APPENDIX

I

Horizontal Clearances

Surface Water Impact Assessment

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ARTC INLAND RAIL

STOCKINBINGAL TO PARKES (S2P) – HORIZONTAL CLEARANCES

SURFACE WATER IMPACT ASSESSMENT

TABLE OF CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

GLOSSARY

AEP	Annual Exceedance Probability. The probability that a design event (rainfall or flood) has of occurring in any 1 year period.
Afflux	With reference to flooding, afflux refers to the predicted change, usually in flood levels, between two scenarios. It is frequently used as a measure of the change in flood levels, between an existing scenario and a proposal scenario.
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ANZG	Australia New Zealand Guidelines for Fresh and Marine Water Quality
ARR	Australian Rainfall and Runoff
AIDR	Australian Institute for Disaster Resilience
The Blue Book	The *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004) series of handbooks, also known as the Blue Book, are an element of the NSW Government's urban stormwater program specifically applicable to the construction phase of developments. These provide guidance for managing soils in a manner that protects the health, ecology and amenity of urban streams, rivers estuaries and beaches through better management of stormwater quality.
BoM	Bureau of Meteorology
Catchment	The area drainage by a stream or body of water or the area of land from which water is collected.
DO	Dissolved oxygen
EC	Electrical conductivity
EY	Exceedances per year. Used to define the frequency of occurrence of more frequent rainfall or flood events. For example, a design event (rainfall or flood) that has a chance of occurring once during every 6 month period is expressed as having 2 Exceedances per Year (2EY).
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Flood prone land	Land susceptible to flooding by the probable maximum flood. Note that the flood prone land is also known as flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. It is necessary to investigate a range of flood sizes before defining flood storage areas.

Floodplain	Area of land which is inundated by floods up to and including the probable maximum flood event (i.e. flood prone land).
GDE	Groundwater dependent ecosystems (GDEs) are defined as ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
GIS	Geographic information systems
Groundwater	Water found in the saturated zone below the water table or piezometric surface
Hydrology	Term given to the study of the rainfall and runoff process, including surface and groundwater interaction; with particular focus on the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
Impact	Influence or effect exerted by a proposal or other activity on the natural, built and community environment.
km	kilometres
NSW	New South Wales
PMF	Probable maximum flood. The flood that occurs as a result of the probable maximum precipitation on a study catchment. The probable maximum flood is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of flood prone land (i.e. the floodplain).
Peak discharge	The maximum discharge occurring during a flood event.
Peak flood level	The maximum water level occurring during a flood event.
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
(the) proponent	Australian Rail Track Corporation (ARTC)
(the) proposal	The construction and operation of the Horizontal Clearance section of Inland Rail.
proposal site	The area that would be directly affected by construction works (also known as the construction footprint). It includes the location of proposal infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds sites etc., that would be used to construct that infrastructure.
study area	The area that may be directly or indirectly affected by the proposal including receptors downstream of the proposal site.
Runoff	The amount of rainfall that ends up as streamflow, also known as rainfall excess.
Simple hazard	Referring to flood hazard, the simple hazard is the product of the maximum depth of floodwaters and the maximum velocity of floodwaters.
TDS	Total dissolved solids
TN	Total Nitrogen

TP	Total Phosphorous
TSS	Total Suspended Solids
WM Act	Water Management Act 2000 (NSW)
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

EXECUTIVE SUMMARY

The Stockinbingal to Parkes (S2P) project will enhance approximately 170km of existing ARTC Rail Corridor between Stockinbingal and Parkes.

Enhancement works are required to be undertaken for S2P at discrete sites to achieve the vertical and horizontal clearances and includes modifications, construction or removal of various structural and track assets along the alignment.

This report relates to Horizontal Clearance works which are proposed at six sites. The six sites are: Forbes Station, Wirrinya Yard, Caragabal yard, Quandialla Yard, Bribbaree Yard and Milvale Yard.

The purpose of this report is to assess the potential surface water impacts (i.e. including flooding, drainage and water quality) from constructing and operating the proposal and identify control measures required to reduce the impacts of the proposal.

The proposed works for the Horizontal Clearance sites will not directly affect the existing catchments and waterways. The design has been developed to mimic the existing drainage conditions; cess drains are proposed in few locations to facilitate the runoff from the rail formation to the drain outlets. Thus, there are no anticipated adverse impacts to flooding and drainage as a result of the proposed works.

The presence of construction compounds and requirement for earthworks during construction would have localised impacts on overland flow paths and water quality in runoff from the construction sites.

These potential impacts to drainage and water quality are localised and limited to the construction phase and can be managed through standard erosion and sedimentation controls and water management during construction.

Given the sites are located on an existing operational rail line there would not be any additional impacts as a result of the proposal.

Mitigation measures have been identified for both construction and operation phases of the proposal. These measures include standard construction management and mitigation strategies (as recommended in the Blue Book) to minimise sediment disturbance and soil mobilisation.

Implementation of the recommended mitigation measures during operation will result in a low likelihood of impact to waterways. These mitigation measures would be documented in line with Australian Rail Track Corporation's (ARTCs) procedures.

1 INTRODUCTION

1.1 OVERVIEW

The Australian Government has committed to delivering a significant piece of national transport infrastructure that will provide a safe, sustainable solution to the freight challenge that exists on Australia's east coast. The Inland Rail Project is a 1,700-kilometre interstate freight rail corridor that will connect Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland (QLD). The Stockinbingal to Parkes (S2P) section, is an enhancement project for Inland Rail Program. It is a 173-kilometre section of existing rail corridor located in regional NSW between the towns of Stockinbingal and Parkes.

A number of enhancement works (which do not constitute a complete upgrade of the track alignment) are required to be undertaken in this section, including modifications to, construction or removal of various structural and track assets along the alignment. Due to the number of enhancement works required along the S2P corridor, the environmental approvals have been split into four Review of Environmental Factors (REF) packages.

This Surface Water Impact Assessment has been prepared for the Horizontal Clearance works (the proposal) at six sites:

- Forbes Station and Yard
- Wirrinya Yard
- Caragabal Yard
- Quandialla Yard
- Bribbaree Yard; and
- Milvale Yard.

1.2 PURPOSE OF REPORT

The purpose of this report is to:

- assess the likely impacts of the proposal on the surface water environment (including flooding and drainage and stormwater/surface water quality) at the proposal site and within adjacent land; and
- identify control measures to reduce the likely impacts of the proposal.

1.2.1 PROJECT REQUIREMENTS

The following documents have been used to inform the project requirements:

1. Basis of Design: Phase 2 – Basis of Design, 2-9000-PEN-00-PR-10000-Rev5, ARTC May 2018 (BoD)
2. Service Brief: Service Brief – Albury to Illabo and Stockinbingal to Parkes, Design and Environmental Services, ARTC 2020.

1.2.2 BASIS OF DESIGN

Table 1.1 below summarises relevant criteria considered in this report extracted from the Basis of Design.

Table 1.1 Project requirements – BoD

ITEM	PERFORMANCE CRITERIA	SECTION IN THIS REPORT
Flood Immunity	Enhancement works must retain existing; track drainage, flood immunity and flood impacts must be no worse than existing.	Section 5.1.1, 5.1.3.4
Damage to Infrastructure	— The design must minimise the damage to the railway infrastructure, resulting from overtopping and scour. — If the formation is designed for overtopping with a flood immunity of less than AEP 2%, the railway must be designed to convey overtopping flows without damage. All bridges and culverts shall be designed to reduce the risk of scour. The scour risk will depend on the flow velocity as well as soil and vegetation types. Within upgrade and enhancement projects observational data should be used. — In the absence of soil data, the outlet velocity for all culverts should be less than 2.5m/s. In cases where there is a risk of scour, the design should incorporate scour protection measures to protect the infrastructure. Any design solutions must not inhibit maintenance activities.	Section 5.1.3.1, 5.1.3.2, 5.1.3.3, 5.1.3.4
Afflux	— For all drainage structures, the afflux must be determined and any impacts outside the railway corridor assessed. — The increase in flood level above the floor level of buildings must be less than 0.01m and this impact criterion must also apply to other sensitive infrastructure. In rural areas or where there is no flooding of buildings, infrastructure or other sensitive locations, this limit will depend on the local circumstances and a higher afflux may be permitted. — The afflux must be calculated at all drainage structures and waterways affected by the rail Infrastructure, including changes to any associated roads, and the changes in flood levels and impacts on properties outside the Rail corridor must be justified.	Section 5.1.3.1
Flood Assessment Procedures	The design must assess afflux produced by the drainage structures. This afflux should be acceptable to stakeholders including local authorities and government agencies, property owners, business operators and any other stakeholders. The allowable afflux will vary depending on specific circumstances, however some guidance is as follows. **a** where there are existing flood prone buildings (habitable and non-habitable), the afflux should be close to zero, with an afflux of 0.01 metre allowed above floor levels of existing buildings **b** the allowable afflux for neighbouring infrastructure such as roads, should generally also be no more than 0.01 metre unless specific permission is obtained **c** in other land use areas, the allowable afflux should be determined based on specific assessments, with a higher afflux possible in particular situations, but a lower afflux is required for specific sensitive locations **d** any relaxation of the allowable afflux will require agreement from all stakeholders and will generally require a risk assessment as well as consultation with affected stakeholders.	Section 5.1.3.1

ITEM	PERFORMANCE CRITERIA	SECTION IN THIS REPORT
Climate Change	The ARR interim guidelines may be revised in the future, so the impact of climate change on the design must be assessed considering the possibility that there may be changes in the future via a waiver and/or deviation.	Section 5.1
Water Quality	Design to be developed to achieve relevant water quality objectives (WQO) for the receiving waters (the ANZECC/ARMCANZ (2000) Guidelines for Fresh and Maine Water Quality and/or local objectives criteria or targets endorsed by State regulators).	Section 4.7 and 5.2
Environmental Impact	The railway infrastructure will impact on the environment in a number of ways, which must be mitigated. The design of drainage structures must ensure that scour and flow velocities should meet environmental criteria. Other environmental impacts associated with the drainage infrastructure include causing breaks in riparian corridors and impacts on fauna movement, including fish passage. The drainage infrastructure must be designed to meet environmental criteria established by the environmental advisors for the project.	

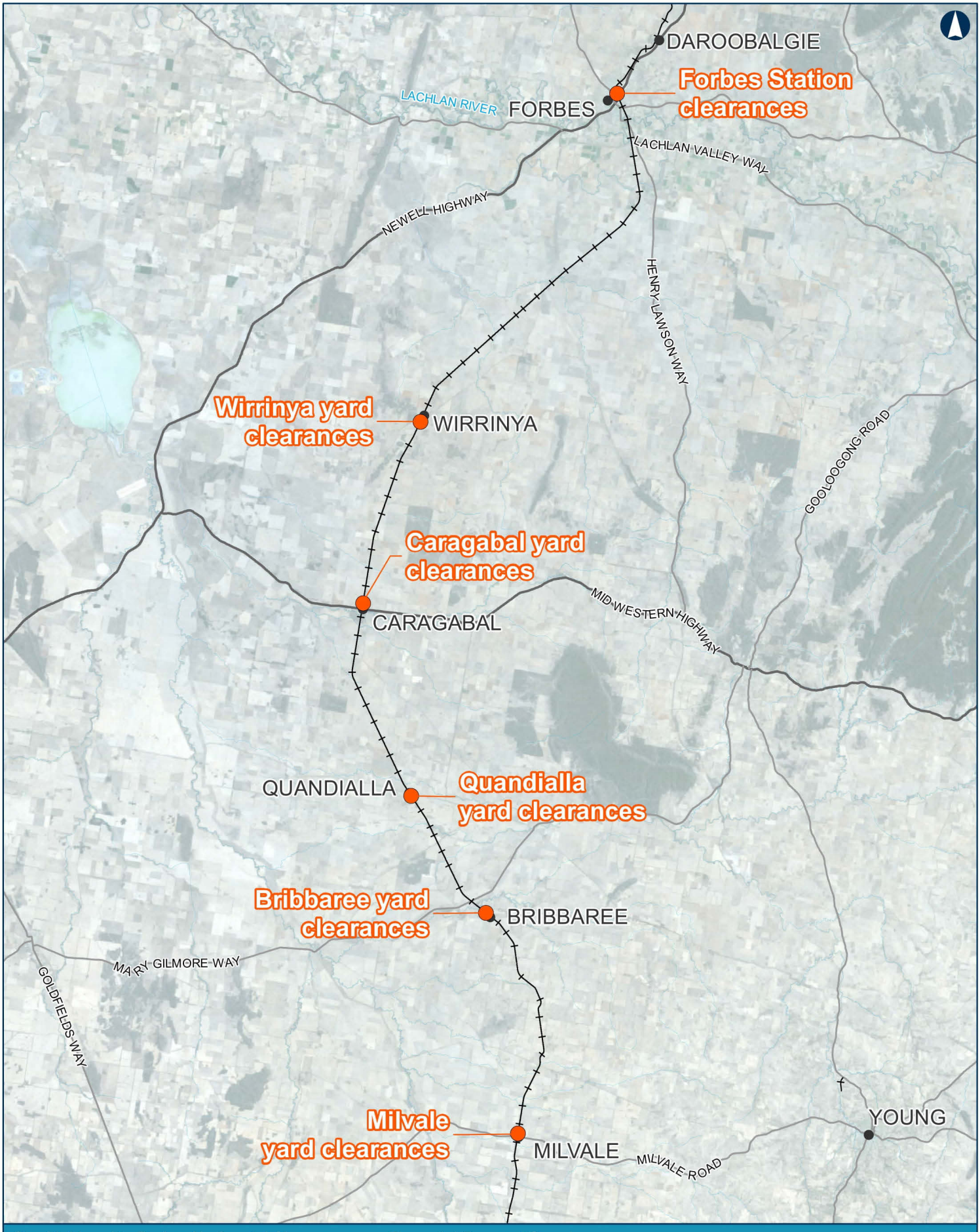
1.3 PROPOSAL AND LOCATION

The proponent is seeking to increase horizontal clearances within the rail corridor between Stockinbingal and Forbes, NSW (the proposal) to accommodate double stack freight trains up to 1800 metres long and 6.5 metres high. It is estimated that S2P would be trafficked by an average of around 12 trains per day in 2027, increasing to 18 trains per day in 2039. The existing horizontal clearances at the six sites shown in Figure 1.1 (the proposal site), do not provide the nominated clearance requirements to allow passage of the double stack freight trains.

The proposed works to achieve the required horizontal clearances include realigning the track away from the adjacent track or structures and by modifying the adjacent structures. Ancillary works include establishing construction compounds, laydown areas and environmental controls and adjusting signalling, communications, and utilities. The key proposed works at each site as described in Table 1.2 would be subject to detailed design.

Table 1.2 Key features of the enhancement sites

SITE	KEY FEATURES
Forbes Station and Yard	— Realignment of approximately 500m of the main line by up to 540mm and associated drainage works. — Realignment of approximately 140m of the goods siding track including installation of a new catch point. — Trimming of the platform awning at Forbes Station by 300mm for the full length.
Wirrinya Yard	— Realignment of approximately 520m of track by up to 350mm.
Caragabal Yard	— Realignment of approximately 250m of track by up to 30mm.
Quandialla Yard	— Removal of redundant pipework from a water tank adjacent to the track.
Bribbaree Yard	— Realignment of approximately 940m of track by up to 300mm, including formation and associated drainage works.
Milvale Yard	— Removal of redundant wiring from a water tank adjacent to the track.



Stockinbingal to Parkes Horizontal Clearances Figure 1.1 Proposal Overview

0 5 10 km

Coordinate System: GDA 1994 MGA Zone 55

Towns
Existing railway
Highway
Main road
Watercourse
Proposal site

Date: 5/08/2021 Paper: A3
Author: WSP Scale: 1:350,000
Data Sources: ARTC, NSWSS

INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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2 LEGISLATION, POLICY AND GUIDELINES

2.1 COMMONWEALTH LEGISLATION AND POLICY

2.1.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian Department of Agriculture, Water and the Environment and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

Under the EPBC Act, proposed actions (i.e. activities or proposals) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- matters of national environmental significance
- the environment of Commonwealth land; and
- the environment in general, if proposed actions are being carried out by an Australian Government agency.

There are no impacts to MNES or the environment of Commonwealth land as part of the proposal in relation to the matters assessed in this surface water impact assessment report.

2.1.2 NATIONAL WATER QUALITY MANAGEMENT STRATEGY (ANZECC / ARMCANZ 2018)

The National Water Quality Management Strategy (ANZECC / ARMCANZ 2018) has been developed by the Australian and New Zealand governments in cooperation with state and territory governments. Endorsed by the Australian and New Zealand Environment and Conservation Council, the strategy establishes objectives to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The National Water Quality Management Strategy includes guidelines for protection of water resources across Australia. These guidelines have been used to determine the existing condition of rivers and water quality objectives for the proposal.

2.1.3 AUSTRALIAN AND NEW ZEALAND GUIDELINES FOR FRESH AND MARINE WATER QUALITY (ANZG 2018/ ANZECC 2000)

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) is a key guideline within the National Water Quality Management Strategy that is used to identify catchment and waterway specific water quality management goals. These guidelines are an updated version of the previous guidelines referred to as the ANZECC 2000 guidelines.

The ANZG 2018 provide a risk-based process for assessing existing water quality condition and developing water quality objectives to sustain current or likely future environmental values for natural and semi-natural water resources. The ANZG 2018 provides default guideline values for water quality indicators for different environmental values. These guideline trigger values are considered as generic starting points for assessing water quality in areas where site specific information is not available and have been considered when describing the existing environment. The ANZG 2018 provide decision frameworks that help users tailor water quality guidelines to local environmental conditions.

2.1.4 WATER ACT 2007

The Water Act 2007 provides the legislative framework for ensuring that Australia's largest water resource—the Murray-Darling Basin—is managed in the national interest.

The Water Act:

- **establishes the Murray-Darling Basin Authority** (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way
- requires the MDBA to prepare the **Basin Plan** – a strategic plan for the integrated and sustainable management of water resources in the Murray-Darling Basin
- establishes a **Commonwealth Environmental Water Holder** to manage the Commonwealth's environmental water to protect and restore the environmental assets of the Murray-Darling Basin, and outside the Basin where the Commonwealth owns water
- provides the Australian Competition and Consumer Commission (ACCC) with a key role in developing and gives the **Productivity Commission** a role in reporting on the effectiveness of the implementation of the Murray-Darling Basin Plan and water resource plans and the progress towards achieving the objectives and outcomes of the National Water Initiative.

2.2 STATE LEGISLATION AND POLICY

2.2.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) provides a framework for environmental planning and assessment in NSW. The EP&A Act also determines the consent authority for the project. The Act allows for the development to occur as exempt, with consent or without consent. The proposal is assessed under Division 5.1 of the EP&A Act and Section 5.5 of the EP&A Act requires a determining authority to examine and consider to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. ARTC is both the proponent and the determining authority. Where the outcome of the environmental assessment is the decision that the proposal is not likely to significantly affect the environment, the proposal can proceed without consent under Division 5.1.

2.2.2 STATE ENVIRONMENTAL PLANNING POLICY (INFRASTRUCTURE) 2007

The State Environmental Planning Policy (Infrastructure) (Infrastructure SEPP) guides the delivery of key infrastructure development across the state including rail infrastructure facilities. Clause 79(1) of the Infrastructure SEPP permits development for the purpose of a 'railway or rail infrastructure facilities' to be carried out on any land by or on behalf of a public authority without consent. As the proposal falls under the definition of 'Rail Infrastructure Facilities', development consent is not required.

Part 2 of the Infrastructure SEPP contains provisions for public authorities to consult with local prior to the commencement of certain types of development. Consultation undertaken with Forbes Shire Council and other relevant public authorities for the proposal is described in Chapter 5 of the REF.

2.2.3 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) recognizes the need to allocate and provide water for the environmental health of rivers and groundwater systems, while also providing license holders with access to water. The WM Act focuses on protecting, enhancing and restoring water resources and encouraging best practice management and use of water.

Under Section 91 of the WM Act a controlled activity approval is required for certain types of developments and activities that have the potential to affect water quality that are carried out at a specified location in, on or under waterfront land. The design and construction of the proposal would consider the NSW Office of Water's guidelines for controlled activities on waterfront land to enable the mitigation of potential impacts to water quality.

2.2.4 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes, amongst other things, the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. The proposal is classified as a 'scheduled activity' and the POEO Act provides that environment protection licences (EPL) are generally required for scheduled activities or scheduled development work.

ARTC currently holds a licence to carry out railway systems activities on other parts of the NSW rail network (licence number EPL3142). Licensing requirements for the proposal would be considered in for construction. Operational requirements of the EPL relevant to surface area:

2.2.5 NSW WATER QUALITY OBJECTIVES

Consistent with the ANZG 2018 framework, the NSW Government has endorsed environmental values for surface waterbodies and identified water quality objectives for each catchment in NSW. These are presented in the NSW Water Quality and River Flow Objectives ('NSW WQO') (Office of Environment and Heritage, 2006). These were adopted following extensive consultation with the community in 1998. The NSW WQO set out:

- the community's values and uses for rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help assess the current condition of waterways and whether they support those values and uses.

The water quality objectives are the specific water quality targets agreed between stakeholders, or set by local jurisdictions, that become the indicators of management performance. These limits or descriptive statements are selected to support and maintain the environmental values of the catchment. They are consistent with the agreed national framework for assessing water quality set out in the ANZG 2018. Essentially, the NSW WQO provide the environmental values, water quality objectives and indicators for NSW water and refers to the ANZG 2018 for default guideline trigger values technical guidance in applying these values.

The guideline trigger values are concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' a management response, e.g. further investigation and subsequent refinement of the guidelines according to local conditions. Assessing whether the exceedance means a risk of impact to the water quality objective requires site-specific investigation, using decision trees provided in the ANZG 2018. If the trigger values are not exceeded, a very low risk of environmental damage can be assumed.

Refer to Appendix A for the NSW Environmental Values, Water Quality Objectives and Criteria.

2.2.5.1 ENVIRONMENTAL VALUES

The NSW WQO categorise and map the rivers and streams within NSW catchments. The catchment affected by the proposal is the Lachlan River catchment. All streams within the proposal site are categorised as 'Uncontrolled Streams', that is streams, wetlands and natural lakes that have largely natural flow patterns and are not major rivers, within estuaries, or urban areas. The environmental values applicable to the proposal are:

- aquatic ecosystems
- visual amenity
- primary contact recreation
- secondary contact recreation
- livestock water supply
- irrigation water supply
- homestead water supply
- drinking water at point of supply – Disinfection only, Groundwater, Clarification and disinfection
- aquatic foods (cooked).

All criteria and water quality indicators associated with the environmental values for the proposal are shown in Appendix A. It is noted that the NSW WQO were completed prior to the ANZG 2018 update and as such still reference the ANZECC 2000 guidelines.

2.2.6 MURRAY-DARLING BASIN PLAN 2012

The Murry Darling Basin Plan (the Basin Plan) was developed in 2012 to manage water in the Basin as a connected system. The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level while supporting farming and other industries.

New water quality targets for catchments were developed under the Basin Plan because the State of the Environment report (NSW, EPA, 2012) noted that there was little relationship between standard water quality targets and aquatic ecosystem health, due to the highly variable nature of natural water quality regionally (Department of Primary Industries – Water, 2015).

The Basin Plan water quality targets for turbidity, total phosphorus, total nitrogen, dissolved oxygen and pH were developed following the methods outlined in the ANZECC Guidelines (2000). Water quality data for rivers and streams in 'reference' condition from each of the water quality zones were used to develop the target values for each zone (Tiller and Newall 2010). Where there were no reference sites, the appropriate default trigger value from the ANZECC Guidelines (2000) for slightly to moderately disturbed systems were used.

Schedule 11 of the Basin Plan 2012 outlines water quality zones and provides water quality targets which are used to assess water quality at inland monitoring stations. These replace the previous default trigger values for slightly disturbed ecosystems listed in the National Water Quality Management Strategy and are reproduced in the water resource plans for each sub catchment of the Murray Darling Basin along with water quality objectives for each catchment.

The Basin Plan 2012 requires the preparation of water resource plans (WRP). The water resource plans set rules on how much water can be taken from the Basin, ensuring that the sustainable diversion limit is not exceeded over time. The Murray-Darling Basin Authority (MDBA) is responsible for monitoring and enforcing compliance with water resource plans. The proposal will be governed by the NSW Lachlan surface water resource plan. As of January 2021, the Lachlan WRP is under revision, however, reference has been made to the WRP as prepared in 2018.

The WRP provides a water quality management plan to support water quality management within the catchments. These management plans provide a framework to protect, improve and restore water quality. The NSW Lachlan surface water WRP divides the Lachlan catchment in to a number of zones. The proposal is in zone B3 Lachlan Valley Upland zone. The WRP includes water quality objectives and associated targets for the zone as shown in Table 2.1. Electrical conductivity targets are not described for each water quality zone of the Murray-Darling Basin Plan. Instead, the Plan adopts End-of-Valley salinity targets, as described in Schedule B Appendix 1 of the Commonwealth *Water Act 2007* and shown in Table 2.2.

Table 2.1 Water quality targets under the Basin Plan for B3 Lachlan Valley, Upland zone

INDICATOR	TARGET
Turbidity (NTU) (Annual median)	20
Total Phosphorus (µg/L) (Annual median)	35
Total Nitrogen (µg/L) (Annual median)	600
Dissolved oxygen (mg/L; or saturation (%) (Annual median within the range)	90–110% or >8mg/L
pH (Annual median within the range)	7.0–8.0
Salinity	End-of-Valley targets for salinity
Temperature (Monthly median within the range)	Between the 20%ile and 80%ile of natural monthly water temperature
Pesticides, heavy metals and other toxic contaminants (values in table 3.4.1 of the ANZECC Guidelines for) (Must not be exceeded)	The protection of 95% of species

Table 2.2 End of valley salinity targets

WATER QUALITY ZONE	ECOSYSTEM TYPE	END OF VALLEY TARGETS (AS ABSOLUTE VALUES)		
		Salinity (EC µS/cm)		Salt load (t/yr)
		Median (50%ile)	Peak (80%ile)	Mean
Lachlan River	Streams, rivers, lakes, wetlands	460	693	275,500

2.3 RELEVANT GUIDELINES

Table 2.3 Other relevant guidelines for the hydrology assessment

AUTHORITY	NAME	DESCRIPTION
Commonwealth, Geoscience Australia	Australian Rainfall and Runoff 2019 (Ball et al. 2019)	Australian Rainfall and Runoff (ARR, 2019 prepared by Ball et al 2019) is a national guideline for the estimation of design flood characteristics in Australia. The aim of the guide is to provide the best available guidance and information on design flood estimation in a manner suitable for use by Australian practitioners to be able to estimate the design flood problem, flood processes, and engineering hydrology.
Commonwealth, Australian Institute for Disaster Resilience	Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, Handbook 7, 2017	This guide prepared by the Australian Institute for Disaster Resilience (AIDR) has been developed to provide guidance on the national principles supporting disaster reliance in Australian through the management and publication of this Handbook and others for other types of hazards. This Handbook is supported by six additional guidelines that cover specific aspects of flood risk management and a practice note to assist with land use planning. This Handbook has been considered when developing criteria for managing flood risk from the proposal and compliments the NSW Floodplain Development Manual (DIPNR 2005) by outlining current best practices for flood risk management.

AUTHORITY	NAME	DESCRIPTION
NSW, Department of Natural Resources	NSW Government's Floodplain Development Manual, 2005	This is the NSW Government's Manual relating to the management of flood liable land in accordance with Section 733 of the Local Government Act 1993. The manual supports the NSW Government's Flood Prone Land Policy in providing for the development of sustainable strategies for managing human occupation and use of the floodplain. The manual applies to floodplains across NSW, in both urban and rural areas. It is also used to manage major drainage issues in local overland flooding areas.
NSW Office of Environment and Heritage	Floodplain Risk Management Guide: Incorporating 2016 Australian Rainfall and Runoff in studies, 2019	The Floodplain Risk Management Guide defines the principles to understand and manage flood risk. The guide provides specific advice on when to consider ARR2016 in studies and how to consider the outcomes of assessments of ARR2016 in decisions. It discusses model selection, runoff routing application and provided advice on the limitations of using the ARR.
NSW, Department of Primary Industries	Guidelines for controlled activities on waterfront land, 2012	Provide guidance on development and activities on waterfront land.
NSW, Office of Environment and Heritage	Guidelines for developments adjoining land and water, 2013	Managed by the Department of Environment, Climate Change and Water it provides guidance on development and activities on waterfront land.
Forbes Shire Council	Forbes Development Control Plan 2013	The purpose of the Forbes Development Control Plan 2013 (DCP) is to guide development within the Forbes LGA. Chapter 4 outlines the development guidelines with respect to flooding and flood affected land.
Landcom	Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition (The Blue Book), 2004	The Managing Urban Stormwater – Soils and Construction (Landcom, 2004) series of handbooks are an element of the NSW Government's urban stormwater program which provide best practice for management of stormwater during construction works for a wide variety of proposals. They provide guidelines, principles, and recommended minimum design standards for good management practice in erosion and sediment control during construction works. Of particular relevance to the proposal is Volume 1, 4th Edition (commonly known as The Blue Book).
ARTC	Inland Rail Program Environmental Management Plan, February 2018	Provides a framework for environmental management across all inland rail projects.

AUTHORITY	NAME	DESCRIPTION
NSW Department of Primary Industries	Lachlan Surface Water Resource Plan, DPI, 2018	The NSW Government is developing water resource plans (WRPs) as part of implementing the Basin Plan 2012 (the Basin Plan). Water resource plans will align Basin-wide and state-based water resource management in each water resource plan area. The WRPS set out rules for water use and outline how each area will achieve the community, environmental and other outcomes outlined in the Basin Plan.
NSW Department of Primary Industries	Lachlan Water Quality Management Plan, DPI, 2018	The Lachlan water quality management plan is a sub plan of the Lachlan WRP. It uses best available information to maintain, implement or develop measures to improve water quality for water resource managers.

3 METHODOLOGY

This chapter outlines the methodology undertaken to assess potential surface water impacts (i.e. water quality, flood and drainage) and identify mitigation measures for the proposal sites.

3.1 STUDY AREA

The proposal sites are located within the Lachlan river catchment and minor watercourse within these catchments (Figure 4.2). Based on review of aerial photographs, topography and other relevant data sources, the study area was considered to be the proposal site with an initial buffer area of 200 metres.

The technical study area for the hydrology, drainage and flooding and water quality impact assessment is the area that may be directly or indirectly affected by the enhancement sites including sensitive receiving environments downstream of the proposal sites.

3.2 DRAINAGE AND FLOODING

The Horizontal Clearance works have negligible changes to the existing drainage conditions (i.e. no changes to the existing catchments and waterways and minimal shift in the vertical alignment of the track). Thus, the drainage and flood impact assessment has been undertaken based on the tasks indicated below:

- review of flooding information available to identify the extent of the flood plain at the proposal sites
- review of any historic information and other studies to inform flood behaviour and also inform existing waterway health and flood risks/mechanisms across the study area
- review of the proposed horizonal clearance works to identify changes to the existing waterways, drainage and flood conditions that may cause impacts.

Given the minor nature of the works to be carried out and that the proposed design for each site is to match existing drainage and flood conditions, no drainage and hydraulic modelling was undertaken.

3.3 WATER QUALITY

The following methodology has been used to understand the existing water quality environment in the study area and to assess potential construction phase, operation phase and cumulative water quality impacts.

3.3.1 DESKTOP REVIEW

A desktop review was carried out to assess the potential water quality impacts of the proposal.

This included:

- review of relevant legislation and guidelines including:
  - Lachlan River Water Quality and River Flow Objectives (NSW OEH, 2006)
  - ANZG 2018 guidelines (previously known as ANZECC 2000)
  - Murray-Darling Basin Plan 2012
  - Lachlan Water Quality Management Plan (DPI, 2018)
  - NSW State of the Environment (NSW Environmental Protection Authority (EPA), 2018)
- establish existing environmental conditions; publicly available catchment data and reports was used to establish the existing environment and likely water quality of the waterways surrounding the proposal site

— cross reference to the Hydrogeology, Contaminated Land and biodiversity impact assessment chapter prepared for the proposal; and

— review of the proposal design features (i.e. culverts, drainage channel and other structures) near waterways.

3.3.2 IMPACT ASSESSMENT

Based on the review of the existing environment (Chapter 4 of this report) there are limited sensitive receivers within or near the proposal site. Therefore, a qualitative assessment has been carried out for this report. All waterways within 200 metres of the proposal site are ephemeral meaning there is no site-specific water quality data available against which to quantify any potential changes.

The qualitative assessment of the potential water quality impacts considers:

— the existing water quality environment
— the potential pollutants and impacts to the water quality environment from construction and operation activities
— the effectiveness of the identified mitigation measures; and
— any residual impacts post-mitigation and the likely performance against the water quality objectives.

The construction impact assessment aims to identify potential water quality impacts based on current understanding of the construction approach and construction methods.

The operational impact assessment identifies potential impacts to water quality during operation of the proposal.

Based on these assessments, this report provides recommendations for mitigation measures during operation to minimise and manage potential impacts to waterways. These are detailed in Chapter 6.

4 EXISTING ENVIRONMENT

4.1 CATCHMENT AND WATERBODIES

The proposal is located in the Lachlan River catchment of the Murray-Darling Basin. Figure 4.1 shows the major catchment areas in NSW.

Figure 4.1 Major catchments in NSW (NSW Office of Water, 2011)

The Lachlan catchment occupies an area of around 90,000km^2. The major watercourse of this catchment is the Lachlan River which runs for 1339km in a general westerly direction from the Breadbane Plain between Goulburn and Yass, to the Murrumbidgee River near Oxley.

The Forbes Station site is located in the Lake Forbes and Back Yamma subcatchments. Lake Forbes is a large body of water in Forbes that joins the Lachlan River to the west of Forbes.

The northern portion of the Wirrinya Yard is located in the Ooma Creek and tributaries sub catchment. Ooma Creek rises near Weddin Gap and flows in a northerly then westerly direction until it reaches Culingatel Lagoon and Jemalong Creek north of the Newell Highway near Wirrinya.

The Caragabal, Quandilla, Bribbaree, Milvale and the southern portion of the Wirrinya Yard are located within the Western Bland Creek subcatchment. Western Bland Creek is a semi perennial creek which runs from west of Cootamundra to Lake Cowal. Bribbaree Creek and Wah Wah Creek which are located nearby the Quandilla and Bribbaree enhancement sites, are tributaries to Bland Creek.

4.2 WATERBODIES NEAR THE PROPOSAL

Table 4.1 describes the waterways and farm dams crossed by or located near the proposal site. These waterways and farm dams are also shown in Figure 4.2.

Table 4.1 Waterways and farm dams near or crossed by the enhancement sites

ENHANCEMENT SITE	WATER WAY	FARM DAMS
Forbes Station and Yard	Both Lake Forbes and Lachlan River are located about 250m and 2km respectively to the south downstream of the site.	One farm dam located 120m to the north-west of the site. The site is not expected to drain to this farm dam.
Wirrinya Yard	A drainage channel crosses the rail corridor 470 metres south of the site at chainage 554.02km. The drainage collects surface water runoff from upstream (east of the site) catchment. Unnamed water course is located 7km south of the site. The unnamed water course discharges to Sandhill Plain Creek.	One farm dam is located approximately 35m to the east of the site. Two farms dams are located approximately 60m to the south downstream of the site.
Caragabal Yard	Caragabal Creek is located 500m to the south downstream of the site.	One farm dam located 100m to the east, which the site would drain towards and one farm dam is located 150m to the west, which are not expected to receive runoff from the site.
Quandialla Yard	Unnamed tributary to Wah Wah Creek is located about 170m to the east downstream of the site.	Three farm dams located on the tributary are over 160m to the north east downstream of the site. One farm dam located 190m to the south east upstream of the site.
Bribbaree Yard	Bribbaree Creek located 500m to the north west downstream of the site.	One farm dam located adjacent to the site to the south and five farm dams located about 100m to the north which the site would drain towards.
Milvale Yard	Unnamed tributary to Milvale Creek located about 500m to the south downstream of the site.	One farm dam located 150m to the south. One located 120m east. Four dams located along the tributary to Milvale Creek downstream of the site.

Stockinbingal to Parkes Forbes Station & Wirrinya Yard Clearances Figure 4.2 Waterways and Farm Dams Located in the Proposal Site

0 2 4 km

Coordinate System: GDA 1994 MGA Zone 55

Date: 3/08/2021 Paper: A3
Author: WSP Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Proposal site
- Watercourse
- Waterbodies

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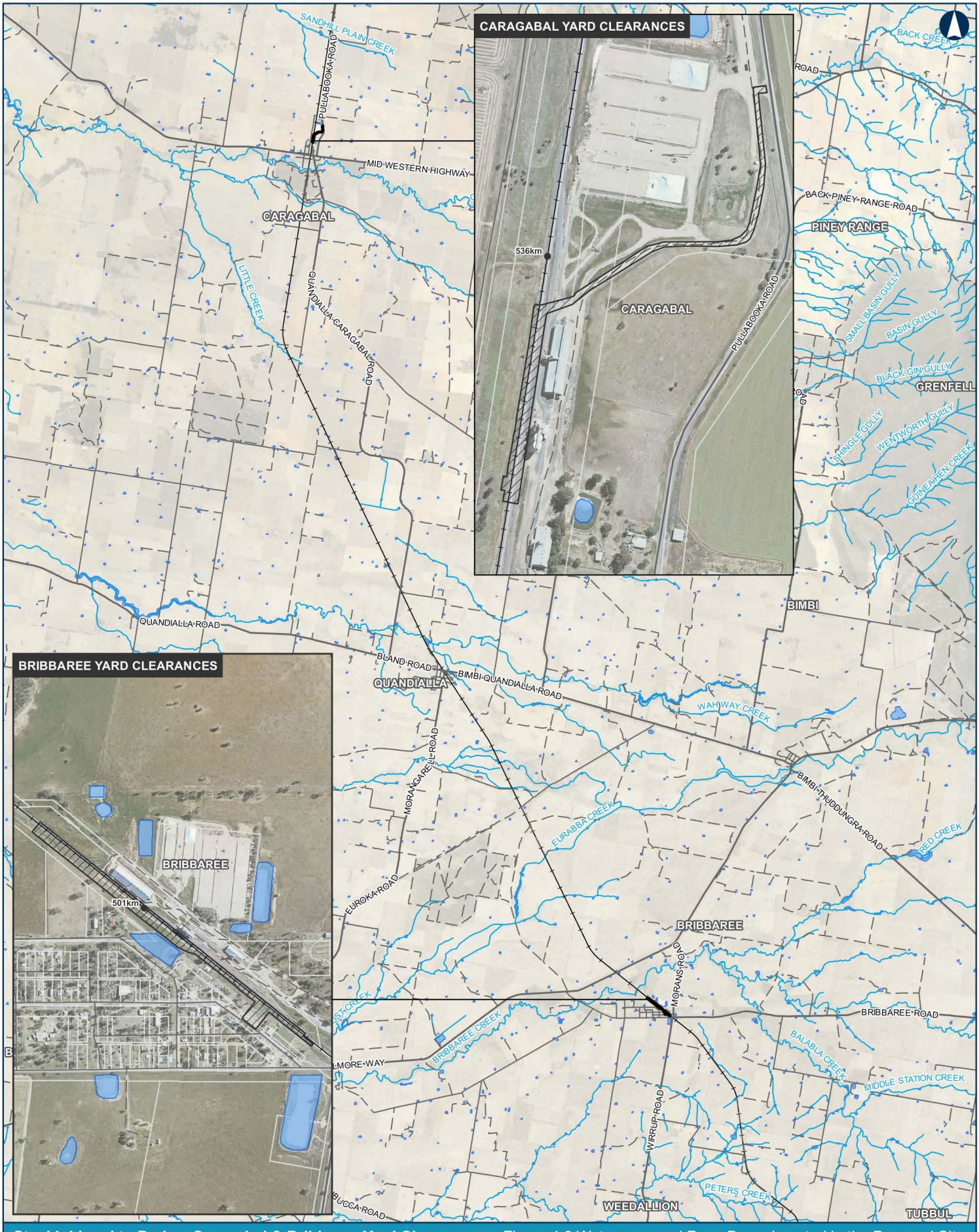

Stockinbingal to Parkes Caragabal & Bribbaree Yard Clearances Figure 4.2 Waterways and Farm Dams Located in the Proposal Site

0 2 4 km

Coordinate System: GDA 1994 MGA Zone 55

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Date: 3/08/2021 Paper: A3
Author: WSP Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Proposal site
- Watercourse
- Waterbodies

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Stockinbingal to Parkes Quandialla & Milvale Yard Clearances

Figure 4.2 Waterways and Farm Dams Located in the Proposal Site

0 2 4 km

Coordinate System: GDA 1994 MGA Zone 55

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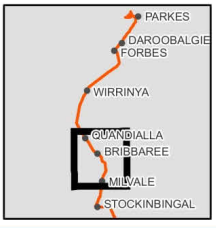
Date: 5/08/2021
Author: WSP
Paper: A3
Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Proposal site
- Watercourse
- Waterbodies



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4.3 TOPOGRAPHY AND DRAINAGE

Table 4.2 describes the topography and general drainage patterns at each enhancement site. Topographic contours at each site are shown on Figure 4.3.

Table 4.2 Topography and drainage of the enhancement sites

ENHANCEMENT SITE	TOPOGRAPHY AND DRAINAGE DESCRIPTION
Forbes Station and Yard	The area is generally flat and there are no formal cess drains along the rail corridor. Surface water runoff flows according to the topography in southern direction. Part of the surface water runoff is intercepted by drainage at CH 597.400km.
Wirrinya Yard	The site is located at 268m elevation and slopes to south west. surface water runoff flows according to the topography in south west direction towards the farm dam located to the east of the site.
Caragabal Yard	The site is at about 226m elevation. The surrounding area is generally flat, at about 224 to 226m elevation. Surface Water runoff gently flows according to the local topography.
Quandialla Yard	The site is located at about 247m elevation. The area is generally flat and there are no formal cess drains along the rail corridor. The land slopes away from the rail on both sides, towards the tributary on the northern side and in a north west direction towards Wah Wah Creek on the southern side.
Bribbaree Yard	The site is located at about 258m to 254m elevation. The surrounding land generally slopes to the north west towards Bribbaree Creek. There are localised low points around the farm dams present. Surface water runoff flows according to the topography
Milvale Yard	The site is located at about 278m. The surrounding land slopes generally to the south and west towards to tributary to Milvale Creek. There is a localised low point at the farm dam located to the east.

4.4 LAND USES

Table 4.3 describes the land use at each of the enhancement sites based on aerial photography. The description includes the designated land zones as per the relevant local environmental plans. Figure 4.3 also shows the land use areas at the enhancement sites. All enhancement sites have historical use as a rail corridor, with rail loading infrastructure adjacent.

Table 4.3 Land uses at the enhancement sites

ENHANCEMENT SITE	LAND USE DESCRIPTION
Forbes Station and Yard	The area to the west of the site contains largely low density residential areas, mixed with some local shopping and industrial sites. This is zoned as IN1 General Industrial, B2 Local Centre and R1 General Residential. The east of the site is zoned as B5 Business Development which contains industrial sites. To the south east is the Forbes golf course which is zoned as RE2 Private Recreation.
Wirrinya Yard	All land surrounding this site is zoned as RU1 Primary Production. The land is largely cleared agricultural land. There are some vegetated areas to the east of the site. Adjacent to the site on the eastern side are some buildings and cleared road and storage area.
Caragabal Yard	The area on the southern side of the site is zoned as RU5 Village and contains low density residences. There is cleared unvegetated land located on the eastern side of the enhancement site around the rail station. The rest of the area to the northern half of the site is cleared agricultural land zoned as RU1.
Quandialla Yard	The area on the western side of the enhancement site is zoned as RU5 Village and contains low density residences. There is cleared unvegetated land located on the eastern side of the enhancement site around the rail station. The rest of the area on the eastern side of the site is cleared agricultural land zoned as RU1.
Bribbaree Yard	The area on the southern side of the enhancement site is zoned as RU5 Village and contains low density residences. Aerial photography indicates there is a scrap yard located on the south western side of Short Street. There is cleared unvegetated land located on the northern side of the enhancement site around the rail station. The rest of the area is cleared agricultural land zoned as RU1.
Milvale Yard	The land is zoned as RU1 Primary Production. The surrounding land is cleared agricultural land. And some rural residences located to the south and south-east.

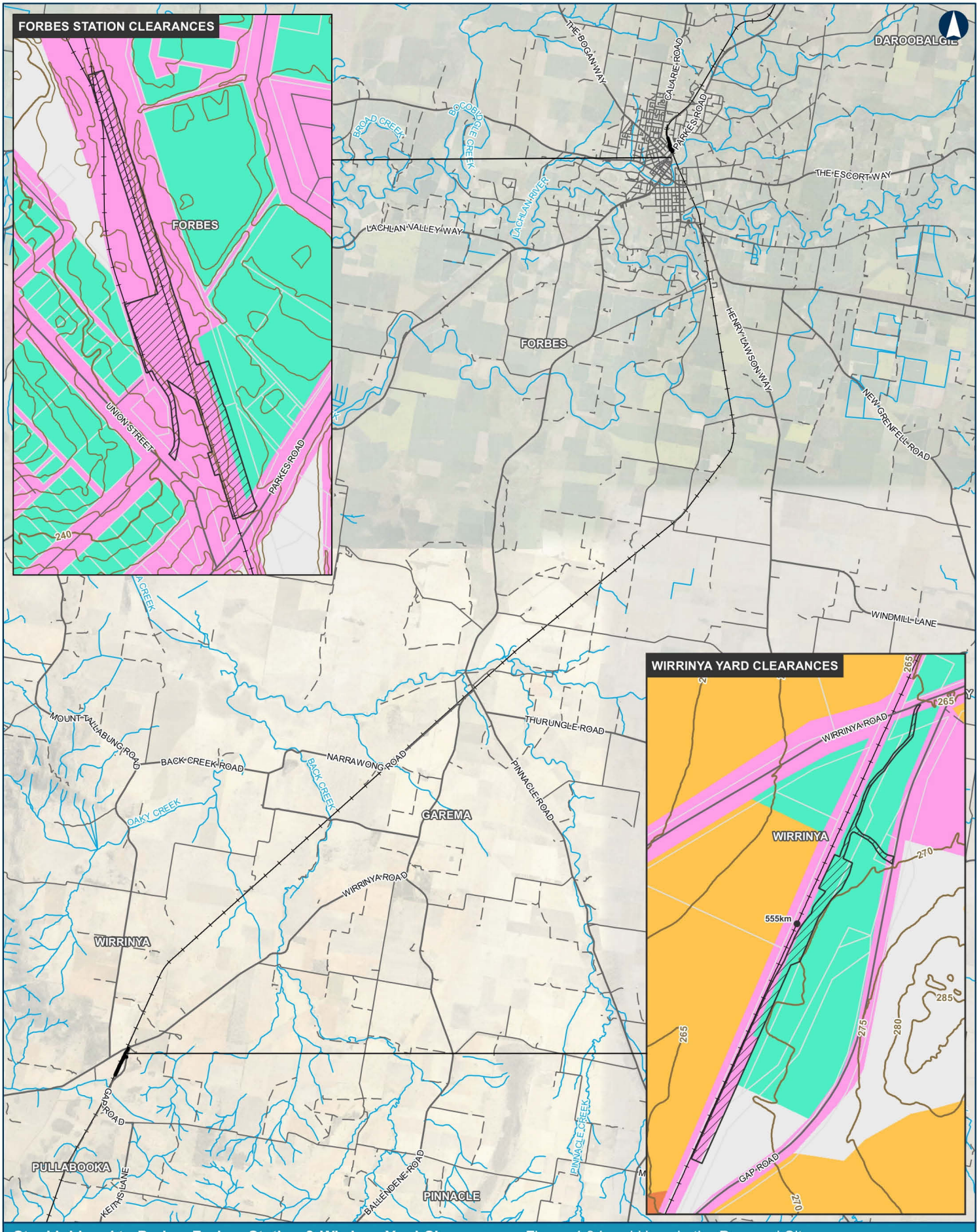
4.5 CLIMATE AND RAINFALL

The climate of the area is described as being temperate, zone 4 (i.e. hot dry summer and cool winter). There is large temperature variation across the year with temperatures ranging from an average high of 32.7 degrees in summer to an average low of 2.7 degrees in winter months (BoM, Forbes (Camp Street), station no: 065016).

The average annual rainfall and rainfall patterns at each site are described in Table 4.4.

Table 4.4 Rainfall patterns at the enhancement sites

ENHANCEMENT SITE	NEAREST WEATHER STATION	MEAN ANNUAL RAINFALL	RAINFALL DESCRIPTION
Forbes Station and Yard	Forbes (Muddy Water) station no: 65039	496.9mm	Rainfall is usually low with slightly higher rainfall from October to March and lower rainfall in the winter months.
Wirrinya Yard	Garema (Forest Lodge) station no: 065072	589.9mm	The rainfall is fairly even across the year with the highest average rainfall at 48.4mm in February and the lowest at 37.8mm in April.
Caragabal, Quandialla and Bribbaree Yard	Quandialla Post Office, station no: 073032	535.5mm	The rainfall is fairly even across the year with the highest average rainfall at 48.8mm in November and the lowest at 40.4mm in September.
Milvale Yard	Tubbul (Keiraville) station number: 073113	543.9mm	The rainfall is generally highest in October to December with a maximum average monthly rainfall of 50.0mm. Rainfall is generally lower from March to Mar with a minimum average monthly rainfall of 39.2 mm.



Stockinbingal to Parkes Forbes Station & Wirrinya Yard Clearances

Figure 4.3 Land Uses in the Proposal Site

0 2 4 km

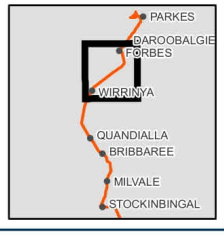
Coordinate System: GDA 1994 MGA Zone 55

Date: 3/08/2021
Author: WSP
Paper: A3
Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Watercourse
- 0.5m contours
- 5m contours
- Proposal site

NSW Land Use Categories - 2017 v1p2

- Cropping
- Grazing modified pastures
- Grazing native vegetation
- Intensive farming and industry
- Services and utilities
- Water use



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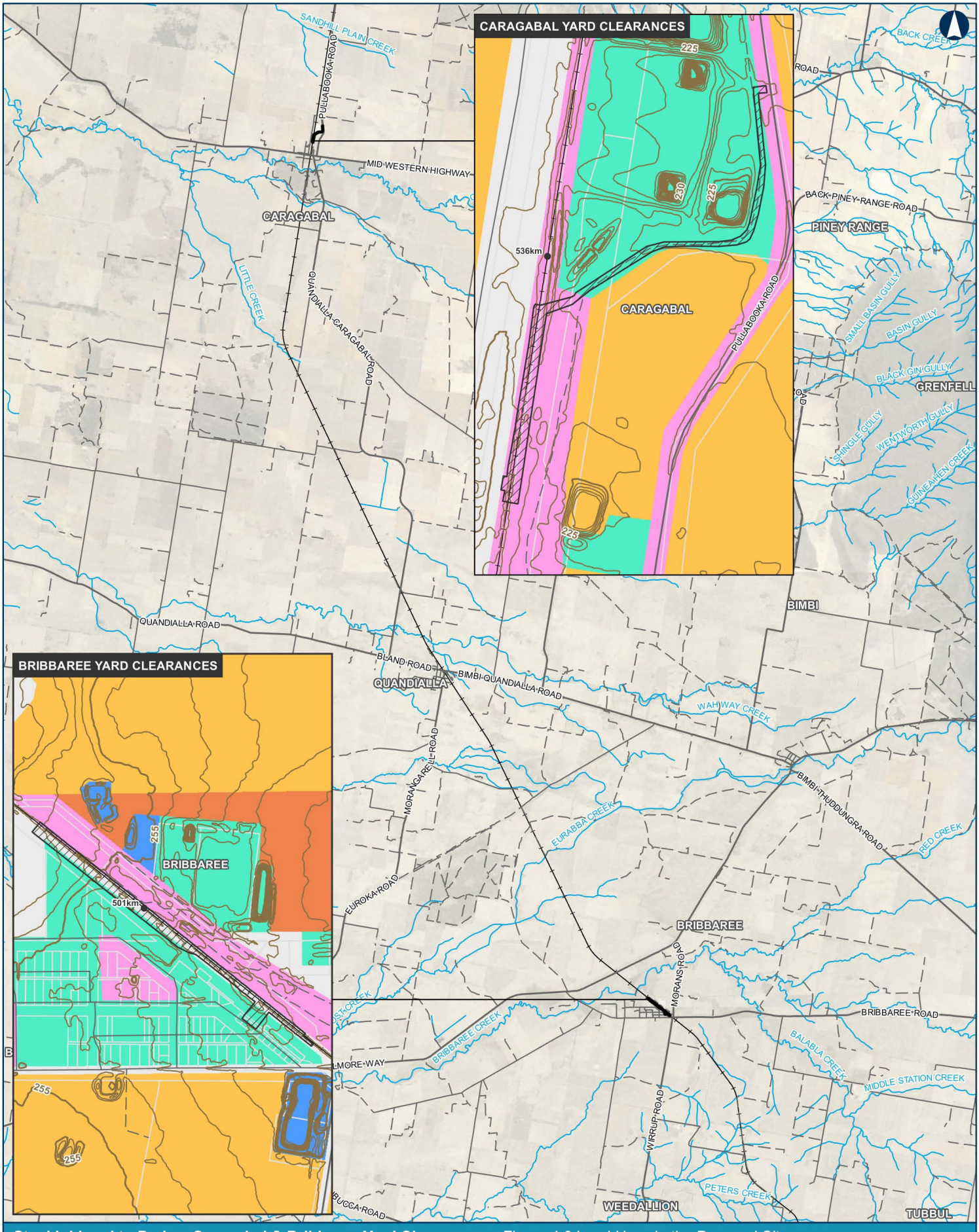


Stockinbingal to Parkes Caragabal & Bribbaree Yard Clearances

Figure 4.3 Land Uses in the Proposal Site

0 2 4 km

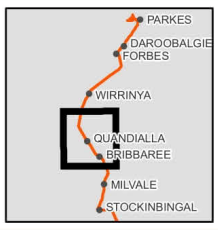
Coordinate System: GDA 1994 MGA Zone 55

Date: 3/08/2021
Author: WSP
Paper: A3
Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Watercourse
- 0.5m contours
- 5m contours
- Proposal site

NSW Land Use Categories - 2017 v1p2

- Cropping
- Grazing modified pastures
- Grazing native vegetation
- Intensive farming and industry
- Services and utilities
- Water use



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4.6 EXISTING FLOODING AND FLOOD RISK

Forbes Station and Yard site is located within flood prone land as per the flood planning sheet in the Forbes Local Environmental Plan (Forbes Shire Council, 2013).

The flood conditions at the Forbes Station and Yard site and surrounding areas were defined using the hydraulic model developed in 2018 by Lyall & Associated as part of the Forbes Flood Study. Flooding is considered in terms of the annual exceedance probability event (AEP), which is the probability that a given rainfall volume accumulated over a given duration will be exceeded in any one year.

The 1% AEP flood extent for Forbes Station is shown in Figure 4.4.

The qualitative desktop flood assessment has not identified the other sites within a flood prone land.

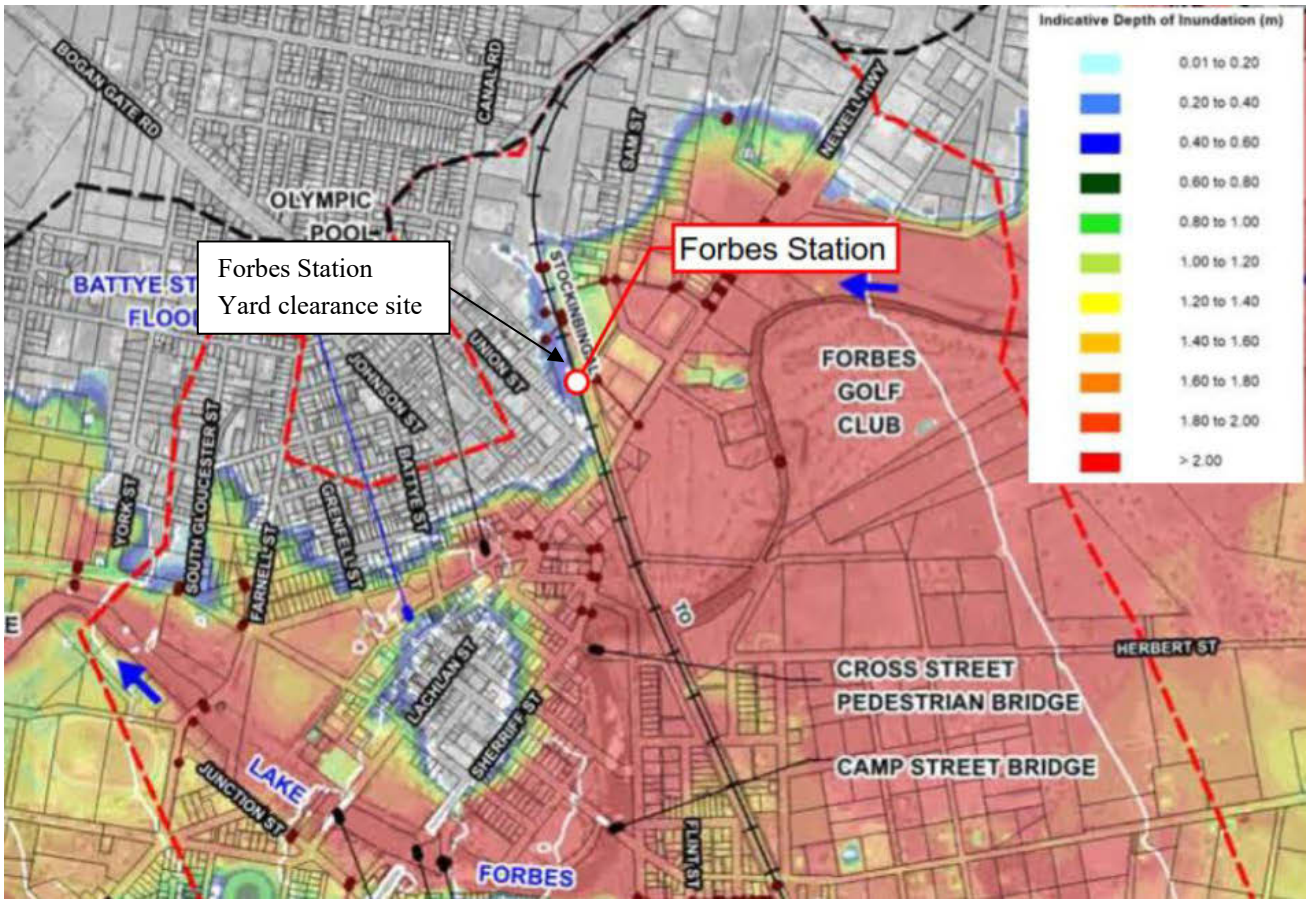


Figure 4.4 1% AEP flood extent at Forbes Station (Lyall & Associated, 2018)

4.7 WATER QUALITY

A desktop review was carried out to establish the existing water quality condition in the study area.

No site specific water quality data was available, so water quality data from the broader catchment areas was reviewed to provide an understanding of the general water quality of the proposal area. The following reports were reviewed:

— Lachlan Water Quality Management Plan (DPI, 2018)
— NSW State of the Environment, 2018 (NSW EPA, 2018).

These reports use Total Suspended Solids (TSS), Total Nitrogen (TN), total Phosphorus (TP) and salinity as key indicators of water quality.

4.7.1 LACHLAN RIVER WATER QUALITY MANAGEMENT PLAN

The Lachlan River Water Quality Management Plan (WQMP) (DPI, 2018) reviewed water quality data along the Lachlan River for the periods 2010–2011 and 2014–2015.

Horizontal Clearance sites are located in the upland region of the Lachlan River catchment as described by the WQMP. The water quality scores given in the report are based on the WaQI water quality index for NSW. The WaQI is a tool to communicate complex water quality data in a simple and consistent way. The WQMP gives an overall integrated score based on the Murray Darling Basin Plan values for dissolved oxygen (DO), turbidity, pH, TN and TP. Poor water quality is defined as elevated levels of nutrients, turbidity, blue-green algae, salinity, toxicants and pathogens or temperature, pH and DO outside specified ranges depending on the purpose and use of the water.

The monitoring site nearest to an enhancement site (Forbes (site 412004)) is located about 4km south west of the Forbes Station clearance site, above the point at which Lake Forbes joins the Lachlan River. This site recorded and overall ‘Poor’ score for water quality, however sites downstream of this at Condobolin Bridge and Lake Cargelligo both recorded overall ‘Good’ scores as shown in Figure 4.5.

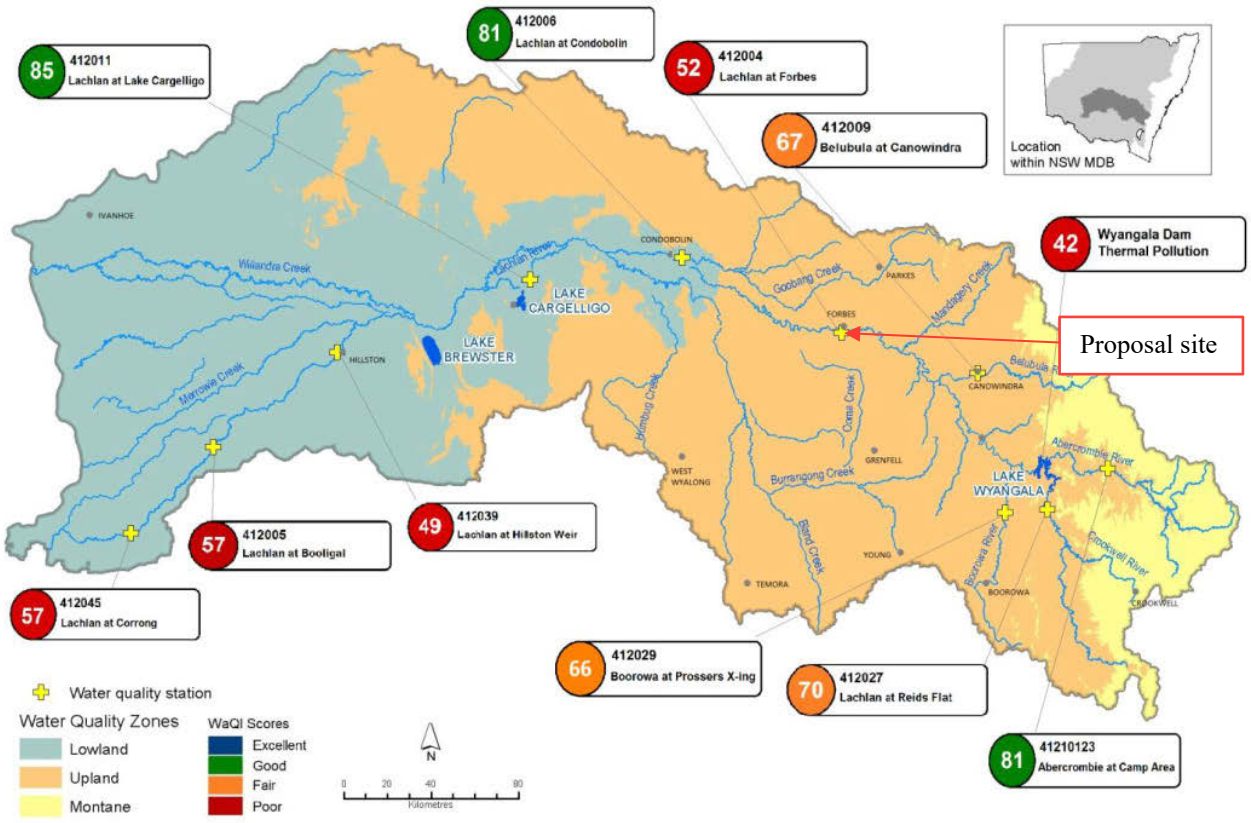


Figure 4.5 Water quality indicators in the Lachlan River catchment from the Lachlan WRP Water Quality Management Plan, 2018

The WQMP also identifies and describes the key causes of water quality degradation in the Lachlan. The key issues identified in the Lachlan and Forbes area are shown in Table 4.5.

Table 4.5 Water quality issues in the Lachlan River catchment (DPI, 2018)

WATER QUALITY IMPACT	CAUSE	WHERE IT OCCURS
Elevated levels of suspended sediment	Land management practices — loss of vegetation in the catchment and/or riparian zones — inappropriate frequency, timing and location of cultivation — overgrazing of catchments and grazing of riverbanks and floodplains — poor soil conservation practices — practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration.	All areas In unregulated tributaries, land management is the key cause of sediment entering the waterways
	Water management practices: — rapid drawdown of water within a surface water resource — the volume or manner of release of water, resulting in bank or bed erosion.	Suspended sediments are linked to flow volumes. Turbidity and TSS typically increase with distance along the catchment from the headwaters.
	Presence of invasive noxious fish Carp (*Cyprinus carpio*)	All areas

WATER QUALITY IMPACT	CAUSE	WHERE IT OCCURS
Elevated nutrient levels	Nutrients entering Lachlan water resources through both point and diffuse sources. The key sources of nutrients are: — soil and organic matter — animal waste — fertilisers — sewage and industrial discharge. Increased nitrogen and phosphorus concentrations in the Lachlan are generally caused by runoff and erosion during rainfall events when there are high flows.	All areas
Elevated levels of salinity (Electrical conductivity – EC)	Landscape situation: — geology — rainfall 400–800mm zone – risk area. Land management practices, largely clearing and cropping, that replace deep-rooted vegetation with shallow rooted crops and pastures, resulting in increased rainfall recharge displacing saline groundwater to surface water systems. The following processes and activities relating to water flow or water management: — saline groundwater and surface water discharges into surface water systems — increased deep drainage below irrigated agricultural land displacing saline groundwater to surface water systems — saline surface and shallow groundwater drainage from irrigated agricultural land into surface water systems — irrigation at high salinity risk locations without adequate drainage management — reduction in stream flows, limiting the dilution of salinity.	All areas
Dissolved oxygen outside natural ranges	Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished, particularly during extended periods of low or no flows.	All areas
	Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.	All areas
	Hypoxic low flow or blackwater events due to release of water following extended dry or low flow periods. Less frequent flooding due to flow management allows increased organic material to accumulate on river banks and floodplains.	Lachlan River – Blackwater events following major flooding have been identified as an issue in the Lachlan.
pH outside natural ranges	The exposure to the air of soils containing iron sulphide minerals. Eutrophication leading to excessive plant growth causing high diurnal variation in pH.	All areas

4.7.2 NSW STATE OF THE ENVIRONMENT, 2018

The NSW State of the Environment report is prepared every three years and reports on the status of key environmental issues facing NSW including river health and water quality. The 2018 State of the Environment reported water quality data against the water quality criteria set out in the Murray Darling Basin Plan 2012. This report showed that 50 to 75% of samples exceeded the water quality criteria for TN and TP at the site located nearest the proposal as shown Figure 4.6.

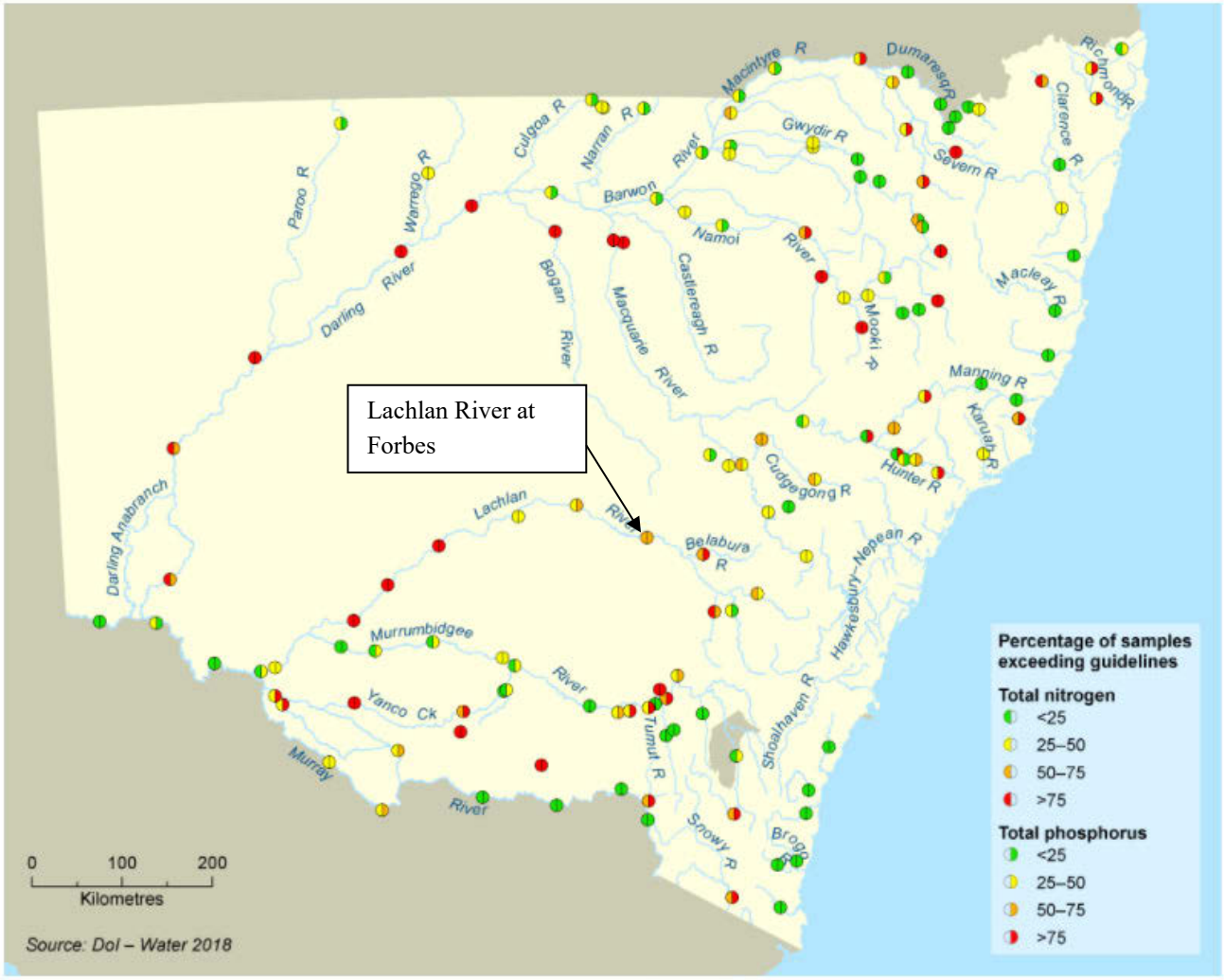


Figure 4.6 Compliance of water quality samples for TP and TN in NSW, State of the Environment 2018

4.7.3 SUMMARY OF WATER QUALITY DATA IN THE STUDY AREA

Given the high proportion of agricultural land within the study area, and ephemeral nature of the waterways, it is unlikely that the waterways near the enhancement sites would achieve the water quality criteria as laid out in the ANZG 2018 and Murray Darling Basin Plan 2012, particularly for nutrients. The sources of the high nutrient levels are likely to be diffuse and related to current and historical agricultural activities within the study area.

4.8 SENSITIVE RECEIVERS

4.8.1 WETLANDS

The Lachlan River catchment features several significant wetlands that are considered of national importance particularly for waterbird habitat. These include Lake Cowal, Lake Brewster, and the Booligal wetlands and Great Cumbung Swamp in the lower Lachlan valley. The closest of these features is Lake Cowal which is located 29 kilometres west of the Wirrinya Yard enhancement site, downstream of the proposal site. Due to the distance from the proposal site, no impacts are anticipated to nationally important wetlands.

The proposal sites are at a considerable distance away from the nearest wetlands of international importance Hattah-kukyne lakes approximately 500–600km upstream.

4.8.2 AQUATIC ECOLOGY

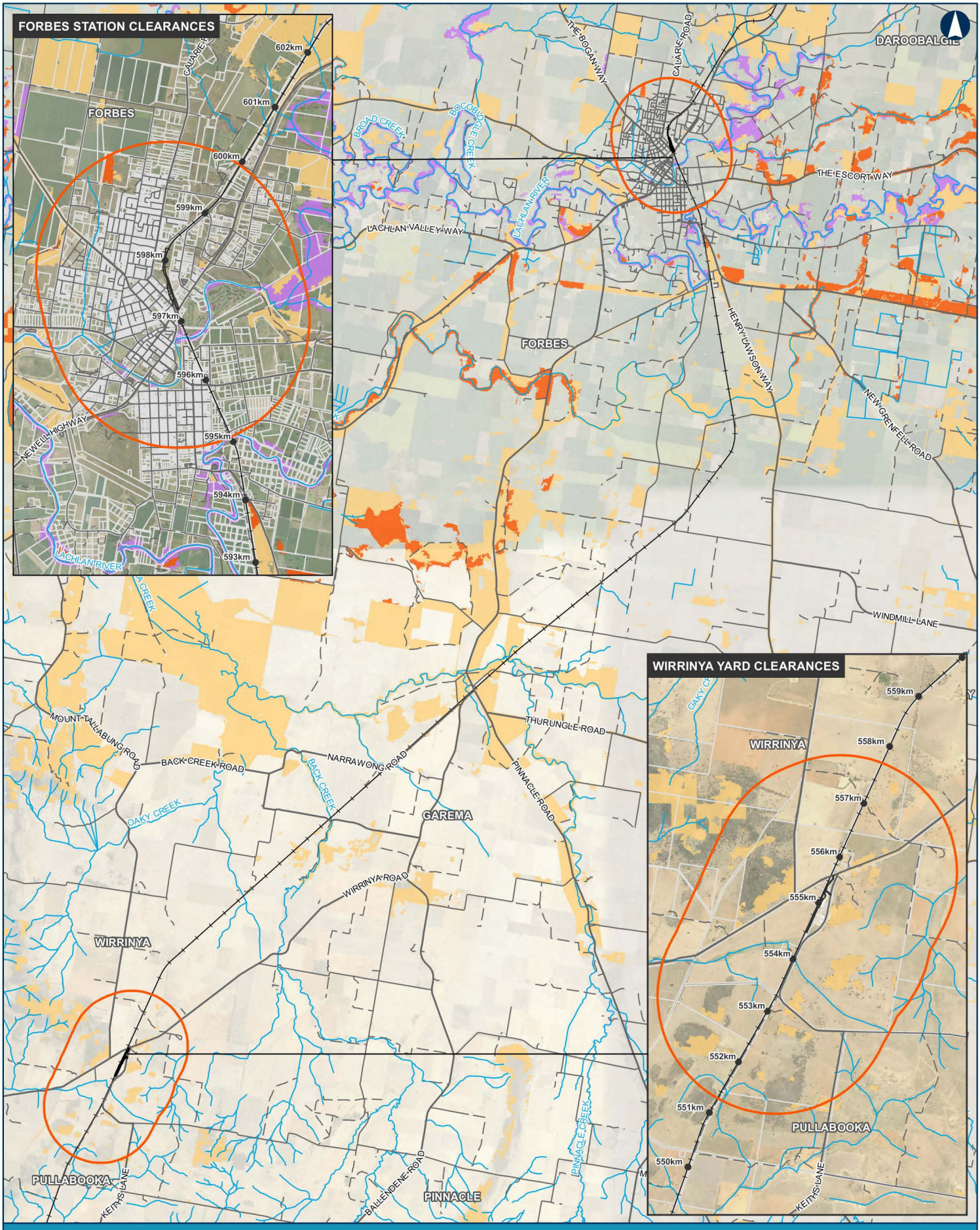
One endangered aquatic ecological community listed under the *Fisheries Management Act 1994* (NSW) occurs in Lachlan River catchment lower Lachlan River aquatic ecological community. This community includes all fish and aquatic invertebrates within the natural drainage system of the lowland catchment of the Lachlan River. The listing includes Lachlan River from Wyangala Dam to the confluence with the Murrumbidgee River and Lake Cowal, Bland Creek and its tributaries. Due to the distance of the proposal site from these waterways and tributaries (refer to Section 4.2), no impacts are anticipated to this aquatic ecological community.

4.8.3 GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater dependent ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation, 2002). When considering GDEs, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary fringe, however it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus, Froend, Loomes, Hose, & Murray, 2006).

The Lachlan River is identified as a low potential aquatic GDE in the Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2020). The associated PCT 11: River Red Gum – Lignum very tall open forest or woodland wetland on floodplains of semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) in the Forbes Station Yard study area is identified as high potential terrestrial GDE. The remaining PCTs identified from within the study areas are low potential terrestrial GDEs.

While GDEs are likely to be present, the proposal does not involve interference with groundwater so is considered unlikely to directly or indirectly interfere with subsurface or groundwater flows associated with any GDEs in or adjacent to the study area.



Stockinbingal to Parkes Forbes Station & Wirrinya Yard Clearances Figure 4.7 Groundwater Dependent Ecosystems in the Study Area

0 2 4 km

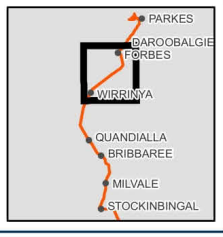
Coordinate System: GDA 1994 MGA Zone 55

Date: 4/08/2021 Paper: A3
Author: WSP Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Watercourse
- Proposal site
- Groundwater study area

Groundwater Dependent Ecosystems

- High potential terrestrial GDE
- Moderate potential terrestrial GDE
- Low potential terrestrial GDE



INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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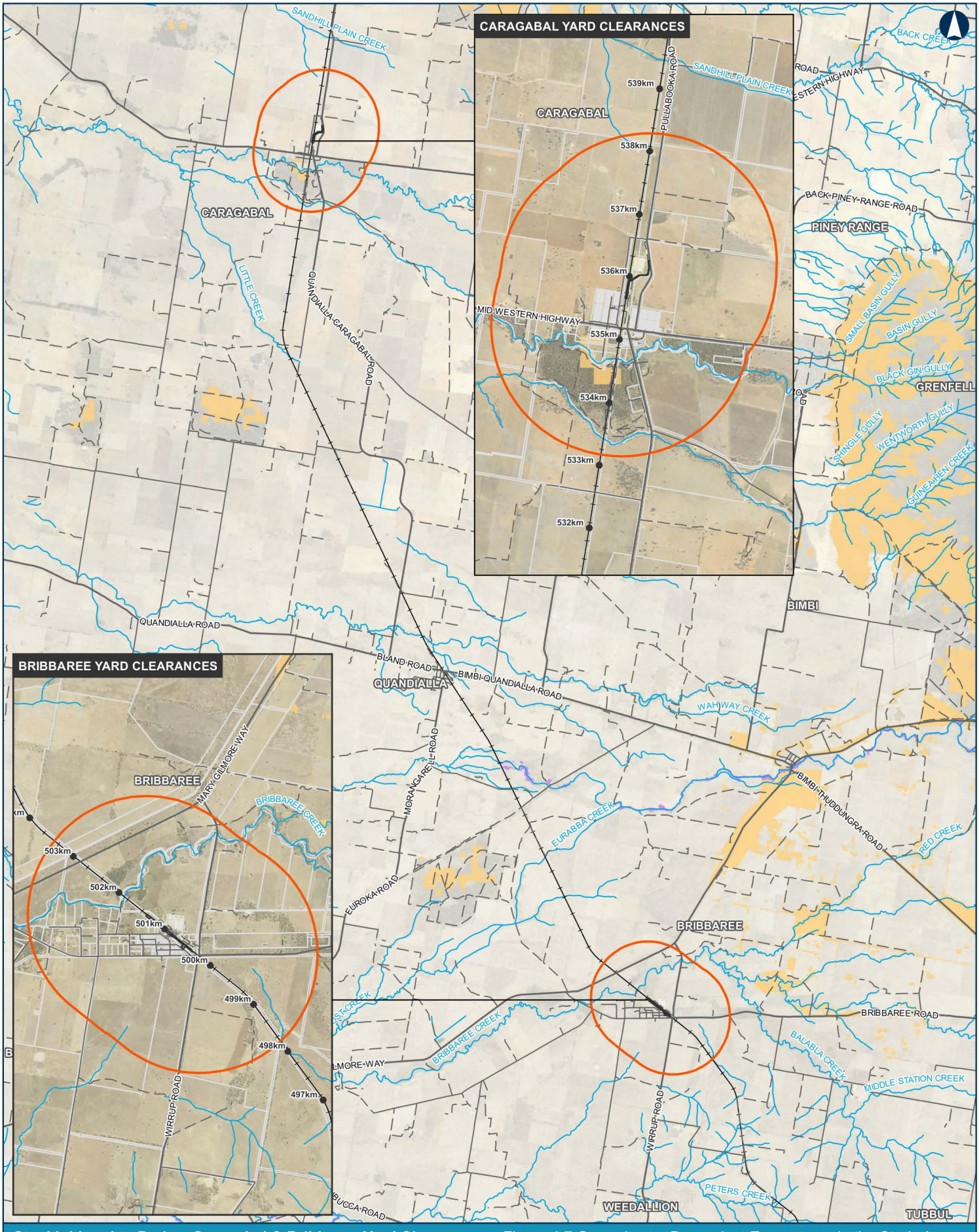


Stockinbingal to Parkes Caragabal & Bribbaree Yard Clearances

Figure 4.7 Groundwater Dependent Ecosystems in the Study Area

0 2 4 km

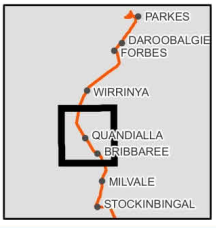
Coordinate System: GDA 1994 MGA Zone 55

Date: 4/08/2021 Paper: A3
Author: WSP Scale: 1:125,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Watercourse
- Proposal site
- Groundwater study area

Groundwater Dependent Ecosystems

- High potential terrestrial GDE
- Low potential terrestrial GDE



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4.9 SOILS

Soils, including likelihood of acid sulfate soils at each site are described in Table 4.6.

Table 4.6 Land uses at the enhancement sites

ENHANCEMENT SITE	SOIL LANDSCAPE	ACID SULFATE SOILS
Forbes Station and Yard	Bald Hill soils	Extremely low probability/Very low confidence
Wirrinya Yard	Caragabal soils	Extremely low probability/Very low confidence
Caragabal Yard	Caragabal soils	Low probability/Very low confidence
Quandialla Yard	Wah Way soils	Low probability/Very low confidence
Bribbaree Yard	Milvale soils	Low probability/Very low confidence
Milvale Yard	Milvale soils	Low probability/Very low confidence

4.10 CONTAMINATION

The proposal is within an operational rail corridor and therefore has an elevated risk for unknown contaminants to be discovered during construction. Contaminants that may be present in the rail corridor include (but are not limited to) asbestos, heavy metals, total recoverable hydrocarbon (TRH), benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs) and dust or paint containing lead. A review of the NSW EPA Contaminated Land Public Record and the POEO Act Public Register were undertaken on 20 April 2021.

The review did not identify a registered contaminated site within 500 metres of the proposal site except at the Forbes Station and Yard site. The ARTC Contaminated Sites Register did not identify contaminated land at any of the sites except for three sites within 500m of the Forbes station site, as described in Table 4.7. Due to the close proximity of the contaminated sites near the Forbes Station and Yard site, there is potential for contaminated soil to be present. Detailed discussion on contamination at the proposal sites are provided in the REF report (Chapter 5).

Table 4.7 Sites from the ARTC Contaminated Site Register near Forbes Station site

CONTAMINATED SITE	LOCATION	CONDITION DESCRIPTION
Forbes—Former Mobil and Shell siding	Stephen Street, Forbes (partially mapped under the location of the site compound and laydown area)	Unlikely to pose a risk of exposure to human health or ecological receptors, as long as not disturbed.
Forbes—Goods shed	Lewis Street, Forbes (adjacent to the Forbes Station site on the western boundary)	Active exposure risk or legislative issue that should be investigated and potentially requires management.
Forbes—Council depot (former swampland)	Little Union Street, Forbes (40m west of the Forbes Station site	Suitable for use in a commercial/industrial land use setting.

5 IMPACT ASSESSMENT

5.1 DRAINAGE AND FLOODING

5.1.1 PROPOSED SCENARIO

The proposed Horizontal Clearance works do not change the existing catchments and waterways. As such surface water runoff at each site mimics the existing drainage conditions.

At some sites cess drains are proposed to collect and convey surface water runoff from the rail formation towards drainage outlets. Table 5.1 summarises the changes to the current drainage system for each site of the Horizontal Clearance works.

Table 5.1 Proposed drainage work

PROPOSAL	PROPOSED WORK – KEY FEATURES	PROPOSED DRAINAGE	CHANGE TO THE EXISTING DRAINAGE AND FLOOD CONDITIONS
Forbes Station and Yard	Realignment of approximately 470m of track by up to 530mm. Raising of the track by approximately 27mm as a result of track works. Trimming of the platform awning at Forbes Station by approximately 300mm for the full length.	Replacement of cess drainage to free drain the new formation installed. Cess drain conveys the formation surface runoff to the existing culvert outlet. No changes to existing drainage structures is proposed.	Cess drain conveys the rail formation runoff; the drainage mimics the existing flow paths. There are no change to the existing waterways. Proposed elevation of the track is likely to change by on average 27mm at Forbes station which is not expected to affect the existing overland flow conditions. As shown in Figure 4.4 the site is located at the fringe of the floodplain. The water flows are controlled by the existing culverts that pass water from east to west of the rail formation. The flood depths of the area at the west of the rail is around 40mm which is lower than the rail formation. As such the minor changes to the rail vertical alignment are considered to have negligible effects to the overland flood mechanisms. No non-compliant impacts are expected as a result of the proposed enhancement works.
Wirrinya Yard	Realignment of approximately 520m of track by up to 350mm.	No drainage works.	No changes to the existing drainage catchments. No change to the existing drainage and surface water conveyance. No change to the existing waterways.

PROPOSAL	PROPOSED WORK – KEY FEATURES	PROPOSED DRAINAGE	CHANGE TO THE EXISTING DRAINAGE AND FLOOD CONDITIONS
Caragabal Yard	Realignment of approximately 250m of track by up to 30mm.	No drainage works.	No changes to the existing drainage catchments. No change to the existing drainage and surface water conveyance. No change to the existing waterways.
Quandialla Yard	Removal of redundant pipework from a water tank adjacent to the track.	No drainage works.	No changes to the existing drainage catchments. No change to the existing drainage and surface water conveyance. No change to the existing waterways.
Bribbaree Yard	Realignment of approximately 900m of track by up to 250m. Nominal track lift to ensure a compliant vertical alignment. Average track lift is 37mm.	Cess drains are provided where the capping layer does not free drain with designed cess drains tie-ing into existing flow paths.	No changes to the existing drainage catchments. Cess drain mimics the existing flow paths. No change to the existing waterways. The site area is not located within a documented local or regional flood prone area. The average track lift of approximately 37mm is comparable to routine track maintenance work. As such there are no expected non-compliant flood impacts as a result of the proposal.
Milvale Yard	Removal of redundant wiring from a water tank adjacent to the track.	No drainage works.	No changes to the existing drainage catchments. No change to the existing drainage and surface water conveyance. No change to the existing waterways.

5.1.2 CONSTRUCTION

Required earthworks, stockpiles and construction compounds may interrupt or alter overland flow paths. This may cause minor impacts to site drainage patterns which may have impacts on construction activities or other nearby buildings and infrastructure. The only enhancement site within flood prone land is Forbes Station Yard. The compound is located within the part of the enhancement site which is subject to lower flood depths of up to 0.60 metres during a one per cent AEP flood event. Given this, the impacts to drainage and flood behaviour are likely to be temporary and contained during construction.

5.1.2.1 WATER USE AND AVAILABILITY

Water would be required for dust suppression at the track realignment sites including Bribbaree Yard, Caragabal Yard, Wirrinya Yard and Forbes Station Yard. It is anticipated a total of 3.6 megalitres of water would be required for this purpose assuming three water carts a day during construction at each track works site. No water supply would be required for works at the water tank modification sites, Milvale Yard and Quandialla Yard.

Local water suppliers including councils and quarries would be consulted to obtain the required water demand. Extraction from bores and surface water is not anticipated to be required for the proposal. Relevant licences and approvals would be sought if required. All potable water will be from potable water deliveries to site compound water tanks. This would generally not be considered to have an impact of local and regional surface water availability.

5.1.3 OPERATION

There will be negligible changes to existing catchments and to the existing waterways as part of the proposal.

The design will mimic the existing drainage conditions. Where necessary (Forbes Station and Bribbaree Yard) cess drains will be provided to collect runoff from the rail platform; the cess drains will facilitate the surface water conveyance from the rail platform towards the drainage outlets.

As the work proposed is not affecting the existing drainage and waterways no drainage or flood impacts are expected for the operation of the proposal.

5.1.3.1 AFFLUX

Table 5.2 summarises the afflux for each proposal sites of the Horizontal Clearance works.

Table 5.2 Afflux Horizontal Clearance

PROPOSAL	PROPOSED DRAINAGE	CHANGE TO THE EXISTING DRAINAGE REGIME	AFFLUX
Forbes Station	Cess drain to free drain the new formation installed. Cess drain conveys the formation surface runoff to the existing culvert outlet.	Cess drains collect the rail formation runoff towards the drainage outlet. No change to the existing waterways. The proposed raising of the track by approximately 27mm has negligible effects on flood impacts in terms of regional flooding due to minimal storage loss capacity and long flood event durations; water would flow through the ballast within the limited section of the proposed vertical alignment without creating flood impacts. Effect to the local drainage system are negligible as the proposed drainage system mimic the existing drainage system.	As there are no changes to the existing drainage catchments and the drainage mimics the existing flow paths, no afflux is expected.
Wirrinya Yard	No drainage work.	No change to the existing drainage and surface water conveyance. No change to the existing waterways.	No afflux is expected as no changes to the existing drainage conditions.

PROPOSAL	PROPOSED DRAINAGE	CHANGE TO THE EXISTING DRAINAGE REGIME	AFFLUX
Caragabal Yard	No drainage work.	No change to the existing drainage and surface water conveyance. No change to the existing waterways.	No afflux is expected as no changes to the existing drainage conditions.
Quandialla Yard	No drainage work.	No change to the existing drainage and surface water conveyance. No change to the existing waterways.	No afflux is expected as no changes to the existing drainage conditions.
Bribbaree Yard	Cess drains are provided where the capping layer does not free drain with designed cess drains tie-ing into existing flow paths.	No changes to the existing drainage catchments. Cess drain mimics the exiting flow paths. No change to the existing waterways.	No afflux is expected as no changes to the existing drainage conditions.
Milvale Yard	No drainage work.	No change to the existing drainage and surface water conveyance. No change to the existing waterways.	No afflux is expected as no changes to the existing drainage conditions.

5.1.3.2 CHANGE IN VELOCITY

As mentioned in sections above, the proposed drainage design mimics the existing flow paths and flood conditions. Consequentially, changes in water velocity are considered negligible.

5.1.3.3 CHANGE IN FLOOD HAZARD

Change in flood hazard are negligible as there are no changes in water level, flood extent, flow and velocity.

5.1.3.4 FLOOD IMMUNITY

As discussed in sections above the Horizontal Clearance works have negligible impacts on the existing drainage conditions.

Except for Forbes Station all the Horizontal Clearance sites are not affected by flooding. At Forbes Station the proposed vertical alignment would improve the existing flood immunity.

Thus, proposed works are not expected to affect the existing flood immunities.

5.1.3.5 WATER USE AND AVAILABILITY

The operational phase will require no water take from the local catchments, will not require extraction of surface water and will generally have no impact on local or regional surface water balance or the frequency, volume and duration of runoff. The new drainage infrastructure proposed has been designed to avoid diversion or disturbance of existing drainage and flooding patterns through and around the rail corridor.

5.2 WATER QUALITY

The key pollutants that are likely to impact the surrounding environment as a result of the construction of the proposal include:

- nutrients (nitrogen and phosphorus) – commonly present in agricultural areas, and may become mobilised as a result of disturbance of agricultural land
- sediments and soils – present in run-off from construction areas
- chemicals, oils, grease and hydrocarbons – from use of plant and equipment during construction and train movements and operations
- concrete slurry and wastewater
- contaminants of concern related to long term operation of the rail corridor and nearby agricultural land uses – heavy metals, TRH, BTEX, PAH, organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), polychlorinated biphenyl (PCBs, volatile organic compounds (VOCs), Per- and Poly-fluoroalkyl Substances (PFAS), lead-based paint and potential asbestos containing material (ACM)
- gross pollutants and litter from construction staff.

5.2.1 CONSTRUCTION PHASE

Table 5.3 shows construction activities for the proposal that have the potential to cause impacts to the water quality environment of the site. As the proposed works at Quandialla and Milvale Yard involve minor alterations to water tanks, negligible impacts to water quality are anticipated.

Table 5.3 Potential construction activities and associated water quality risks

CONSTRUCTION ACTIVITY	POTENTIAL IMPACTS
Vegetation clearing and earthworks	Vegetation clearing primarily of native grasslands at all sites, except Quandialla and Milvale Yards, would expose and potentially destabilise soils increasing potential for erosion and runoff of materials to waterways. Earthworks would be required at Forbes Station and Bribbaree Yard sites. This will involve stripping of existing track, cut and fill for new drains and import of new structural fill and capping material where required. Ground disturbance would occur at Wirrinya Yard and Caragabal Yard due to track realignment works but earthworks are not proposed. Vegetation clearing and earthworks, including transport of earthworks materials, may mobilise sediments which would increase the risk of run off of soils to waterways. These activities may also expose and mobilise contaminants such as heavy metals (refer to Section 4.10) or excess nutrients particularly from agricultural areas or near identified contaminated sites near Forbes Station. Increased erosion may lead to increased turbidity, lowered dissolved oxygen levels, contaminants and increased nutrients in waterways. The increased deposition of materials in waterways may reduce aquatic habitat.
Dust suppression	Use of water on all sites, except Quandialla and Milvale Yards, for dust suppression which may increase erosion and runoff volumes.
Stockpiling of soils and materials	Presence of loose stockpiled materials at Forbes Station and Bribbaree Yard sites increases the risk of run off of materials and soils to waterways.
Use of machinery and heavy vehicles	Potential for spills of fuels and chemicals at each site which may reach downstream waterways via runoff.
Staff activity	Gross pollutants and litter from each site entering receiving waterways.

Impacts to water quality would be more likely during rainfall events which cause runoff particularly in construction areas that have been cleared, around stockpiles or where there are exposed soils. Given the minor nature of the work being carried out at the Horizontal Clearance sites it is anticipated that risk water quality impacts during construction would be low.

If construction management and mitigation strategies are applied during the construction of the proposal it is anticipated that there would be limited risk of impacts to water quality. Refer to Chapter 6 for detail in mitigation measures. Erosion and sediment controls in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004), and Volumes 2A and 2C (NSW Department of Environment, Climate Change and Water 2008) are commonly applied to construction sites to minimise sediment disturbance, mobilisation and runoff during construction.

5.2.2 OPERATION PHASE

There is potential for water quality impacts as a result of spills or litter generated from operation and maintenance activities along the rail line near waterways, however, these impacts would be minor and localised. Provided correct operation procedures and safeguards are implemented the residual likelihood of impacts would be low.

Given the sites are located on an existing operational rail line there would not be any additional impacts as a result of the proposal.

6 MITIGATION MEASURES

Chapter 5 identified a range of impacts as a result of the proposal during construction and operation. The impacts are largely related to water quality. The following sections provide the mitigation measures which would be implemented for the proposal.

6.1 DRAINAGE AND FLOODING

6.1.1 CONSTRUCTION

Table 6.1 Drainage and flooding mitigation measures

ID	MITIGATION MEASURE
FH1	Construction planning and the layout of construction work sites and compounds would be undertaken with consideration of overland flow paths and flood risk.
FH2	A flood and emergency response plan would be prepared and implemented as part of the CEMP. The plan would include measures, processes and responsibilities to minimise the potential impacts of construction activities on flood behaviour. It would also include measures to manage flood risks during construction including the evacuation protocol of personnel and monitoring of weather forecasts. The plan would be developed in consultation with Forbes Shire Council, emergency services and key affected landholders.

6.2 WATER QUALITY

6.2.1 CONSTRUCTION

Table 6.2 Construction water quality mitigation measures

ID	MITIGATION MEASURE
WQ1	An erosion and sediment control plan and a Soil and Water Management Plan (SWMP) would be prepared as part of the Construction Environmental Management Plan (CEMP). The SWMP would comply with the existing EPL3142 and be in accordance with best on site practice, reflected in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004), and Volumes 2A and 2C (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. The SWMP and erosion and sediment control plan would include: — surface controls to promote ground stability, limit runoff lengths and reduce runoff velocities within the construction areas — sediment and erosion controls would be built to a design storm that will ensure non-erodible velocities — inspection and maintenance of erosion and sediment controls throughout the works to ensure they are operating effectively — rainfall monitoring requirements — management protocols of problem soils (e.g. erosive, dispersive, reactive, acidic, saline, sodic, alkaline soils) — management protocols for any contaminated soils — vehicle, machinery and imported fill hygiene protocols and documentation — measures to prevent/minimise mud and dirt being tracked onto public roadways by trucks and any equipment leaving the site — provision of a spill contaminant kit — requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction.
WQ2	Discharge of any rainwater collected on site during construction would be undertaken in accordance with the environment protection licence (EPL 3142) for construction of the proposal and would consider the hydrological attributes of the receiving waterbody.
WQ3	A contamination and hazardous materials plan would be prepared and implemented as part of the CEMP. It would include measures, processes and responsibilities to minimise the potential for contamination impacts on the local community, workers and environment, and procedures for incident management and managing unexpected contamination finds (an unexpected finds protocol).
WQ4	Disturbed areas would be rehabilitated following construction in accordance with the rehabilitation strategy.
WQ5	Clearing extents would be limited to that required to construct the works, and clearing is scheduled to minimise the exposure time of unprotected earth.
WQ6	Where practical, vegetation clearing and ground disturbing works should be staged sequentially / across the project to minimise areas exposed to erosion and sediment risk.

7 CONCLUSION

This report assesses the potential impacts to the surface water environment as a result of the Horizontal Clearance works proposed as part of the Stockinbingal to Parkes Inland Rail project.

The proposal is located within the Lachlan River catchment. The assessment has identified the Lachlan River, Wah Wah Creek, Bribbaree Creek and Caragabal Creek as potential nearby receivers. The Forbes Station and Yard is the only enhancement site identified to be located in flood prone land.

The water quality of the existing environment was assessed broadly based on the existing information and is considered to be generally poor, particularly in relation to nutrients.

There will be no change to existing catchments and no change to the existing waterways as part of the proposal. The design will mimic the existing railways and cess drains will be provided to collect runoff from the rail line. As such there are no anticipated impacts to flooding as a result of the proposal.

The presence of construction compounds and requirement for earthworks during construction may impact overland flow paths in the enhancement site areas. This may cause changes to drainage regimes and potential impacts to construction areas and other nearby infrastructure. Any construction impacts to overland flow paths will be addressed through construction planning during detailed design. The impacts to drainage and flood behaviour are likely to be temporary, localised and insignificant during construction.

The construction of the proposal has the potential to impact water quality of the study area due to runoff from exposed or disturbed areas entering receiving drainage systems and waterways downstream. Construction activities that may cause water quality impacts would include installation of construction compounds and stockpiles, earthworks and track modification works. These activities may cause increased sediment and pollutant mobilisation which may lead to erosion and sedimentation and run off the receiving waterways during rainfall events.

If construction management and mitigation strategies identified in this report are applied during the construction of the proposal it is anticipated that there would be limited risk of impacts to water quality. Erosion and sediment control in accordance with the Blue book would minimise sediment disturbance, mobilisation and runoff during construction.

Operational activities that may cause water quality impacts would include spills of chemicals and contaminants from trains, dust from carriages and maintenance works which may include minor vegetation clearing and disturbance of sediment and pollutants. The proposal would be operated in line with ARTC's standard operating procedures and as such impacts from the operation of the proposal would be low to negligible.

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APPENDIX I

Horizontal Clearances

Surface Water Impact Assessment

Appendix A NSW water quality objectives, environmental values and criteria

STOCKINBINGAL TO PARKES REVIEW OF ENVIRONMENTAL FACTORS

Table A.1 Water quality objectives and trigger values for environmental values in the Lachlan River catchment

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Aquatic ecosystems (Upland rivers)		
Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	20µg/L
	Total nitrogen	250µg/L
	Chlorophyll-a	Not applicable
	Turbidity	2–25 NTU
	Salinity (electrical conductivity)	30–350µS/cm
	Dissolved oxygen	90–110%
	pH	6.5–8.0
Visual amenity		
Aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus
Secondary contact recreation		
Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100mL, with 4 out of 5 samples < 4000/100mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100mL (maximum number in any one sample: 450-700 organisms/ 100mL).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. Toxic substances should not exceed values in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
	Visual clarity and colour	Use visual amenity guidelines.
	Surface films	Use visual amenity guidelines.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Primary contact recreation		
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	Turbidity	A 200mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6m (approximately 6 NTU).
	Faecal coliforms	Beachwatch considers waters are unsuitable for swimming if: — The median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100 mL) for five samples taken at regular intervals not exceeding one month, or — The second highest sample contains equal to or greater than 600 cfu/ 100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: — Median over bathing season of < 150 faecal coliforms per 100mL, with 4 out of 5 samples < 600/100mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Beachwatch considers waters are unsuitable for swimming if: — The median enterococci density exceeds 35 cfu/100mL for five samples taken at regular intervals not exceeding one month, or — The second highest sample contains equal to or greater than 100 cfu/ 100mL (enterococci) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: — Median over bathing season of < 35 enterococci per 100mL (maximum number in any one sample: 60-100 organisms/100mL).
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note, it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines.
	Faecal coliforms	Large numbers of midges and aquatic worms are undesirable.
	pH	5.0–9.0
	Temperature	15°–35°C for prolonged exposure.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000.
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable
	Visual clarity and colour	Use visual amenity guidelines
	Surface films	Use visual amenity guidelines

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Livestock water supply		
Protecting water quality to maximise the production of healthy livestock	Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3µg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 (ANZECC 2000 Guidelines).
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100mL (median value).
	Chemical contaminants	Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2004) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.
Irrigation water supply		
Protecting the quality of waters applied to crops and pasture	Algae & blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, several interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC Guidelines
	Heavy metals and metalloids	Long term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in Table 4.2.10 of the ANZECC 2000 Guidelines.
Homestead water supply		
Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. No guideline values are set for cyanobacteria in drinking water. In water storages, counts of < 1000 algal cells/mL are of no concern. >500 algal cells/mL – increase monitoring. >2000 algal cells/mL – immediate action indicated; seek expert advice. >6500 algal cells/mL – seek advice from health authority
	Turbidity	5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some micro-organisms from disinfection. (see supporting information)
	Total dissolved solids	< 500mg/L is regarded as good quality drinking water based on taste. 500-1000mg/L is acceptable based on taste. >1000mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
	Faecal coliforms	0 faecal coliforms per 100mL (0/100mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority. See also the Guidelines for Microbiological Quality in relation to Monitoring, Monitoring Frequency and Assessing Performance in the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 2004).
	pH	6.5-8.5 (see supporting information)
	Chemical contaminants	See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).
Drinking water at point of supply - Disinfection only, Groundwater, Clarification and disinfection		
Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. >500 algal cells/mL – increase monitoring. < 2000 algal cells/mL – water may be used for potable supply. >2000 algal cells/mL – immediate action indicated; seek expert advice. >6500 algal cells/mL – seek advice from health authority. >15 000 algal cells/mL – may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon. Source: Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).
	Turbidity	Site-specific determinant.
	Salinity (electrical conductivity)	<1500µS/cm > 800µS/cm causes a deterioration in taste.
	Faecal coliforms*	0 faecal coliforms per 100mL (0/100mL)
	Total coliforms*	95% of samples should be 0 coliforms/100mL throughout the year. Up to 10 coliform organisms may be accepted occasionally in 100mL. Coliform organisms should not be detected in 100mL in any two consecutive samples.
	Dissolved oxygen	> 6.5mg/L (> 80% saturation)
	pH	6.5–8.5
	Chemical contaminants	See ANZECC 2000 guidelines, Section 6.2.2.
Aquatic foods (cooked)		
Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	Algae & blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli /g of flesh with a standard plate count of 100,000 organisms /g.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
(Note: The ANZECC 2000 Guidelines lists this environmental value as Aquaculture and human consumption of aquatic foods)	Toxicants (as applied to aquaculture activities)	Copper: less than 5µgm/L. Mercury: less than 1µgm/L. Zinc: less than 5µgm/L. Organochlorines: Chlordane: less than 0.004µgm/L (saltwater production) PCB's: less than 2µgm/L.
	Physico-chemical indicators (as applied to aquaculture activities)	Suspended solids: less than 40 5µgm/L (freshwater) Temperature: less than 2 degrees Celsius change over one hour.