CHAPTER

20

Soils and contamination

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

ARTC | INLAND RAIL
An Australian Government Initiative

Contents

Tables

Figures

20 Soils and contamination

This chapter assesses the existing soil environment and potential sources of contamination for the N2NS Phase 2—Moree to Camurra North study area. Through a 'Phase 1' desktop contamination investigation, this chapter assesses the potential impacts from construction and operation, provides recommended mitigation and management measures for later design phases, as well as during construction and operation of the proposal.

The SEARs relevant to soils and contamination, and where they are addressed, are listed in Table 20-1 below. Full copies of the SEARs are provided in Appendix A: Secretary's Environmental Assessment Requirements.

TABLE 20-1 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS FOR SOILS AND CONTAMINATION

Key issue	Requirement	Where addressed
12. Other Issues	1 An assessment of the following issues must be undertaken in accordance with the commitments in section 6 of the Scoping Report: a topography, geology and soils.	This chapter

20.1 Summary of impacts

The potential soil and contamination risks associated with the construction and operation of the proposal include:

- disturbance and erosion of soils during earthwork activities
- changes to the soil surface as a result of earthwork activities, vegetation clearing or formation of embankments, resulting in erosion and sedimentation down-gradient
- contamination of land and waterways due to existing contaminated material within the rail corridor, leaks and spills during construction and maintenance and operational train activities
- unexpected finds of hazardous materials during construction and maintenance activities
- inappropriate management and disposal of contaminated waste material
- diversion of existing contamination due to construction activities.

During the detailed design phase, a site-specific contamination investigation would be undertaken to assess the three potential sites listed on the ARTC Contaminated Site Register.

Prior to construction, both an erosion and sediment control plan and a contaminated land and hazardous materials management plan would be prepared as part of the construction environment management plan (CEMP), in accordance with relevant guidelines.

Specific mitigation measures are provided in section 20.7.3 and Chapter 27: Environmental Management.

No residual soil and contamination impacts are expected.

20.2 Assessment approach

Soil and groundwater contamination has the potential to adversely impact human health and the environment. For a significant or identifiable risk to be present, there must be an exposure pathway. The exposure pathway comprises the following three components:

- the source, which is the presence of a substance that may cause harm
- the receptor, which is the presence of an ecological or human receiver that might be harmed at an exposure point
- the pathway, which is the existence of a means or mechanism of exposing a receptor to the source.

In the absence of a plausible exposure pathway, there would be minimal risk; therefore, the presence of 'something measurable', e.g. volumes of a chemical or presence of asbestos, does not necessarily imply that there would be measurable environmental or human harm. For an impact to occur, it is necessary to have a significant source of contamination, an effective pathway for this to be presented to a receptor, and the receptor must have a reasonable chance of having a negative response to this exposure.

The nature and importance of sources, receptors and exposure pathways will vary with every site, situation, intended end use and environmental setting. Management measures, design considerations and land use planning decisions can be implemented to reduce the risks associated with site contamination.

For the proposal, the contamination risk considerations include:

- the potential impact to workers during construction works, including demolition of existing structures, disturbance of surface and near surface soils, excavation of service trenches, landscaping activities and potential interception of shallow groundwater
- the potential impact to residents and agriculture (particularly children and the elderly) from residual contamination, including the ingestion of soil in unsealed backyards, consumption of home-grown or farmed vegetables and poultry, or soil vapours
- the potential impact to the environment through residual contamination, including contamination of waterways and soils during construction and operation activities
- the potential impact to the public, including contact with soil in public reserves and other public open spaces.

20.3 Methodology

A 'Phase 1' desktop contamination investigation was undertaken by IRDJV for the study area, which included a contaminated land and hazardous materials assessment in accordance with the Inland Rail Program Environmental Assessment procedure. This investigation was undertaken to assist the design phase by identifying the key risks the proposal may have on human health and the environment. This investigation includes:

- assessing features of the existing environment to identify potential impact to soils and water and potential sources of contamination, including:
  - geology and soil types
  - soil condition including dispersive and reactive soils
  - potential acid sulfate soils (ASS)
  - potential saline soils
  - registered contaminated land
  - potential sources of contamination
- a review of publicly available data on government websites and databases, to identify and map soil types, soil condition, areas of potential ASS and saline soils
- identifying registered contaminated land and potential sources of contamination through searches of the NSW EPA Contaminated Sites Register, list of sites notified to the NSW Environment Protection Authority (EPA) and list of sites holding an environmental protection licence (EPL)
- reviewing the findings from previous assessments, including the *Inland Rail Program: Narrabri to North Star Project Environmental Impact Statement* (GHD, 2017), the *N2NS Geotechnical Factual Report* (IRDJV, 2018) (3-0001-260-IGE-00-RP-0001) and *N2NS Geotechnical Interpretative Report* (IRDJV, 2019)
- a review of *ETC-08-03 Rev1.3 Earthworks Materials Specification* (ARTC, 2020) in relation to contaminated soils
- a review of the ARTC's Contaminated Site Register.

The soil and contamination assessment was desk based and did not involve field and intrusive investigation.

20.4 Legislative and policy context

Legislation relevant to this 'Phase 1' desktop investigation includes:

- *Contaminated Land Management Act 1997* (NSW) (CLM Act)
- *Protection of the Environment Operations Act 1997* (NSW) (POEA Act)
- *Environmentally Hazardous Chemicals Act 1985* (NSW)
- Environmentally Hazardous Chemicals Regulation 2008
- *Work Health and Safety Act 2011* (NSW)
- Protection of the Environment Operations (Waste) Regulation 2014.

The scope of works and methodology for the Phase 1 desktop contamination investigation, including soil erosion and sediment transport, were generally based on the practices and principles in the following guidelines:

- *Managing Land Contamination: Planning Guidelines— State Environmental Planning Policy* (Resilience and Hazards) (NSW Government, 2021)
- Earthworks Materials Specification ETC-08-03 Rev1.3. (ARTC, 2020)

- *Guidelines for Consultants Reporting on Contaminated Sites* (NSW Office of Environment and Heritage (OEH), reprinted 2011)
- *Guidelines for the NSW Site Auditor Scheme* (EPA, 2017)
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (EPA, 2015)
- *Urban and Regional Salinity* (NSW Department of Land and Water Conservation (DLWC), 2002)
- *Landslide risk management guidelines* (Australian Geomechanics Society, 2007)
- Soil and Landscape Issues in Environmental Impact Assessment (DLWC, 2000)
- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2* (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (Department of Environment and Climate Change (DECC), 2008)
- *Acid Sulfate Soils Assessment Guidelines* (Acid Sulfate Soils Management Advisory Committee, 1998)
- Contaminated Sites: Sampling Design Guidelines (EPA, 1995)
- National Environment Protection (Assessment of Site Contamination) Measure (1999, 2013 amendment) (the site contamination NEPM)
- other guidelines made or approved under section 105 of the CLM Act.

20.5 Existing environment

20.5.1 Geology and soils

20.5.1.1 Regional soils and geology

A search of the NSW Department of Planning and Environment's (DPE) eSPADE website, undertaken in October 2020, identified the regional soil landscape of the study area as predominantly Watercourse Road (alluvial) landscape, with several areas of Black Creek, Mehi River and Nee Nee Creek landscapes along the creek lines (NSW Department of Minerals and Energy, 2005).

The Watercourse Road landscape is a large floodplain that is associated with the Mehi River, Carole Creek and Gingham Watercourse. The majority of this landscape lies on Quaternary alluvials of the Marra Creek formation with small pockets of meander plains facies of the Bugwah formation scattered throughout.

The Marra Creek formation is comprised of unconsolidated dark yellow clay, slightly silty with rare carbonate nodules and quartz sand, common desiccation cracks, laminations and rootlets. The Bugwah formation is comprised of unconsolidated to semi-consolidated, poorly to very poorly sorted, orange to brown to grey silt, silty clay and fine sand with common carbonate nodules, minor medium sand, ferromagnesian nodules, charcoal and salts. Very deep (150–500 centimetres (cm)), very slowly permeable and very poorly drained self-mulching Grey and Dark Grey Vertosols (Grey Clays) dominate this landscape (approximately 80 per cent).

A summary of the soil landscape characteristics for Black Creek, Mehi River and Nee Nee Creek landscapes are outlined in Table 20-2 and distribution over the study area is shown in Figure 20-1.

TABLE 20-2 SOIL LANDSCAPE TYPES FOR CREEK LINES WITHIN THE STUDY AREA

Soil landscape type	Landscape characteristics	Soil characteristics
Black Creek	Active floodplains, levees, meander scrolls and oxbow lakes associated with active floodplains in the Gwydir Floodplains.	Very deep (150–<500 cm) poorly drained to very poorly drained Grey and Brown Vertosols (Grey and Brown Clays) with very deep (150–<500 cm) imperfectly drained Brown Chromosols (Red–Brown Earths) on paleo-levees and occasional very deep (150–<500 cm) very poorly drained Black Vertosols (Black Earths).
Mehi River	Present-day active river channels, anabranches and oxbow lakes of the Mehi River and other major rivers on Quaternary alluvium of the Marra Creek formation. Slopes <2%, local relief 0–15 metres (m), elevation 172–183 m. Partially cleared tall open-forest and wetland woodland.	Dominated by moderate (50–500 cm), very slowly permeable and very slowly drained Grey Vertosols (Grey Clays), and rare Sodosols.

Soil landscape type	Landscape characteristics	Soil characteristics
Nee Nee Creek	Largely abandoned and relict sections of former floodplain channels occurring as ephemeral linear closed depressions, intermittent shallow channels and swales, and other areas of poor drainage on alluvial plains. Slopes 0–1%, local relief.	Field observations identified deep to very deep (>150 cm), imperfectly drained Black Vertosols (Black Earths) and Grey Vertosols (Grey Clays) in swales, prior stream channels and drainage lines.

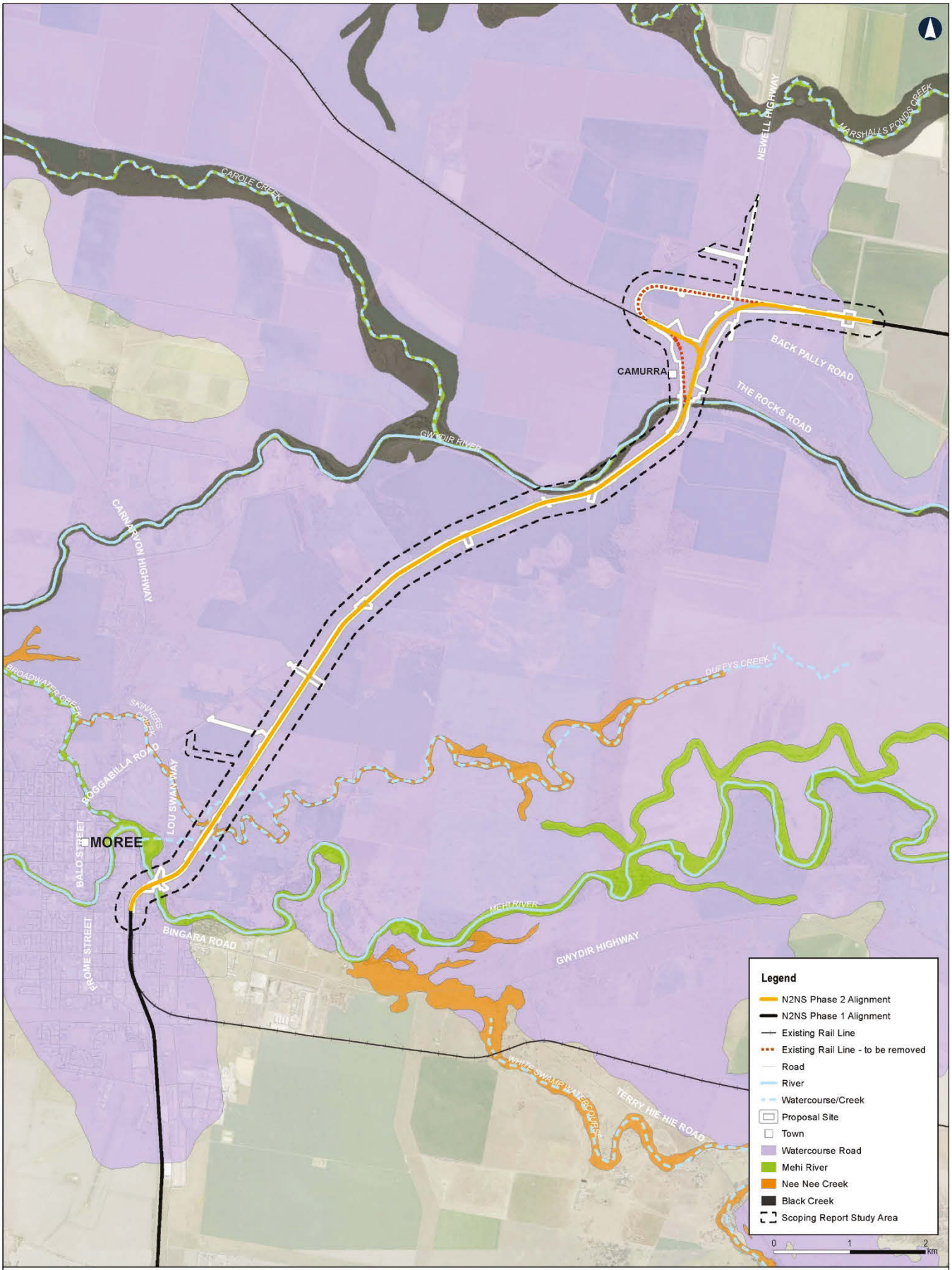

Figure 20-1 Soil landscape profile

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:45,000
Paper size: A3
Date: 9/22/2021
Map 1 of 1

N2NS_SP2_EIS_F20_01_SoilLandscapeProfile_r3v2.mxd

A geotechnical assessment was conducted as part of an EIS prepared by GHD in 2017, which involved excavating 121 test pits between Narrabri to North Star, NSW, including 23 test pits in the construction footprint for the proposal (GHD, 2017). Table 20-3 outlines the subsurface conditions identified in the GHD EIS for the test pit excavation samples.

TABLE 20-3 SUMMARY OF SUBSURFACE CONDITIONS IDENTIFIED IN THE GHD GEOTECHNICAL ASSESSMENT (GHD, 2017)

Subsurface type	Depth encountered (metres)	Generalised description
Ballast—encountered in track formation only		
Top ballast	0.14	Gravel, coarse angular to sub-angular igneous gravel. Clean to moderately fouled.
Sub-ballast	Between 0.34 and 0.50	Gravel, fine to coarse grained, angular to sub angular basalt. Typically, with sand. Fouled to highly fouled.
Fill		
Gravelly ash fill (in track formation only)	Between 0.60 and 1.05	Typically gravelly sand or sandy gravel with low plasticity fines.
Clay fil (cohesive)	Between 1.05 and 1.75	Typically clay, sandy clay and gravelly clay, medium to high plasticity.
Sand fill (non-cohesive)	Between 0.6 and 1.40	Gravelly sand, or clayey sand. Fine to medium grained or coarse grained. Moist to wet.
Natural soil		
Alluvium	Between 0.73 to 1.65	Typically clay and sandy clay, medium to high plasticity.
Residual	Between 0.85 to 1.77	Typically clay or sandy clay with medium to high plasticity. Can also include sandy gravel or clayey gravel, fine to coarse grained, dense to very dense.

Geotechnical investigations were conducted by IRDJV in 2017 and 2018 for the whole N2NS alignment, including the proposal, with the results detailed in the *N2NS Geotechnical Factual Report* (IRDJV, 2018) and *N2NS Geotechnical Interpretative Report* (IRDJV, 2019).

A test pit investigation was developed to assess ground conditions for track formation and structures, targeting gaps in testing from previous investigations conducted by GHD in 2017. Test pits were generally excavated to a target depth of 2 m below top of rail or prior refusal (or slow progress) on very stiff to hard clay or rock. A total of 342 test pits were excavated into the track formation and at structures. The test pits targeted near surface soils, which generally comprised the following materials:

- ballast: gravel, with varying finer components
- ash materials: generally sandy gravel
- fill: generally clay mixtures, some gravelly mixtures of variable compaction and moisture content
- natural soils: alluvium and underlying residual soils; generally clay and silty clay, medium to high plasticity
- weathered rock was only encountered in some areas.

Table 20-4 outlines the soil profile and rock materials encountered during the IRDJV geotechnical investigations.

TABLE 20-4 TYPICAL SOIL AND ROCK MATERIALS ENCOUNTERED WITHIN N2NS TEST PITS IDENTIFIED IN THE IRDJV GEOTECHNICAL INVESTIGATIONS (2018)

Unit	Unified soil classification system (UCSC)	Typical description summary
Ballast (fill)		
1A—Clean	GP	Gravel, medium-to-coarse grained, sub-angular to angular, grey, with fine to coarse grained sand, trace fine grained angular gravel.
1B—Moderately clean	GP	Gravel, medium-to-coarse grained, sub-angular to angular, grey, with fine to coarse grained sand and with fine grained angular gravel.
1C—Moderately fouled	GP	Sandy gravel, fine-to-coarse grained, sub-angular to angular, grey, fine to coarse grained sand, trace silt.
1D—Fouled	GP	Sandy gravel/gravelly sand, fine-to-medium grained sub-angular to angular gravel, grey-black, fine to coarse grained sand, with silt.

Unit	Unified soil classification system (UCSC)	Typical description summary
1E—Fouled to highly fouled	GW	Sandy gravel/gravelly sand, fine-to-coarse grained, sub-angular to angular gravel, grey-black, fine-to-coarse grained sand, with silt.
1F—Highly fouled	GW	Clayey sandy gravel, fine-to-coarse grained, sub-angular to angular, dark grey-pale brown, fine to coarse grained sand, low plasticity clay.
Ash (fill)		
Ash	SC	Clayey/gravelly sand, fine-to-medium, dark grey sand, fine-to-medium/coarse, angular to sub-angular (basalt, slag and charcoal) gravel, low-medium plasticity clay, with ash and charcoal fragments.
Fill (General uncontrolled)		
Granular fill	SC/GC	Clayey gravelly sand, fine-to-coarse, red brown–orange brown sand, low-to-medium plasticity clay, fine to coarse grained rounded to sub-angular (resembles river pebbles) gravel.
Cohesive fill	CL, CL/CI, CI/CH, CH	Clay/silty clay/clay with sand; plasticity ranges from low to high. Colour varies between black, grey, dark brown, brown, orange brown and red brown.
Natural soil		
Topsoil (generally present in greenfield or cess areas only)	CH/CI/CL	Silty clay/clay with sand; plasticity ranges from low to high, brown, dark brown to black, with fine to medium grained sand.
Alluvium	CH, CI/CH	Clay/silty clay; plasticity typically high, black-grey, dark brown and brown.
Residual	CH, CI/ CL, CL	Clay/sandy clay; plasticity is varied, pale brown, brown and orange brown, with varied secondary components including gravel and sand.
Weathered rock		
Siltstone/sandstone	n/a	Fine grained, pale brown sandstone, white-brown siltstone, highly weathered, very low strength (260_TP_3_006, 260_TP_3_345). Massive/poorly developed bedding, yellow brown, disseminated fine grained sand (260_TP_3_334).
Siltstone	n/a	Yellow siltstone, extremely weathered, extremely low to very low strength, poorly developed bedding (260_TP_3_328, 260_TP_3_332).

The *N2NS Geotechnical Interpretative Report* (IRDJV, 2019) classified the soil underlying the proposal for the study area as meander plains, which are variably dispersive in areas south-west of the Mehi River, adjacent to Moree and at the northern section of the proposal. Some areas along the alignment were not investigated during the previous geotechnical investigations; however, ongoing geotechnical investigations would form part of any design refinement.

20.5.1.2 Acid sulfate soils

Acid sulfate soils (ASS) are naturally occurring sediments that contain iron sulfide minerals. If the soils are drained, excavated or exposed to air, the sulfides react with oxygen to form sulfuric acid. ASS develop in waterlogged, saline and anaerobic conditions; they are widespread around coastal regions and are also locally associated with saline, sulfate-rich groundwater in some agricultural areas, or with freshwater wetlands. ASS can also occur inland, in waterways, wetlands and drainage channels.

The Acid Sulfate Soil Risk maps prepared by DLWC, as well as the *Australian Soil Resource Information System* (Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2016), were reviewed in October 2020, which identified the soil in the study area as having no known probability of ASS occurrence.

20.5.1.3 Soil salinity

Soil salinity refers to the accumulation of salts in soil and water to levels that impact on human and natural assets. Land salinity can occur naturally; however, it typically occurs as a result of a change to the hydrologic balance within a catchment. Salinity occurs when salts present in the landscape are mobilised by surface water or groundwater. Increases in salinity occurring in a landscape can be a result of but not limited to:

- changes in water balance such as over-irrigation of crops, improved pastures, and private gardens and lawns
- sources of salt and redistribution in the landscape
- varieties of groundwater processes
- dry scalds which expose saline soils
- a decrease in deep-rooted vegetation
- alteration of natural drainage patterns by the construction of houses, roads, railways, channels, etc.
- creation of wet zones of waterlogged soil by impeded drainage.

A search of the NSW DPE's eSPADE website was undertaken in October 2020 to identify any areas of high land salinity or salinity hazard within the study area. No areas of high land salinity were found for the study area and the local soil profile was identified as having 'no salting evident'.

The geotechnical investigations conducted by IRDJV in 2017 and 2018 included salinity readings for registered groundwater bore data within 1 kilometre (km) of the N2NS alignment, which includes the proposal. Sixteen of 127 registered bores within 1 km of the alignment had saline groundwater noted as either 'brackish', 'salty' or salinity>500 ppm. The highest recorded salinity measurement was 7001–10000 ppm at CH 614.35. This corresponds with a low relief area in deep alluvium, with groundwater at approximately 15 metres below ground level (mbgl) and corresponds with 'highly saline' groundwater.

20.5.2 Contamination

20.5.2.1 Surrounding land use

The landscape to the north, east and west of the study area comprises cleared agricultural land with several rural houses on large lots. The town of Moree is located to the south of the study area, and includes the Moree Race Club, residential housing, various retail stores, amenities and industrial spaces (refer Chapter 9: Land use and property for further details).

In accordance with the Moree Plains Local Environmental Plan (LEP) 2011, the land zones surrounding the proposal consist mostly of Primary Production Small Lots (Land Zoning Code RU4). There are pockets of Large Lot Residential (Land Zoning Code R5); General Residential (Land Zoning Code R1); Light Industrial (Land Zoning Code IN2); Public Recreation (Land Zoning Code RE1); and Infrastructure (rail) (Land Zoning Code SP2) in the southern section of the proposal towards Moree town centre (refer to Chapter 9).

In the RU4 Land Zoning Code, the use of the land is limited to:

- agricultural services: agricultural produce industries, extensive agriculture, farm buildings, intensive plant agriculture, aquaculture
- business: bed and breakfast accommodation, home businesses, home industries, landscaping material supplies, plant nurseries, roadside stalls
- community services: community facilities, cemeteries, crematoria, places of public worship, recreation facilities (outdoor), veterinary hospitals
- infrastructure: building identification signs, business identification signs, heliports, roads, water reticulation systems
- environmental: environmental facilities, environmental protection works, flood mitigation works
- residential: dwelling houses.

Home occupations can take place without consent in RU4 zoned areas.

20.5.2.2 Desktop searches

The NSW EPA record of notices is a searchable database of:

- orders made under Part 3 of the CLM Act
- notices available to the public under section 58 of the CLM Act
- approved voluntary management proposals under the CLM Act that have not been fully carried out and where EPA approval has not been revoked
- site audit statements provided to the EPA under section 53B of the CLM Act that relate to significantly contaminated land
- where practicable, copies of anything formerly required to be part of the public record
- actions taken by the EPA (or the previous State Pollution Control Commission) under sections 35 or 36 of the *Environmentally Hazardous Chemicals Act 1985* (NSW) (EHC Act).

The EPA also publishes a list of contaminated land notified under section 60 of the CLM Act. These sites have been assessed by the EPA as being potentially contaminated but may not always require regulation under the CLM Act.

A search of the NSW EPA record of notices under section 58 of the CLM Act and list of notified sites under section 60 of the CLM Act was carried out in October 2020. A radius of 250 m was considered suitable due to the surrounding geology and potential for contaminants to migrate into the study area. The search did not identify any sites within, or in 250 m of, the proposal that are registered in the EPA record of notices or list of notified sites. This is inconsistent with the findings from the EIS prepared by GHD in 2017, which found four sites on the list of notified sites under section 60 of the CLM Act within 250 m of the proposal, which is illustrated in Figure 20-2. The four sites include:

- Rest House (unknown contaminant)
- vacant land (former rail siding) (unknown contaminant)
- Newell Highway by-pass (unknown contaminant)
- tennis club (former grain store) (unknown contaminant).

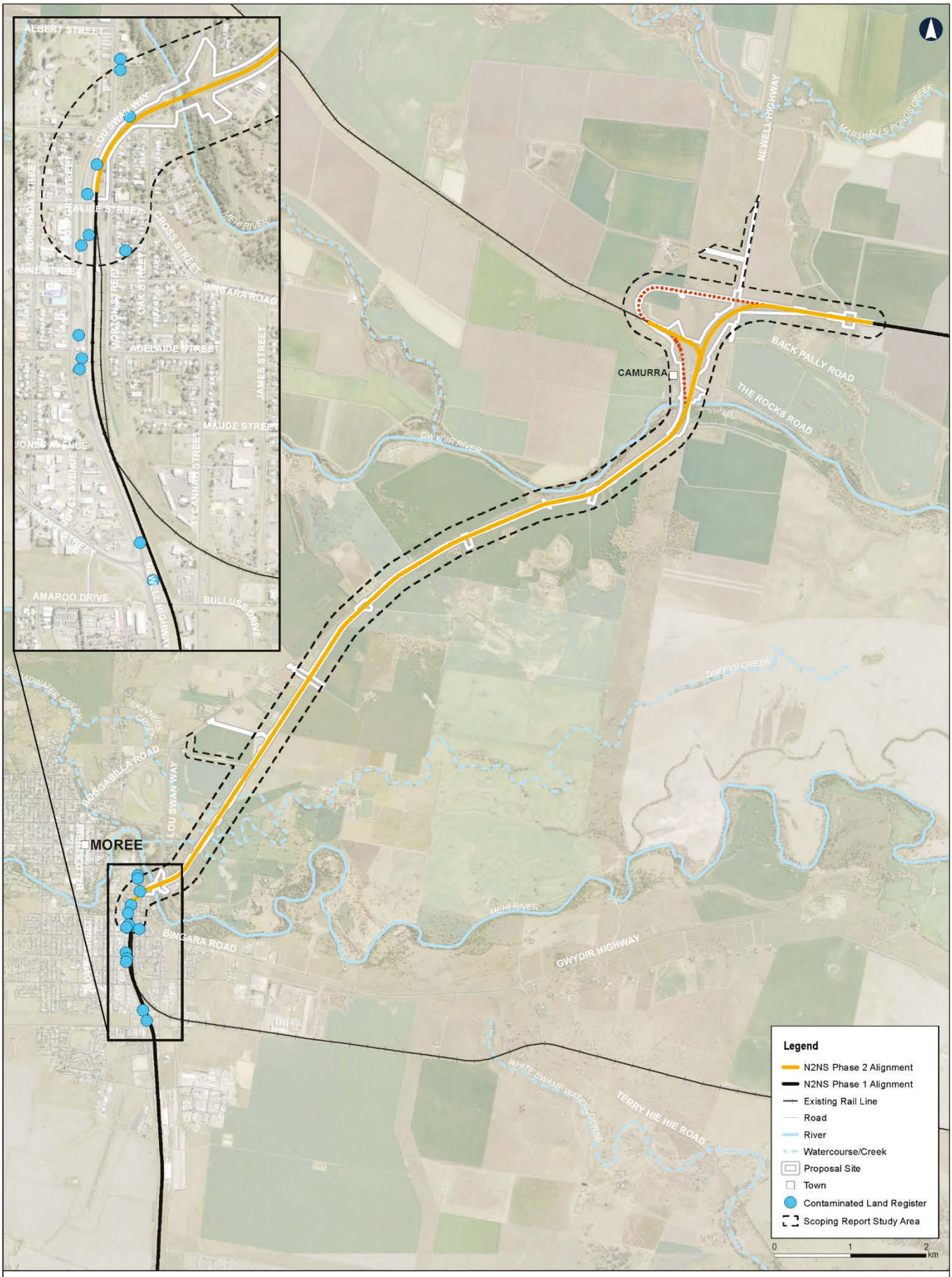

Figure 20-2 ARTC contaminated land register

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:45,000
Paper size: A3
Date: 9/22/2021

Map 1 of 1

N2NS_SP2_EIS_F20_02_ContaminatedLandRegister_r2v2.mxd

The EPA POEO Act public register under section 308 of the POEO Act records the following:

- EPLs
- applications for new licences and to transfer or vary existing licences
- environment protection and noise control notices
- penalty notices issued by the EPA
- convictions in prosecutions under the POEO Act
- the results of civil proceedings
- licence review information
- exemptions from the provisions of the POEO Act or regulations
- approvals granted under clause 9 of the POEO (Control of Burning) Regulation
- approvals granted under clause 7A of the POEO (Clean Air) Regulation
- audits required to be undertaken in relation to a licence
- pollution studies required by a condition of a licence
- pollution reduction programs required by a condition of a licence
- penalty notice issued in relation to a premise.

An online search of the NSW EPA POEO register database was undertaken in October 2020 for records that lie within, or 250 m from, the proposal. No EPLs, applications, notices, audits, or pollution studies and reduction programs were identified within, or in 250 m of, the proposal.

ARTC keeps a contaminated site register for sites leased from ARTC to third parties that may be contaminated. Eight sites were identified in proximity to the proposal and are listed on the ARTC contaminated sites register. The EIS prepared by GHD (GHD, 2017) identified the majority of these sites as being leased from ARTC for use as either service stations, grain storage or fuel storage. Three of these sites fall within the construction footprint for the proposal. No detail of the nature of contaminants was available from the ARTC Contaminated Site Register. Figure 20-2 provides the location of the ARTC contaminated land register sites.

Further investigation, during detailed design, is required to confirm the nature and extent of potential contamination at these sites, as outlined in section 20.7.

20.5.2.3 Potential for contamination

Based on the land zoning for areas surrounding the proposal, potential sources of contamination for the study area include:

- agricultural activities leading to soil, surface water and groundwater contamination from the discharge of agrochemicals and organic matter
- unknown and/or imported fill material along the rail corridor, which may contain asbestos material, hydrocarbons, heavy metals, agrichemicals and other contaminants
- rail activities (especially from diesel trains and transport of coal), which may discharge polycyclic aromatic hydrocarbons, heavy metals and other hydrocarbons
- nearby industrial activities, which may contain hazardous materials, including chemical storage, agrochemicals, heavy metals, polycyclic aromatic hydrocarbons and asbestos.

Railway corridors have the potential to contain various contaminated materials from historical and operational sources. Such sources relate to the long-term operation of the railway and the history of nearby contaminating activities. Possible sources of contamination may include fill materials, hazardous materials from structures, leaks and spills of fuels or chemicals, historical use of pesticides and asbestos dust from train brake pads.

The geotechnical assessments conducted as part of the EIS (GHD, 2017) required the excavation of 121 test pits along the Narrabri to North Star alignment, which included 23 test pits within the construction footprint for the proposal. Soil samples from these test pits were submitted to a National Association of Testing Authorities (NATA)-accredited laboratory for analysis of the following contaminants of potential concern:

- asbestos
- total recoverable hydrocarbons
- polycyclic aromatic hydrocarbons
- organochlorine pesticides

- heavy metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, and zinc)
- polychlorinated biphenyls.

The findings from the contamination assessment is outlined below.

The assessment criteria used by GHD for asbestos was taken from the site contamination NEPM and *Managing asbestos in or on soil* (WorkCover NSW, 2014). These provide guidance on what constitutes an 'acceptable' level of asbestos in soil. The site contamination NEPM emphasises that the assessment and management of asbestos contamination should take into account the condition of the asbestos materials, the potential for damage, and resulting release of asbestos fibres. No asbestos was detected in any of the samples within the construction footprint (GHD, 2017).

The contamination assessment confirmed that soils within the construction footprint of the proposal were suitable to remain within the construction footprint for the use proposed (that is, for railway purposes). Based on the findings of the contamination assessment, notification to the EPA under section 60 of the CLM Act is not required. Additionally, no visual or olfactory evidence of contamination was noted during the site investigation (GHD, 2017).

For the purpose of assessing the contamination status of the Narrabri to North Star alignment, including within the construction footprint for the proposal, GHD analysed the test pit samples to determine the human health risk. The assessment criteria (investigation levels) for the contamination assessment were taken from the following guideline levels provided by the site contamination NEPM (refer to Schedule B1 of the NEPM):

- health investigation levels (HILs) to assess human health risk via all relevant pathways of exposure
- health screening levels (HSLs) for hydrocarbon vapour intrusion under different land use scenarios.

The criteria for commercial and industrial premises (HILs and HSLs 'D' level) was adopted as the assessment criteria. The results of the laboratory analysis for samples taken within the construction footprint were below the laboratory limit of reporting or below the relevant human health-based screening criteria (GHD, 2017).

A preliminary soil waste classification was performed by GHD in 2017, which was used to guide any offsite soil disposal that may be required. The analyte concentrations in the tested soil samples were compared to the criteria in Table 2 of the *Waste Classification Guidelines—Part 1: Classifying waste* (EPA, 2014) (Waste Classification Guidelines). These samples were consistent with a General Solid Waste classification (GHD, 2017).

20.6 Impact assessment

This section assesses the potential soils and contamination impact associated with construction and operation of the proposal. Refer to Chapter 13: Surface water quality impact assessment for impacts relating to water quality as a result of soil erosion and Chapter 25: Health and safety (including hazardous materials) for impacts associated with the transport of hazardous materials and dangerous goods.

20.6.1 Risk assessment

Appendix C: Environmental risk assessment outlines the potential soils and contamination risks associated with the construction and operation of the proposal. The potential risks assessed as medium or above included:

- exposure and potential erosion or saline soils and/or ASS
- disturbance and erosion of soils during earthwork activities
- disturbance and mobilisation of existing contamination due to construction activities, causing further contamination of soils and groundwater
- changes to the soil surface, as a result of earthwork activities, vegetation clearing or creating embankments, resulting in erosion and sedimentation down-gradient
- contamination of land and waterways due to leaks and spills during construction.
- potential spill of contaminant from maintenance products and material.

Potential soils and contamination risks associated with the proposal would be managed in accordance with the relevant legislation and guidelines outlined in section 20.4. These risks would be considered during the design, construction and operation phases for the proposal and minimised through implementation of the mitigation and management measures discussed in section 20.7.

20.6.2 Construction impacts

20.6.2.1 Soils

Construction work that is likely to disturb soil includes:

- vegetation removal
- general earthworks and excavation
- reinstatement activities
- stockpiling of materials
- transport of construction materials and use of heavy machinery
- structure foundation works (e.g. bridge works)
- temporary work (i.e. access roads, compounds, laydown areas and pads).

If earthwork activities are not appropriately performed and managed, there is a risk of erosion of exposed soils and stockpiled material. Reinstatement activities also require minor earthworks, which may lead to erosion of disturbed soils if not managed properly. This may increase the sediment load entering local stormwater systems and generate an excess of dust in the air.

Vegetation removal and earthworks expose the ground surface, which could increase soil erosion through water runoff and wind. Heavy rainfall events may increase water runoff, further dispersing any loose soils and sediments from earthwork activities. This could impact the biodiversity in the area, by entering waterways and reducing the water quality for aquatic habitats, as well as changing the soil characteristics for the vegetation and habitat in nearby areas.

The removal of vegetation and topsoil could cause the water table to rise due to an increase in the amount of water infiltration, which may bring salt to the soil surface. Additionally, runoff from disturbed soils or stockpiled spoil may disperse acid sulfate soils or saline soils into receiving waterways; however, there is low risk of mobilisation of saline or ASS due to the low potential of occurrence in the local landscape.

Vehicle movement for transport of construction material and personnel, as well as transport and use of heavy machinery, could compact soils, erode surface soils and/or spread loose soil particles onto nearby paved roads.

Impact to soils (outside the corridor or in greenfield areas) as a result of construction activities associated with the proposal is considered unlikely. The majority of excavated spoil would be reused onsite, reducing the volume of spoil stockpiled onsite or transported to an offsite facility. The potential for soil erosion and runoff impacts during construction would be minimised through implementation of the mitigation measures described in section 20.7.

20.6.2.2 Contamination

Potential impacts attributable to construction might include:

- poor management of contaminated waste and hazardous materials (e.g. asbestos) leading to their escape into the environment
- use of contaminated material for fill or other purposes, allowing contaminants to migrate into the environment
- disturbance of contaminated soils, including rail contaminants, which may disperse them into local waterways through runoff or reduce air quality through dust accumulation
- accidental leaks or spills associated with vehicles and heavy machinery.

Incorrect management of contaminated waste or hazardous materials could pollute nearby ecosystems and waterways, as well as put site workers at risk of exposure to hazardous substances. Fuel and chemicals from vehicles and heavy machinery may also enter nearby receiving environments if not maintained appropriately.

Disturbance of contaminants in the soil during construction may put site workers at risk (through direct contact or inhalation when soil is dispersed into the air) or enter receiving environments (including waterways and surrounding ecosystems). Contaminated or hazardous fill material and spoil intended to be reused on site may disperse contaminants into the environment if not adequately detected.

The findings from this assessment and the site investigation conducted for the EIS for N2NS Phase 1 prepared by GHD, identify the potential for encountering contaminated land during construction as low. Asbestos was not detected within the construction footprint for the proposal during the site investigation (GHD, 2017).

There is potential for uncovering unexpected contamination during construction (particularly earthworks). Indicators of contamination may include:

- unexpected odours or stains
- asbestos containing materials
- underground or abandoned storage tanks or machinery
- buried waste materials
- imported fill materials.

Primarily impacts would be dependent on the nature, extent and magnitude of construction activities and their interaction with known and potential contaminated land sources. The potential for contamination impacts during construction would be minimised through implementation of the mitigation measures described in section 20.7.

20.6.3 Operation impacts

20.6.3.1 Soil

Potential impact to soils as a result of operational activities would include:

- surface soil erosion due to an increase in works associated with rail activities, including:
  - maintenance and repair activities, which may involve minor earthworks and disturb the soil
  - drainage networks
  - use of access roads
- dispersion of loose or eroded soils due to an increase in surface runoff.

Erosion of soils may disperse into nearby drainage systems, which may silt up cut batters, culvert crossings and drainage lines. The potential for soil erosion and runoff impacts during operation would be minimised through implementation of the mitigation measures described in section 20.7.

20.6.3.2 Contamination

Potential contamination impacts as a result of operational activities include:

- accidental fuel and chemical leaks/spillage due to rail activities
- fuel spillage during maintenance and repair activities, or uncovering unexpected contamination (including asbestos) during minor earthworks.

Accidental spills of petrol, chemicals or hazardous materials could contaminate nearby waterways and ecosystems if uncontrolled. The potential for contamination impacts during operation would be minimised through implementation of the mitigation measures described in section 20.7.

20.7 Mitigation and management

20.7.1 Approach to mitigation

During detailed design, a site-specific contamination investigation would be undertaken, which would assess the three sites listed on the ARTC Contaminated Site Register within the construction footprint of the proposal. Soil samples would be taken at each of these sites and analysed to determine the extent of contamination and any potential risks associated with the construction and operation of the proposal. Areas previously unsampled in the GHD EIS would also be investigated further to assess the area for asbestos and hazardous fill material, including between TP_3_200 and TP_3_201 (CH669.300 to 669.900), TP_3_208 and 2602_TP10 (CH671.700 to 672.500), TP_3_216 and 2602_TP11 (CH 672.600 to 673.400), 2601_TP12 and TP_3_220 (chainage 674.600 to 675.300) and between TP_3_224 and 2603_TP04 (chainage 676.800 to 677.800). This investigation would serve as an input to the design of the proposal and appropriate treatment measures would be identified.

Prior to construction, a Soil and Water Management Plan would be prepared as part of the CEMP in accordance with relevant guidelines, including *Managing Urban Stormwater: Soils and Construction Volume 1* and *Volume 2C: Unsealed roads*.

This management plan would include auditing and monitoring requirements to be implemented during construction.

A Contaminated Land and Hazardous Materials Management Plan would be developed as part of the CEMP to detail how potential and actual contaminated soils and materials would be managed to minimise the potential for on and offsite impacts. An unexpected finds protocol would be developed as part of the management plan to ensure that any unexpected contamination encountered during construction does not expose workers, site users and/or the environment to contamination in excess of regulatory guideline levels.

If contaminated areas are encountered prior to or during construction, appropriate control measures would be implemented to manage the immediate risks of contamination. The unexpected finds protocol would outline the activities to be undertaken, which would include making the site safe, carrying out an assessment of the finds, and managing the finds based on the results of the assessment. All other work that may impact on the contaminated area would stop until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions are identified in consultation with the ARTC Environment Manager and/or EPA.

The ARTC *Earthworks Materials Management Framework* (ETC-08-03 Rev 1.3) would be used as guidance for selecting earthworks materials for construction of railway earthworks that comply with relevant codes and standards for the management of contamination.

The Contaminated Land and Hazardous Materials Management Plan would consider the *NSW Waste Classification Guidelines* for handling and disposing any hazardous waste, including asbestos.

The *Lan-3 Contamination and remediation* credit from the ISCA 1.2 (ISCA, 2016) provides guidance for assessing contamination and achieving sustainable remediation, through the establishment of the sustainability hierarchy for remediation outlined in Figure 20-3. The Contaminated Land and Hazardous Materials Management Plan would include measures for treating any contaminated soil onsite/offsite to either destroy it or reduce associated risks to an acceptable level. If this cannot be achieved, the contaminated soil would be consolidated and isolated in a containment with a barrier or transported to an approved offsite facility. If an assessment of contaminated soil indicates that remediation is not a suitable approach (as it would not provide beneficial results or have adverse impacts to the environment), an appropriate management strategy would be implemented.

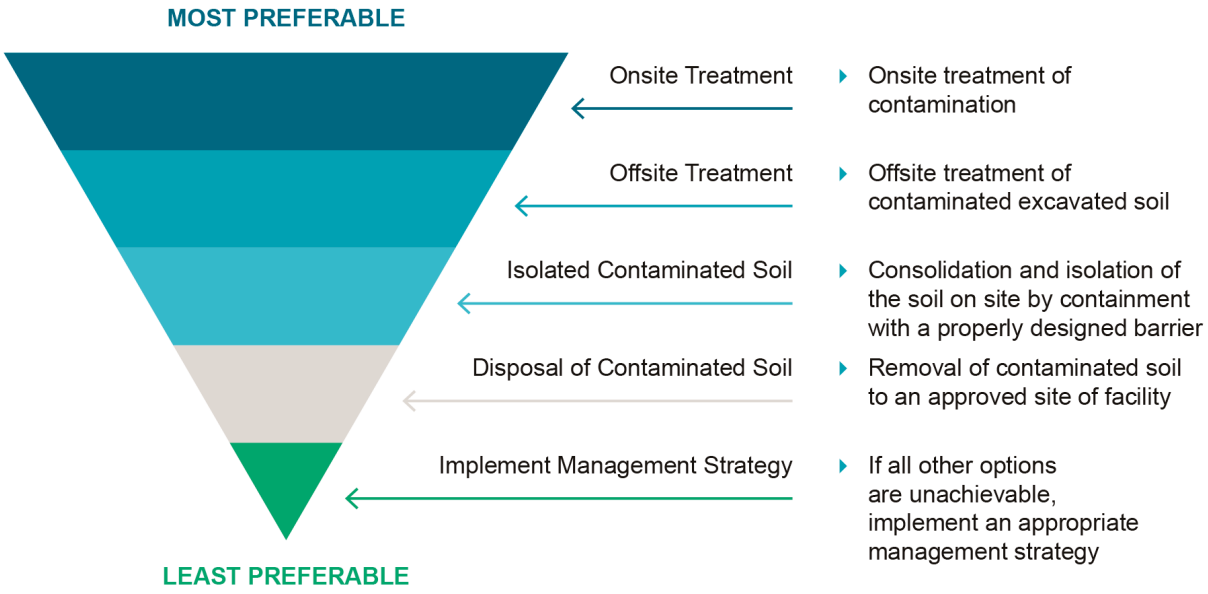

FIGURE 20-3 ISCA 1.2 SUSTAINABILITY HIERARCHY FOR REMEDIATION

Management of asbestos and hazardous waste will be included in the Spoil and Waste Management Plan, as described in Chapter 21: Waste.

Management of exposure of workers to contaminated soils will be included in the Health and Safety Management Plan, discussed in Chapter 25.

20.7.2 Interactions between mitigation measures

The mitigation measures provided in this chapter for soils and contamination may overlap with measures provided for the control of air quality, water quality, health and safety and waste management impacts. The CEMP would consolidate all of these measures and identify any common impacts and mitigation measures between different environmental aspects.

Mitigation measures in other chapters that are relevant to the management of potential impacts for soils and contamination include:

- Chapter 13: Surface water quality impact assessment; specifically, measures that address stormwater management and the migration of sediment into waterways
- Chapter 14: Groundwater; specifically, measures that address groundwater levels and the migration of contaminants through groundwater
- Chapter 21: Waste; specifically, storage and handling of waste material, including contaminated and hazardous material
- Chapter 25: Health and safety (including hazardous material); specifically, the storage and handling of hazardous materials.

Together, these mitigation measures would minimise potential impact of the proposal.

20.7.3 Summary of mitigation measures

The mitigation measures in Table 20-5 would be implemented during detailed design, construction and operation of the proposal to minimise soil and contamination impacts.

TABLE 20-5 SUMMARY OF SOIL AND CONTAMINATION MITIGATION MEASURES

Ref	Impact	Mitigation measure	Timing
SC-1	Soil structural integrity	Detailed design would include engineering measures to minimise operational risks from dispersive and/or low strength soils, particularly through foundation and batter design. Potentially dispersive soils were identified in areas southwest of Mehi River, adjacent to Moree (along CH665.00 and CH667.50), between TP_3_204 and TP_3_216 (CH671.00 and CH672.50) and at the northern section of the proposal (CH680.00).	Detailed design
SC-2	Soil management	A Soil and Water Management Plan (SWMP) would be prepared and implemented as part of the CEMP. The SWMP would identify risks relating to soil erosion and contamination and describe how these risks would be addressed during construction including for ancillary sites, site compounds and borrow sites. This SWMP would contain measures including: ▸ delegation of responsibilities for soil management and site practices ▸ location of site compounds and stockpile areas ▸ material and stockpile management ▸ surface water and erosion control measures.	Pre-construction/ construction
SC-3	Erosion management	An Erosion and Sediment Control Plan (ESCP) would be prepared and implemented as part of the SWMP in accordance with *Managing Urban Stormwater Soils and Construction (Blue Book)*. The plan would include arrangements for managing wet weather events, including monitoring of potential high-risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.	Pre-construction/ construction
SC-4	Management of sediments	Consistent with any specific requirements of the approved SWMP, control measures would be implemented to minimise risks associated with erosion and sedimentation, and entry of materials to drainage lines and waterways. That would include but not necessarily be limited to: ▸ sediment management devices, such as fencing, straw bales or sandbags ▸ measures to divert or capture and filter water prior to discharge, such as drainage channels and sediment basins ▸ scour protection and energy dissipaters at locations of high erosion risk ▸ installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays ▸ appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate. During operation, sediment and erosion control devices would be installed where soils are exposed—in accordance with *Managing Urban Stormwater: Soils and Construction*.	Construction and operation

Ref	Impact	Mitigation measure	Timing
SC-5	Contamination	A Contaminated Land and Hazardous Materials Management Plan would be prepared and implemented as part of the CEMP. The plan would include but not be limited to: ▸ further investigations during detailed design would be required to characterise contamination at the three contaminated sites identified in the ARTC register. This would be used to inform CEMP requirements ▸ identify methodology to manage excavation and spoil with known contaminated sites ▸ capture and management of any surface runoff contaminated by exposure to the contaminated land ▸ measures to ensure the safety of site personnel, environment and local communities during construction ▸ procedures for incident management and managing unexpected contamination finds (an unexpected finds protocol).	Detailed design, pre-construction and construction
SC-6	Contamination	If contaminated areas are encountered during construction, appropriate control measures would be implemented to manage the immediate risks of contamination. All other work that may impact on the contaminated area would cease until the nature and extent of the contamination has been confirmed, and any necessary site-specific controls or further actions are identified in consultation with the ARTC Environment Manager and/or EPA.	Construction
SC-7	Accidental spill	A site-specific emergency spill response plan would be developed, and include spill management measures, in accordance with the relevant EPA guidelines. The plan would address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including ARTC Environment Manager and/or EPA officers). ARTC's existing spill response procedures would be reviewed to determine applicability and suitability during operation. The adopted procedure would include measures to minimise the potential for impacts on the local community and the environment as a result of any leaks and spills.	Construction and operation
SC-8	Contamination	All requirements set out in the ARTC Earthworks Materials Management Framework (ETC-08-03 Rev 1.3) would be complied with, including meeting the criteria for earthworks, material selection and imported fill.	Design and construction
SC-9	Ongoing management	ARTC would routinely maintain all plant and equipment within the rail corridor to minimise any leaks of fuels and oils. During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction*.	Operation

SC-1	Soil management	A soil and water management plan (SWMP) would be prepared and implemented as a sub-plan of the CEMP. The SWMP would include a detailed list of measures that would be implemented during construction to minimise the potential for soil and contamination impacts, including:
		▸ soil/land conservation objectives for the proposal
		▸ management of problem soils (refer Chapter 20: Soils and contamination), such as:
		  ▸ cracking clays (vertosols) that are expected to be encountered directly south of the Macintyre River
		  ▸ saline soils, particularly in potential expression areas such as soil salt stores, artificial restrictions and roads
		▸ specification of the type and location of erosion and sediment controls
		▸ allocation of general site practices and responsibilities
		▸ material management practices
		▸ stockpiling and topsoil management, including prompt stabilisation of spoil mounds (e.g. through mixing of gypsum)
		▸ surface water and erosion control practices that take into account site-specific soil types.
			Pre-construction/ construction

Ref	Impact	Mitigation measure	Timing
SC-2	Soil structural integrity	Detailed design would include engineering measures to minimise operational risks from dispersive and/or low-strength soils, particularly through foundation and batter design.	Detailed design
SC-3	Erosion management	An erosion and sediment control plan (ESCP) would be prepared and implemented as part of the SWMP in accordance with *Managing Urban Stormwater Soils and Construction (Blue Book)*. The ESCP would include arrangements for managing wet weather events, including monitoring of potential high-risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather. Also refer to the flood mitigation measures.	Pre-construction/ construction
SC-4	Soils	Soil conditions across the study area would be appropriately characterised at a suitable scale in accordance with the SWMP prior to construction, to inform design and environmental management measures. This would include identification of potential/actual ASS, reactive soils, erosive soils, dispersive soils, saline soils, acidic soils, alkaline soils and contaminate soils.	Design and pre-construction
SC-5	Topsoil stripping and stockpiling	Topsoil would be stripped progressively in areas designated for construction and stockpiled separately onsite for use in rehabilitation and stabilisation works.	Construction
SC-6	Management of sediments	Consistent with any specific requirements of the approved SWMP, control measures would be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. Control measures would include but not necessarily be limited to: ▸ sediment management devices, such as fencing, straw bales or sandbags ▸ measures to divert or capture and filter water prior to discharge, such as drainage channels and sediment basins ▸ scour protection and energy dissipaters at locations of high erosion risk ▸ installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays ▸ appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate. During operation, any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction (Blue Book)*.	Construction and operation
SC-7	Contamination	A contaminated land and hazardous materials management plan would be prepared and implemented as part of the CEMP. The plan would include but not be limited to: ▸ further investigations during detailed design would be required to characterise contamination at the three contaminated sites listed in the ARTC register. Results would be used to further inform CEMP requirements ▸ identify methodology to manage excavation and spoil management with known contaminated sites ▸ capture and management of any surface runoff contaminated by exposure to the contaminated land ▸ measures to ensure the safety of site personnel, environment and local communities during construction ▸ procedures for incident management and managing unexpected contamination finds (an unexpected finds procedure).	Detailed design, pre-construction and construction

Ref	Impact	Mitigation measure	Timing
SC-8	Contamination	Site investigations would be undertaken by a suitably qualified and experience consultant as defined in Schedule B9 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 to assess exposure risks to site workers and other receptors as a result of disturbances to areas considered to be at a higher risk of being contaminated. The results of the site investigations would be assessed against the criteria contained within the National Environment Protection (Assessment of Site Contamination) Measure 1999 to determine the need for any remediation.	Design and pre-construction
SC-9	Contamination	If contaminated areas are encountered during construction, appropriate control measures would be implemented to manage the immediate risks of contamination. All other work that may impact on the contaminated area would cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the ARTC Environment Manager and/or the EPA.	Construction
SC-10	ASS	Prior to ground disturbance in high probability acid sulfate areas, testing would be carried out to determine the presence of ASS. If ASS are encountered, they would be managed in accordance with the *Acid Sulfate Soils Assessment Guidelines* (ASSMAC, 1998), and the *Waste Classification Guidelines—Part 4: Acid Sulfate Soils*.	Design and pre-construction
SC-11	Contamination	All requirements set out in the *ARTC Earthworks Materials Management Framework* (ETC-08-03 Rev 1.3) would be complied with, including meeting the criteria for earthworks material selection and imported fill.	Design, pre-construction and construction
SC-12	Contamination	The reuse or retention of contaminated or potentially contaminated material onsite (i.e. soil, ballast and timbers) would be subject to a risk assessment.	Design and pre-construction
SC-13	Ongoing management	ARTC would routinely maintain all plant and equipment within the rail corridor to minimise any leaks of fuels and oils. During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction*.	Operation
SC-14	Contaminants and unexpected finds	All staff and contractors working in ground-disturbing works would be provided with induction training in the identification of potential contaminated soil/material, relevant controls and the unexpected finds procedure.	Design and pre-construction