA

6.1 Soil

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

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

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 DSI are as follows:

1. 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.
2. HIL C – Health investigation level for recreational/open space such as parks, playgrounds, playing fields, secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site specific assessment may be more appropriate.
3. 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.
4. EIL for urban recreational 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 (2019c) determined a site-specific trigger level (SSTL) protective of current and future onsite workers of 2,200 mg/kg.

The human health and ecological criteria adopted for the DSI 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 C – Recreational/ Public Open Space	HIL D – Commercial/ Industrial	EIL – Urban Residential and Public Open Space	EIL - Commercial/ Industrial
Aluminium	-	-	-	-	-
Arsenic	100	300	3,000	100	160
Barium	-	-	-	-	-
Beryllium	60	90	500		
Cadmium	20	90	900	-	-
Chromium	100[a]	300[a]	3,600[a]	430[b,c]	710[b,c]
Cobalt	100	300	4,000	-	-
Copper	6,000	17,000	240,000	110[c]	160[c]
Iron	-	-	-	-	-
Lead	300	600	2,200[d]	1,100	1,800
Manganese	3,800	19,000	60,000	-	-
Mercury	40[e]	80[e]	730[e]	-	-
Nickel	400	1,200	6,000	200[c]	340[c]
Zinc	7,400	30,000	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 2019c).

[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:

1. National Environment Protection Council (NEPC), National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 (NEPM, 2013).
2. 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).
3. National Health and Medical Research Council (NHMRC), National Resource Management Ministerial Council (NRMMC) Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).
4. Department of Environment and Conservation (DEC) Guidelines for the Assessment and Management of Groundwater Contamination (DEC, 2007).
5. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) (available at www.waterquality.gov.au/anz-guidelines).
6. 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, refilling swimming pools and irrigation of commercial worm farms. Therefore, the beneficial uses and environmental values of the regional aquifer are considered to include:

1. Irrigation of produce and stock watering.
2. Freshwater ecosystems.
3. Irrigation watering of fields.
4. Drinking water.

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	-	-
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 sediment contamination 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 Assessment Criteria – 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 DGV was derived using a ranking of both observed field and laboratory ecotoxicity-effects and represents the 10th percentiles of that data distribution.
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.

7. RESULTS

Discussion of results is presented below with regard for the goals which were adopted from the VMP and included:

1. Undertake delineation of the Contaminant within the site and at the former Loadout Complex.
2. Install groundwater monitoring wells to assess impacts to groundwater from the Contaminant originating from the site.
3. Assess the potential migration from the site of the Contaminant in surface waters and sediments.

Additional goals that were adopted included:

1. To address community concern relating to potential offsite migration of the Contaminant in airborne dust and the potential for associated impacts.
2. To assess road haulage of ore concentrate from the mine to the corridor and/or the use of lead based paint as additional sources of offsite contamination.

7.1 Delineation of the Contaminant within Soils at the Site and at the Loadout Complex

Delineation of the Contaminant within soils at the site and at the Loadout Complex is presented in **Sections 7.1.1** to **7.1.3**. Regional delineation of the Contaminant within groundwater and surface water is presented in **Sections 7.2** and **7.3**.

7.1.1 Review of Historic Assessments

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. The Contaminant was observed in cess drain soils and surface waters upstream and downstream of the three culverts identified onsite.

7.1.2 Vertical Delineation of the Contaminant within the site

Results indicate the vertical extent of contamination in site soil was generally limited to the upper 0.5m bgl. One exception was observed where elevated lead was observed on the east side of the former loadout complex (MW2) where lead exceeded assessment criteria at a depth of one meter below ground level. The elevated concentration observed at MW2 (3,600 mg/kg) occurred in material indicative of the site surface during operation of the Loadout Complex (ie: before application of capping).

Assessment of the vertical extent of lead in site soil (integrating results from historic assessment and recent sampling from monitoring well boreholes) is summarised on **Figures 2a** – **2e**, **Appendix 1** in summary tables which describe lead concentrations reported at increasing depth through the soil profile at 15 locations. Those summary tables have been further consolidated 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)	4615.7	25293.6	87.9	357.0	148.8	64.3	51.8	29.8
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

Concentrations of lead were observed to be highest in shallow soils and generally dropped below assessment criteria from 0.5 mbgl. Continued reduction in lead concentrations was observed from 0.5 – 4.5m and qualitative assessment indicates a relationship between concentrations of lead and other metals such as copper and zinc.

7.1.3 Additional Assessment of Site Surface Soil

Visual evidence of ore concentrate was observed in surface soils adjacent a drainage line onsite in June 2020. It is considered likely these impacts occurred during the rail loop extension as this evidence was not observed during previous assessment of the area. Assessment by field portable XRF identified concentrations of the Contaminant above assessment criteria for the site. Further, concentrations of the Contaminant and other metals were observed that could be expected to adversely impact the receiving environment for downstream surface waters.

Soils were analysed at 0.1 mbgl at three locations where concentrated lead was reported at the surface (PIA2, PIA4, PIA5). 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 Loadout Complex) has been delineated and is described by red shading on **Figures 2a** – **2e**, **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 freshwater ecosystem criteria.

Generally concentrations of the Contaminant, 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 soil described in **Section 7.1.2** 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 identified site contamination and copper, lead, and chromium were observed in groundwater onsite down gradient of site contamination. Lead was only observed onsite in one pre-existing well (GW053976). 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.

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 a regional conditions unrelated to the site.

Dissolved 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

Lead concentrations in surface water were reported above the freshwater ecosystems criteria in seven of the ten locations and above the stock watering criteria in two of the ten locations sampled in April 2020, with the higher lead concentrations reported in SW3, SW4 and SW1 located within the area of known lead impact in the rail corridor and appeared to decrease down-gradient of the site. Upstream samples, SW1_UP and SW9, and SW8 located downstream of the Mulwaree River tributary did not report lead concentrations above the laboratory limit of reporting. Lead concentrations in sediment followed a similar distribution to the surface water samples, with the highest lead concentrations reported in SED1, SED2 and SED4 above the GV-high criterion, indicating there is potential for toxicity-related adverse effects to be observed in these locations. The lowest lead sediment concentrations were reported in upstream samples SED1_UP and SW9, and SED8 located downstream of the Mulwaree River tributary.

Other heavy metals were variably reported above the adopted criteria for surface waters and sediments, with the highest concentrations generally reported in sample locations within the area of known lead impact (SW1, SW3 and SW4). Heavy metal concentrations remain relatively consistent between the earlier surface water sampling rounds in August and September 2019, with no significant changes between monitoring rounds.

7.4 Discrete Property Investigation

The results of the discrete property investigation indicate that lead concentrations reported within the surface and near surficial soil at the 42 properties investigated is unlikely to be the result of migration from the site, with the exception of SMC (located immediately adjacent to the site) and P29, P39 and P40 located along the overland flow path from the site towards Mulwaree River where lead concentrations have the potential to impact on human health and ecological receptors.

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

Lead concentrations reported within rainwater tank water were low and not likely to pose a risk to human health in all tanks sampled. Lead concentrations reported within rainwater tank sediment were low and below the adopted assessment criteria for tank sediment with the exception of properties SMC, P1, P24, P25, P26, P27 and P39, located immediately east and west of the site. The elevated lead concentrations in these tank sediment samples are considered to be potentially the result of dust migration from the site.

Lead concentrations in dust samples were reported above the adopted criteria in ten properties across the investigation area. Internal dust sampling included swab and vacuum sampling. Lead loadings (as ug/m^2) from swab samples were compared directly to adopted guidelines. Indicative loadings from vacuum samples were used to assess the presence or absence of elevated levels of lead in dust (generally vacuum sampling occurred on carpets). The calculated dust lead loading is not indicative of the level of lead in dust that people may be exposed to when accessing the carpet, however the elevated levels triggered further assessment.

The level of lead in dust samples collected by vacuum can be reported as a concentration, just like for outdoor soil. The soil HILs are concentration based guidelines that represents safe lead concentrations where lead exposure can occur from both outdoor soil and indoor dust. In the absence of elevated outdoor soil lead concentrations, the indoor dust concentrations collected by vacuum can be directly compared with the HILs.

Elevated lead loadings were reported from vacuum samples where loadings from swab samples were reported below criteria at four discrete properties (P5, P11, P17 and P18). At each of these properties the approach described above was applied and supported conclusion that risks from lead in internal dust were low and acceptable.

Analysis of additional heavy metals in soil on properties along the overland flow path (namely P6, P29 and P39) indicate that copper and zinc may be present at levels that have the potential to cause harm to ecological receptors. Lead based paint was observed at six properties (P12, P18, P32, PS and SMC) and in poor condition at two of these properties.

7.5 Public Spaces

The results of the public space investigation by XRF indicate 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:

1. In areas along the haul route between the mine and the rail corridor.
3. On Mulwaree Street and in the roadside drain downstream.
4. On an overland flow path from the rail corridor adjacent the Station Masters Cottage and across Boyd Street.

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

1. The Contaminant has been delineated onsite with the exception of 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).
2. 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
3. The haul route and Mulwaree Street are elevated above the site such that movement of the Contaminant via surface water is infeasible; and
4. 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 considered to be related to the migration of lead ore from the rail corridor by surface water and further investigation of this is required.

8. SITE CHARACTERISATION

The primary source of the Contaminant was identified as the ore concentrate from the former Loadout Complex that has been deposited within the rail formation and adjacent shallow soils. Concentrations of the Contaminant have been identified as a driver for remediation onsite across approximately 20,500 m^2 as presented on **Figure 2a** – **2e**, **Appendix 1**, to a maximum depth of approximately 0.5 mbgl. On this basis a reasonably foreseeable upper limit on the volume of contaminated material requiring remediation has been calculated at 10,250 m^3.

Secondary sources were identified as:

1. Surface water and sediment in drainage lines onsite and in the local offsite receiving environment; and
2. Dust that has accumulated within buildings and as sediment in rainwater tanks close to the site.

Surface water and sediment in drainage lines onsite forms part of the 20,500 m^2 described above. Tier 2 risk assessment for offsite surface water and sediment impacts is occurring. Properties where remediation of offsite surface water and sediment is required based on tier 1 risk assessment are presented on **Figure 1**, **Appendix 1**.

Remedial drivers for dust in buildings and sediment in rainwater tanks were identified at a number of properties close to the site. These are being addressed under the Action Plan (Ramboll 2020b) and are not included in the ROA.

9. 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.

9.1 Sources of the Contaminant

The primary source of the Contaminant was identified as the ore concentrate from the former Loadout Complex that has been deposited within the rail formation and adjacent shallow soils. Secondary sources were identified as:

1. Surface water and sediment in drainage lines onsite and in the local offsite receiving environment; and
2. Dust that has accumulated within buildings and as sediment in rainwater tanks close to the site.

Sources considered within this CSM are those clearly related to the Contaminant as defined above.

Lead contamination that has been identified but which is not related to the site (ie: is not the Contaminant) includes impacts on the haul route between the mine and the rail corridor and on Mulwaree Street. Additionally, several instances of localised lead contamination that was geographically separated from the site were identified on private properties. At some of these properties lead based paint was identified in poor condition and lead is generally known to be a cheap and useful metal found frequently in the environment and older homes (NSW EPA 2020). Lead contamination that has been identified but which is not related to the site should be considered further by the polluters, property owners and relevant regulatory stakeholders. Where it is reasonable to conclude that contamination is not the Contaminant at the site or related to the migration of the Contaminant from the site that contamination has been excluded from further consideration.

9.2 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.

The human receptors identified were:

1. Onsite workers (including intrusive maintenance and construction workers)
2. Users of Tarago Train Station
3. The owners of the Station Masters Cottage
4. Other local residents
5. A range of community facilities including the Public School, Preschool and Townhall

6. Workers in adjacent public road reserves.

The ecological receptors identified were:
1. Onsite ecology
2. Offsite ecology including crops and livestock
3. Ecological receptors in the Mulwaree River.

9.3 SPR Linkages

An assessment of the SPR linkages for the Contaminant onsite (including the former loadout complex) is summarised in **Table 9-1**.

Table 9-1: Exposure Assessment Summary

Exposure Route	Potentially Complete SPR? (Y / N / P)							
	Onsite Workers	Onsite Ecology	Residents	Community Activities	Offsite Workers	Offsite Ecology	Irrigation and Livestock	Justification
Soil and Sediment								
Direct Contact	P	P	P[1]	N	P	P	P	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. Concentrations in sediment / soil offsite exceed human health and ecological criteria.
Inhalation	P	P	P[1]	N	P	P	P	
Incidental Ingestion	P	P	P[1]	N	P	P	P	
Root Uptake	N/A	P	N/A	N/A	N/A	N/A	N/A	
Surface Water								
Direct Contact	N	P	N	N	N	P	P	Flow was not observed in any of the drains or culverts present at the site. However, this is likely upon rainfall, which can mobilise contaminated soils into the local waterway where aquatic ecological receptors may become exposed.
Incidental Ingestion	N	P	N	N	N	P	P	
Root Uptake	N/A	P	N/A	N/A	N/A	P	N/A	
Migration to groundwater	N	P	N	N	N	P	P	
Groundwater								
Potable use including drinking	N	N/A	N	N	N	N/A	N/A	Concentrations in groundwater reported below human health criteria. Some metals exceed ecological criteria onsite though not defined offsite and do not appear to discharge to the receiving Mulwaree River so ecological exposure 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	Contaminant migration via airborne dust has occurred to several local houses and lead exceeds assessment criteria.
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 below criteria.
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								
Direct Contact	N/A	N/A	P	N	N/A	P	N	Contaminant migration via airborne dust has occurred and concentrations in tank sediment exceeds criteria for soil at some houses. Exposure to sediment could occur if sediment is discharged to the ground when cleaning tanks[2].
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 2020b) and is not considered further.

9.4 Data Gaps

Risks associated with offsite contaminant migration via surface water are the subject of further assessment. The degree and extent of impacts at depth within the footprint of the former loadout complex buildings requires further delineation. The findings of these data gaps will be considered in preparation of the RAP.

10. REMEDIAL OPTIONS ASSESSMENT

10.1 Remedial Goal

The objective for this remedial options assessment has been adopted from the VMP and is to assess remedial options to address risks from the Contaminant on, or originating from, the site.

A risk is identified as a concentration of the Contaminant or any other COPC present on site or resulting from the site at concentration representing a risk to a receptor when considering criteria presented in **Section 6.** Remedial options have been considered within this context.

10.2 Extent of remediation required

The remediation required onsite is defined in **Section 8** and on **Figures 2a** – **2e**, **Appendix 1**. Additionally, remedial options have been considered for offsite areas as defined on **Figure 1**, **Appendix 1** based on tier 1 risk assessment however further site specific (tier 2) risk assessment is being completed to define remedial requirements.

As described in Section 8, approximately 10,250 m^3 of material has been calculated as requiring remediation at the site. For the purpose of assessing remedial options volumes of contaminated material have been assumed at 106 Goulburn Street (100m^3) and cumulatively at the Braidwood site and the Boyd Street site (400m^3).

10.3 Remedial Options Assessment

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

1. On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
2. 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,

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

or,

5. 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.

Remedial options are considered with regard for the hierarchy of options in **Table 10-1** below. Options are considered separately for onsite contamination, contamination at 106 Goulburn Street and contamination at other offsite locations. Common to all remedial options are requirements for ordering of two elements of work as follows:

1. Remediation of onsite contamination should occur before remediation of 106 Goulburn Street based on potential contaminant migration onto 106 Goulburn Street during remediation onsite.
2. Remediation of 106 Goulburn Street should start with removal or repair of lead based paint to reduce potential for this source to impact soil / dust after remediation has occurred

Additionally, further risk assessment based on derivation of Site Specific Trigger Values for ecology and agriculture are required to confirm remedial requirements at 2135 Braidwood Road (The Braidwood site) and 16 Wallace Street (The Boyd St site).

Remedial options not considered included:

1. Any option with the potential to generate significant onsite dust, such as onsite chemical treatment. The proximity of the residential areas and the difficulty in maintaining dust controls meant that these options were not preferred by the client.
2. Any option to remove impacted soils from within the operational rail formation Contaminant concentrations within the main Goulburn - Bombala line and the Tarago Loop line (the operational formation) 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. The option of retaining contaminated materials beneath operational lines would remain subject to validation that active management measures are not required to mitigate contaminant risks during normal operation of the rail corridor. Remnant contamination within operational lines could be managed under a LTEMP describing controls such as identification of future excavation within active rail formations as lead risk work.
3. Any option to transport waste across cadastral boundaries for temporary storage or long term management unless to an appropriately licensed waste receiving facility or under a resource recovery exemption (RRE).

10.3.1 Options Evaluation Metrics

The sustainability (environmental, economic and social) of each option has been considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking each option. A semi-quantitative approach has been adopted through numeric ranking of the environmental and social elements and numeric scoring of economic sustainability based on 1 point per million dollars (or part thereof) in projected cost. The environmental and social rankings and economic scores are summed for each option and preferred remedial options for each area are defined by the lowest sum.

Table 10-1: Remedial Options Assessment

Area	Option	Description	Sustainability: Environmental	Ranking	Economic[1]	Ranking	Social	Ranking	Overall Ranking
Remedial Options for Contamination Onsite	**Option 1 - Return of ore impacted materials from the site to 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. Confirmation with Heron Resources that it will receive ore impacted materials and any limitations associated with receipt (e.g.: chemical or geotechnical properties) 2. Application for a Resource Recovery Exemption and Order to be submitted to the NSW EPA 3. Excavation and cartage of ore impacted materials to the Woodlawn Mine 4. Beneficial reuse	Return of ore impacted materials to the Woodlawn Mine would consolidate contaminated materials in an area where similar contaminant concentrations occur. Extraction of ore through hydraulic mining processes already implemented at the mine represents the most favourable environmental outcome identified. Remnant materials could be beneficially reused in stabilisation of the tailings dam at the mine contributing to a positive environmental outcome at this location. Beneficial reuse at the mine is identified as a higher order remedial outcome than those considered under the hierarchy of remedial options recommended under the NEPM (NEPC 2013). Sustainability as measured by carbon footprint and landfill space consumption is favourable compared with other options.	1	The cost of progressing excavation and cartage to the mine is estimated at $700 - 900k (ex GST).	1	Intergenerational equity is achieved through this option as the contaminant is adequately managed with like materials in perpetuity.	1	3
	Option 2 - Onsite containment[2]	The onsite containment option considered includes: 1. Location of a cell onsite to mitigate potential risks to human health or the environment in the event of disturbance to the containment system. Onsite containment could occur opposite Tarago Train Station across an area of approximately 6000 m2. Clay fill historically applied across the footprint of the former Loadout Complex could be excavated to the former site surface level and then reused as capping material for the containment cell. 2. Welded 2 mm thick High-Density Polyethylene (HDPE) geomembrane at the base and sides with a 750gm geofabric cushion layer inside the HDPE 3. Vegetation to mitigate erosion of capping or application of a durable surface layer 4. A 100-year design life is projected as a required parameter for engineering design.	Containment systems can provide durable long-term management options however environmental risks remain in the event of containment system failure. Future remediation may therefore be required, and this could place a burden on future generations. Environmental effects as measured by carbon footprint and landfill space consumption is favourable compared with other options.	3	The cost of progressing this option is estimated at $1.2 – 1.4M (ex GST) as an immediate investment. Additionally, a financial assurance value has been modelled based on a 100 year containment system design life and estimated at $550,000 (ex GST) net present value. This integrates costs projected for annual monitoring and replacement of topsoil every 10 years[3]. Further detail is presented in **Appendix 3**. The cumulative investment is estimated at $1.7M - $1.95M (ex GST) and could be expected to be reset after 100 years.	2	A need to manage the contaminated soils in the future may impact future generations.	3	8
	Option 3 - Offsite treatment and disposal[4]	A NSW waste facility capable of receiving the volume and type of material proposed to be generated during onsite remediation has not yet been identified. A pathway for offsite disposal exists however 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. This pathway would include: 1. A treatability trial to confirm an optimal treatment process 2. Application for an immobilisation approval for disposal of treated waste as GSW 3. Amendment to Woodlawn Veolia waste facility to allow chemical immobilisation at the facility 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	Chemical immobilisation could be expected to reduce potential for migration of the Contaminant however the Contaminant in surficial soils for decades and only localised migration has been identified. Additionally, oversize materials sieved out before treatment would represent a significant secondary waste stream. This indicates the environmental benefit of chemical immobilisation may be limited. Offsite disposal would eliminate contaminant risks from a large part of the site. Further, the chemical immobilisation of contaminated materials as a preliminary stage of this option would reduce risks to an acceptable level before disposal to landfill. Environmental effects as measured by carbon footprint and landfill space consumption is unfavourable compared with other options.	5	The cost of progressing this option is estimated at $4.2M – 5.35M (ex GST).	5	Intergenerational equity is however achieved as the contaminant is adequately managed within an appropriate management structure in perpetuity.	2	12

Area	Option	Description	Sustainability						Overall Ranking
			Environmental	**Ranking**	**Economic**[1]	**Ranking**	**Social**	**Ranking**	
Remedial Options for Contamination at 106 Goulburn Street[5]	**Option 1a - Return of ore impacted materials from 106 Goulburn Street to Woodlawn Mine**	Return of ore impacted materials to the mine could occur as described under Option 1 however further assessment (e.g.: other contaminants) would be required to confirm suitability.	Per Option 1.	1	The cost of progressing this option is estimated at $70k - $80k	1	Per Option 1.	1	3
	Option 4 - Offsite disposal of contaminated materials from 106 Goulburn Street	Disposal of waste from 106 Goulburn Street could occur at Veolia Woodlawn under reclassification of waste contaminated with lead from residential premises as General Solid Waste. Chemical assessment for lead would not be required.	Offsite disposal would eliminate contaminant risks from 106 Goulburn Street and within this context would provide a favourable environmental outcome. Environmental impacts other than contaminant risks are high compared to other options and include reduction of the capacity of the local landfill and a high carbon footprint.	2	The cost of progressing this option is estimated at $90k - $120k	2		2	6
Remedial Options for Contamination at the Braidwood site and the Boyd Street site	**Option 1b - Return of ore impacted materials from the Braidwood site and the Boyd Street site to Woodlawn Mine**	Per Option 1a above	Per Option 1a above	1	The cost of progressing this option is estimated at $90k - $110k	1	Per Option 1a above	1	3
	Option 4a - Offsite disposal of contaminated materials from the Braidwood site and the Boyd Street site	Per Option 4 above	Per Option 4 above	2	The cost of progressing this option is estimated at $230k - $320k	2	Per Option 4 above	2	6

Notes:

1. Cost estimates have been developed for the purpose of comparing remedial options and are based on provision of limited information to potential remedial contractors. Further consultation with remedial contractors should occur to confirm costs and assumptions. Costs are based on 10,000m^3 or 18,000T of material requiring remediation. Remedial cost calculations are presented for each option as **Appendix 2** and are based on preliminary assessment of industry rates in 2020.
2. Onsite containment options have been limited to above the natural site surface to mitigate potential interference with groundwater (inferred at 6.1m bgl at the former Tarago Loading Station). The location proposed is opposite Tarago Train Station. Site preparation would include excavation of historically applied gravelly clay fill. This material would be reapplied as capping over contained materials.
3. The financial assurance model applied integrates an interest rate of 3%, inflation of 2%, annual inspection and reporting once established, $40k every 10 years for topsoil / capping surface reinstatement. No provision is made for acute damage to the containment system (eg: accidental penetration or potential damage from flooding) or for the management of contaminated materials after the 100 year design life. Assumptions adopted in the financial assurance calculation are presented as **Appendix 3**.
4. Offsite disposal options integrate consideration of two local landfills (Hi Quality - Minda landfill, Windellama and Veolia Woodlawn Waste Facility, Woodlawn). The disposal fee adopted for Minda was $115/t. The disposal fee adopted for Woodlawn was $225/t.
5. Costs associated with removal / repair of lead based paint at 106 Goulburn Street are excluded from this assessment.
6. Costs associated with all other services such as planning, stakeholder engagement, environmental protection during the works and validation of remediation, are excluded from this assessment.

10.4 Preferred Remedial Option

Return of contaminated material to Woodlawn Mine was identified as the most sustainable option and based on preliminary communication with Heron Resources planning for this option was progressed. Woodlawn Mine activities subsequently shifted from Operational to Care and Maintenance modes and Heron Resources has advised that return of contaminated material to the mine is no longer feasible.

The assessment identified that the second preferred remediation option was containment of impacted soils within the rail corridor however based on the proximity of the surrounding community to contamination in the rail corridor at Tarago and historic migration of this contamination into the surrounding area, it was considered likely that more suitable containment locations could exist within the broader rail corridor outside of Tarago. Additionally, containment at Tarago could provide a constraint to future development of the rail corridor.

Within this context and in consultation with the JHR, the following remediation strategy is proposed:

4. Remediation onsite through insitu retention of contaminated materials beneath active lines and excavation and transport of contaminated materials from other areas for containment within the CRN at a location to be confirmed
5. Remediation of 106 Goulburn Street through return of contaminated materials from other areas of the site to the Woodlawn Mine subject to assessment of additional potential contaminants of concern
6. Remediation of the Braidwood site and the Boyd Street site, if determined to be required is proposed through return of contaminated materials to the Woodlawn Mine subject to assessment of additional potential contaminants of concern.

10.5 Environmental Planning Framework

Legislative planning requirements relevant to remediation in NSW are defined under the Environmental Planning and Assessment Regulation 2000 (EP&A Regulation), under State Environmental Planning Policy 55: Remediation of Land (SEPP 55) and under the State Environmental Planning Policy (Infrastructure) 2007. The planning pathway remains the subject of further consideration.

11. CONCLUSION

11.1 Preferred Remedial Option

In consultation with the JHR, the following remediation strategy is proposed:

1. Remediation onsite through insitu retention of contaminated materials beneath active lines and excavation and transport of contaminated materials from other areas for containment within the CRN at a location to be confirmed
2. Remediation of 106 Goulburn Street through return of contaminated materials from other areas of the site to the Woodlawn Mine subject to assessment of additional potential contaminants of concern
3. Remediation of the Braidwood site and the Boyd Street site, if determined to be required is proposed through return of contaminated materials to the Woodlawn Mine subject to assessment of additional potential contaminants of concern.

11.2 Considerations and Next Steps

Key considerations relating to the implementation of the preferred remedial options are:

1. Further risk assessment based on derivation of Site Specific Trigger Values for ecology and agriculture are required to confirm remedial requirements at 2135 Braidwood Road (The Braidwood site) and 16 Wallace Street (The Boyd St site)
2. Remediation of onsite contamination should occur before remediation of 106 Goulburn Street based on potential contaminant migration onto 106 Goulburn Street during remediation onsite.
3. Remediation of 106 Goulburn Street should start with removal or repair of lead based paint to reduce potential for this source to impact soil / dust after remediation has occurred

Resolution of items 1 -2 are limiting factors for preparation to Remedial Action Plans.

12. REFERENCES

Department of Environment and Climate Change (DECC) (2019) NSW EPA Interim Construction Noise Guideline

DM McMahon Pty Ltd (2015) Tarago Rail Sliding Extension: Preliminary Contaminated Site Assessment, June 2015

Heron Resources https://www.heronresources.com.au/woodlawn-zinc-copper-project accessed 6 September 2019

National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) 2013

NSW EPA 2017 Site Auditor Scheme Guidelines 3rd Edition

NSW EPA Contaminated Sites Sampling Design Guidelines 1995

NSW EPA (2017) Guidelines on resource recovery Orders and Exemptions for the land application of waste materials as fill

NSW EPA (2020) Consultants reporting on contaminated land – Contaminated Land Guidelines

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

Ramboll (2020b) Tarago Lead Management Action Plan

13. LIMITATIONS

Ramboll Australia Pty Ltd prepared this report in accordance with the scope of work as outlined in our proposal to John Holland Rail and in accordance with our understanding and interpretation of current regulatory standards.

A representative program of sampling and laboratory analyses was undertaken as part of this investigation, based on past and present known uses of the site. While every care has been taken, concentrations of contaminants measured may not be representative of conditions between the locations sampled and investigated. We cannot therefore preclude the presence of materials that may be hazardous.

Site conditions may change over time. This report is based on conditions encountered at the site at the time of the report and Ramboll disclaims responsibility for any changes that may have occurred after this time.

The conclusions presented in this report represent Ramboll's professional judgment based on information made available during the course of this assignment and are true and correct to the best of Ramboll's knowledge as at the date of the assessment.

Ramboll did not independently verify all of the written or oral information provided to it during the course of this investigation. While Ramboll has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

13.1 User Reliance

This report has been prepared exclusively for John Holland Rail and may not be relied upon by any other person or entity without Ramboll's express written permission.

APPENDIX 1
FIGURES

RAMBOLL AUSTRALIA - GIS MAP file : 318000780_GIS_P018_T22_RAPs_01_RemOpt | F001_Locality_V01 | 19/08/2020

A4
1:10,000

Legend

- Site boundary
- Area of offsite impact
- Rail corridor
- Rail corridor fence

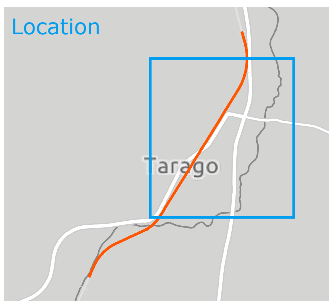
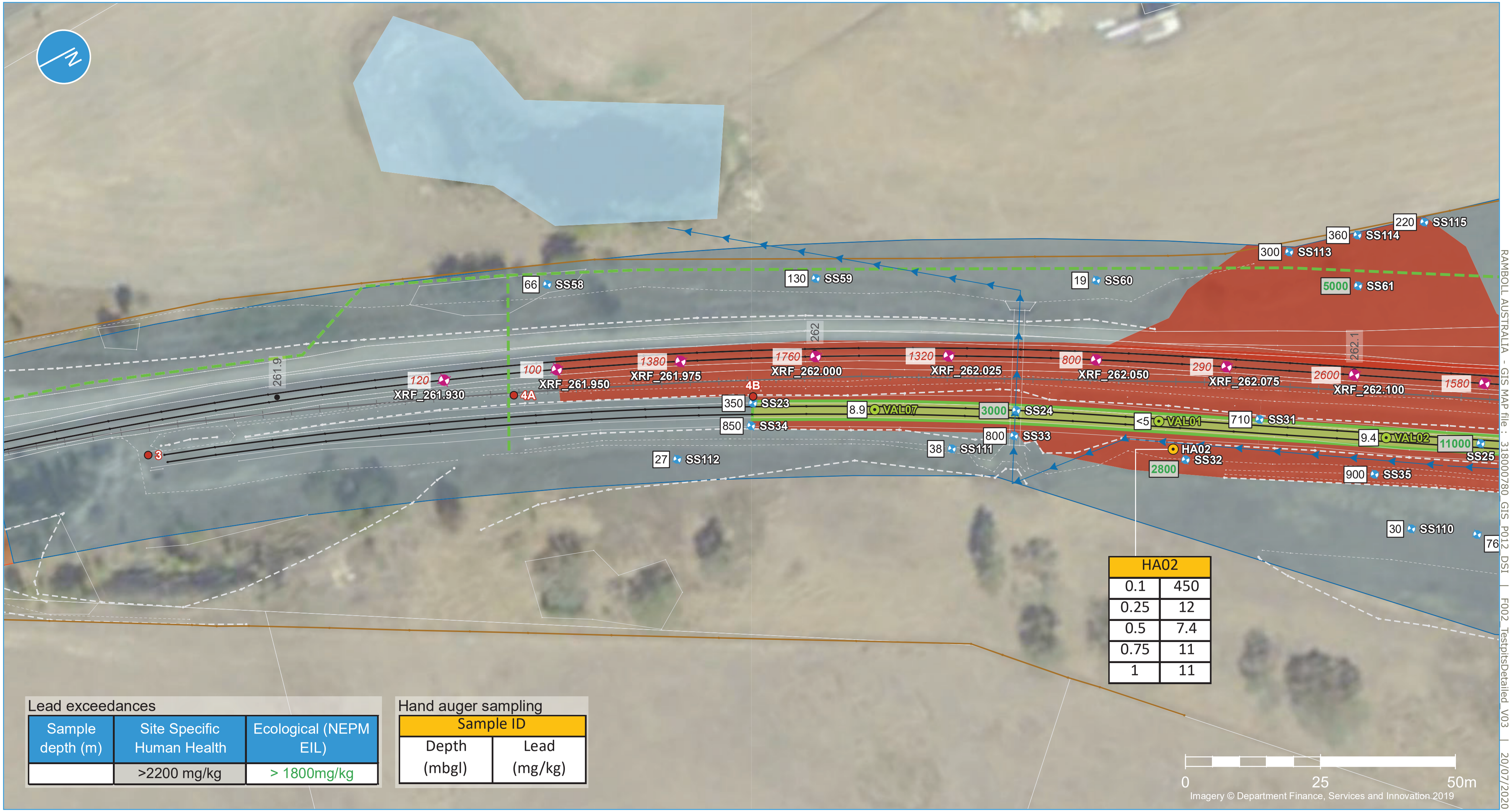


Figure 1 | Locality Plan



HA02	
0.1	450
0.25	12
0.5	7.4
0.75	11
1	11

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
- Rail corridor fence
- 0.1km chainage point
- Signal trench (approximate)
- Surface water flow (indicative)

Survey lines

- Rail track
- Top of bank
- Bottom of bank
- 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
- Area of excavation during loop extension (no further excavation proposed)

Note: X-Ray fluorescence sampling results were conservatively assessed against a management threshold of 1200 mg/kg Pb to mitigate uncertainty associated with these.
Data relating to impacts on private properties has not been presented to maintain privacy for affected parties. Data for TP1 – TP9 and TP15 from the Woodlawn siding is presented in Appendix 3, Table H2 – H3. Data for TP1 – TP20 from the Loadout Complex Footprint is presented in Appendix 3, Table 7.

A4 1:1,000

Location

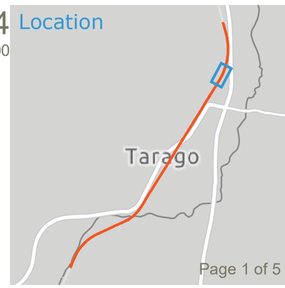
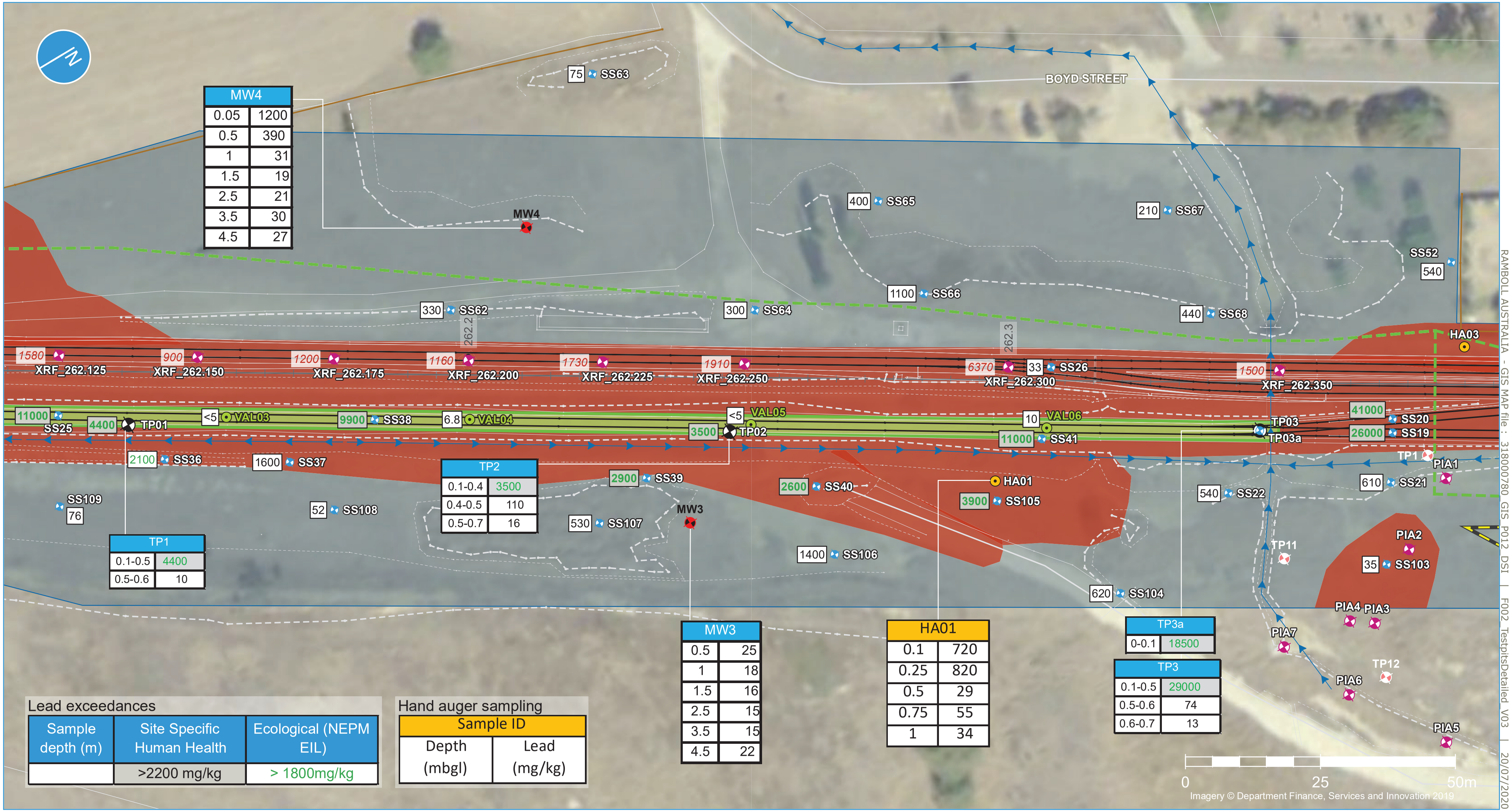


Figure 2a | Site Plan



Legend

- Site boundary
- Rail corridor fence
- 0.1km chainage point
- Signal trench (approximate)
- Surface water flow (indicative)

Survey lines
- Rail track
- Top of bank
- Bottom of bank
- 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
- Area of excavation during loop extension (no further excavation proposed)
- Former loadout road (approximate)

Note: X-Ray fluorescence sampling results were conservatively assessed against a management threshold of 1200 mg/kg Pb to mitigate uncertainty associated with these.
Data relating to impacts on private properties has not been presented to maintain privacy for affected parties. Data for TP1 – TP9 and TP15 from the Woodlawn siding is presented in Appendix 3, Table H2 – H3. Data for TP1 – TP20 from the Loadout Complex Footprint is presented in Appendix 3, Table 7.

A4 1:1,000

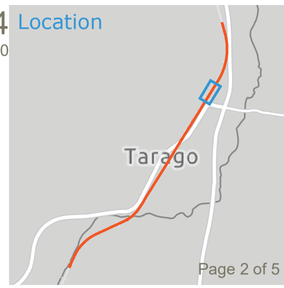
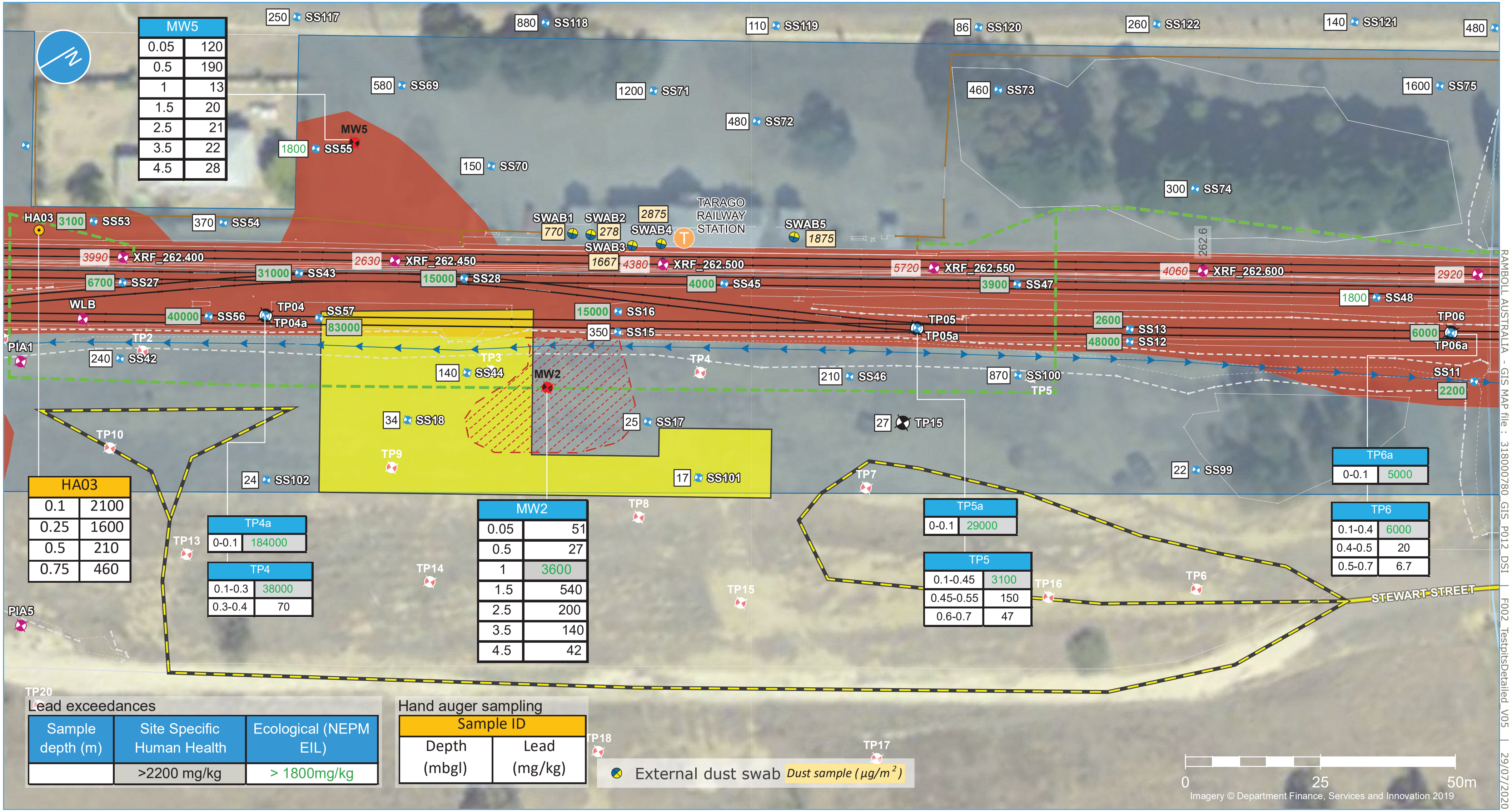


Figure 2b | Site Plan



Legend

- Site boundary
- Rail corridor fence
- 0.1km chainage point
- Signal trench (approximate)
- Surface water flow (indicative)

Survey lines
- Rail track
- Top of bank
- Bottom of bank
- 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)

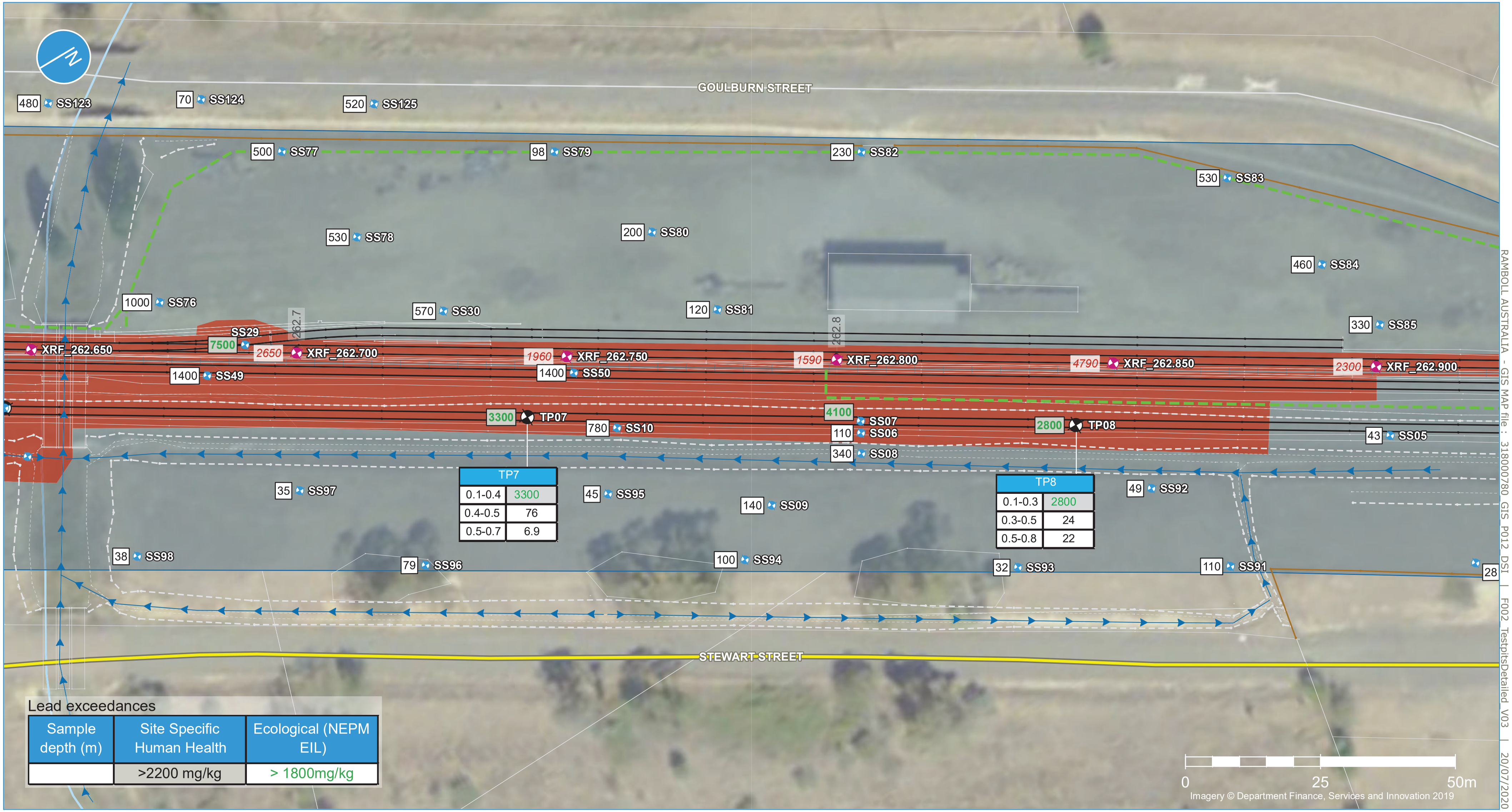
- Lead impacted area
- Indicative lead impacted area
- Former loadout road (approximate)
- Former loadout complex building footprint
- Haul route

Note: X-Ray fluorescence sampling results were conservatively assessed against a management threshold of 1200 mg/kg Pb to mitigate uncertainty associated with these.
Data relating to impacts on private properties has not been presented to maintain privacy for affected parties. Data for TP1 – TP9 and TP15 from the Woodlawn siding is presented in Appendix 3, Table H2 – H3. Data for TP1 – TP20 from the Loadout Complex Footprint is presented in Appendix 3, Table 7.

A4
1:1,000

Location

Figure 2c | Site Plan



Legend

- Site boundary
- Rail corridor fence
- 0.1km chainage point
- Signal trench (approximate)
- Surface water flow (indicative)

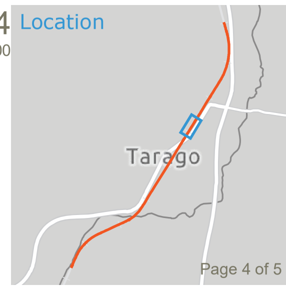
Survey lines

- Rail track
- Top of bank
- Bottom of bank
- 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)

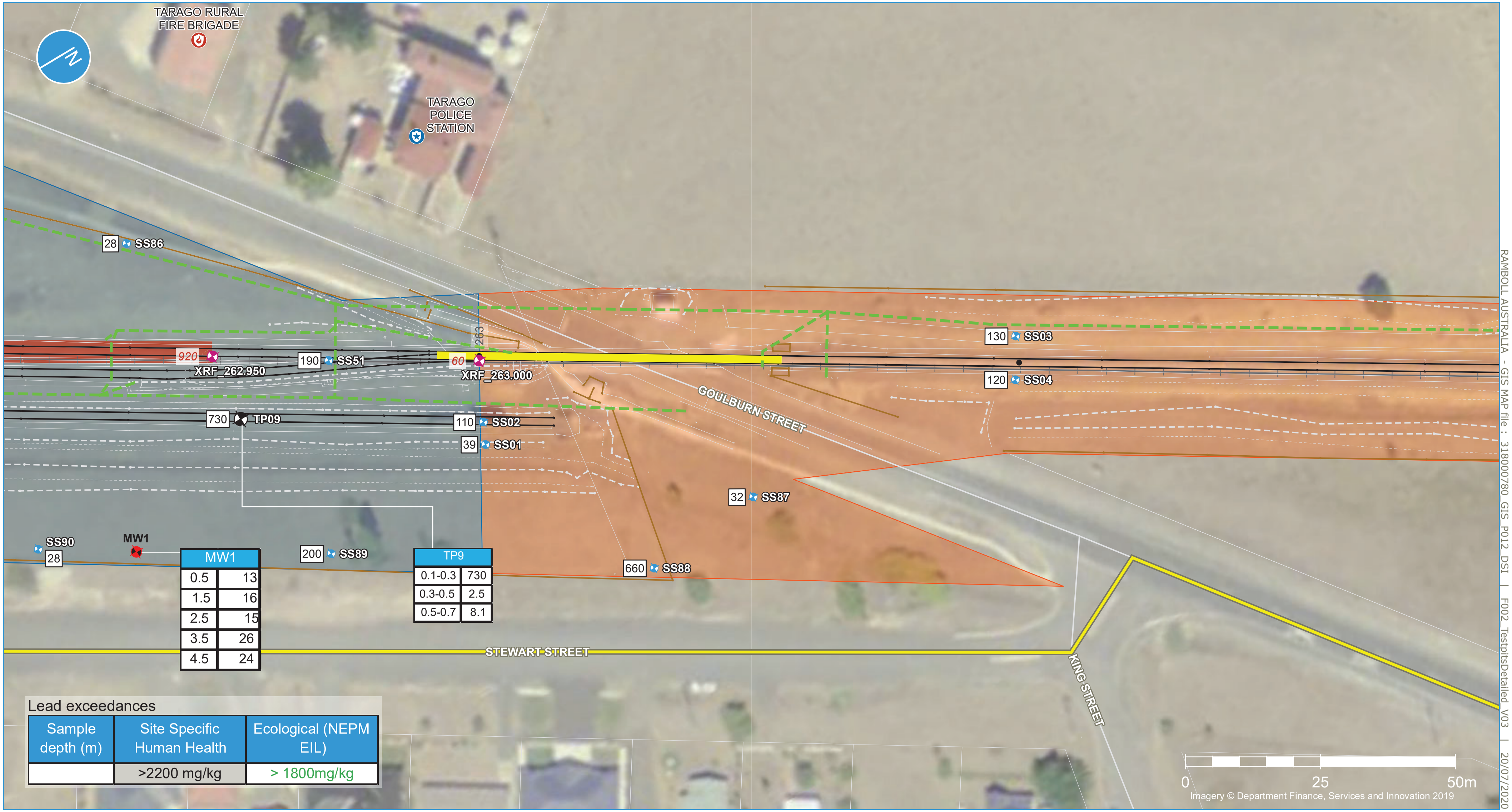
- Lead impacted area
- Haul route

A4
1:1,000



Note: X-Ray fluorescence sampling results were conservatively assessed against a management threshold of 1200 mg/kg Pb to mitigate uncertainty associated with these.
Data relating to impacts on private properties has not been presented to maintain privacy for affected parties. Data for TP1 – TP9 and TP15 from the Woodlawn siding is presented in Appendix 3, Table H2 – H3. Data for TP1 – TP20 from the Loadout Complex Footprint is presented in Appendix 3, Table 7.

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

Legend

- Site boundary
- Rail corridor fence
- 0.1km chainage point
- Goulburn Street level crossing
- Signal trench (approximate)
- Surface water flow (indicative)

Survey lines

- Rail track
- Top of bank
- Bottom of bank
- 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

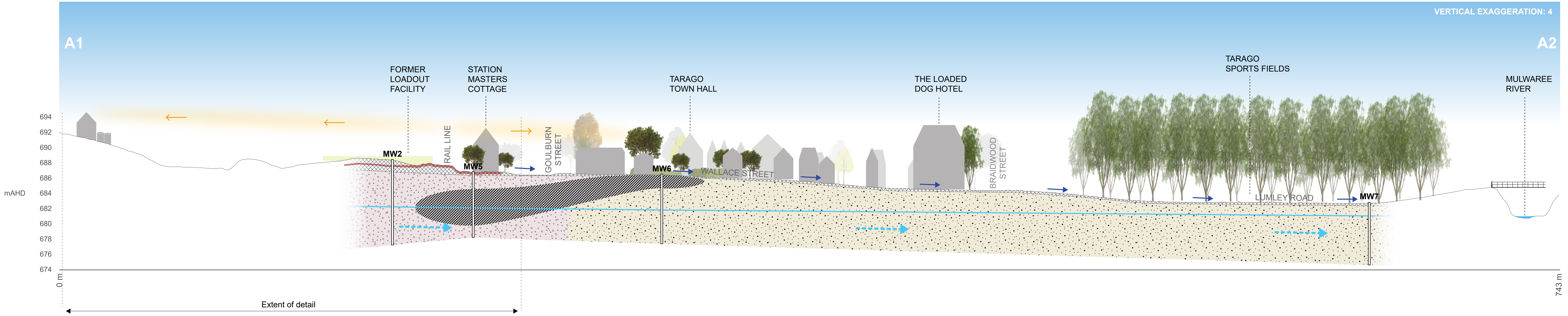
- Lead impacted area
- Haul route

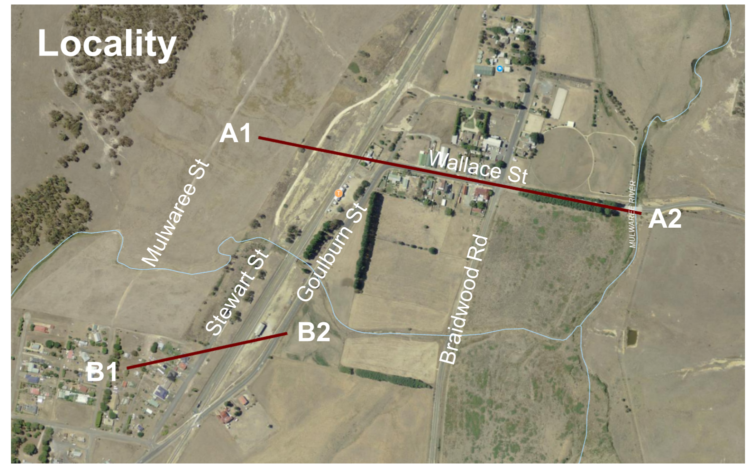
A4 1:1,000

Location

Note: X-Ray fluorescence sampling results were conservatively assessed against a management threshold of 1200 mg/kg Pb to mitigate uncertainty associated with these.
Data relating to impacts on private properties has not been presented to maintain privacy for affected parties. Data for TP1 – TP9 and TP15 from the Woodlawn siding is presented in Appendix 3, Table H2 – H3. Data for TP1 – TP20 from the Loadout Complex Footprint is presented in Appendix 3, Table 7.

Figure 2e | Site Plan





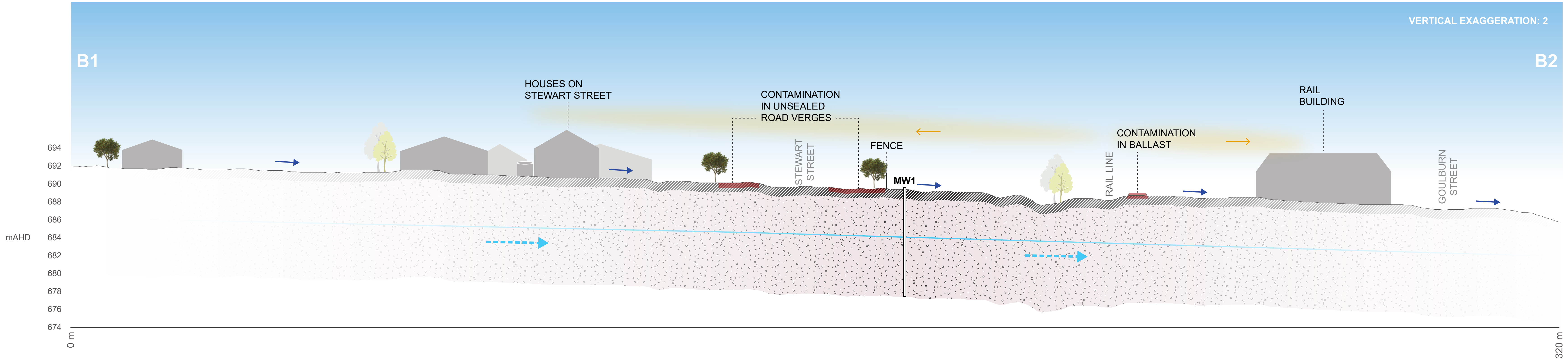
KEY

- Fill
- Clay
- Gravelly clay
- Clayey gravel
- Extent of soil contamination
- Groundwater flow direction
- Surface water flow direction
- Standing water level
- Historic dust - Not observed since application of controls in the corridor (2020)

Section A1 - A2

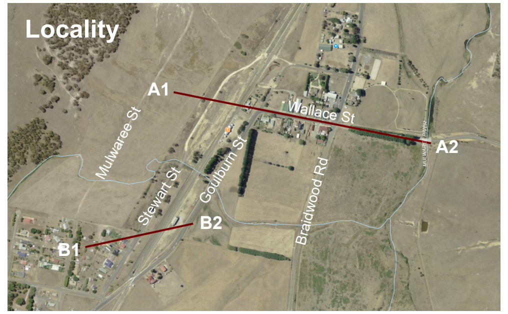
Tarago

DATE	VERSION	MAP#	ISSUE
29/07/2020	**05**	01	FINAL
PAGE	SCALE		SPATIAL REFERENCE
na	na		na



Section B1 - B2

Tarago



KEY

Grass overlying clay	Groundwater flow direction
Gravelly clay	Surface water flow direction
Extent of soil contamination	Standing water level
	Historic dust - Not observed since application of controls in the corridor (2020)

DATE	VERSION	MAP#	ISSUE
22/07/2020	**04**	02	FINAL
PAGE	SCALE		SPATIAL REFERENCE
na	na		na

APPENDIX 2
REMEDIAL COSTS

Remedial Option Cost Estimates for Onsite Contamination

Option 1 - Return of ore impacted materials from the site to Woodlawn Mine

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$5,000	1	$5,000
Mobilisation and site establishment	Item	$10,000	1	$10,000
Project Management	Week	$6,500	6	$39,000
Excavation of impacted material to loading area	M3	$25	10,250	$256,250
Loading impacted material into truck and dogs and transport to mine (assumes tip only, handling of material at mine site excluded)	Tonne	$25	18,450	$461,250
Demobilisation	Item	$5,000	1	$5,000
Estimated Total				**$776,500**

Option 2 - Onsite containment

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$7,500	1	$7,500
Mobilisation and site establishment	Item	$20,000	1	$20,000
Project Management	Week	$6,500	10	$65,000
Excavate capping layer to stockpile (assume 6,000m2 x 0.5m thick)	M3	$25	3,000	$75,000
Excavate containment cell – spoil cart to stockpile within 100m – unsure of final destination of this	M3	$25	10,250	$256,250
Install HDPE and geofabric liner to containment cell	M2	$25	15,000	$375,000
Excavate impacted material, transport to containment cell, place and compact in cell	M3	$35	10,250	$358,750
Place capping layer from stockpile to cap containment cell	M3	$20	3,000	$60,000
Demobilisation	Item	$15,000	1	$15,000
Estimated Total				**$1,232,500**

Table 1: Remedial Option Cost Estimates for Onsite Contamination

Option 3 - Offsite treatment and disposal of ore impacted materials onsite

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$10,000	1	$10,000
Mobilisation and site establishment	Item	$25,000	1	$25,000
Project Management	Week	$6,500	12	$78,000
Bench-scale trial and obtain SIA	Item	$20,000	1	$20,000
Excavation of impacted material to loading area	M3	$25	10,250	$256,250
Loading impacted material into truck and dogs and transport to Local Landfill	Tonne	$25	18,450	$461,250
Screen material to remove ballast	Tonne	$15	18,450	$276,750
Disposal of Ballast as GSW (assume 50% ballast)	Tonne	$115	9,225	$1,060,875
Immobilisation of impacted material following ballast removal	Tonne	$100	9,225	$922,500
Disposal of immobilised material as GSW at Hi Quality Minda Landfill	Tonne	$115	9,225	$1,060,875
Disposal of immobilised material as GSW at Veolia Woodlawn Landfill	Tonne	$225	9,225	$2,075,625
Demobilisation	Item	$20,000	1	$20,000
Estimated Total for disposal at Minda Landfill				**$4,191,500**
Estimated Total for disposal at Veolia Woodlawn				**$5,206,250**

Remedial Option Cost Estimates for Contamination at 106 Goulburn Street

Option 1a - Return of ore impacted materials from 106 Goulburn Street to Woodlawn Mine

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$10,000	1	$10,000
Project Management	Week	$6,500	1	$6,500
Excavation of impacted material to loading area	M3	$25	100	$2,500
Loading impacted material into truck and dogs and transport to the mine (assumes tip only, handling of material at mine site excluded)	Tonne	$25	180	$4,500
Site Reintatement	Item	$50,000	1	$50,000
Estimated Total				**$73,500**

Option 4 - Offsite disposal of ore impacted materials from 106 Goulburn Street

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$10,000	1	$10,000
Project Management	Week	$6,500	1	$6,500
Excavation of impacted material to loading area	M3	$25	100	$2,500
Loading impacted material into truck and dogs and transport to Local Landfill	Tonne	$25	180	$4,500
Disposal of material preclassified as GSW at Hi Quality Minda Landfill	Tonne	$115	180	$20,700
Disposal ofmaterial preclassified as GSW at Veolia Woodlawn Landfill	Tonne	$225	180	$40,500
Site Reintatement	Item	$50,000	1	$50,000
Estimated Total for disposal at Minda Landfill				**$94,200**
Estimated Total for disposal at Veolia Woodlawn				**$114,000**

Remedial Option Cost Estimates for Contamination at the Braidwood site and the Boyd Street site

Option 1b - Return of ore impacted materials from the Braidwood site and the Boyd Street site to Woodlawn Mine

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$10,000	1	$10,000
Project Management	Week	$6,500	2	$13,000
Excavation of impacted material to loading area	M3	$25	400	$10,000
Loading impacted material into truck and dogs and transport to the mine (assumes tip only, handling of material at mine site excluded)	Tonne	$25	720	$18,000
Site Reintatement	Item	$50,000	1	$50,000
Estimated Total				**$101,000**

Option 4a - Offsite disposal of contaminated materials from the Braidwood site and the Boyd Street site

Description	Unit	Budget Rate	Estimated Qty	Estimated Total
Preliminaries and Management Plans	Item	$10,000	1	$10,000
Project Management	Week	$6,500	2	$13,000
Excavation of impacted material to loading area	M3	$25	400	$10,000
Loading impacted material into truck and dogs and transport to Local Landfill	Tonne	$25	720	$18,000
Disposal of material preclassified as GSW at Hi Quality Minda Landfill	Tonne	$115	720	$82,800
Disposal ofmaterial preclassified as GSW at Veolia Woodlawn Landfill	Tonne	$225	720	$162,000
Site Reintatement	Item	$100,000	1	$100,000
Estimated Total for disposal at Minda Landfill				**$233,800**
Estimated Total for disposal at Veolia Woodlawn				**$313,000**

APPENDIX 3
FINANCIAL ASSURANCE ASSUMPTIONS

Client: John Holland Rail
Job No: 318000780
Project Name: Tarago Lead Management
20-08-20

Table 1: Financial Assurance Assumptions

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
q-factor	100.0%	97.1%	94.3%	91.5%	88.8%	86.3%	83.7%	81.3%	78.9%	76.6%	74.4%	72.2%	70.1%	68.1%	66.1%	64.2%	62.3%
Price escalation	100.0%	102.0%	104.0%	106.1%	108.2%	110.4%	112.6%	114.9%	117.2%	119.5%	121.9%	124.3%	126.8%	129.4%	131.9%	134.6%	137.3%
Investment	-1,233,000																
Ongoing Maintenance and Monitoring Requirements																	
Environmental Monitoring																	
Inspection and reporting		-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000
Periodic topsoil replacement											-40,000						
Recontainment																	
Security checks by third party																	
Maintenance																	
Administrator																	
Total (without price escalation)	**-1,233,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**
Total (with price escalation)	-1,233,000	-5,100	-5,202	-5,306	-5,412	-5,520	-5,631	-5,743	-5,858	-5,975	-54,855	-6,217	-6,341	-6,468	-6,597	-6,729	-6,864
NPV	**-1,233,000**	**-4,951**	**-4,903**	**-4,856**	**-4,809**	**-4,762**	**-4,716**	**-4,670**	**-4,625**	**-4,580**	**-40,817**	**-4,491**	**-4,448**	**-4,404**	**-4,362**	**-4,319**	**-4,277**
	-1,253,000																
Total NPV	**-1,793,937**																
NPV Risk realistic	-376,792																
NPV Risk worst	-305,589																
NPV Captial	-1,233,000																
NPV Monitoring and management	-541,418																

Note: the q-factor quantifies the effect of interest and inflation on future costs of long term environmental management and informs calculation of net present value required for financial assuranc

Client: John Holland Rail
Job No: 318000780
Project Name: Tarago Lead Management
20-08-20

Table 1: Financial Assurance Assumptions

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
60.5%	58.7%	57.0%	55.4%	53.8%	52.2%	50.7%	49.2%	47.8%	46.4%	45.0%	43.7%	42.4%	41.2%	40.0%	38.8%	37.7%	36.6%	35.5%	34.5%	33.5%	32.5%
140.0%	142.8%	145.7%	148.6%	151.6%	154.6%	157.7%	160.8%	164.1%	167.3%	170.7%	174.1%	177.6%	181.1%	184.8%	188.5%	192.2%	196.1%	200.0%	204.0%	208.1%	212.2%
-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000
			-40,000										-40,000								
-5,000	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**
-7,001	-7,141	-7,284	-66,868	-7,578	-7,730	-7,884	-8,042	-8,203	-8,367	-8,534	-8,705	-8,879	-81,511	-9,238	-9,423	-9,611	-9,803	-9,999	-10,199	-10,403	-10,611
-4,236	**-4,195**	**-4,154**	**-37,023**	**-4,074**	**-4,034**	**-3,995**	**-3,956**	**-3,918**	**-3,880**	**-3,842**	**-3,805**	**-3,768**	**-33,582**	**-3,695**	**-3,659**	**-3,624**	**-3,588**	**-3,554**	**-3,519**	**-3,485**	**-3,451**

Client: John Holland Rail
Job No: 318000780
Project Name: Tarago Lead Management
20-08-20

Table 1: Financial Assurance Assumptions

39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
31.6%	30.7%	29.8%	28.9%	28.1%	27.2%	26.4%	25.7%	24.9%	24.2%	23.5%	22.8%	22.1%	21.5%	20.9%	20.3%	19.7%	19.1%	18.5%	18.0%	17.5%	17.0%
216.5%	220.8%	225.2%	229.7%	234.3%	239.0%	243.8%	248.7%	253.6%	258.7%	263.9%	269.2%	274.5%	280.0%	285.6%	291.3%	297.2%	303.1%	309.2%	315.4%	321.7%	328.1%
-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000
	-40,000										-40,000										-40,000
-5,000	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**
-10,824	-99,362	-11,261	-11,486	-11,716	-11,950	-12,189	-12,433	-12,682	-12,935	-13,194	-121,121	-13,727	-14,002	-14,282	-14,567	-14,859	-15,156	-15,459	-15,768	-16,083	-147,646
-3,418	**-30,460**	**-3,352**	**-3,319**	**-3,287**	**-3,255**	**-3,223**	**-3,192**	**-3,161**	**-3,130**	**-3,100**	**-27,629**	**-3,040**	**-3,011**	**-2,981**	**-2,952**	**-2,924**	**-2,895**	**-2,867**	**-2,839**	**-2,812**	**-25,060**

Client: John Holland Rail
Job No: 318000780
Project Name: Tarago Lead Management
20-08-20

Table 1: Financial Assurance Assumptions

61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**
16.5%	16.0%	15.5%	15.1%	14.6%	14.2%	13.8%	13.4%	13.0%	12.6%	12.3%	11.9%	11.6%	11.2%	10.9%	10.6%	10.3%	10.0%	9.7%	9.4%	9.1%	8.9%
334.7%	341.4%	348.2%	355.1%	362.3%	369.5%	376.9%	384.4%	392.1%	400.0%	408.0%	416.1%	424.4%	432.9%	441.6%	450.4%	459.4%	468.6%	478.0%	487.5%	497.3%	507.2%
-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000
									-40,000										-40,000		
-5,000	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**
-16,733	-17,068	-17,409	-17,757	-18,113	-18,475	-18,844	-19,221	-19,606	-179,980	-20,398	-20,806	-21,222	-21,646	-22,079	-22,521	-22,971	-23,431	-23,899	-219,395	-24,865	-25,362
-2,757	**-2,731**	**-2,704**	**-2,678**	**-2,652**	**-2,626**	**-2,601**	**-2,575**	**-2,550**	**-22,731**	**-2,501**	**-2,477**	**-2,453**	**-2,429**	**-2,405**	**-2,382**	**-2,359**	**-2,336**	**-2,313**	**-20,618**	**-2,269**	**-2,247**

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Table 1: Financial Assurance Assumptions

83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
8.6%	8.3%	8.1%	7.9%	7.6%	7.4%	7.2%	7.0%	6.8%	6.6%	6.4%	6.2%	6.0%	5.9%	5.7%	5.5%	5.4%	5.2%
517.4%	527.7%	538.3%	549.1%	560.0%	571.2%	582.7%	594.3%	606.2%	618.3%	630.7%	643.3%	656.2%	669.3%	682.7%	696.3%	710.3%	724.5%
-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000	-5000
							-40,000										-40,000
-5,000	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-5,000**	**-45,000**
-25,869	-26,387	-26,914	-27,453	-28,002	-28,562	-29,133	-267,441	-30,310	-30,916	-31,535	-32,165	-32,808	-33,465	-34,134	-34,817	-35,513	-326,009
-2,225	**-2,203**	**-2,182**	**-2,161**	**-2,140**	**-2,119**	**-2,098**	**-18,702**	**-2,058**	**-2,038**	**-2,018**	**-1,998**	**-1,979**	**-1,960**	**-1,941**	**-1,922**	**-1,903**	**-16,963**