

APPENDIX

P

INLAND
RAIL 

Surface Water Quality Technical Report

PART 1 OF 2

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Inland Rail Border to Gowrie EIS

Appendix P – Surface Water
Quality Technical Report

**Australian Rail Track
Corporation**

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Abbreviations

Abbreviation	Explanation
AEP	Annual exceedance probability
ANZG 2018	Australian and New Zealand guidelines for fresh and marine water quality
ARTC	Australian Rail Track Corporation Ltd
AquaBAMM	Aquatic Biodiversity Assessment Mapping Method
ASS	Acid sulfate soils
B2G	Border to Gowrie Project
Ch	Chainage
Cth	Commonwealth
DAF	Department of Agriculture and Fisheries
EP Act	<i>Environmental Protection Act 1994 (QLD)</i>
EP Reg	<i>Environmental Protection Regulation 2019 (QLD)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i>
EPP (Water and Wetland Biodiversity)	<i>Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (QLD)</i>
EVs	Environmental Values
Fisheries Act	<i>Fisheries Act 1994 (QLD)</i>
GDE	Groundwater dependent ecosystems
Inland Rail Program	Melbourne to Brisbane Inland Rail
km	Kilometres
m	Metre
MNES	Matters of National Environmental Significance
NATA	National Association of Testing Authorities
NSW	New South Wales
PA	<i>Planning Act 2016 (QLD)</i>
PAH	Polycyclic aromatic hydrocarbons
QLD	Queensland
RCBC	Reinforced concrete box culvert
RCP	Reinforced concrete pipe
SDOWO Act	<i>State Development and Public Works Organisation Act 1971</i>
SPP	<i>State Planning Policy 2017 (QLD)</i>
the proponent	Australian Rail Track Corporation Ltd
Water Act	<i>Water Act 2000 (QLD)</i>
WMIP	Water Monitoring Information Portal
WQO	Water quality objectives

Glossary

Term	Explanation
AquaBAMM	The Aquatic biodiversity assessment mapping method used to determine aquatic conservation assessments
Aquascore	An overall conservation value of a wetland unit based on eight separate criteria of an AquaBAMM aquatic conservation unit
Annual exceedance probability (AEP)	The probability that a given rainfall total accumulated over a given duration that will be exceeded in any one year
Alignment	The proposed rail line for the Project
Ballast	Crushed rock, stone etc used to provide a foundation for a railway track. Ballast usually provides the bed on which railway sleepers are laid, transmits the load from train movements, and restrains the track from movement
Catchment	Catchment at a particular point is the area of land that drains to that point
Chainage	A measure of distance along the rail corridor. The nominated values are not exact distances as there are some local adjustments made to reflect progressive changes to the rail as works are progressively implemented to, for example, ease bends.
Cumulative impact area of influence	The area of the Project that incorporates other projects for assessment of cumulative impact. In matters relating to water quality, cumulative impact area of influence is related to intra-catchment processes
Dispersive	A characteristic of soil indicating the potential for the breakdown of clay material into single clay particles in solution
Ephemeral	Temporary, short-lived. An ephemeral waterway is one that flows following periods of heavy rainfall
Environmental values	The qualities of water that make it suitable for supporting aquatic ecosystems and human water uses
Hydrology	The study of rainfall or runoff process
Impact assessment area	The area being assessed by each technical discipline, with the potential to be directly or indirectly affected by the Project. The actual size and extent of the impact assessment area varies according the nature and requirements of each discipline's technical methodologies.
Limit of reporting (LOR)	The smallest concentration at which the laboratory can quantify the presence of a particular parameter of interest. This is usually dictated by the test methodology.
Megalitres (ML)	A unit of measure of fluid, indicating equivalence of 1,000,000 litres
Micro Siemens per centimetre (μscm^{-1})	A unit of electrical conductivity which is calculated as a dimension of mass, length, time and electric current and is a measurement of electrical conductivity which is dependent on concentration of ion in solution.
Micrograms per litre (μgL^{-1})	A measurement of mass concentration (as one part per billion) within a litre of a certain mixture (in this instance freshwater)
Milligrams per litre (mgL^{-1})	A measurement of mass concentration (as one part per million) within a litre of a certain mixture (in this instance freshwater)
Perennial	Lasting or enduring. A perennial waterway has continuous flow all year-round during years of normal rainfall
Permanent footprint	The areas of the Project that will be permanently and directly impacted by the operation of the rail line and associated facilities
pH units	The measurement of presence of Hydrogen ion concentration indicating from a range of 1-14, the degree of acidity or basicity, respectively
Impact assessment area	The total area incorporated for assessment of existing environmental conditions and potential impact from the Project. The area extends 1 km from the Project alignment
Runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek
Salinity	Refers to the amount of salt present in the soil or aquatic solution
Stream order	A measure of the relative size of a waterway

Term	Explanation
Temporary footprint	The areas of the Project that will be directly impacted by the construction of the rail line, laydown areas, borrow pits, and other areas that will only be used during construction and will be rehabilitated prior to operation, i.e. expectation of temporary impact.
Track	The combination of rails, rail connectors, sleepers, ballast, points, crossings and any substitute devices
Watercourse	A watercourse is defined in the <i>Water Act 2000</i> as a river, creek or other stream which includes a stream in the form of an anabranch or a tributary where water flows either permanently or intermittently, regardless of flow frequency. In this report, reference to a 'watercourse' is generally made in relation to the management of water resources, consistent with the purpose of the <i>Water Act 2000</i> .
Waterway	A flow path that may operate during times of surface runoff. Generally, the flow path will have a defined cross-sectional shape. The use of waterways typically defines drainage pathways through the impact assessment area that are not defined as watercourses under <i>Water Act 2000</i> . Therefore, in addition to its statutory meaning under the <i>Fisheries Act 1994</i> , 'waterway' has been adopted in this report as the primary term when referring to drainage features (e.g. rivers, creeks and streams) of the impact assessment area.
Water type	Water quality sub-regions within the wider surface water basins, as defined in healthy water management plans.
Water quality objectives	Guidelines which advise water quality objectives across a variety of parameters for specific protection of a variety of environmental values across broad catchments and sub catchments.

Executive summary

The Project

Australian Rail Track Corporation (ARTC) is seeking approval to construct and operate the Border to Gowrie section of the Inland Rail Program ('the Project') which consists of approximately 216.2 km of single-track railway. The Project extends from the New South Wales and Queensland border, approximately 18 km to the south east of Goondiwindi near Kurumbul, to a tie-in with the Gowrie to Helidon section of the Inland Rail Program between Leeson Road and Draper Road, on the south eastern outskirts of Kingsthorpe.

The Project is located within the Condamine-Balonne Rivers basin and the Queensland section of the Border Rivers basin and is expected to intersect seven main watercourses (as defined under *Water Act 2000*) and several unnamed tributaries along the rail alignment.

Purpose

This surface water quality technical report has been prepared to assess potential impacts of the proposed Project on surface water quality.

This report outlines the legislative framework and methodology for undertaking the surface water quality assessment and potential impacts related to the Project. This report describes the existing water quality for the impact assessment area, providing a summary of the environmental values (EVs) and water quality objectives (WQOs) for the identified waterways.

Environmental values

Water quality objectives measure levels of particular indicators of water quality (such as salinity or turbidity) that protect EVs and are defined under the EPP (Water and Wetland Biodiversity) as objectives for physical, chemical and biological characteristics of the water. The defined EVs pertinent across the sub-catchments associated with the Project include:

- Aquatic ecosystems
- Irrigation
- Farm supply
- Stock water
- Visual recreation
- Drinking water
- Cultural, spiritual and ceremonial.

Other EVs identified across some of the sub-catchments associated with the Project include:

- Aquaculture (Upper Oakey water type zones)
- Human consumer (Upper Oakey, Condamine River South Branch, Lower Macintyre Brook, and Macintyre Barwon Floodplain water type zones)
- Primary recreation (Upper Oakey, Lower Macintyre Brook, and Macintyre Barwon Floodplain water type zones)
- Secondary recreation (Upper Oakey, Condamine River South Branch, and Macintyre Barwon Floodplain water type zones)
- Industrial use (Upper Oakey, Condamine River South Branch, and Condamine River North Branch water type zones).

Water quality objectives

The Healthy Waters Management Plans are a key planning mechanism established under EPP (Water and wetland biodiversity) and have been prepared to meet accreditation requirements under the 'Commonwealth *Water Act 2007* – Basin Plan 2012'. Waterway targets have been created for the Water Plan (Border Rivers and Moonie) 2019 and the Water Plan (Condamine and Balonne) 2019 and are expected to form continuing objective-based protection for watercourses within the Border Rivers and Moonie sub-catchment and Condamine River basin (DES, 2019a, b).

The Project alignment extends through the following water type zones within the Border Rivers and Condamine basins, as published in the relevant Healthy Waters Management Plan:

- Condamine River basin:
 - Oakey Creek
 - Central Condamine
 - Southern Condamine
- Border Rivers basin:
 - Canning Creek
 - Lower Macintyre Brook
 - Macintyre Barwon floodplain.

As such, the waterways targets for each respective water plan have been utilised to feed water quality thresholds for the protection of surface water quality within the Queensland Border Rivers and Condamine River basins.

Existing environment

- The impact assessment area is situated within a region of typically hot and dry conditions with seasonally distributed rainfall; rainfall is predominant during summer months
- Surface water catchments relevant to the impact assessment area include the Condamine-Balonne Rivers catchment (here within referred to as the Condamine River basin) and Border Rivers basin
- The defined watercourses (as defined under *Water Act 2000* and through further consultation with the Department of Natural Resources, Mines and Energy) intersected by the Project alignment are:
 - Macintyre River
 - Macintyre Brook
 - Canning Creek
 - Grasstree Creek
 - Pariagara Creek
 - Cattle Creek
 - Back Creek
 - Bringalily Creek
 - Nicol Creek
 - Back Creek drainage feature
 - Condamine River (Main Branch)
 - Condamine River (North Branch)
 - Umbiram Creek drainage feature

- One Mile Creek drainage feature
- Westbrook Creek
- Dry Creek
- Gowrie Creek
- Surface and groundwater-use is primarily related to recreational, commercial and domestic uses
- There are no wetlands of international importance (Ramsar wetlands) within 10 km of the Project, however multiple HES (High Ecological Significance) wetlands occur within the impact assessment area
- The impact assessment area typically traverses areas of modelled high and medium salinity hazard rating, with the proposed rail alignment crossing in sections, areas of modelled high salinity hazard which occur in some instances alongside the intersection of watercourses
- Ecosystem health within both catchments has been identified as poor under the most recent sustainable rivers audit 2 (MDBA, 2012). Typically, existing water quality conditions within the impact assessment area, noted during the existing environment assessment, indicated waterways relevant to the impact assessment area do not currently fully meet WQOs for either catchment.

Surface water quality receptors

All waterways within the impact assessment area were nominated as moderate sensitivity water quality receptors for identification of potential impacts, associated mitigation measures and identification of residual impact after implementation of mitigation. The Project alignment intersects the Macintyre River, Macintyre Brook, Canning Creek and the Condamine River. These areas were considered high sensitivity receptors due to the potential presence of Matters of National Environmental Significance (MNES) species including the Murray Cod (*Maccullochella peelii*), as well as the potential presence of Matters of State Environmental Significance (MSES) values within the impact assessment area.

Potential impacts

Potential impacts from the Project were grouped into the following six discrete categories (with interplay between each category in regard to impact):

- Increase in debris
- Changes to receiving water quality and hydrology
- Increase in salinity
- Increases in erosion and sedimentation
- Increase in contaminants
- Exacerbation of impacts listed above, from inadequate rehabilitation processes.

Significant residual impact assessment

In order to determine the significance of potential impacts of the Project upon the identified surface water quality receptors, sensitivity categories were applied to each of the receptors. The sensitivity of the potential impact was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the receptor. The magnitude of impact was grouped into four categories: high, moderate, low and negligible. Both the sensitivity of an impact and the magnitude of the potential impact were used to determine the significance of a potential impact.

The proposed mitigation measures (after design considerations) for the Project were identified in order to reduce the significance of the potential impacts upon the identified receptors. Following the application of the mitigation hierarchy (i.e. avoid, minimise, mitigate), there will be a low residual significance of risk on water quality receptors:

- During construction, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate potential impacts, such that the residual significance would be low
- For operation, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate potential impacts, such that the residual significance would be low.

Cumulative impacts

A cumulative impact assessment was undertaken where potential surface water impacts of the Project were assessed together with existing or planned surrounding activities. The cumulative impact assessment identified a medium risk of potential impact occurring during construction phase activities through riparian vegetation loss from vegetation clearing/removal. Further mitigation measures (during detail design) may be necessary and specific management practices applied.

1 Introduction

1.1 Purpose

The purpose of this report is to provide an overview of the existing surface water quality, establish potential impacts and propose reasonable mitigation measures for the Border to Gowrie section of the Inland Rail Program ('the Project'). The Project consists of approximately 216.2 kilometres (km) of single-track railway extending from the NSW/QLD border, approximately 18 km to the south east of Goondiwindi near Kurumbul, to a tie-in with the Gowrie to Helidon section of the Inland Rail Program between Leeson Road and Draper Road, on the south eastern outskirts of Kingsthorpe.

This technical report includes an assessment of the quality of water and the existing uses of surface waters (known as environmental values (EVs)), as well as the water quality objectives (WQOs) that have been established to protect these values.

The existing environment is described, and an assessment is made of the potential impacts of the Project. Potential short and long term impacts on local and regional surface waterways have been assessed based on a review of the Project's construction and operation phases. The results of the impact assessment and recommended mitigation measures have been outlined, along with potential cumulative impacts.

This technical report has been prepared to support the Border to Gowrie Project Environmental Impact Statement (EIS), particularly Chapter 12: Surface water and hydrology.

1.2 Terms of reference requirements

The purpose of this report is to address elements of the *Terms of reference for an environmental impact statement: Inland Rail - Border to Gowrie project (November 2018)* (DSDMIP, 2018) (ToR) relevant to surface water quality. Locations where each relevant ToR requirement is addressed in this report is presented in Table 1.1.

Table 1.1 Compliance against relevant sections of the terms of reference

Section	Surface water quality terms of reference requirements	Report section
Water		
Existing environment		
10.4	Describe and illustrate the topography of the proposed rail alignment and surrounding area, and highlight any significant features shown on the maps. Include and name all waterways and floodplains, including watercourses, rivers and creeks. Maps should include a scale and have contours at suitable increments relevant to the scale, location, potential impacts and type of Project, shown with respect to Australian Height Datum (AHD) and drafted to GDA94.	Section 5
11.24	The EIS must also provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Sections 5 and 6 Appendix R: Groundwater Technical Report
11.36	Identify the water related environmental values and describe the existing surface water and groundwater regime within the study area and the adjoining waterways in terms of water levels, discharges and freshwater flows.	Sections 3.2.1, Section 5 and Section 6 Appendix Q1 and Q2: Hydrology and Flooding Technical Report Appendix R: Groundwater Technical Report

Section	Surface water quality terms of reference requirements	Report section
11.37	With reference to the EPP (Water and wetland biodiversity) Policy 2009, section 9 of the EP Act, and SPP State Interest Guideline - Water Quality, identify the environmental values of surface water and groundwater within the Project area and immediately downstream that may be affected by the Project, including any human uses of the water and any cultural values.	Section 3.1, Section 3.2, Section 5.7, Section 5.11 and Section 5.12 Appendix R: Groundwater Technical Report
11.38	At an appropriate scale, detail the chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the Project. Include a description of the natural water quality variability within the study area associated with climatic and seasonal factors, and flows.	Section 6 Appendix R: Groundwater Technical Report
11.39	Describe any existing and/or constructed waterbodies adjacent to the proposed alignment.	Section 5.6
Water quality		
Impact assessment		
11.41	The assessment of impacts on water will be in accordance with the DES Information guideline for an environmental impact statement – TOR Guideline – Water, where relevant, located on the DES website (refer to Appendix 1).	Section 3.1 The assessment contained within Appendix P: Surface Water Quality Technical Report is consistent with the DES Information guideline for an environmental impact statement – TOR Guideline – Water
11.42	Identify the quantity, quality and location of all potential discharges of water and wastewater by the Project, whether as point sources (such as controlled discharges) or diffuse sources (such as irrigation to land of treated sewage effluent).	Section 6.4.1.1 and Section 6.4.1.2
11.43	Assess the potential impacts of any discharges on the quality and quantity of receiving waters taking into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts.	Section 6.3, Section 6.4.1.1 and Section 6.4.1.2
11.44	Where significant cuttings are proposed, identify the presence of any sulphide minerals in rocks with potential to create acidic, metalliferous and saline drainage. Should they be present, describe the practicality of avoiding their disturbance. If avoidance is not practicable, characterise the potential of the minerals to generate contaminated drainage and describe abatement measures that will be applied to avoid adverse impacts to surface and groundwater quality.	Section 5.5.2.2 Primarily addressed in Appendix R: Groundwater Technical Report
11.45	Describe the potential impacts of in-stream works on hydrology and water quality.	Section 6.4.1, Section 6.4.2 and Section 6.4.3
11.46	Undertake a salinity risk assessment in accordance with Part B of the Salinity Management Handbook, Investigating Salinity (refer to Appendix 1). In particular, consider how the Project will change the hydrology of the Project area and provide results of the risk assessment.	Section 5.10 and Section 6.4.1 Salinity hazard is primarily addressed in Chapter 8: Land resources of the Border to Gowrie EIS.
Mitigation measures		
11.47	Describe how the water quality objectives identified above would be achieved, monitored and audited, and how environmental impacts would be avoided or minimised and corrective actions would be managed.	Section 7.2 and Section 7.3

Section	Surface water quality terms of reference requirements	Report section
11.48	Describe appropriate management and mitigation strategies and provide contingency plans for:	-
	(a) potential accidental discharges of contaminants and sediments during construction and operation	Section 7.1 and Section 7.2
	(b) stormwater run-off from the Project facilities and associated infrastructure during construction and operation, including the use of appropriate best practice erosion and sediment control practices (refer to Appendix 1), and the separation of clean stormwater run-off from disturbed and operational areas of the site	Section 7.1 and Section 7.2
	(c) flooding of relevant river systems, the effects of tropical cyclones and other extreme events	Appendix Q1 and Q2: Hydrology and Flooding Technical Report
	(d) management of acid sulfate soils and acid producing rock and associated leachate from excavations and disturbed areas.	Section 7.1 and Section 7.2
11.49	Describe treatment processes for all waste water produced as a result of the Project.	Section 2.6.1.1, Section 6.4.1.1 and Section 7.2
11.50	Propose suitable measures to avoid or mitigate the impacts of in stream works on water quality and the stabilisation and rehabilitation of any such works.	Section 7.1 and Section 7.2
11.51	Where a salinity risk is identified, detail strategies to manage salinity ensuring the development must be managed so that it does not contribute to the degradation of soil, water and ecological resources or damage infrastructure via expression of salinity. See Part C of the salinity management handbook second edition, Department of Environment and Resource Management 2011 (refer to Appendix 1).	Section 7.2 Salinity hazard is primarily addressed in Chapter 8: Land resources of the Border to Gowrie EIS.
Water resources		
Impact assessment		
11.52	Provide details of any proposed impoundment, extraction (i.e. volume and rate), discharge, use or loss of surface water or groundwater. Identify any approval or allocation that would be needed under the Water Act, Water Supply (Safety and Reliability) Act 2008 or Planning Act.	Section 2.6.1.1, Section 6.4.1.1
11.53	Detail any significant diversion or interception of overland flow. Include maps of suitable scale showing the location of diversions and other water-related infrastructure.	Section 2.4 and Figure 2.1
11.54	Develop hydrological models as necessary to describe the inputs, movements, exchanges and outputs of all significant quantities and resources of surface water and groundwater that may be affected by the Project. The models should address the range of climatic conditions that may be experienced at the site, and adequately assess the potential impacts of the Project on water resources. This should enable a description of the Project's impacts at the local scale and in a regional context including proposed:	Appendix Q1 and Q2: Hydrology and Flooding Technical Report
	(a) changes in flow regimes from structures and water take	
	(b) alterations to riparian vegetation and bank and channel morphology	
	(c) direct and indirect impacts arising from the Project	
	(d) impacts to aquatic ecosystems, including groundwater dependent ecosystems and environmental flows.	
11.55	Provide information on the proposed water usage by the Project including details about:	-
	(a) the estimated supply required to meet the demand for construction and full operation of the Project, including timing of demands	Sections 2.6, Section 5.11 and Section 6.4.2
	(b) the quality and quantity of all water supplied to the site during the construction and operational phases based on minimum yield scenarios for water reuse, rainwater reuse and any bore water volumes	Section 2.6
	(c) a plan outlining actions to be taken in the event of failure of the main water supply	Section 2.6 and Section 6.4.2

Section	Surface water quality terms of reference requirements	Report section
	(d) sufficient hydrogeological information to support the assessment of any temporary water permit applications.	Appendix R: Groundwater Technical Report
11.56	Describe proposed sources of water supply given the implication of any approvals required under the Water Act. Estimated rates of supply from each source (average and maximum rates) must be given and proposed water conservation and management measures must be described.	Sections 2.6 and Section 6.4.2 Chapter 5: Project Description of the Border to Gowrie EIS
11.57	Determination of potable water demand must be made for the Project, including the temporary demands during the construction period. Include details of any existing town water supply to meet such requirements. Detail should also be provided to describe any proposed on-site water storage and treatment for use by the site workforce.	Sections 2.6
11.58	Identify relevant Water Plans and Resources Operations Plans under the Water Act. Describe how the Project will impact or alter these plans. The assessment should consider, in consultation with Department of Natural Resources, Mines and Energy (DNRME), any need for:	Section 3.1, Section 5.11 and Section 6.4.2
	(a) a resource operations licence	A resource operations licence is not considered to be required by the Project
	(b) an operations manual	An operations manual is not considered to be required by the Project
	(c) a distribution operations licence	A distribution operations licence is not considered to be required by the Project
	(d) a water licence	Section 2.6 and Section 3.1
	(e) a water management protocol.	A water management protocol is not considered to be required by the Project
11.59	Identify other water users that may be affected by the proposal and assess the Project's potential impacts on other water users.	Section 3.2, Section 5.11, Section 5.12 and Section 6.4.3
11.60	Identify and quantify likely activities involving the excavation or placement of fill or the removal of vegetation that will be undertaken in any watercourse, lake or spring. Where works are not consistent with the Riverine Protection Permit Exemption Requirements (Appendix 1) provide sufficient information to meet riverine protection permit requirements.	Section 2.2, Section 6.4.1, Section 6.4.2 and Section 7.2 Chapter 5: Project Description of the Border to Gowrie EIS
Mitigation measures		
11.61	Provide designs for all infrastructure utilised in the treatment of on-site water, including how any on-site water supplies are to be treated, contaminated water is to be disposed of and any decommissioning requirements and timing of temporary water supply/treatment infrastructure is to occur.	Section 2.5, Section 7.1 and Section 7.2
11.62	Describe measures to minimise impacts on surface water and ground water resources.	Section 7.1 and Section 7.2
11.63	Provide a policy outline of compensation, mitigation and management measures where impacts are identified.	Section 7.1 and Section 7.2 Primarily addressed in Appendix R: Groundwater Technical Report

1.3 Impact assessment area

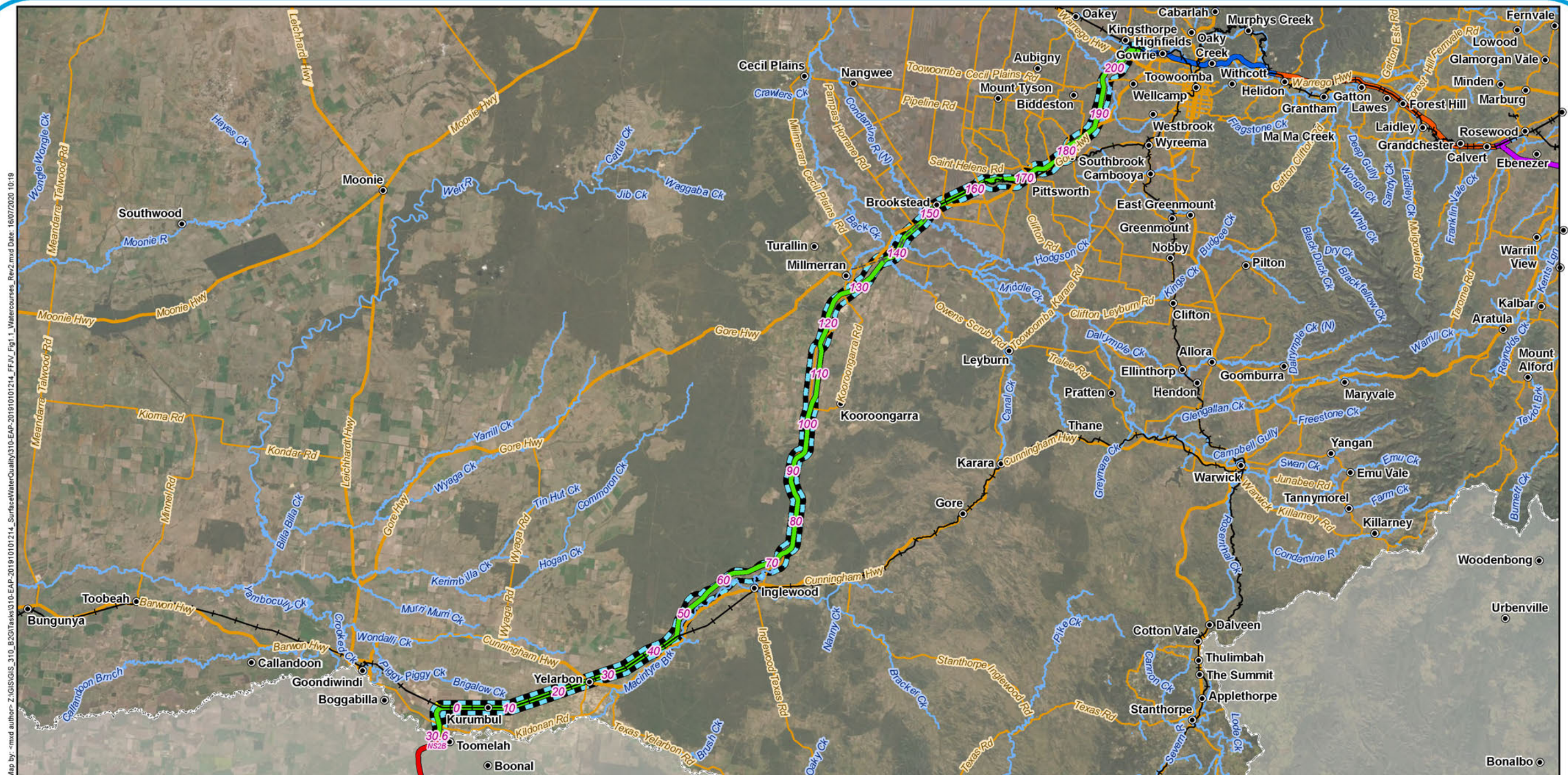
The impact assessment area for the assessment of surface water is 1 km either side of the Project alignment. The impact assessment area includes the whole of the Project footprint and has been established to enable assessment of foreseeable direct and indirect impacts to water quality.

The impact assessment area is shown on Figure 1.1 in relation to the Project alignment and surrounding hydrological features.

1.4 Overview of surface water environment

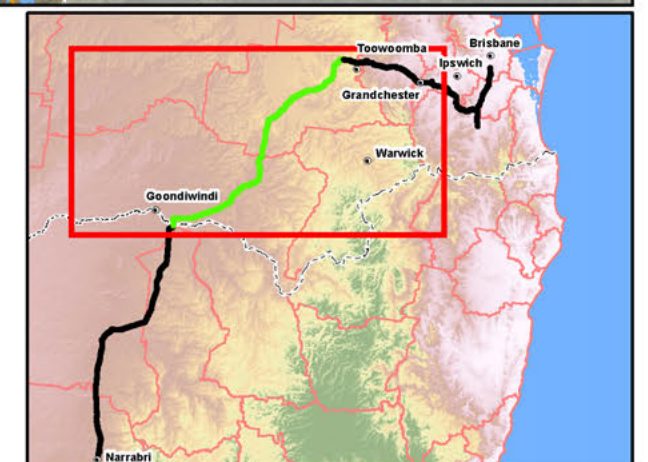
The Project is located across two surface water catchment areas, the Condamine River basin and the Border Rivers basin (refer Figure 5.1). The Project alignment extends through the Border Rivers basin from the NSW/QLD border to approximately 15 km southwest of Millmerran (Ch 117.0 km). From this point, the Project alignment is located in the Condamine River basin until its northern end point at Ch 206.9 km.

Both catchments reside within the larger Murray-Darling basin, and cross Queensland and New South Wales state borders. Multiple watercourses and waterbodies occur within the impact assessment area. These are discussed in Section 5.6 and shown on Figure 1.1.



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Defined watercourses (Water Act 2000)
- NSW/QLD border
- Surface water impact assessment area



A3 scale: 1:800,000
0 6 12 18 24 30 km

2 Project description

The Project is a 216.2 km section of new single track railway between the NSW/QLD border and Gowrie, in Queensland. The Project is comprised of 7.0 km of standard gauge rail (1,435 mm) and 209.2 km of dual standard/narrow gauge rail (1,435 mm standard and 1,067 mm narrow). The new railway will be positioned within approximately 145.0 km of new rail corridor (greenfield) and approximately 71.2 km of existing rail corridor (brownfield), currently utilised by QR's South Western Line and Millmerran Branch Line.

The Project commences at Ch 30.60 km (NS2B) at the NSW/QLD border, the median point of the Macintyre River, approximately 18 km southeast of Goondiwindi. The Project runs northeast via Yelarbon, Inglewood, Millmerran, Pampas, Brookstead, Pittsworth, Southbrook and the Toowoomba Wellcamp Airport to Ch 206.95 km at Gowrie Junction, northwest of Toowoomba.

The Project is one of the "missing links" within the Inland Rail Program. As part of the broader Inland Rail Program, the Project provides a more direct route between Melbourne and Brisbane in comparison with the existing inland and coastal road and rail networks and meets the Australian Government's objective of providing a long-term rail solution for competitive freight movement.

At the commencement of operation, the Project will accommodate the use of double-stacked, 1,800 m long trains, with future provision to accommodate trains up to 3,600 m.

Key components of the Project can be attributed to either the construction or operational phase. The key components of the Project during the pre-construction and construction phases are summarised in Table 2.1 and the key components of the operational phase are summarised in Table 2.2.

Quantities specified here are reflective of the reference design for the Project and may be subject to change through the detail design and construction process.

Table 2.1 Key reference design components (pre-construction and construction phases)

Component	Quantity
Non-resident workforce accommodation facilities	3
Bridge laydowns	35
Track laydown areas	39
Cut volume (total)	12,525,037 cubic metre (m ³) (rail and road)
Maximum cut depth	29.7 m
Fill volume (total)	12,250,669 m ³ (rail) 1,096,670 m ³ (road)
Maximum fill depth	24.5 m
Bridge crossings	34
Bridge length (total)	11,653 m
Culverts	Reinforced concrete box culverts: 928 cells in 120 locations Reinforced concrete pipes: 1,553 pipes in 212 locations
Concrete batching plants	2 sites nominated. Only one expected to be required.
Flash butt welding facilities	1 site nominated. If a second is desirable, opportunities to share the flash butt welding facility established for the adjoining Gowrie to Helidon project will be explored
Refuelling	150,000 litres (L) storage capacity, distributed across 12 sites

Table 2.2 Key reference design components (operational phase)

Component	Quantity
Rail length (Ch 30.60 km (NS2B) to Ch 206.95 km)	Standard gauge: 7.0 km Dual gauge: 209.2 km Total: 216.2 km
Rail interfaces (tie-ins): - QR South Western Line: - Connection at Kildonan, towards Goondiwindi - Connection at Whetstone, towards Warwick - Turnouts to existing sidings and loops (six locations) - QR Millmerran Branch Line: - Connection at Millmerran - Connection at Yarranlea - Turnouts to existing sidings (two locations)	12
State-controlled road interfaces: - Active level crossing - Grade separation: rail-over-road - Grade separation: road-over-rail	7 roads in 9 locations 2 5 2
Local government road interface treatments: - Goondiwindi Regional Council - Passive level crossing - Active level crossing - Grade separation: rail-over-road - Grade separation: road-over-rail - Toowoomba Regional Council - Passive level crossing - Active level crossing - Grade separation: rail-over-road - Grade separation: road-over-rail	8 8 2 0 12 7 6 1
Crossing loops	5, located as follows: - Loop 1 – Yelarbon - Loop 2 – Inglewood - Loop 3 – Kooroongarra - Loop 4 – Yandilla - Loop 5 – Broxburn

2.1 Project phases

2.1.1 Pre-construction and early works

Pre-construction activities are required to enable the construction of permanent infrastructure components of the Project to commence. These activities are expected to include:

- Land acquisition
- Obtaining additional environmental and planning approvals
- Surveys and geotechnical investigations
- Establishment of access tracks

- Utility/service relocations, realignments or protection
- Relocation or protection of Queensland Rail (QR) assets
- Modification and re-instatement of fauna pest exclusion fencing
- Establishment of site compounds and construction facilities, including vehicle workshops and washdown facilities as required
- Establishment of non-resident workforce accommodation
- Delivery of materials with long lead times.

2.1.2 Construction

The general construction activities for the Project will include:

- Site set out and pegging
- Clearing – utilising dozers, chainsaws, excavators, trucks and similar equipment
- Bulk earthworks – major cut to fill operations include the winning of suitable construction material from sections of cut along the railway alignment or from borrow areas external to the site
- Supply, delivery and installation of ballast and concrete sleepers
- Construction of drainage facilities – cut off drains, table drains and culvert structures
- Installation of rail track and other items of rail infrastructure using rail mounted equipment
- Construction and installation of concrete railway bridges and culverts
- Installation of railway signalling and communications equipment
- Construction of railway maintenance facilities
- Other miscellaneous activities to complete the works.

2.1.3 Operation

The Project will involve operation of a single rail track with crossing loops, initially to accommodate double stacked freight trains 1,800 m long and 6.5 m high. Train speeds will vary according to axle loads and track geometry, and range from 80 to 115 km/hr.

It is estimated that once operational, the Project will involve an annual average of about 14 train services per day in 2026. This is likely to increase to an average of 20 trains per day in 2040, and up to 25 per day during peak operational periods. Annual freight tonnages will increase in parallel, from approximately 14.2 million tonnes per year in 2026 to 21.8 million tonnes per year in 2040.

Operation phase activities will include the use of the railway for freight purposes, operation and maintenance of safety systems, signalling, and general track and infrastructure maintenance. Typically, these activities include minor maintenance works, such as bridge and culvert inspections, sleeper replacement, rail welding, rail grinding, ballast dropping and track tamping, through to major periodic maintenance, such as ballast cleaning and reconditioning of track.

2.2 Bridges

The Project involves the construction of new bridge structures over waterways and/or floodplains. The new bridge structures are typically founded on driven precast or bored *in situ* piled foundations, supporting *in situ* reinforced concrete substructures. Bridge superstructures are typically formed from pre-stressed precast concrete girders with *in situ* decks incorporating walkways, guardrails and barriers as appropriate. The bridges are of various lengths and spans to suit the Project alignment and topography.

New rail bridges that are proposed to cross watercourses or roads are summarised in Table 2.3.

At each bridge location, works will be required adjacent to and within the bankfull width of the waterway. Such works may involve the excavation or placement of fill or the removal of vegetation that will be. The detail design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with the intent of:

- Riverine protection permit exemption requirements (WSS/2013/726)
- Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF, 2018).

Table 2.3 Summary of rail bridges

Bridge name	Chainage start (km)	Chainage end (km)	Crossing type	Bridge length (m)
Macintyre River Viaduct	30.5 (NS2B)	30.7 (NS2B)	Watercourse	165
	30.7 (NS2B)	31.1 (NS2B)	Watercourse	435
Macintyre Floodplain #1 Rail Bridge	31.4 (NS2B)	31.6 (NS2B)	Watercourse	140
Macintyre Floodplain #2 Rail Bridge	32.2 (NS2B)	32.8 (NS2B)	Watercourse and road	546
Macintyre Brook Rail Bridge 1	52.4	52.7	Watercourse	207
Macintyre Brook Rail Bridge 2	55.4	55.6	Watercourse	207
Pariagara Creek Rail Bridge	67.2	67.5	Watercourse	345
Cattle Creek Rail Bridge	88.2	88.3	Watercourse	138
Native Dog Creek Rail Bridge	93.8	94.0	Watercourse	184
Bringalily Creek 1 Rail Bridge	97.4	97.7	Watercourse	299
Bringalily Creek 3 Rail Bridge	100.1	100.7	Watercourse	621
Nicol Creek Rail Bridge	104.3	104.4	Watercourse	92
Millmerran-Inglewood Road Rail Bridge #2	115.5	115.6	Road	75
Millmerran-Inglewood Road Rail Bridge #3	126.9	127.1	Road	167
Back Creek Rail Bridge	127.9	128.1	Watercourse	230
Grasstree Creek #1 Rail Bridge	138.0	138.3	Watercourse	336
Grasstree Creek #2 Rail Bridge	138.8	139.3	Watercourse	952
Condamine River #1 Rail Bridge	141.3	142.0	Watercourse	658
Condamine River #2 Rail Bridge	142.6	144.5	Condamine River	1,918
Condamine River #3 Rail Bridge	144.5	145.1	Condamine River	602
Condamine River North Branch Rail Bridge	147.8	149.3	Condamine River North Branch	1,568
Yarranlea Road Rail Bridge	161.2	161.2	Road	69
Roche Road Rail Bridge	163.2	163.3	Road	121
Oakey Pittsworth Road Rail Bridge	170.9	171.0	Road	69
Lochaber Road Rail Bridge	172.4	172.5	Road	75
Biddeston-Southbrook Road Rail Bridge	183.5	183.7	Road	144
Toowoomba-Cecil Plains Road Rail Bridge	196.1	196.1	Road	92
Westbrook Creek Rail Bridge	197.1	197.4	Watercourse	230
Dry Creek Rail Bridge	197.9	198.0	Watercourse	184
Brimblecombe Road Rail Bridge	198.7	198.8	Road	75
Warrego Highway Rail Bridge	203.0	203.1	Road	132
Chamberlain Road Rail Bridge	204.4	204.5	Road	299

2.3 Drainage infrastructure

2.3.1 Cross-drainage

Cross-drainage structures have been incorporated into the reference design where the Project intercepts existing watercourses and other drainage features. The type of cross-drainage structure included in the reference design depends on various factors such as the natural topography, rail formation levels, direction of flow and soil type.

Bridges are proposed at all major waterway crossings to minimise disturbance to the existing flow regime. In some instances, bridges are provided in locations which may have multiple drainage features passing under the rail corridor, such as across the Condamine River floodplain.

Cross-drainage structures, including culverts, have been incorporated into the reference design to enable the Project to achieve the flood immunity specified in the Basis of Design of a 1% AEP event. Culverts incorporated into the design are a mix of reinforced concrete pipe culverts and reinforced concrete box culverts. The location and design of culverts will be refined, if required, during the detail design phase to reflect design changes through that process.

Scour protection measures have been included around culvert entrances and exits, on disturbed stream banks and on land bound by a watercourse to avoid erosion. Scour protection or energy dissipation measures have been specifically designed and sized for each culvert location in accordance with Austroads Guide to Road Design Part 5B: Drainage – Open Channels, Culverts and Floodways (Austroads, 2013b) (AGRD) with consideration for flow velocity, soil type and vegetation cover. Scour protection measures incorporated into the reference design for culverts include:

- Concrete apron
- Concrete wingwalls
- Rock mattress scour protection, with geotextile underlay.

Scour protection measures for culvert outlets have been designed to ensure that the maximum allowable flow velocities in a 1% Annual Exceedance Probability (AEP), as specified in Table 3.1 of AGRD, are not exceeded. Maximum allowable flow velocities in Table 3.1 of AGRD are specific to the soil type at each culvert location, as follows:

- Stable rock – 4.5 m/s
- Stones 150 mm diameter or larger – 3.5 m/s
- Gravel 100 mm or grass cover – 2.5 m/s
- Firm loam or stiff clay – 1.2 to 2 m/s
- Sandy or silty clay – 1.0 to 1.5 m/s.

The scour protection length and minimum rock size (d50) have been determined from Figure 3.15 and Figure 3.17 in AGRD. All required scour lengths were predicted to fit within the rail corridor.

The number, location and sizing of culverts included in the reference design are provided in Appendix G for the following floodplains:

- Gowrie Creek
- Westbrook Creek and Dry Creek
- Condamine River
- Back Creek
- Nicol Creek
- Bringalily Creek
- Cattle Creek

- Pariagara Creek
- Macintyre Brook
- Macintyre River

2.3.2 Longitudinal drainage

The purpose of longitudinal or track drainage is to remove water that has percolated through the track ballast, and to divert surface runoff to the nearest bridge or culvert location before it reaches the subgrade. Without adequate track drainage, the subgrade may become saturated leading to weakening and subsequent failure of the subgrade.

Two types of track drainage are proposed:

- Embankment drains – longitudinal drains that run parallel to the railway and are located within the rail corridor, at the foot of the railway embankment
- Catch drains – longitudinal drains that run parallel to the railway and are located within the rail corridor, on the up-slope side of cuttings

Track drainage is proposed at specific locations along the Project alignment where the gradient is steep enough to divert surface runoff to the nearest bridge or culvert location. As with culverts, the design and location of track drainage will be refined, if required, during the detail design phase.

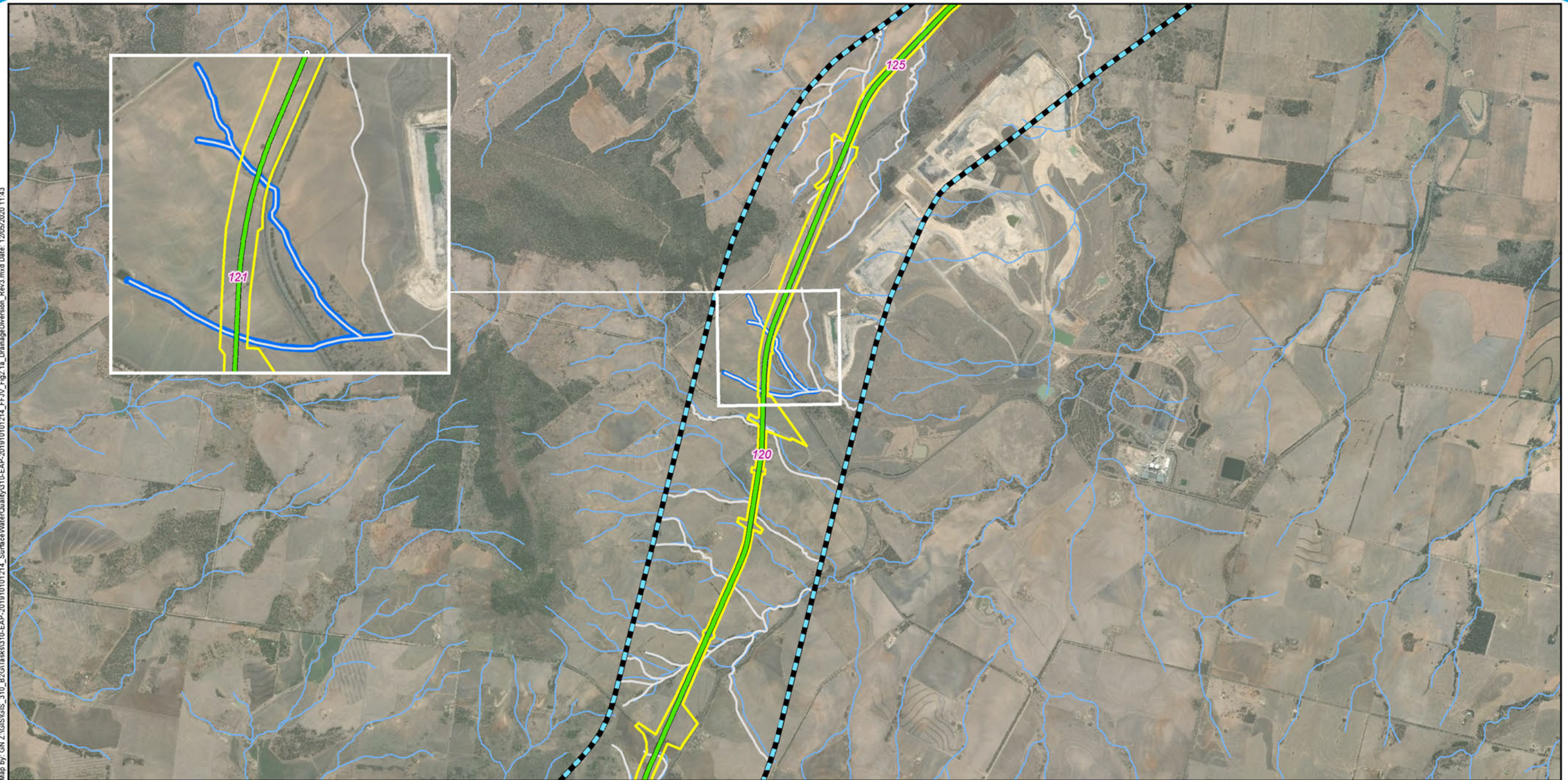
2.4 Waterway diversions

The reference design does not require permanent diversion of any watercourses, as defined under the Water Act. However, three drainage features (not mapped watercourses under the Water Act) defined as waterways under the Fisheries Act are expected to require diversion based on the reference design (refer Section 5.6.3 and Figure 2.1).

One trapezoidal diversion drain is required from Ch 120.77 km to Ch 121.92 km to divert runoff from the west away from the rail alignment, which is located in cut in this chainage range. The rail in cut intersects two waterway flow paths at Ch 120.77 km and Ch 121.43 km. The diverted flow returns to the original flow path 750 m downstream of the rail at Ch 120.77 km. The diversions from Ch 120.77 km to Ch 121.92 km are identified as low risk-of-impact waterways under the Department of Agriculture and Fisheries *Queensland Waterways for Waterway Barrier Works* spatial mapping.

An additional trapezoidal diversion drain is proposed where the rail embankment overlays an existing flow path. This affected flow path runs for 150 m long from Ch 190.66 km to Ch 190.81 km. Where waterway diversions are deemed required on unmapped waterways following final design then a watercourse determination will need to be made in order to determine approval requirements. The diversion from Ch 190.66 km to Ch 190.81 km is identified as a low risk of impact waterway under the Department of Agriculture and Fisheries *Queensland Waterways for Waterway Barrier Works* spatial mapping.

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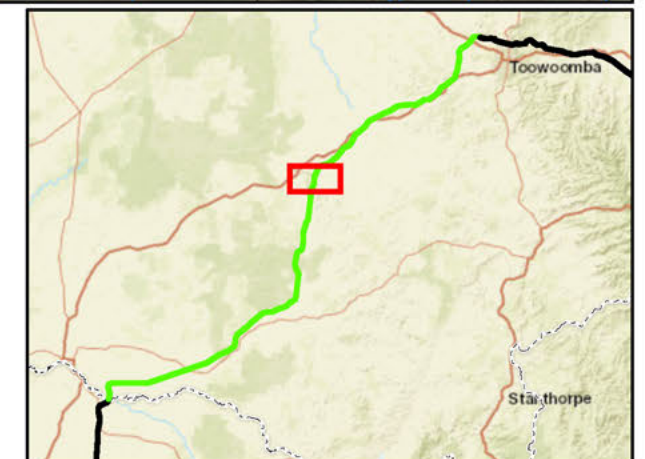


Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- Drainage features
- Impacted section of water feature
- Project footprint
- Surface water impact assessment area

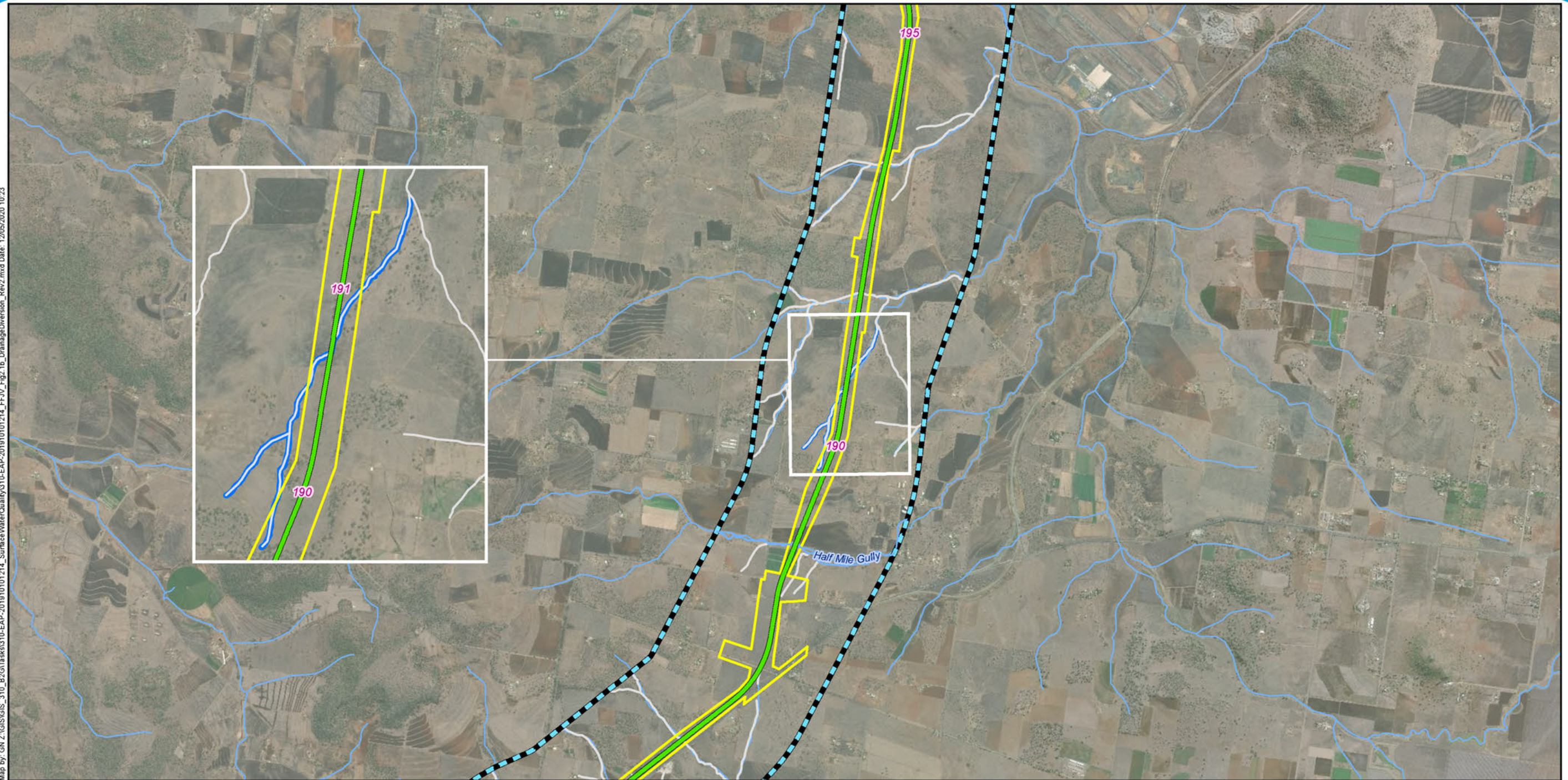
Watercourse identification map [Water Act 2000]

— Unmapped



A3 scale: 1:50,000
 0 0.5 1 1.5 2 2.5km

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Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- Drainage features
- Impacted section of water feature
- Project footprint
- Surface water impact assessment area

Watercourse identification map [Water Act 2000]

— Unmapped



A3 scale: 1:50,000
 0 0.5 1 1.5 2 2.5km

2.5 Erosion and sediment control basins

Temporary site drainage and water management controls will be installed in order to minimise the impacts of runoff and sedimentation from construction activities on adjacent receptors.

Temporary site drainage and water runoff management will be in line with the International Erosion Control Association's Best Practice Erosion and Sediment Control Document and will:

- Minimise runoff and sedimentation from Project activities to existing watercourses and drainage features
- Minimise disturbance to the water quality of existing watercourses and drainage features along the Project alignment.

The reference design includes 17 sediment basins, as identified in Table 2.4. All of the proposed sediment basins are passive which allows surface runoff from a catchment to flow into the sediment basin without the need for pumping.

The locations of sediment basins are shown in working plans and longitudinal sections presented in Volume 3 of the draft EIS.

The placement and sizing of sediment basins for the Project has been established based on the landform and earthworks required to construct the reference design. Therefore, the placement and sizing of sediment basins will need to be reassessed and revised, as required, as part of the detail design process. Sufficient allowance has been included in the Project footprint for sediment basins to be relocated and/or resized, as required to support the detail design.

Table 2.4 Sediment basins for the Project

Sediment basin ID and chainage ¹	Catchment size (m ²)	Settling volume (m ³)	Total volume (m ³)
Sediment basin 1 (Ch.48.5 km)	35,175	409	613
Sediment basin 2 (Ch.73.7 km)	116,116	1,349	2,024
Sediment basin 3 (Ch.52.7 km)	88,708	1,031	1,546
Sediment basin 4 (Ch.55.5 km)	86,440	1,004	1,506
Sediment basin 5 (Ch.60.4 km)	85,664	995	1,493
Sediment basin 6 (Ch.61.5 km)	31,279	363	545
Sediment basin 7 (Ch.63.1 km)	27,150	315	473
Sediment basin 8 (Ch.73.6 km)	40,187	467	700
Sediment basin 9 (Ch.163.1 km)	20,571	239	359
Sediment basin 10 (Ch.170.6 km)	20,720	241	361
Sediment basin 11 (Ch.172.6 km)	82,424	958	1,436
Sediment basin 12 (Ch.179.9 km)	68,475	796	1,193
Sediment basin 13 (Ch.183.5 km)	41,256	479	719
Sediment basin 14 (Ch.191.8 km)	51,268	596	893
Sediment basin 15 (Ch.195.7 km)	67,138	780	1,170
Sediment basin 16 (Ch.204.4 km)	63,918	743	1,114
Sediment basin 17 (Ch.204.6 km)	7,425	86	129

2.6 Project water requirements and usage

2.6.1 Construction water

2.6.1.1 Water requirement

Significant volumes of water will be required for various activities associated with construction of the Project, including for earthworks, concrete production, track works and the operation of non-resident workforce accommodation. The following sections provide a discussion on the anticipated water demand for each of these purposes.

Earthworks

The greatest water demand for the Project will be for earthworks, which predominately includes conditioning of fill material, haul road and laydown pad maintenance and dust suppression.

The rates of water application for earthworks activities have been adopted based on the rates used during earthworks for a recent, previous transport infrastructure project in the region and are as follows:

- Material conditioning is expected to require approximately 100 L/m³ of fill, however this is variable, dependent upon material properties.
- General dust suppression across the site will be a constant activity. An allowance of 50 L/m³ of fill has been made. This allowance also covers the water required to re-establish vegetation on disturbed surfaces following the completion of works.
- Haul road and laydown area maintenance will also require water. An allowance of 40 L/m³ of fill has been made.

Based on these rates of application and the volume of fill required for the reference design (13,347,369 m³), a total of 2,536 ML of water that is not quality dependent is estimated to be required for earthworks during construction. Water volumes for each earthworks activity are presented in Table 2.5.

Fill and water volumes for the Project will be confirmed during the detail design process.

Table 2.5 Construction water requirements for earthworks activities

Earthworks activity	Assumed application rate (L/m ³)	Total volume (ML)
Rail (Fill = 12.251 Mm³)		
Material conditioning	100	1,225
Dust suppression and revegetation ¹	50	613
Haul road and laydown area maintenance	40	490
Roads (Fill = 1.097 Mm³)		
Material conditioning	100	110
Dust suppression and revegetation ¹	50	55
Haul road and laydown area maintenance	40	44
Total		2,536

Table note:

- ¹ This allowance covers the water required to re-establish vegetation on disturbed surfaces following the completion of works.

Concrete batching

The Project is expected to rely on a combination of existing commercial concrete batching plants and a temporary plant for the batching and precast of concrete, established to service the Project.

Concrete batching has specific water quality requirements in order to achieve structural integrity and asset life objectives. The water requirements for use in the supply of concrete are specified in AS 1379:

Specification and supply of concrete. Established plants are connected into mains water supply, so the quality and uninterrupted supply of water is not an issue for existing commercial facilities. Therefore, the water requirement for concrete supplied by existing concrete/precast concrete suppliers does not contribute to the Project's direct water requirement.

Locations for two temporary plants, with combined concrete batching and precast function, have been nominated in the Toowoomba LGA to service the Project, one at Ch 137.0 km (Yandilla) and another at Ch 150.5 km (Dieckmann Road). The demand for an on-site temporary batching and precast plant is driven by the large number and scale of concrete structural elements that are included in the design solution for the crossing of the Condamine River floodplain. Whilst two locations have been nominated, only one plant is expected to be necessary to supplement the supply of concrete from established commercial operators.

If a temporary batching and precast plant is established, a dedicated water supply sourced from mains water will be required. A temporary concrete batching and precast plant would be established with on-site water storage tanks, which would be filled by water trucks drawing water from mains connections in local towns, being Brookstead or Millmerran, if capacity is available. Alternatively, water would be sourced from further afield.

A water requirement of 200 L/m³ has been estimated for the on-site batching of concrete (wet and precast). Using this rate, the water requirement for on-site concrete batching activities is estimated to be 15 ML, as summarised in Table 2.6.

Table 2.6 Estimated water usage for on-site concrete production

Concrete product	Volume required for the reference design (m ³) ¹	Water requirement (L/m ³)	Total estimated water usage (ML)
Precast	24,000	200	4.8
Wet (bulk)	51,000 ²	200	10.2
Total:			15.0

Table notes:

- 1 Excludes concrete (insitu and precast) for culverts, which will all be supplied by existing commercial suppliers.
- 2 For insitu concrete required between Ch 138 km and Ch 165 km. Insitu concrete required outside of this chainage range will be supplied by existing commercial concrete batching plants.

The availability of mains water for the use in a temporary batching facility would be discussed with TRC as the construction approach is refined during the detail design process. In the planning of water access, maintaining the uninterrupted supply of potable water to existing residential and commercial users will be the priority.

Track works

The predominant requirement for construction water during track works is for dust suppression relating to ballasting works, in particular ballast dropping and ballast regulating works during track tamping activities.

Based on previous rail project experiences, a conservative allowance of 6 L per track metre has been assumed for dust suppression during ballast dropping and 4 L per track metre for dust suppression during tamping and regulating activities.

For 216.2 km of rail alignment, track works is estimated to require a total of 2.16 ML of water that is not quality dependent. A breakdown of this total volume is presented in Table 2.7.

Table 2.7 Construction water requirements for track work activities

Track works activity	Assumed application rate (L/m)	Total project volume (ML)
Dust suppression during ballast dropping	6	1.30
Dust suppression during tamping and regulating	4	0.86
Total		2.16

Non-resident workforce accommodation

The total daily water usage on non-resident workforce accommodation is a factor of a facility's occupancy numbers and includes water used for the following purposes:

- Toilets
- Showers
- Laundry
- Food preparation
- Cleaning

The average daily water use per person recorded by TRC in February 2020 was 120 L per person per day (L/p/d), with a maximum of 322 L/p/d (Millmerran) and a minimum of 44 L/p/d (Haden) (TRC, 2020). Based on this data, a conservative daily volume of 340 L/p/d has been adopted to estimate the water usage for non-resident workforce accommodation. For three non-resident workforce accommodation facilities operating at full capacity (300 beds) over a 58 month period, a total conservative water usage of 540 ML is estimated. A breakdown of this total volume is presented in Table 2.8.

Table 2.8 Estimated water usage for non-resident workforce accommodation

Rate of water usage (L/p/d)	Occupants per facility	Daily water usage (kL/day/facility)	Days of accommodation operation ¹	Total water usage per facility (ML)	Number of accommodation facilities	Total water usage (ML)
340	300	102	1,765	180.03	3	540.09

Table note:

¹ Based on a 58 months of non-resident workforce accommodation operation.

2.6.1.2 Water sourcing

ARTC recognises water sourcing and availability is critical to supporting the construction program for the Project. Sources of construction water will be finalised as the construction approach is refined during the detail design phase of the Project (post-EIS). Through this process detailed water demand planning will be undertaken, including detailed contingency options in the event that protracted dry seasonal conditions prevail and water supply options become unavailable.

The ultimate water sourcing strategy for the Project will be documented in a Construction Water Plan and be dependent on:

- Climatic conditions in the lead up to construction
- Confirmation of private water sources made available to the Project by landowners under private agreement and in consultation with DNRME
- Confirmation of access agreements with local governments for sourcing of mains water
- Consultation with the State regarding access to water via markets, water licenses and water permits.

Options for the sourcing of construction water, subject to availability, are anticipated to be as follows:

- Commercial, licensed water supplies where capacity exists
- Public surface water storages, i.e. dams and weirs

- Permanently (perennial) flowing watercourses
- Privately held water storages, i.e. dams or ring tanks, under private agreement
- Existing registered and licensed bores
- Treated water, e.g. from waste water treatment plants
- New bores established to service the Project under appropriate water licence or entitlement (least preferred option).

An assessment of the suitability of each source will need to be made for each construction activity requiring water, based on the following considerations:

- Legal access
- Volumetric requirement for the activity
- Water quality requirement for the activity, e.g. accommodation will need potable water
- Source location relative to the location of need.

A summary of the considerations for accessing water from each potential surface water source is presented in the following sections.

Surface water storages

Dams and weirs are constructed barriers that hold back water to provide a reservoir for water supply. Various dams and weirs are located in the vicinity of the Project and are listed in Table 2.9. These dams have, subject to climatic conditions, the ability to supply the required volume for construction water for the Project. However, the transportation cost of sourcing all construction water from these locations is prohibitive. Therefore, other sources will need to be accessed to meet the full construction water demand for the Project.

Table 2.9 Water storages in proximity to the Project

Storage	Operator	Water supply scheme	Location	Full supply volume	Current capacity/ flow rate
Boggabilla Weir	Dumaresq–Barwon Border Rivers Commission	Border Rivers	9 km upstream of Goondiwindi on the Macintyre River and 12 km via road from the Project alignment	5,850 ML when reservoir water level at 216 m AHD ¹	Reservoir water level: 216.0 m AHD ²
Ben Dor Weir	Sunwater	Macintyre Brook	11 km upstream of Yelarbon on the Macintyre Brook and 5 km via road from the Project alignment	700 ML	Volume: 572 ML (81.8%) ³
Whetstone Weir	Sunwater	Macintyre Brook	17 km downstream of Inglewood and 2 km via road from the Project alignment	506 ML	Volume: 512 ML (>100%) ³
Lemon Tree Weir	Sunwater	Upper Condamine	12 km downstream of Yandilla on the Condamine River and 14 km via road from the Project alignment	305 ML	Volume: 42 ML (13.7%) ³
Yarramalong Weir	Sunwater	Upper Condamine	5 km downstream of Tummalville on the Condamine River and 7 km via road from the Project alignment	390 ML	Data not available
Talgai Weir	Sunwater	Upper Condamine	13 km upstream of Ellangowan and 60 km via road from the Project alignment	638 ML	Volume: 168 ML (26.3%) ³
Coolmunda Dam	Sunwater	Macintyre Brook	14 km east of Inglewood, 18 km via road to the Project alignment	69,060 ML	Volume: 19,889 ML (28.8%) ³

Storage	Operator	Water supply scheme	Location	Full supply volume	Current capacity/ flow rate
Cooby Dam	TRC	Nil	14 km northeast of Kingsthorpe and 27 km via road from the Project alignment	19,703 ML	Volume: 3,763 ML (19.1%) ⁴
Perseverance Dam	TRC	Cressbrook Creek	35 km northeast of Kingsthorpe and 48 km via road from the Project alignment	26,893 ML	6,714 ML (25.0%) ⁴

Table notes:

AHD = Australian Height Datum

- 1 Resource Operations Licence (Water Act 2000), DNRME [mdba.gov.au/sites/default/files/pubs/qld-border-rivers-water-supply-scheme-resource-operations-licence-2019.PDF] [Accessed 30 October 2020]
- 2 NSW Dam and River Levels, WaterNSW [realtimedata.watnsw.com.au/] [Accessed 30 October 2020]
- 3 Water Storage Levels, Sunwater [storagelevels.sunwater.com.au/win/reports/win_storages.htm] [Accessed 30 October 2020]
- 4 Dam levels, rainfall and water use statistics, TRC [tr.qld.gov.au/environment-water-waste/water-supply-dams/dams-bores/8066-water-supply-and-dam-level-statistics] [Accessed 30 October 2020]

Alternative surface water storages, identified in Table 2.9 or otherwise, may be accessed for the sourcing of construction water subject to obtaining the appropriate water allocation or licence under the *Water Act 2000*.

Current dam levels are reflective of the prolonged drought conditions in Queensland. The availability of water from these sources will continue to be dependent on climatic conditions prior to and during construction.

Consultation with the Dumaresq-Barwon Border Rivers Commission, Sunwater, GRC and TRC during the detail design process will be required to establish the availability of water from dams and weirs in proximity to the Project.

Watercourses

The following perennial watercourses are in proximity to the Project:

- Oakey Creek
- Hodgson Creek
- Condamine River North Branch
- Condamine River
- Canning Creek
- Macintyre Brook
- Brigalow Creek
- Macintyre River.

Extraction of water from a watercourse typically requires:

- A water allocation, water licence or water permit. Applications for resource entitlements are assessed against relevant criteria in the Water Act and relevant water resource plan and resource operations plan.
- A development permit for use of water that is assessable development under the Planning Act.

The DNRME maintains *Exemption requirements for construction authorities for the take of water without a water entitlement (WSS/2013/666)*. These exemption requirements may only be used by a constructing authority defined under Schedule 2 of the AL Act and includes State government departments and local governments. At present these guidelines do not directly apply to ARTC. However, ARTC's eligibility to operate under the exemption requirements will be reassessed prior to the commencement of construction.

If ARTC, and its contractors, remain ineligible to operate under the exemption requirements, or are unable to comply with the requirements, then a Temporary Water Permit would be required before taking any water for construction purposes.

Other water source opportunities

Other opportunities for potential sources of water for the Project are as follows:

- Recycled water: A 97 km pipeline currently transfers water from the Wetalla Water Treatment Plant in Toowoomba to the Millmerran Power Station. This potential water source could be further investigated through consultation with the operators of the Millmerran Power Station, InterGen, during the detail design process (post-EIS) to determine if there is unutilised capacity that may be suitable for construction water.
- Commodore Mine: Water is supplied to the Commodore Mine. Waste water is also generated through the mine's operations. These potential water sources could be further investigated through consultation with the operators of the mine, InterGen, during the detail design process (post-EIS) to determine if there is unutilised capacity that may be suitable for construction water.
- Privately owned water storages: Smaller dams located on private properties along the Project alignment may be suitable as a source of construction water. Accessing such water would require private agreement between ARTC and the relevant landholder.

2.6.1.3 Water quality

The quality characteristics of water used by the Project during construction will be dependent on its intended use. The water quality requirements for the various activities associated with construction of the Project are summarised in Table 2.10.

Table 2.10 Water quality requirements for construction activities

Activity	Water quality requirement
Earthworks	No specific quality criteria
Concrete batching	Specified in <i>AS 1379: Specification and supply of concrete</i>
Track works	No specific quality criteria
Non-resident workforce accommodation	Potable water will need to achieve the quality requirements specified in the Australian Drinking Water Guidelines (NHMRC & NRMCC, 2011)
Vegetation establishment, landscaping and rehabilitation	Water should be consistent with the quality requirements specified for irrigation and general water use in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2018)

2.6.2 Operation water

The Project's operational water requirements are anticipated to be minor relative to the construction phase requirements. Water may be required to support localised maintenance activities, such as high pressure cleaning of culverts. The volumes required will be dependent on the specific activities and frequency of undertaking, and therefore cannot be quantified at this stage of the Project.

Vegetation planted as part of the landscaping design for the Project will be self-sustaining and will not require watering once established.

An assessment of the suitability of each source will need to be made for each maintenance activity requiring water, based on the following considerations:

- Legal access
- Volumetric requirement for the activity
- Water quality requirement for the activity
- Source location relative to the location of need.

3 Regulatory and legislative framework

This section describes the legislative, policy and management framework for the Project, including:

- Legislative framework which applies to the assessment of surface water quality for the Project at the Commonwealth, State and local levels, and provides the statutory context for which the surface water quality assessment has been undertaken
- Statutory approvals that may be required as a result of potential impacts to surface water quality, based on consideration of the overall approvals pathway for the Project and the scope of applicable exemptions under applicable legislation
- Environmental values and water quality objectives that apply to surface waters within the impact assessment area.

3.1 Legislation, policies, standards and guidelines

An overview of the Commonwealth and State legislation, policies, standards and guidelines that are relevant to the surface water quality values of the Project, outlining the intent and applicability to the Project, is presented in Table 3.1.

Table 3.1 Legislation, policies, standards or guidelines relevant to the surface water quality values of the Project

Legislation, policy, standard or guideline	Relevance to the Project
Commonwealth legislation	
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act)	The EPBC Act provides that any action (i.e. a Project, development, undertaking or series of activities) that has, will have or is likely to have a significant impact on a matter of national environmental significance (MNES). Additionally, other matters protected under the EPBC Act such as the environment of Commonwealth land, requires approval from the Commonwealth Environment Minister Under section 45 of the EPBC Act, the Australian Government and Queensland Government have implemented a bilateral agreement relating to environmental assessment. This agreement allows the Commonwealth Minister for the Department of Environment and Energy (now Department of Agriculture Water and Environment) to rely on specified environmental impact assessment processes of Queensland in assessing actions under the EPBC Act. On 9 April 2018, the Commonwealth Minister for the Environment and Energy determined the Project to be a 'controlled action' under the EPBC Act, (reference number EPBC 2018/8165).
<i>Water Amendment Act 2008</i> (Cth)	Transfer of functions from the Murray-Darling Basin Commission to the Murray-Darling Basin Authority. This Act applies to the Project as the it occurs within the Murray-Darling basin
<i>Water Act 2007</i> (Cth)	The <i>Water Act 2007</i> (Cth) provides the legislative framework for ensuring that the Murray Darling basin (Australia's largest water resource) is managed in accordance with Australia's national interests. The Act recognises that Australian states in which the Murray Darling basin is located continue to manage water resources within their jurisdictions. The Act includes the various applicable sections of framework (but is not limited to): ■ Establishes the Murray Darling Basin Authority 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 Murray Darling Basin Authority 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 water to protect and restore the environmental assets of the Murray Darling basin, and outside the basin where the Commonwealth owns water.

Legislation, policy, standard or guideline	Relevance to the Project
	Both the Queensland Border Rivers and Balonne-Condamine drainage basins are situated within the Murray Darling basin. The Project will likely require approval from supplemented water allocation, in line with the objective to protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling basin. The Project will also be required to adhere to EV and corresponding WQOs (under the Queensland EPP (Water and Wetland Biodiversity) which is accredited under the Water Act (and the legislative instrument – Basin Plan).
State legislation	
<i>Planning Act 2016</i> (Planning Act)	The Planning Act sets out a planning system for development assessment, plan making and dispute resolution. The system is performance based, which allows for innovation and flexibility in how development can be achieved. Whilst ensuring responsiveness to community needs and expectations. Under the Planning Act, development is either accepted, assessable or prohibited. Assessment is carried out through the Development Assessment Rules (DA Rules). The Project may trigger the requirements to obtain approval for aspects of development (e.g. waterway barrier works) that are assessable under the Schedule 10 of the Planning Regulation 2017 (and integrated through other legislation as part of the DA Rules process) following completion of the EIS process.
<i>Environmental Protection Act 1994</i> (EP Act)	The objective of the EP Act is to achieve protection of Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. Under the EP Act, environmental protection policies are developed as subordinate legislative instruments to cover specific aspects of the environment. The EVs of Queensland waterways, including those located within the impact assessment area are protected under the EP Act and the subordinate legislation. Under this legislation establishes the Healthy Waters Management Plans (HWMP) as a key planning mechanism to improve water quality in Queensland waterways. HWMPs associated with the Project alignment include the Condamine and Queensland Border Rivers Moonie river basins.
<i>Water Supply (Safety and Reliability) Act 2008</i>	The <i>Water Supply (Safety and Reliability) Act 2008</i> provides for the safety and reliability of water supply. The purpose is achieved by providing: ■ A regulatory framework for providing water and sewerage services in the State, including functions and powers of service providers ■ A regulatory framework for providing recycled water and drinking recycled water and drinking water quality, primarily for protecting public health ■ The regulation of referable dams ■ Flood mitigation responsibilities ■ Protecting the interests of customers of service providers. The Project will need to achieve the <i>Water Supply (Safety and Reliability) Act 2008</i> purpose. This will involve the protection of interests of 'service providers' in regard to the quality of surface waters affected by Project activities.
<i>Water Act 2000</i> (Water Act)	The Water Act provides for the sustainable management of non-tidal waters and other water resources, together with the establishment and operation of water authorities. Under the Water Act, a watercourse is defined as: A river, creek or other stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events- ■ In a natural channel, whether artificially modified or not ■ In an artificial channel that has changed the course of the stream. The Queensland Government maintains Watercourse Identification Mapping (WIM), which identifies defined watercourses under the Water Act, as well as watercourses (not related under the Water Act). Through the Planning Act, certain water related development is assessable under the Water Act and requires assessment and approval for most works in a defined watercourse. Where applications are made for the purposes of 'taking or interfering with water' (including surface water, artesian water, and in some instances overland flow where regulated through a water quality plan), a water licence is required as evidence prior to lodging a Development Application.

Legislation, policy, standard or guideline	Relevance to the Project
	In addition to the approvals triggered under the Planning Act, the Water Act regulates the undertakings of works that involve the excavating or placing fill in a water course, lake or spring. Under the Water Act, a proponent must obtain a Riverine Protection Permit in order to lawfully undertake these works unless the works can be undertaken in accordance with a Riverine Protection Permit Exemption Requirements (WSS/2013/726 Version 1.01). The Water Act provides for the sustainable management of non-tidal waters and other resources, together with the establishment and operation of water authorities, and for other purposes. The Project involves works within defined watercourses and as such the provisions of the Water Act may apply. Further the Project involves the removal of vegetation, excavation or placing fill in a waterway, lake or spring which is regulated under the Water Act. It is noted the proponent (Australian Rail Track Corporation) is an 'approved entity' for exemption from the requirement for Riverine Protection Permit applications under the Water Act as administered by DNRME.
<i>Fisheries Act 1994</i> (Fisheries Act)	The Fisheries Act provides for the use, conservation and enhancement of fish habitats and resources, together with the management of aquaculture activities. Under the provisions of the Fisheries Act and the Planning Act, a Development Permit for Operational Works involving Waterway Barrier Works is required for works which pose a barrier to fish passage (including permanent, partial and temporary barriers) within a waterway which is mapped by Department of Agricultural Fisheries (DAF) on the spatial data layer 'Queensland waterways for waterway barrier works' unless: ■ The works have a low impact to fisheries productivity and comply with DAF's requirements for 'works which are not waterway barrier works' which include (subject to specific design and construction requirements): – New single or multi-span bridges – Maintenance of existing bridge structures not subject to an existing permit – Bank revetment – Road resurfacing at waterway crossings – Stormwater outlet construction. The works are either temporary or permanent waterway barrier works and can comply with the relevant self-assessable code for Waterway Barrier works. The Project transverses mapped waterways for waterway barrier works and therefore may trigger the requirement to obtain a Development Permit for Operational Works involving constructing or raising waterway barrier works. The Project will require licencing approval for major risk of impact waterways in order to maintain connectivity and water quality. As such, while waterway barrier works are not explicitly related to water quality (as a physical barrier), incorporating waterway barrier works licencing codes into the water quality assessment underpins the cautionary approach to impact methodology used throughout the EIS of the Project. All instream works that are undertaken, within waterways that provide for fish passage must be in accordance with the DAF factsheet 'what is not a waterway barrier work' or accepted development requirements for operational work that is constructing or raising waterway barrier works or under a relevant development approval. The Project will have accepted development and assessable development barrier works.
Policy, standard or guideline	
EPP (Water and Wetland Biodiversity)	The quality of Queensland waters is protected under the EPP (Water and Wetland Biodiversity) and seeks to achieve the objective of the EP Act in relation to Queensland waters. Schedule 1 of the EPP (Water and Wetland Biodiversity) lists the EVs and WQOs that need to be considered by planners and managers when making decision about waters and/or water quality. The quality of water within the impact assessment area is required to be assessed against the EPP (Water and Wetland Biodiversity) EVs and WQOs.

Legislation, policy, standard or guideline	Relevance to the Project
<i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> (ANZG) (ANZECC & ARMCANZ, 2018)	The ANZG provide an agreed framework for assessing water quality in terms of whether the water is suitable for range of EVs (including human uses). The framework guides users through the necessary steps for planning and managing water quality or sediment quality. The guidelines provide detailed approaches, identifying indicators and values for selected indicators to protect management goals. The ANZG values can be regarded as guideline values that can be modified into regional, local or site-specific guidelines, with consideration to the variability of the subject environment, soil type, rainfall and contaminant exposure. Exceedances of the guideline values would indicate a potential environmental issue and trigger an environmental management response.
Queensland Water Quality Guidelines (QWQG) (DEHP 2009)	The QWQG provide a framework for assessing water quality in Queensland by setting of WQOs. The QWQG are intended to address the need identified in the ANZG Guideline (2018) by: ■ Providing guideline values (numbers) that are tailored to Queensland regions and water types ■ Providing a process/framework for deriving and applying more locally specific guidelines for waters in Queensland.
<i>Monitoring and Sampling Manual</i> (DES, 2018e)	The Monitoring and Sampling Manual provides an overview of the common techniques, methods and standards for the collection, handling, quality assurance and control, custodianship and data management in relation to water quality samples. The manual helps to ensure that monitoring data are collected in a consistent and scientifically-accurate manner.
Healthy Waters Management Plans	Healthy Waters Management Plans are a key planning mechanism to improve the quality of Queensland waters under the EPP (Water and Wetland Biodiversity). Healthy Waters Management Plans provide an ecosystem-based approach to integrated water management. The Healthy Waters Management Plans provide: ■ Identification and mapping of EVs, desired levels of aquatic ecosystem protection and management goals for Queensland waters ■ WQOs under the National Water Quality Management Strategy to protect the EVs. The relevant Healthy Waters Management Plans for the Project include: ■ Ch 30.6 km (NS2B) to Ch 117.0 km: within the boundaries of the Border Rivers basin. The relevant EVs for the impact assessment area are described in the <i>Healthy Waters Management Plan: Queensland Border Rivers and Moonie River Basins</i> (DES 2019c). ■ Ch 117.0 km to Ch 206.9 km: within the boundaries of the Condamine-Balonne River basin. The relevant EVs for the impact assessment area are described in the <i>Healthy Waters Management Plan: Condamine River Basin</i> (DES 2019b). As the Queensland Border Rivers and the Condamine River basins are located within the Murray-Darling basin, these Healthy Water Management Plans also contribute to the requirements of a Water Quality Management Plan (WQM Plan) under the Commonwealth Water Act 2007— Basin Plan 2012.
Basin Plan 2012 (Basin Plan)	The Basin Plan is a Commonwealth instrument, made under subparagraph 44(3)(b)(i) of the <i>Water Act 2007</i> (Cth), that provides a framework to manage the water resources of the Murray-Darling basin and sets out limits for sustainable use of surface water and groundwater in each water resource plan area. The impact assessment area is located within the Condamine and Balonne and the Border Rivers and Moonie water resource plan area, which are covered by the Basin Plan.
Water Plans	Water sharing plans were developed under the Water Act to sustainably manage and allocate water resources in Queensland. The plans apply to water in watercourses and lakes, water in springs, overland flow water, and groundwater and allow for identification of availability of water options for project uses. Three water sharing plans are relevant to the Project: ■ Water Plan (Border Rivers and Moonie) 2019 ■ Water Plan (Condamine and Balonne) 2019 ■ Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017.

Legislation, policy, standard or guideline	Relevance to the Project
Shaping South East Queensland (SEQ) Regional Plan 2017	ShapingSEQ is the Queensland government's plan to guide the future for the SEQ region. ShapingSEQ is based on the understanding that the region relies on its environmental assets to support our communities and lifestyles. ShapingSEQ provides strategies to protect and sustainably manage the region's catchments to ensure the quality and quantity of water in waterways, aquifers, wetlands, estuaries, Moreton Bay and oceans, meets the needs of the environment, industry and community. The Project has been identified as a key priority in the region and is considered to be consistent with the ShapingSEQ.
Darling Downs Regional Plan 2013	The Darling Downs Regional Plan 2013 identifies priority outcomes for the region's transport network which include prioritisation of transport programs to improve freight movement and reduce conflicts in urban areas with other network users. The plan also identifies opportunities for protecting the quality of the surface and groundwater quality of the region. The Project is considered to be consistent with the Darling Downs Regional Plan via the adoption of WQO under Schedule 1 of EPP (Water and Wetland Biodiversity) as basis of existing environment condition.
State Planning Policy 2017 (including <i>State Planning Policy – State Interest Guideline (Water Quality) 2016</i>)	The SPP is a key component of the Queensland land use planning system which expresses the State's interest (as defined under the Planning Act) in land use planning and development. The SPP defined the Queensland government's State interests in land use planning and development which notably includes State transport infrastructure. The SPP includes a SPP code (Water Quality Appendix 2) that provides performance outcomes to ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of EVs identified in the EPP (Water and Wetland Biodiversity). Whilst no components of the Project are assessable under the provisions of a local government planning scheme, State approval requirements will trigger the Chief Executive of the DSDMIP as a referral agency for a number of applications. As such, relevant provisions of the SPP will be required to be addressed as part of the supporting application materials to be submitted (around water quality performance outcomes with discharge from tunnel infrastructure) and will be considered in the assessment process.
Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball et al., 2019)	Australian Rainfall and Runoff (ARR) is a national guideline document, data and software suite that can be used for the estimation of design flood characteristics in Australia. The 2019 edition is published and supported by the Commonwealth of Australia and is an update to the ARR 2016. ARR is pivotal to the safety and sustainability of Australian infrastructure, communities and the environment. It is an important component in the provision of reliable and robust estimates of flood risk. Consistent use of ARR ensures that development does not occur in high risk areas and that infrastructure is appropriately designed. ARR 2016, being the current version of this guideline during the formative stages of Inland Rail and this Project, was adopted as a guiding document for flooding aspects of this assessment to ensure consistency in assessment across the Inland Rail Program.
AS7637:2014: Railway Infrastructure – Hydrology and Hydraulics	This Standard describes the hydrological and hydraulic requirements (functions, performance, design constraints and risk attributes) for the design and assessment of railway infrastructure in relation to all forms of drainage and flood-prone areas.
Guide to Road Design Part 5: Drainage – General and Hydrology Considerations (Austroads, 2013)	This Guide provides information on the elements that need to be considered in the design of a drainage system. Guidance is provided on the safety aspects of stormwater flows, environmental considerations and water sensitive treatments within a drainage system. Drainage considerations are outlined covering the determination of the flood immunity, freeboard to be used for the design, types of structures, and operational and maintenance requirements. The hydrologic assessment provides guidance on rainfall intensities, run-off coefficients and determining the design discharges. Design processes and formulae necessary to design effective drainage systems and infrastructure are included. It is supported by appendices containing design charts and worked examples. This Guide outlines good practice in relation to drainage design that will apply in most situations, rather than specifying mandatory practice.

Legislation, policy, standard or guideline	Relevance to the Project
Evaluating Scour at Bridges: Fifth edition (FHWA, 2012)	This manual is part of a set of Hydraulic Engineering Circulars issued by Federal Highway Administration (USA) to provide guidance for bridge scour and stream stability analyses. This document provides guidelines for the following: ■ Designing new and replacement bridges to resist scour ■ Evaluating existing bridges for vulnerability to scour ■ Inspecting bridges for scour ■ Improving the state-of-practice of estimating scour at bridges
Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulic Engineering Circular Number 14 (HEC-14), Third Edition (FHWA, 2006)	This manual is part of a set of Hydraulic Engineering Circulars issued by Federal Highway Administration (USA) to provide design procedures for energy dissipator designs for highway applications.
Bridge Scour Manual: Supplement to Austroads Guide to Bridge Technology Part 8, Chapter 5: Bridge Scour (DTMR, 2019d)	This manual sets out a multi-disciplinary approach to the estimation of the depth and extent of scour required for design of waterway bridges. It is a guide to those involved in the planning, design, operation and maintenance of bridges spanning waterways. This manual represents the policy of the DTMR with respect to the planning, design, operation and maintenance of scour in bridges.

3.2 Water quality objectives and environmental values

The Project alignment traverses through the Border Rivers basin (Ch 30.6 km (NS2B) to Ch 117.0 km) and the Condamine River basin (Ch 117.0 km to Ch 206.9 km), as recognised under the EPP (Water and Wetland Biodiversity) (refer Figure 5.1).

Water quality objectives have been developed under the provisions of the EPP (Water and Wetland Biodiversity), under the EP Act, to support and protect different EVs identified for waters within both the Condamine River and Border River basin areas. Under the EVs, it is expected that each WQO is achieved in order to maintain existing water quality standards, or aspirational water quality standards, where present. Typically, WQOs are assessed against a median assessment of the existing environment, however for this assessment, grab samples were assessed against the WQO with reference to prevailing conditions and trending data in regard to seasonal environment conditions.

3.2.1 Environmental values

The Project alignment crosses through eight sub-catchments of the Condamine River basin and the Border Rivers basin, each of which are recognised for their own unique EVs, as outlined in Table 3.2.

Table 3.2 Environmental values for sub-catchments that the Project alignment intersects

Environmental values	Aquatic Ecosystems	Irrigation	Farm Supply	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Sub-catchments of the Condamine River basin												
Upper Oakey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hodgson Creek	✓	✓	✓	✓		✓			✓			✓
Ashall Creek	✓	✓	✓	✓					✓		✓	✓
Condamine River North Branch	✓	✓	✓						✓	✓	✓	✓
Condamine River South Branch	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
Sub-Catchments of the Border Rivers basin												
Canning Creek	✓	✓		✓					✓			✓
Lower Macintyre Brook	✓	✓	✓	✓		✓	✓		✓	✓		✓
Macintyre Barwon Floodplain	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓

Source: DES (2019b, 2019c)

3.2.2 Water quality objectives

The Project alignment extends through the following water type zones within the Border Rivers and Condamine basins, as published in the relevant Healthy Waters Management Plan:

- Condamine River basin:
 - Oakey Creek
 - Central Condamine
 - Southern Condamine
- Border Rivers basin:
 - Canning Creek
 - Lower Macintyre Brook
 - Macintyre Barwon floodplain.

Water quality objectives for each of these water type zones are presented in Table 3.3 and Table 3.4.

The WQOs in Table 3.3 are for physico-chemical parameters and are consistent with the accreditable water quality target values published in the relevant Healthy Waters Management Plan. WQOs in Table 3.3 are presented for low flow and high flow conditions.

The WQOs in Table 3.4 are for heavy metals and other toxic contaminants and are consistent with the toxicant default guideline values published in the ADWG (ANZECC & ARMCANZ, 2018).

Table 3.3 Water quality objectives for moderately disturbed waters intersected by the Project

Water type zone	Water flow	Turbidity (NTU)	Total P (µg/L)	Chlorophyll a (µg/L)	Total nitrogen (µg/L)	Oxidised nitrogen (µg/L)	Ammonium N (µg/L)	Dissolved oxygen		pH	EC µS/cm	Salinity mg/L	TSS mg/L
								mg/L	% sat				
Condamine River basin ¹													
Oakey Creek (Sites 34-43)	Low flow	13	110	5	1,000	5	10	ID	60-110	7.7-8.3	510	NA	14
	High flow	55	340	ID	1,280	ID	ID			7.4-8.1	380		65
Central Condamine (Sites 27-33)	Low flow	25	170	9	860	4	4			7.4-8.3	890		25
	High flow	220	950	4	2,200	480	ID			7.0-7.6	290		130
Southern Condamine (Sites 21-26)	Low flow	9	45	5	595	3	6			7.2-7.9	170		8
	High flow	25	60	ID	830	ID	ID			7.0-7.6	160		17
Border Rivers basin ²													
Canning Creek (Sites 9-20)	Low flow	35	30	ID	520	6	10	>5	60-110	7.2-7.8	200	NA	25
	High flow	50	40	ID	600	ID	ID			6.9-7.9	165		60
Lower Macintyre Brook (Sites 3-8)	Low flow	11	55	ID	710	18	8			7.4-8.0	370		10
	High flow	25	70	ID	910	ID	ID			7.2-8.0	250		25
Macintyre Barwon Floodplain (Sites 1-2)	Low flow	30	70	3	575	10	20			7.4-8.0	240		25
	High flow	110	150	ID	900	195	ID			7.0-7.5	180		70

Table notes:

P, EC and TSS = phosphorus, electrical conductivity and total suspended solids respectively.

ID = Insufficient data for determination of water quality objective

NTU = Nephelometric Turbidity Units

µg/L = micrograms per litre

mg/L = milligrams per litre

µS/cm = microsiemens per centimetre

Source: 1. Healthy Waters Management Plan: Condamine River Basin (DES 2019b); 2. Healthy Waters Management Plan: Queensland Border Rivers and Moonie River Basins (DES 2019c)

Table 3.4 Water quality objectives for protection of slightly to moderately disturbed waters: heavy metals and other toxic contaminants

Water type zone	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Nickle (mg/L)	Zinc (mg/L)	Naphthalene (mg/L)
Condamine River basin									
Oakey Creek	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016
Central Condamine	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016
Southern Condamine	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016
Border Rivers basin									
Canning Creek	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016
Lower Macintyre Brook	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016
Macintyre Barwon floodplains	0.024	0.0055	0.0004	0.0014	0.0034	0.0006	0.011	0.008	0.016

Source: ANZG (ANZECC & ARMCANZ, 2018)

4 Methodology

4.1 Surface water quality assessment

The methodology adopted for the assessment of surface water has been established to provide sufficient information to determine:

- Existing receiving surface water condition
- Impacts to surface water quality and resources that may arise as a consequence of the Project
- Mitigation measures that can feasibly be implemented through future Project phases to avoid or reduce the significance of impacts to surface water
- Cumulative impacts to surface waters, as a consequence of Project activities occurring in parallel to activities of other projects in the region.

The existing condition of surface waters within the impact assessment area was established through assessment of publicly available datasets (refer Section 4.1.1), in combination with water quality data collected across five sampling events (with seasonal variation) (refer Section 4.1.2).

In combination these datasets were used to determine the quality of receiving waters within the impact assessment area and were subsequently used to assess the potential for impacts to surface waters to arise as a consequence of Project activities.

4.1.1 Literature and database review

This section details the desktop analysis undertaken to identify existing information pertaining to the surface water quality values of the impact assessment area. Details of the relevant database sources, search dates, search area parameters and type of information considered for the desktop study are summarised in Table 4.1. Where relevant, copies of search results are provided in Appendix D.

Table 4.1 Database review summary

Database/data source name	Database search date	Database search area	Data type
Map of Referable Wetlands	21 April 2020	Impact assessment area	Includes State significant, referable wetlands, important wetlands in the Great Barrier Reef catchments and wetland REs
WetlandInfo (DES)	21 April 2020	Impact assessment area	Includes nationally (DIWA) and internationally important (Ramsar) wetlands
Queensland waterways for waterway barrier works	22 April 2020	Impact assessment area	Waterways where proposed waterway barrier works require assessment and approval under the <i>Fisheries Act 1994</i>
Watercourse Identification Mapping	21 April 2020	Impact assessment area	Known extent of watercourses and watercourses that are managed under the Water Act
Fish Habitat Areas	21 April 2020	Impact assessment area	Boundaries of gazetted, declared fish habitat areas.

Database/data source name	Database search date	Database search area	Data type
Matters of State Environmental Significance	21 April 2020	Impact assessment area	Location of Matters of State Environmental Significance including: - Protected areas - Marine parks - Management A and Management B declared fish habitat areas - Threatened and special least concern wildlife listed under the <i>Nature Conservation Act 1992</i> - Regulated vegetation under the <i>Vegetation Management Act 1999</i> - Wetlands in a wetland protection area or wetlands of high ecological significance - Wetlands and watercourses in high ecological value waters as defined in the <i>Environmental Protection (Water) Policy 2009</i>, schedule 2 - Legally secured offset areas.
Department of Natural Resources, Mines and Energy (DNRME) Water Monitoring Information Portal	21 April 2020	Impact assessment area	Includes information pertaining to stream height and stream flow values from the department's water monitoring stations throughout Queensland, historic streamflow data from decommissioned river and stream monitoring stations and the Department's water monitoring network site lists.
Climate data from the Bureau of Meteorology	23 April 2020	Impact assessment area	Includes climate data for the impact assessment area, including rainfall, evaporation and temperature data.
Queensland Government water quality, water quantity and aquatic ecosystem monitoring programs	23 April 2020	Impact assessment area	Includes information on Queensland's water quality, water quantity and aquatic ecosystem monitoring programs.
Public notices of water licence applications 2018/2019	8 February 2019	Impact assessment area	Lists public notices of water licence applications.
Queensland land use mapping program	21 April 2020	Impact assessment area	Land use mapping which identifies land use patterns and changes.
Digital drainage and topographic data	22 April 2020	Impact assessment area	Topographic data providing spatial and attribute information pertaining to drainage and topography.
Water plan (Border Rivers and Moonie) 2019	21 April 2020	Impact assessment area	Water plans which provide information on how water is managed and accessed in the water plan area.
Water plan (Condamine River Water Plan)	21 April 2020	Impact assessment area	Water plans which provide information on how water is managed and accessed in the water plan area.
BoM GDE Atlas	22 April 2020	Impact assessment area	Groundwater Dependent Ecosystems (GDEs).
Queensland GDE database (DES)	22 April 2020	Impact assessment area	Aquatic Groundwater Dependent Ecosystems (GDEs).
Department of Science, Information Technology and Innovation Springs Database	01 July 2018	20 km buffer from impact assessment area	GDE Spring database
AquaBAMM	23 April 2020	Impact assessment area	AquaBAMM assesses the conservation values of aquatic ecosystems within a specific area

Details of the existing literature and previous study reports which have been reviewed for the desktop study are summarised in Table 4.2.

Table 4.2 Assessments and reports relevant to the Project

Document title	Reference
Initial Advice Statement: Inland Rail – Border to Gowrie (2-3100-0000-EAP-RP-0001) February 2018	ARTC 2018
Australian Rail Track Corporation Limited/Transport – Land/Multiple lots/Queensland/Inland Rail Border to Gowrie Project, QLD (EPBC referral 2018/8165)	ARTC 2018
<i>Inland Rail – Border to Gowrie Aquatic Ecology Report</i> . Prepared for FFJV.	Eco Logical Australia 2019
Inland Rail Brief: Tonnage Profile and Train Plan (0-0000-900-POP-00-BR-1000 Rev 2)	ARTC 2018

4.1.2 Field assessment

The surface water quality field assessment was designed to provide sufficient information to address the ToR and to provide an understanding of existing EVs and potential impacts for the Project.

The data collection approach is consistent with the *Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy* (DES 2018) which occur within Queensland. The surface water quality field assessment methodology is described in further detail below.

4.1.2.1 Assessment timing

Five surface water field surveys were planned (including opportunistic water quality sampling undertaken at limited water quality monitoring sites during May 2019 to assist with aquatic ecology assessments), with two surveys undertaken at the same time as the aquatic ecology surveys (June, dry season and November/December, early wet season) and the remaining three surveys completed in February 2019 and April/May 2019 (early dry season) (refer Table 4.3). The timing was selected in order to efficiently incorporate varying environmental conditions (expected seasonal variation) with regards to base flow and non-base flow surface water conditions with the expectation this will be the typical environmental conditions encountered during construction and operational works related to the Project.

Dry conditions were noted throughout the monitoring period. Watercourse flow was limited, however conditions were consistent with the highly seasonal, and sporadic flow regimes throughout the impact assessment area. Noting the seasonal flow regimes of the watercourses, timing of the assessments was chosen in order to capture dry or wet condition water quality samples.

In situ water quality field data was collected each monitoring round in addition to samples collected for laboratory analysis. All *in situ* water quality field data and laboratory samples were collected by a suitably qualified and experienced environmental scientist.

Table 4.3 Field assessment timing

Sampling event	Date	Season	Preceding conditions
First	11 to 20 June 2018	Winter	Dry season
Second	26 November to 3 December 2018	Spring/summer	Early wet season
Third	11 to 19 February 2019	Summer	End of wet season
Fourth	29 April 2019 to 2 May 2019	Autumn	Early dry Season
Fifth	15 May 2019 to 19 May 2019	Autumn	Early dry Season

4.1.2.2 Assessment sites

Forty three sites along the Project alignment were initially selected as potentially suitable sampling sites (refer Figure 4.1). This number was significantly more than what was intended to be surveyed, but allowed for sites to be removed from the selection if land access proved to be problematic or if sites were found to be unsuitable when accessed in the field. The inclusion of a large number of potential sampling sites also provided greater certainty that sufficient water would be present at a representative selection of sites in the event that dry conditions were experienced.

Sites were positioned as close as possible to locations where the reference design rail alignment traversed watercourses, waterways or other drainage features. Sites were nominally assigned into one of the following categories:

- Aquatic ecology and surface water quality sites – where an assessment of aquatic ecology habitat values and surface water quality was to be undertaken
- Surface water quality sites – where assessment of surface water quality only was to be undertaken.

The distribution of sampling sites along the rail alignment was determined from a range of factors, including:

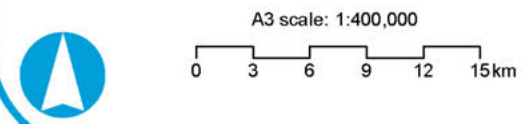
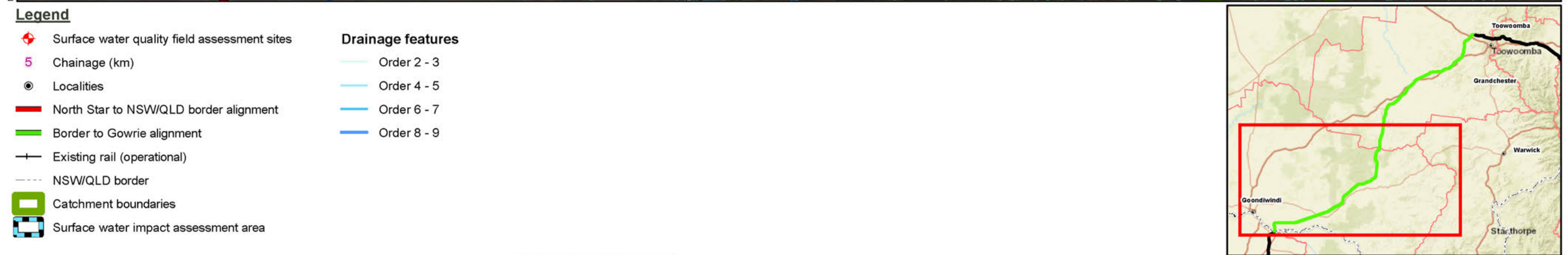
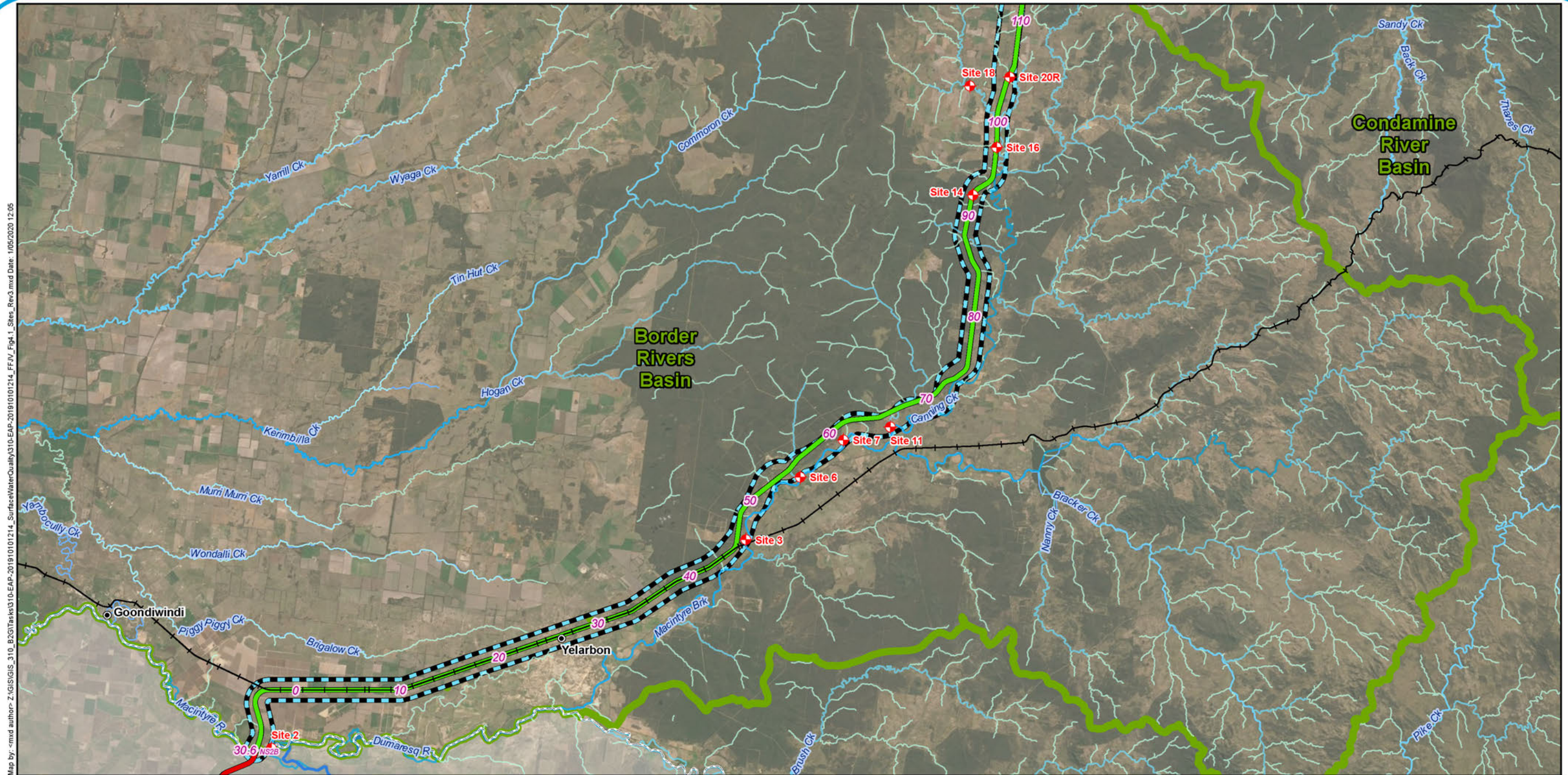
- Mapping and aerial photography products which provide information on aquatic habitat features, including DAF waterway barriers and DES aquatic habitat mapping
- Inclusion of waterways with a variety of stream orders within the Project footprint, ensuring water features of varying size and complexity were sampled
- Representation of a variety of aquatic habitat types and surrounding land uses (e.g. areas where remnant riparian vegetation was intact, and areas that had been subject to disturbance from existing infrastructure or agricultural land uses)
- A relatively even spread of survey sites along the Project alignment, to determine spatial variability in aquatic and water quality values
- Practicality of access to the site and the safety of field teams.

Where practical, surface water quality sites were located upstream and downstream of the reference design, if access was possible. This positioning of sampling sites ensured that the collected data retained value for assessment purposes in the event that localised alignment shifts occurred during the design development process.

Consistent and reliable access was obtained for 34 sites that were suitable for the surface water assessments. Sites were assigned a number in approximate numerical order from west to east. On some occasions when a site could not be accessed, an alternative site was identified on public land nearby and labelled with the site number and the letter 'R' (e.g. Site 20R). This allowed the assessment of water quality information from areas adjacent to the original site. Where sites were deemed as not reliable for assessment (due to access or lack of water), the site was removed from the original 43 sites.

Due to identification of replacement sites after the initial assessment, several of the replacement sites were assessed in two discrete sampling events during the start of April 2019 and the end of April 2019 (into May 2019) (refer Section 4.1.2.1). There were 20 water quality sites that were assessed across the whole water quality monitoring period (refer Table 4.4).

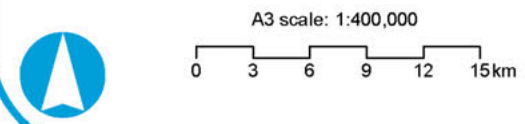
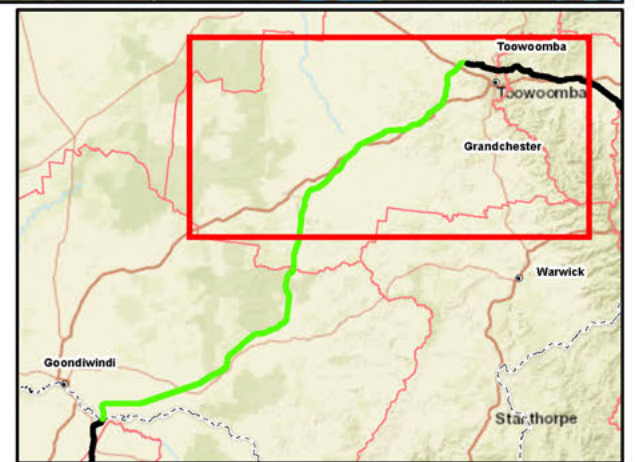
Due to access requirements, several water quality monitoring sites were located outside of the impact assessment area. All sites (including those outside of the impact assessment area) were considered to be representative of the existing environment, upstream or downstream of the Project alignment intersection of the assessed waterway. Waterbody names were determined by the Water Act watercourses and other related waterflow paths.





- Legend**
- ◆ Surface water quality field assessment sites
 - 5 Chainage (km)
 - Localities
 - Border to Gowrie alignment
 - Gowrie to Helidon alignment
 - Helidon to Calvert alignment
 - Existing rail (operational)
 - - - Existing rail (non-operational)
 - Catchment boundaries
 - Surface water impact assessment area

- Drainage features**
- Order 2 - 3
 - Order 4 - 5
 - Order 6 - 7



Border to Gowrie
Figure 4.1b:
Surface water quality field assessment sites

Table 4.4 Surface water quality survey sites assessed for water quality

Site ID	Site location (zone 56J)		Waterway	Position	Water present at time of assessment			
	Easting	Northing			Jun 2018	Nov/ Dec 2018	Feb 2019	Apr 2019
2	252526.14 m E	6826589.54 m S	Macintyre River	6 km downstream of the rail alignment	Yes	Yes	Yes	Yes
2R	As per Site 2				No	Yes	Yes	Yes
3	297987.40 m E	6846544.39 m S	Macintyre Brook	900 m downstream of rail alignment	Yes	Yes	Yes	Yes
6	303224.05 m E	6852534.59 m S	Macintyre Brook	1.2 km downstream of rail alignment	Yes	Yes	Yes	Yes
7	307340.87 m E	6856089.27 m S	Macintyre Brook	1.3 km downstream of rail alignment	Yes	Yes	Yes	Yes
11	311857.57 m E	6857333.54 m S	Canning Creek	1.3 km downstream of rail alignment	Yes	Yes	Yes	Yes
14	319758.71 m E	6879596.17 m S	Unnamed waterway	10 m upstream of rail alignment	Yes	Yes	Yes	Yes
16	322034.45 m E	6884153.22 m S	Unnamed waterway	20 m downstream of rail alignment	Yes	Yes	Yes	Yes
18	319459.85 m E	6890038.43 m S	Unnamed waterway	3 km upstream of rail alignment	No	No	Yes	Yes
20R	323287.61 m E	6890895.62 m S	Nicol Creek	20 m downstream of rail alignment	No	No	No	Yes
23	330232.23 m E	6913921.81 m S	Unnamed waterway	1.8 km upstream of rail alignment	No	No	Yes	Yes
24	337772.29 m E	6919155.06 m S	Grasstree Creek	670 m upstream of rail alignment	Yes	Yes	Yes	No
27	338748.32 m E	6922941.94 m S	Condamine River	2 km upstream of rail alignment	Yes	No	Yes	Yes
29	342210.77 m E	6922517.08 m S	Unnamed waterway	900 m downstream of rail alignment	No	No	No	Yes
30	347306.73 m E	6920094.77 m S	Condamine River	7 km downstream of rail alignment	Yes	Yes	Yes	Yes
32	344676.97 m E	6926062.65 m S	Condamine River (North Branch)	20 m upstream of rail alignment	No	No	Yes	No
33	345293.94 m E	6925389.04 m S	Condamine River (North Branch)	870 m downstream of rail alignment	No	Yes	No	No
39	379694.11 m E	6952313.72 m S	Westbrook Creek	800 m downstream of rail alignment	Yes	Yes	Yes	Yes
40	379972.90 m E	6954172.10 m S	Dry Creek	30 m downstream of rail alignment	Yes	Yes	No	Yes

Site ID	Site location (zone 56J)		Waterway	Position	Water present at time of assessment			
	Easting	Northing			Jun 2018	Nov/ Dec 2018	Feb 2019	Apr 2019
42	383710.24 m E	6954556.98 m S	Dry Creek	2.17 km downstream of rail alignment	Yes	Yes	Yes	Yes

4.1.2.3 In-situ analysis of surface water quality

A suite of water quality parameters were selected for the assessment of the existing environmental condition in relation to anticipated activities and associated impacts from the Project. Qualitative data was collected to provide contextual supplementary information in relation to the water quality values.

A multi-probed, battery operated water quality meter (YSI Professional Plus) was used to measure physio-chemical parameters. The device was calibrated in the field prior to the collection of data and used to take measurements of the following parameters:

- Dissolved oxygen (DO) (mg/L) and saturation (per cent)
- pH
- Electrical conductivity (EC) (µs/cm)
- Temperature (°C)
- Turbidity (NTU)
- Total dissolved solids (TDS) (ppm)
- Oxidation reduction potential (ORP) (mV).

Additionally, the following qualitative data was recorded:

- Time
- Water flow (none/low/mod/high/flood/dry)
- Optical clarity (clear/slight/turbid/opaque/other)
- Odour (normal/sewage/hydrocarbon/chemical)
- Surface condition (none/dust/oily/leafy/algae)
- Algae cover (none 0-5% cover / some – 6-25% cover / lots – 26-100% cover)
- Other visual observations/ comments (colour, fish, presence of litter)
- A photo and GPS point were collected from each sampling site.

Calibration certificates for the water quality monitoring probes used during the sampling works are provided in Appendix A.

4.1.2.4 Laboratory analysis of surface water quality

Before the commencement of field sampling, a National Association of Testing Authorities (NATA) accredited laboratory (Eurofins) was chosen and communicated with to understand their requirements for analysing water samples collected.

Surface water samples were collected at each monitoring location listed in Table 4.4 and submitted to the chosen NATA accredited laboratory (Australian Laboratory Services) for analysis of the following water quality parameters:

- EC and salinity

- Total suspended solids
- Total hardness as calcium carbonate (CaCO₃)
- Nutrient suite (ammonia, nitrite, nitrate, total nitrogen, total Kjeldahl nitrogen (TKN), nitrogen oxides (Nox), reactive phosphorus (P) and total P)
- Organic nitrogen
- Dissolved metals (eight metals suite: arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury)
- Polycyclic aromatic hydrocarbons (PAHs)
- Chlorophyll *a*.

These parameters were analysed to determine existing water quality within the impact assessment area. Laboratory analytes were selected to assess both existing water quality conditions in reference to current land use, and, potential impacts from construction and operation of the Project.

Surface water quality samples were collected in accordance with industry-accepted standards and quality assured procedures, including the *Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009* to assess the condition and trend of Queensland waters (DES 2018a). Field quality control included rigorous sample collection, decontamination procedures (where appropriate), and sample documentation.

Where possible, surface water quality samples were collected from the centre of the watercourse, where the velocity is the highest. The mouth of the sampling container was held above the base of the channel to avoid disturbing or collecting any settled solids or materials.

The surface water quality samples were collected directly into the appropriate sampling bottles provided by the laboratory to avoid potential contamination associated with the use of intermediate containers. Where a sampling pole was required to be used to enable safe sample collection, the sampling bottle was placed on the pole and the sample collected directly into the sampling bottle. Syringes and filters were flushed with water from the sampling site prior to use.

As per the *Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009* (DES, 2018a) samples were collected in bottles supplied by the laboratory and transferred to portable coolers immediately after sampling. In order to avoid a breach of holding times for some analytes, the following approach was taken to the delivery of samples to the laboratory:

- A mid-field trip consignment of approximately half of the samples to be collected was delivered to the laboratory by the field team for analysis to commence
- Water samples for chlorophyll *a* were filtered through a glass fibre filter in the field, with the filter paper double wrapped in aluminium foil and stored in a freezer, as described in DES (2018a). Application of this method extended the laboratory holding time for Chlorophyll *a* from 2 days to 28 days.

4.1.3 Sampling and laboratory quality assurance/quality control

Surface water quality samples were collected in accordance with industry-accepted standards and quality assured procedures, including the *Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009* (DES, 2018). Field quality control included rigorous sample collection, decontamination procedures (where appropriate), and sample documentation. As each sample was collected, it was labelled with a unique sample identifier, the initials of the sampler, the date and the Project number. Once collected, samples were immediately preserved following prescribed techniques. The Chain of Custody forms include data such as sample identification, date sampled, matrix type, preservation method, analyses required and name of sampler.

At one monitoring site for each field trip, a second suite of water samples (duplicates) were taken and labelled DUP. This sample was a 'blind duplicate' of another site (unknown to the laboratory) and provided an opportunity to determine within-laboratory variation in the results between samples collected from the same location. The relative percent difference was calculated for duplicate samples, with a criterion of <35 per cent applied for further investigation. An additional blank sample was taken during sampling to identify field-based contamination from sampling.

Laboratory QA/QC included analysis of laboratory duplicates, method blanks, laboratory control samples, matrix spikes and surrogates. All laboratory QA/QC were within the acceptance range. All samples were collected into the appropriate sample containers for the analysis required and arrived at the laboratory chilled and within the relevant holding times (with the exception of oxidised nitrogen parameters (Nitrates and Nitrites) and reactive P). Noting that oxidised nitrogen parameters and reactive P concentrations were not assessed against WQO, and were used as complementary analytes, it is considered that QA/QC procedures were adequate.

Overall the reported analytical results are considered to be valid and representative of the concentrations of the analysed compounds at the sample locations.

Relative percent differences for duplicate samples in June 2018 (Site 6) and November 2018 (Site 3) were below the criterion of 35 per cent for all parameters except TSS in November 2018, which was 82 per cent (raw values of 11 and 20 mg/L). When sampling pools of water that are not well mixed, there is potential for one sample to have quantities of detritus or sediment that differs slightly from the duplicate sample. This is the most likely explanation for different results for samples collected from the same location. In order to remove potential error from analysis of water quality, this value is reported (as indicative) but not assessed against WQO for the site.

Results for field blank samples were at or below the laboratory level of detection for all samples, except ammonia in November 2018, which recorded a result of 0.03 mg/L, slightly above the laboratory limit of detection of 0.01 mg/L. This result indicates that the process of collecting the field blank may have resulted in some very minor contamination of the distilled water. However, several other samples in the batch had concentrations of ammonia below the laboratory limit of detection, so any contamination was localised.

On the basis of the analytical data validation process (including identification of violation of quality assurance processes), the overall quality of the analytical data collected is considered to be of an acceptable standard for interpretive use.

4.1.4 Assessment of results

Field and laboratory results were compared against relevant WQOs as presented in Section 3.2.

The data obtained in the field was assessed against the data obtained during the desktop assessments to supplement identified data gaps and provide a contemporary assessment of the physical and chemical status of aquatic systems to be intersected by the Project alignment, against current WQO.

WQOs and assessment of surface water quality monitoring results against the relevant WQOs is discussed in further detail in Section 6.

4.2 Impact assessment methodology

The surface water quality assessment for the Project uses a significance-based impact assessment framework to identify and assess Project related impacts in relation to water quality receptors.

For the purposes of the assessment, a significant impact depends upon the sensitivity of the surface water value, the quality of the environment which is impacted, and upon the intensity, duration, magnitude and potential spatial extent of the potential impacts. Determination of the sensitivity or vulnerability of the surface water quality receptor and the magnitude of the potential impacts facilitate the assessment of the significance of potential impacts. The following sections discuss and define impact magnitudes, receptor sensitivity and impact significance.

4.2.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on sensitive receptors. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 4.5). The magnitude of impacts is determined using assessment of potential impacts against existing condition, Project activities and potential impacts to facilitate an estimation of the extent, duration and frequency of the impacts (refer Table 4.6).

Table 4.5 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact.
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact.
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the Project is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls.
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.
Negligible	An extremely localised impact that is barely discernible and is effectively mitigated through standard environmental management controls.

Table 4.6 Timeframes for duration terms

Duration term	Timeframe – to be defined for each receptor type if required
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term	Up to 2 year (i.e. 6 to 24 months)
Medium term	From 2 to 11 years ¹
Long-term/long lasting	From 11 to 21 years ²
Permanent or irreversible	More than 21 years ³

Table notes:

1. Derived from the term 'moderate' EAM Risk Management Framework 2009 (GBRMPA, 2009)
2. Derived from the term 'major' EAM Risk Management Framework 2009 (GBRMPA, 2009)
3. Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (GBRMPA, 2009)

4.2.2 Sensitivity

To assess the significance of potential impacts on water quality receptors, sensitivity categories were applied to each of the features. The sensitivity categories are split into five discrete groups as described in Table 4.7.

These groupings are based on qualitative assessments utilising information related to the sensitivity of the water quality receptor, in addition to the potential of a water quality receptor's occurrence within the receiving environment. Sensitive features are treated individually. In the case where there are conflicting classes, the highest (major) sensitivity is selected.

Through the determination of sensitivity categories for each of the water quality receptors, the features are then able to be assessed through a matrix against the magnitude of the potential Project impact type to indicate the level of significance for each of the impact types on the water quality receptors.

Table 4.7 Sensitivity criteria for sensitive values/receptors within the impact assessment area

Sensitivity	Description
Major	■ The water quality receptor is listed on a recognised or statutory state, national or international register as being of conservation significance and/or ■ The water quality receptor is entirely intact and wholly retains its intrinsic value and/or ■ The water quality receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world and/or ■ It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the water quality receptor. ■ Project activities would have an adverse effect on the value.
High	■ The water quality receptor is listed on a recognised or statutory state, national or international register as being of conservation significance and/or ■ The sensitive is intact and retains its intrinsic value and/or ■ The water quality receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region and/or ■ The water quality receptor has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the water quality receptor. ■ Project activities would have an adverse effect on the water quality receptor.
Moderate	■ The water quality receptor is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers and/or ■ The water quality receptor is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements and/or ■ The water quality receptor is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are exposed to threatening processes and/or ■ Threatening processes have reduced the water quality receptor's resilience to change. Consequently, changes resulting from Project activities may lead to degradation of the prescribed value and/or ■ Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	■ The water quality receptor is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g. historical societies and/or ■ The water quality receptor is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value and/or ■ It is not unique or rare and numerous representative examples exist throughout the system/area and/or ■ It is abundant and widely distributed throughout the host systems/areas and/or ■ There is no detectable response to change or change does not result in further degradation of the water quality receptor and/or ■ The abundance and wide distribution of the water quality receptor ensures replacement of unavoidable losses is achievable.
Negligible	■ The water quality receptor is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations and/or ■ The water quality receptor is not unique or rare and numerous representative examples exist throughout the system/area and/or ■ There is no detectable response to change or change does not result in further degradation of the water quality receptor.

4.2.3 Significance of impact

The significance of a potential impact is a function of the significance of the water quality receptor, the sensitivity of the receptor and the magnitude of the potential impact. Although the sensitivity of the receptor will not change (i.e. is generally determined qualitatively by the interaction of the receptor's condition, adaptive capacity and resilience), the magnitude of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the water quality receptor was identified, and the sensitivity of the receptor and the magnitude of the potential impact was determined, the assessment of the significance of the potential impact was derived through use of a five by five matrix (refer Table 4.8).

Following the identification of the level of significance (refer Table 4.9), mitigation measures were then applied to the potential (unmitigated) impacts to identify the residual (mitigated) impacts.

Table 4.8 Significance assessment matrix

Magnitude of impact	Sensitivity category				
	Major	High	Moderate	Low	Negligible
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

Table note:

Significance categories as identified in Table 4.8 are defined in Table 4.9. Magnitude categories are defined in Table 4.5.

Table 4.9 Significance classifications

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an water quality receptor that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the water quality receptor. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate	Results in degradation of the water quality receptor due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the water quality receptor ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where a water quality receptor is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on water quality receptors. This typically occurs where the activities are located in already disturbed areas.

4.3 Cumulative impact assessment

4.3.1 General assessment methodology

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered.

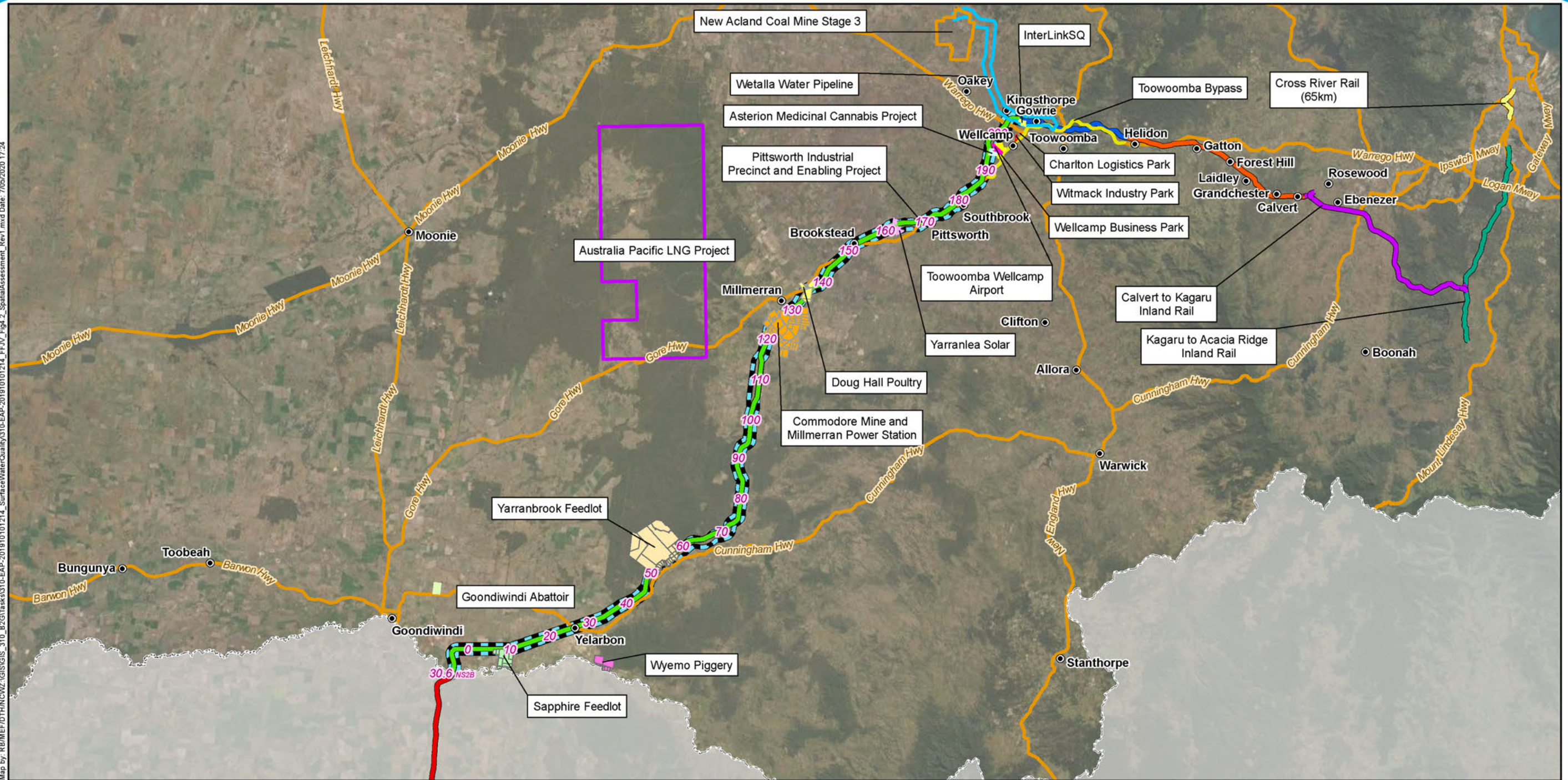
The cumulative impacts of multiple projects occurring in the vicinity of the impact assessment area may contribute to impacts to water quality if not managed appropriately (refer Figure 4.2).

The approach used to identify and assess potential construction phase cumulative impacts of the Project is as follows:

- A review of the potential impacts identified within the assessment. The environment at the time of the ToR is the baseline, prior impacts from past land use has not be considered.

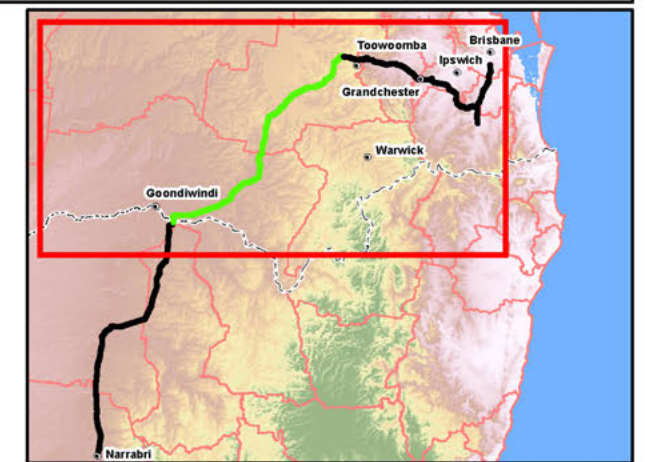
- A preliminary list of projects for consideration in the cumulative impact assessment was collated with timelines to demonstrate the temporal relationship between projects. This preliminary list of projects was compiled through consideration of the following:
 - Projects subject to assessment under the EP Act or SDPWO Act, with an Initial Advice Statement published by DES or Department of State Development, Tourism and Innovation (DSDTI)
 - Projects listed in GRC and TRC development application databases
 - Development within Priority Development Areas and State Development Areas
 - Economic Development Queensland development projects
 - Community Infrastructure Designation projects
 - Projects within the public register of environmental authorities
 - DTMR infrastructure projects
 - Private infrastructure facilities
 - Development in accordance with Regional Planning Interests
 - The Inland Rail projects immediately adjacent to the Project, being the North Star to NSW/QLD Border and Gowrie to Helidon projects
- The preliminary list of projects was assessed to identify those that meet one of the following criteria:
 - Projects that have been approved but where construction has not commenced
 - Projects that have commenced construction subsequent to issuance of the ToR for the Project, but have potential for overlap in construction activities with the Border to Gowrie Project
 - Projects that have been completed subsequent to issuance of the ToR for the Project
 - Are operational developments that have future plans for expansion
- Projects that were excluded from further assessment were:
 - Existing projects, with no known plans for expansion. Such projects are typically considered part of the 'existing environment' and have been accounted for in the impact assessment of each specific matter.
 - Proposed projects that have not been developed to the point that details of their scale, size, location and core activities would be publicly available.
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment was undertaken to determine the nature of the cumulative impact. The spatial extent of cumulative impact assessment for surface water quality is shown on Figure 4.2.
- An assessment matrix method (further detailed in Table 4.10 and Table 4.11) has been used to determine the significance of cumulative impacts with respect to beneficial or detrimental effects.
- Where cumulative impacts are deemed to be of medium or high significance, additional mitigation measures are proposed, beyond those already proposed by the relevant technical impact assessments.

Map by: RB/MEF/DTM/CWZ:GIS/GIS 310_B2GIS/310-EAP-201910101214_SurfaceWaterQuality310-EAP-201910101214_FFIV_Fig 2_SpatialAssessment_Rev1.mxd Date: 7/05/2020 17:24



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Kagaru to Acacia Ridge/Bromelton alignment
- Major roads
- NSW/QLD border
- Surface water quality impact assessment area



A3 scale: 1:1,000,000
0 7.5 15 22.5 30 37.5 km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 7/04/2020 Version: 1
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.2:

Area of spatial assessment subject to the cumulative impact assessment for surface water quality

4.3.2 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor score of low, medium and high has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 4.10.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 4.10 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 4.11. For example, if an environmental value such as riparian vegetation loss was considered to have a probability of impact of 2, duration of impact of 3, magnitude /intensity of impact of 1 and a sensitivity of receiving environment of 1 the significance of impact would be $(2+3+1+1 = 7)$ = Medium.

Table 4.10 Assessment matrix

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/Intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 4.11 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general Project monitoring programme.
Medium	7 to 9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring Program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring Program necessary, where appropriate.

4.4 Assumptions of assessment

This report has been prepared based on publicly available information and field water sampling results. The description of the existing surface water condition in this report is a desktop study from publicly available data complemented by contemporary field water quality samples (with seasonal variation) to enable an assessment of existing environmental conditions.

Some of the proposed sampling sites were located on or required access through privately owned land. ARTC and FFJV coordinated access to private properties with the agreement of landowners. However, in some cases, access to private properties could not be negotiated or facilitated in the timeframes of the surveys. In such cases, alternative sampling sites in accessible areas were selected, where practical (in regard to access and suitability of site).

The laboratory holding times for some water quality analytes (e.g. reactive P, nitrite and nitrate which have a holding time of two days) were shorter than was practical for the transport of samples to the laboratory. The number of parameters affected was minimised by transporting samples to the laboratory at the mid-point of each field trip and using alternative methods for preservation of samples where possible (e.g. chlorophyll a). Consequently, results for some parameters (notably Chlorophyll a) were obtained outside of the recommended holding times and has been considered (as confidence) when interpreting the results.

Periods of minimal hydrological flow within the water courses across the Project was observed (during periods of fully declared drought conditions). Noting this, historic gauging stations across the water quality impact assessment area allowed for the existing environment to supplement the field assessment of available waters discharge and water quality parameters analysed indicated the region to experience cyclic, episodic hydrological regime of the impact assessment area and aligned with the limited data obtained during the field assessment. As such, the field data gathered during this assessment was considered to be indicative of existing environmental conditions and relevant for assessment under the ToR.

5 Description of environmental values/existing conditions

5.1 Local government areas

The Project is situated in the local government areas of the Toowoomba Regional Council between Gowrie and south of Millmerran and Goondiwindi Regional Council, between south of Millmerran and the Queensland Border.

5.2 Catchment areas

The Project is located across two surface water catchment areas, the Condamine River basin and the Border Rivers basin (refer Figure 5.1).

The Border Rivers basin covers approximately 23,800 km² and, in combination with the Moonie River basin, comprises approximately 12 per cent of the Queensland portion of the Murray-Darling basin (DES, 2019c). This basin resides predominantly in Queensland with a portion extending into New South Wales.

The Border Rivers are a network of perennial streams that rise in the western slopes of the Great Dividing Range on the Granite Belt and New England Tablelands and together form the headwaters of the Darling River (DES, 2019c). In Queensland, the Macintyre Brook, Severn River, Mole River and Beardy River drain from the Inglewood, Granite Belt, Tenterfield and Deep Water districts, respectively. The confluence of the Severn River and the Mole River becomes the Dumaresq River which forms part of the border between Queensland and New South Wales. The Dumaresq River enters the Macintyre River above Goondiwindi and continues to form the border between the two states.

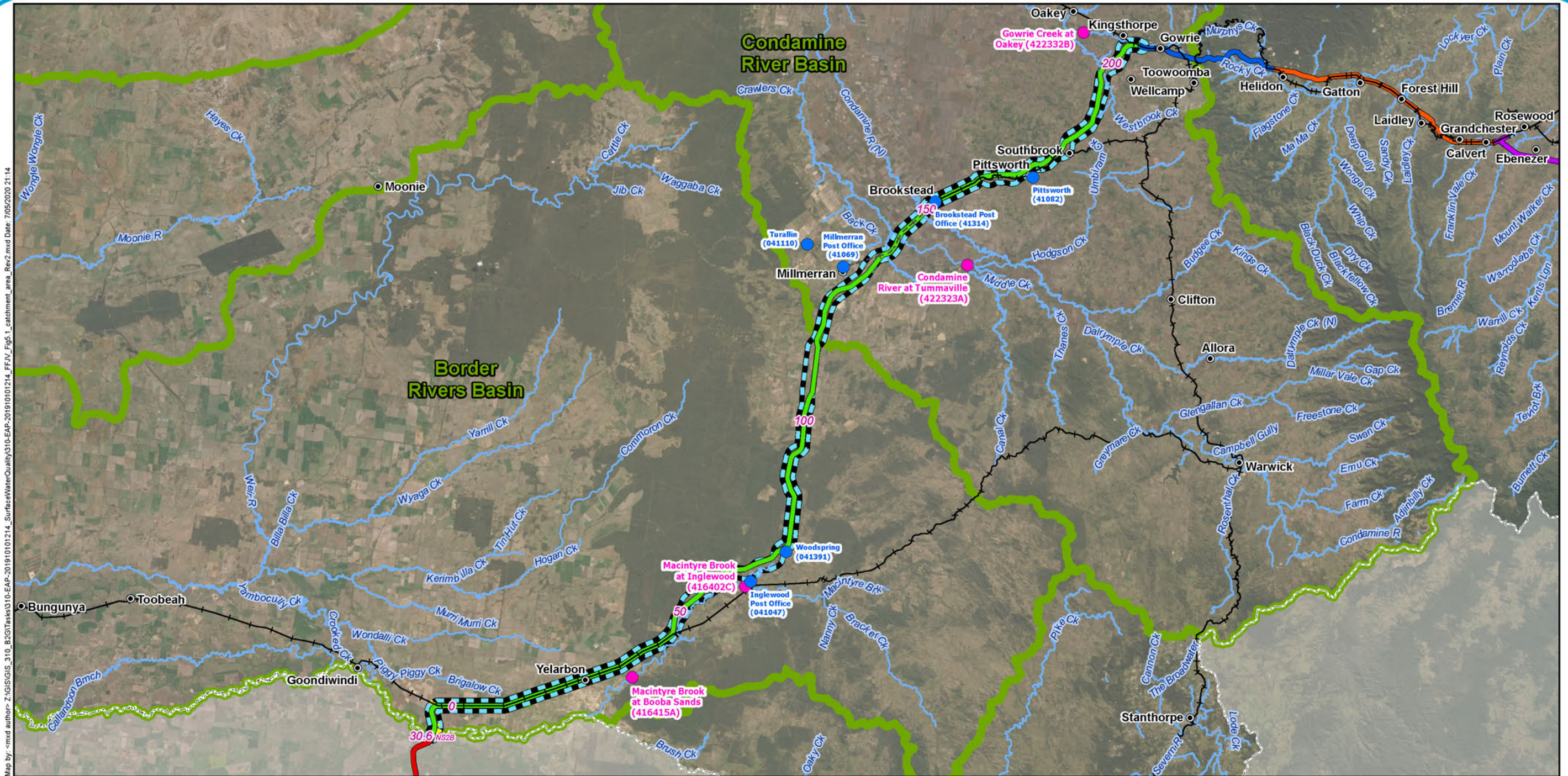
The Macintyre River flows generally west before reaching its confluence with the Weir River, west of Goondiwindi. The Weir River headwaters are located in the Dunmore State Forest south west of Cecil Plains. It is fed by a number of tributaries that drain to an area west of Millmerran and Inglewood and north of Goondiwindi. The Weir River generally flows in a southwest direction and combines with the Macintyre River, north of Mungindi, where it becomes the Barwon River (DES, 2019c).

Water type zones within the Border Rivers basin include Canning Creek, Dumaresq Floodplain, Granite Belt, Kumbarilla Ridge, Lower Moonie River, Lower Macintyre Brook, Lower Weir River, Macintyre Barwon Floodplain, Middle Moonie River, Traprock, Upper Moonie River and Upper Weir River.

The Condamine River basin covers approximately 25,440 km² and comprises approximately 9% of the Queensland Murray-Darling basin (DES, 2019b). The Condamine River basin forms part of the headwaters of the Murray-Darling basin river system that flows through the southern states.

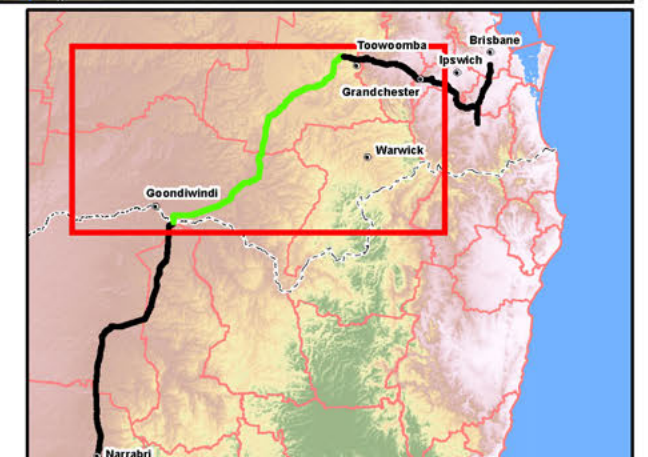
The main channel in this basin begins in the headwaters of the Condamine River, near Warwick. This is within the Main Range National Park. The Condamine River flows north-west until around Brigalow, where the river turns west and crosses into the Maranoa and Balonne River basin. It then becomes the Balonne River between the town of Condamine and Surat and eventually discharges into the NSW intersecting streams. Tributaries of the Condamine River include Emu Creek, Glengallan Creek, Hodgson Creek, Oakey Creek, Wilkie Creek and Charleys Creek.

Water type zones within the Condamine River basin include: North-Western, South-Western, Kumbarilla Ridge, Central Condamine, Oakey Creek, Upper Condamine, Middle Condamine, Southern Condamine, Lower Condamine, South-Eastern, Emu Creek.



Legend

- BOM weather station
- DNMRE gauging station
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- NSW/QLD border
- ▭ Catchment boundaries
- ▭ Surface water impact assessment area



A3 scale: 1:798,797
0 6 12 18 24 30km

The major water storages in the Queensland Border River basin are Glenlyon Dam (capacity 254 gigalitres) and Coolmunda Dam (capacity 69 gigalitres), which are approximately 68 km and 10 km from the Project footprint respectively (direct linear distance). The major water storage in the Condamine River basin is Leslie Dam with a capacity of 106 gigalitres, which is located approximately 72 km east of the Project footprint (direct linear distance). Additionally, smaller water storages are present for the management of supplemented and non-supplemented (regulated or natural) flow for irrigation, stock and domestic uses throughout the catchment (DES 2019b & 2019c).

5.3 Land use

Approximately one third of the Project length will involve upgrade, enhancement or construction of new track coincident with existing rail corridor. The balance of the project has been co-located with existing road infrastructure or will be established on land that, by and large, has been subject to previous disturbance for agricultural purposes.

Land surrounding the Project is predominantly used for livestock grazing, combined with other agricultural uses including irrigated cropping. Other land uses include production forestry, other minimal use (consisting of areas of land that are largely unused, for example, residual native cover or land reserved for stock routes) and transport and communication.

The Project traverses through, or near to the townships of Yelarbon, Inglewood, Millmerran, Pampas, Brookstead, Pittsworth, Southbrook, Athol, Gowrie Mountain and Kingsthorpe. Notable land uses traversed by, or located within proximity to the Project include the Kildonan Key Resource Area (KRA 120), Whetstone State Forest, Bringalily State Forest, Commodore Mine, several intensive animal production operations including cattle feedlots, poultry farms and piggeries and, at the northeastern end, the Toowoomba Wellcamp Airport and Toowoomba Enterprise Hub.

5.4 Physical environment

The Köppen Climate Classification system indicates that the impact assessment area falls within the 'Cfa – Humid Subtropical Climate' region which is characterised by hot and humid summers, and mild winters. A review of Bureau of Meteorology (BoM) climate data of relevance to surface water conditions within the impact assessment area was undertaken to validate this classification and to establish an appreciation of location-specific conditions. This climatic data was sourced from several representative BoM monitoring stations within the impact assessment area, as identified in Table 5.1.

5.4.1 Rainfall

Rainfall data from 1883 to 2018 was collected from six weather stations across the impact assessment area. Both currently active and inactive stations indicated that the area receives an average of between 600 mm and 700 mm of annual rainfall (BoM, 2019c).

Table 5.1 identifies the recorded rainfall data for the six weather stations across the impact assessment area. The region receives its heaviest rainfall in summer, with the highest recorded single rainfall event occurring in January 2010 with 433.6 mm. During the winter months, the area predominantly receives low to no rainfall (BoM 2019c).

Table 5.1 Weather stations within proximity of the Project and rainfall data

Station number	Name	Locality (distance from alignment (km))	Operation date	Annual rainfall average (mm)	Month of highest average rainfall/ amount (mm)	Month of lowest average rainfall/ amount (mm)
041391	Woodspring	Woodspring (~5)	1954-2020	627.8	Dec (90.3)	Aug (28.8)
041047	Inglewood Post Office	Inglewood (~2)	1883-2020	647.3	Jan (84.2)	Aug (32.3)
41069	Millmerran Post Office	Millmerran (~2)	1900-2014	663.2	Jan (88.8)	Aug (30.9)
041110	Turallin	Turallin (~10)	1909-2015	655	Jan (91.1)	Sep (31.5)
41314	Brookstead Post Office	Brookstead (<1)	1958-2020	639.8	Dec (103.1)	Jun (27.8)
41082	Pittsworth	Pittsworth (~1)	1886-2020	694.6	Dec (98.2)	Aug (30.3)
041529	Toowoomba Airport	Toowoomba (~8)	1996-2020	690	Dec (100.6)	Jul (26.6)

Source: BoM (2019c)

5.4.2 Evaporation

There are relatively few BoM weather stations that record daily evaporation. The closest BoM weather station that records evaporation is the Oakey Aero station (041359), which is located approximately 13 km northwest of Gowrie and 11 km from the impact assessment area. From 1973 to 2018 evaporation data for the impact assessment area generally consisted of higher evaporation in the summer months where the mean average evaporation rate was 7.7 mm compared to the winter months where the mean evaporation rate was 3.2 mm (BoM, 2019c).

5.4.3 Temperature

The climate of the impact assessment area remains relatively warm all year round with cooler temperatures occurring during winter nights and early mornings (BoM, 2019c). Data was collected from the Texas Post Office (041100) weather station which is located approximately 46 km south east of Yelarbon and the Project. Between 1969 and 2019 the impact assessment area recorded an average maximum temperature of 33.1°C during summer and an average minimum temperature of 4.3°C during winter. The hottest day recorded for the impact assessment area occurred in December 1979 where it reached 37.5°C, whilst the coldest ever day record reached by the area was -1.1°C in July 1972. Figure 5.2 provides the mean maximum and minimum temperature recorded at the Texas Post Office (041100).

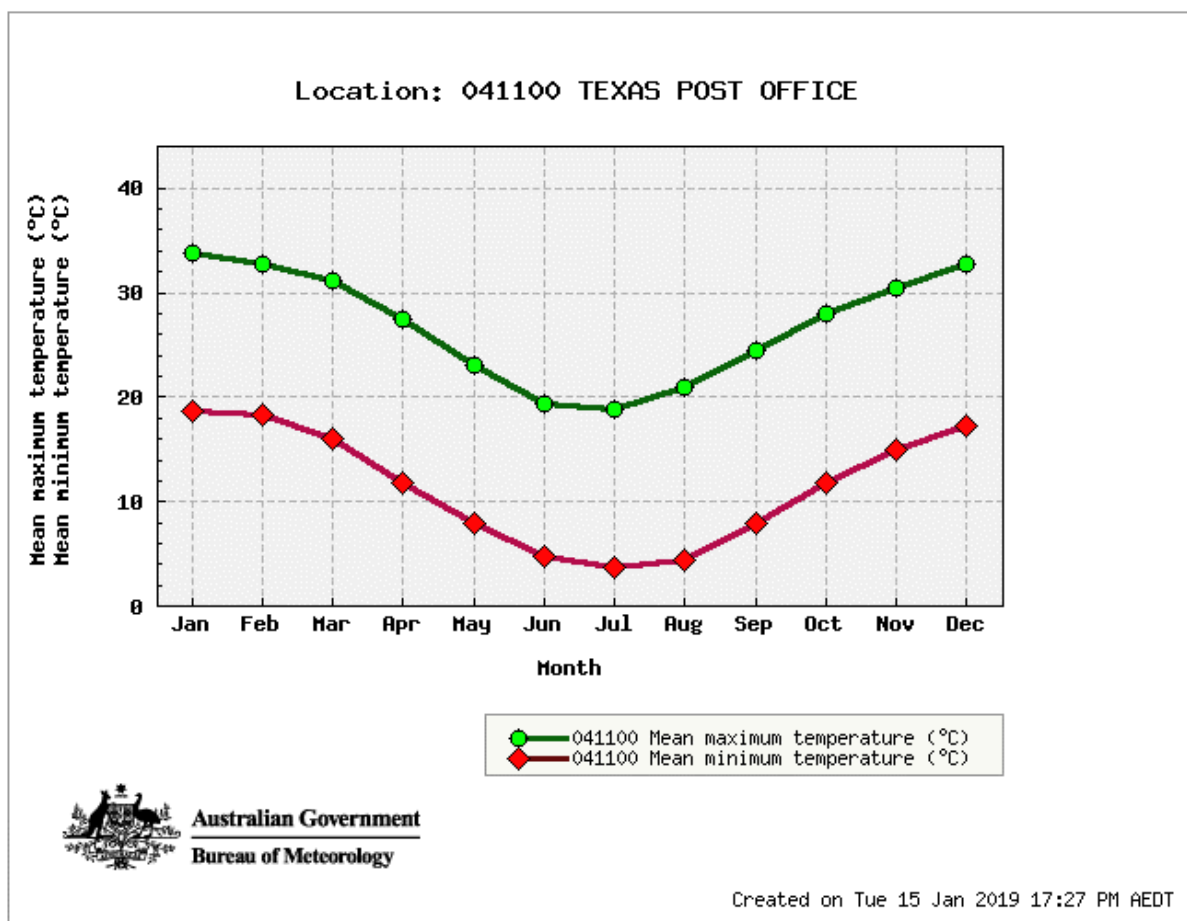


Figure 5.2 Summary of the maximum and minimum temperature recorded at Texas Post Office (041100)

Source: BoM (2019c)

5.4.4 Gauging station water monitoring (discharge and water quality)

The DNRME maintain a Water Monitoring Information Portal (WMIP) for stream gauge data with datasets typically including rainfall, stream flow and water quality data for numerous gauging stations across Queensland.

There are four stream flow monitoring stations located within the impact assessment area that record real time data including flow creek data and other basic parameters. The stations and their location relative to the Project alignment are provided in Table 5.2. Conditions observed during the water quality monitoring events appear typical of the general stream flow observed with the gauging stations on Gowrie Creek, the Condamine River and Macintyre Brook, with low median discharge per day, and sub-optimal water quality, relative to WQOs (refer Table 5.2 and Table 5.3).

Table 5.2 Department of Natural Resources, Mines and Energy gauging stations

DNRME gauging station	Location in relation to the Project alignment
Condamine River basin	
Gowrie Creek at Oakey (422332B)	Located approximately 12 km downstream of the Project alignment at Gowrie Creek
Condamine River at Tummaville (422323A)	Located approximately 18 km upstream of the rail alignment
Border Rivers basin	
Macintyre Brook at Inglewood (416402C)	Located approximately 3 km downstream of the rail alignment
Macintyre Brook at Booba Sands (416415A)	Located approximately 3 km downstream of the rail alignment

Source: DNRME (WMIP) (2020)

Table 5.3 Summary of electrical conductivity and discharge at gauging stations and rainfall per month (January 2015 to July 2019)

Gauging station	Median rainfall (mm/month)	Median electrical conductivity (μScm^{-1}) (WQO)	Median discharge (Megalitres (ML) / day)
Condamine River basin			
Gowrie Creek at Oakey (422332B)	41.2 BoM site (41529)	930 (510)	20.60
Condamine River at Tummaville (422323A)	33.6 BoM site (41219)	388 (165)	7.04
Border Rivers basin			
Macintyre Brook at Inglewood (416402C)	30.2 BoM site (41047)	N/A (370)	26.10
Macintyre Brook at Booba Sands (416415A)	31 BoM site (41519)	398 (370)	14.20

Table notes:

- 1 Number in bracket denotes WQO for the given watercourse
- 2 Highlight denotes exceedance of WQO

Source: DNRME (WMIP) (2020), BoM (2020)

Comparison with historical water quality data indicates limited achievement of relevant WQOs for each of the discrete watercourses (refer Table 5.3 and Table 5.4). Additionally, although limited in terms of available data (due to highly seasonal flow), plots of streamflow (as stream discharge at megalitres per day against electrical conductivity) indicate decreases in EC during periods of increased stream discharge (refer Appendix E).

Table 5.4 Gauging station water quality data (median)

Water parameter	Gowrie Creek at Oakey (422332B) (1992- 2018)			Condamine River at Tummaville (422323A) (1963-2019)			Macintyre Brook at Inglewood (416402C) (1981-2019)			Macintyre Brook at Booba Sands (416415A) (1986-2019)		
	Sample number	Recorded value	WQO	Sample number	Recorded value	WQO	Sample number	Recorded value	WQO	Sample number	Recorded value	WQO
pH	180	7.53	7.7-8.3	126	7.79	7.2-7.9	82	7.56	7.4-8.0	71	7.56	7.4-8.0
Turbidity (NTU)	149	440	< 13	76	44.50	9.00	80	8.05	11.0	68	11.00	11.00
Total suspended solids (mg/L)	172	875.5	< 6.0	116	47.50	8.00	74	14.50	10.0	63	19.00	10.00
Ammonia (mg/L)	48	0.06	< 0.02	23	0.007	0.006	24	0.005	0.008	27	0.017	0.008
Total nitrogen (mg/L)	98	3.32	< 0.5	36	0.84	0.595	35	0.86	0.705	37	0.92	0.705
Total P (mg/L)	153	2.97	< 0.05	45	0.24	0.045	41	0.06	0.055	42	0.07	0.055

Table notes:

Number in bracket denotes WQO for the given watercourse (for low flow condition)

Highlight denotes exceedance of WQO

Dates in caption are indicative of timeframes between commencement of analysis of a minimum of one parameter and latest analysis of a minimum of one parameter

Source: DNRME (WMIP) (2019)

Stream discharges at these gauging stations typically show the same distinct seasonal distribution as rainfall with the majority of flow occurring in summer months. Stream flows are highly episodic and with discharges typically generated only as a result of significant runoff events across the four gauging stations. Figure 5.3, Figure 5.4, Figure 5.5 and Figure 5.6 present the stream discharge and water level data for the four DNRME gauging stations ranging from 1961 to 2019.

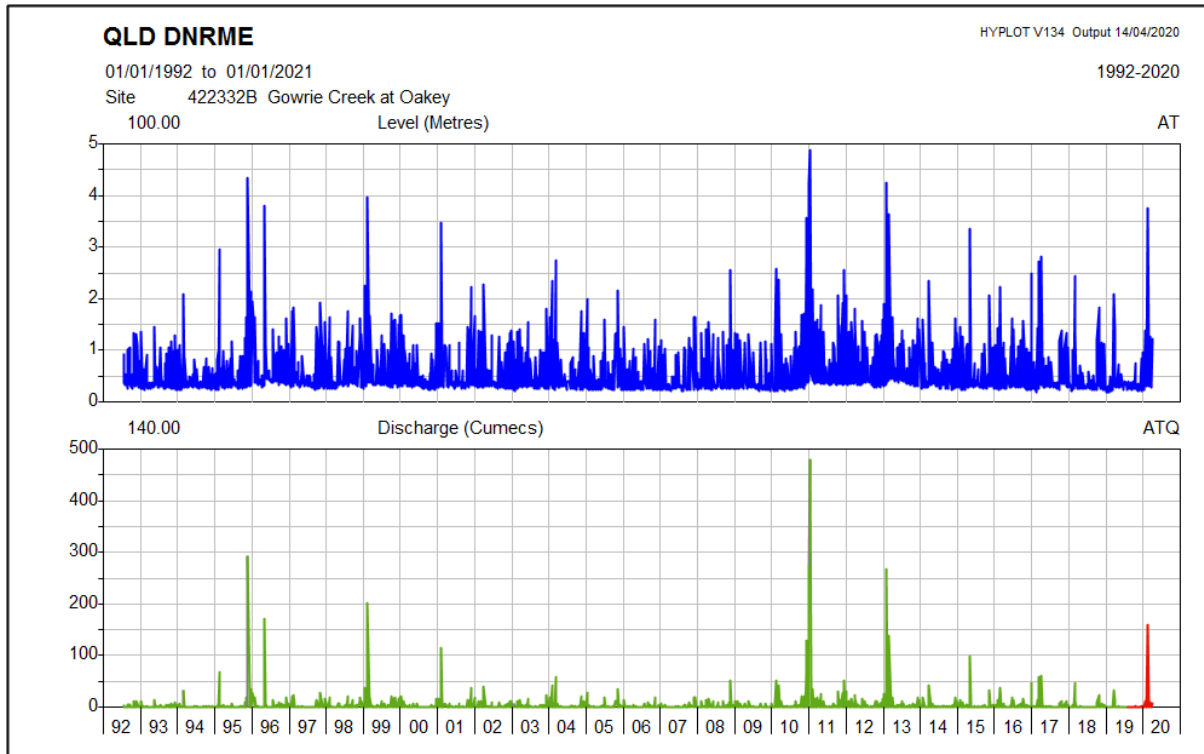


Figure 5.3 Historic stream water level and discharge at Gowrie Creek at Oaky (422332B) (1992 to 2018)

Figure note:

Red plot lines denotes unvalidated data value for discharge

Source: DNRME (2020)

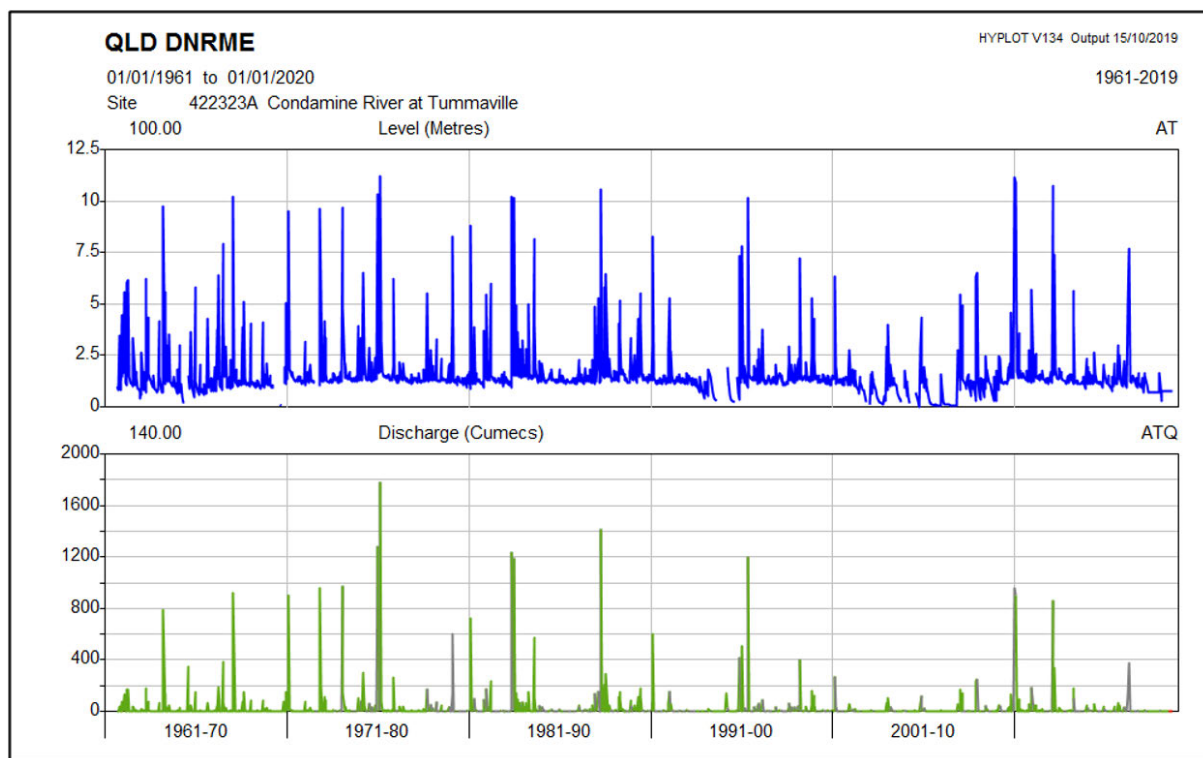


Figure 5.4 Historic stream water level and discharge at Condamine River at Tummaville (422323A) (1961 to 2019)

Figure note:

Grey plot lines denotes unvalidated data value for discharge

Source: DNRME (2020)

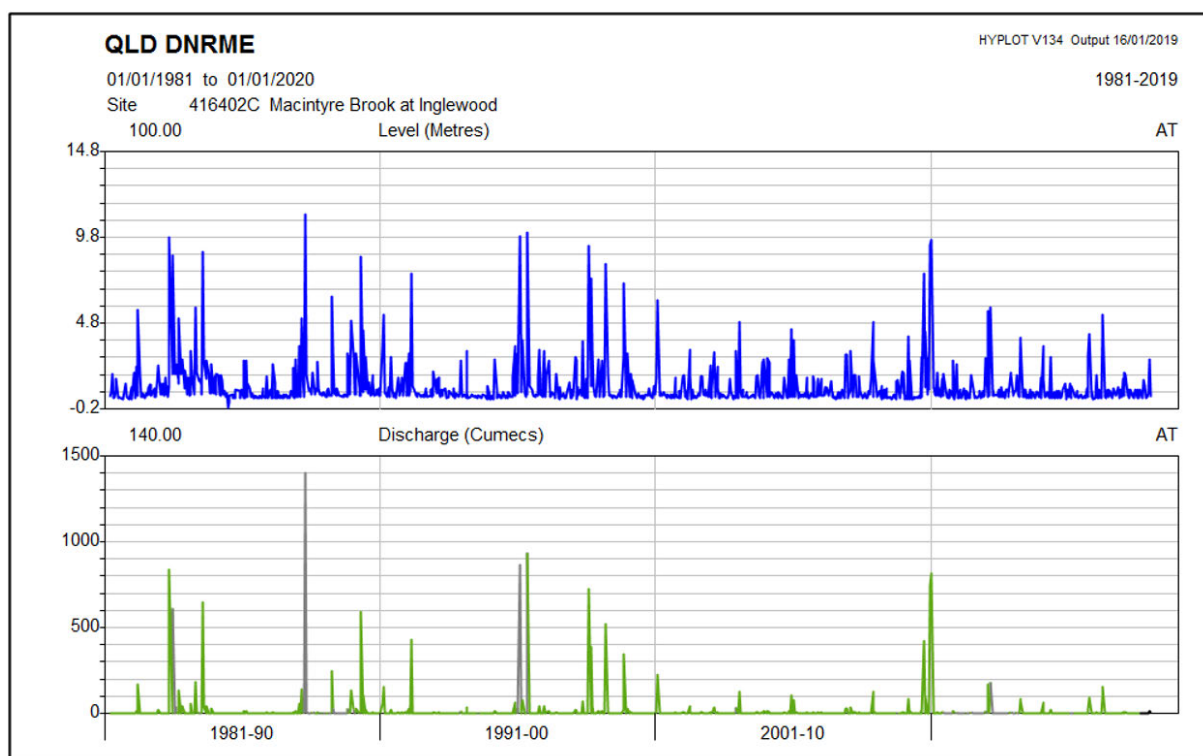


Figure 5.5 Historic stream water level and discharge at Macintyre Brook at Inglewood (416402C) (1981 to 2019)

Figure note:

Grey plot lines denotes unvalidated data value for discharge

Source: DNRME (2020)

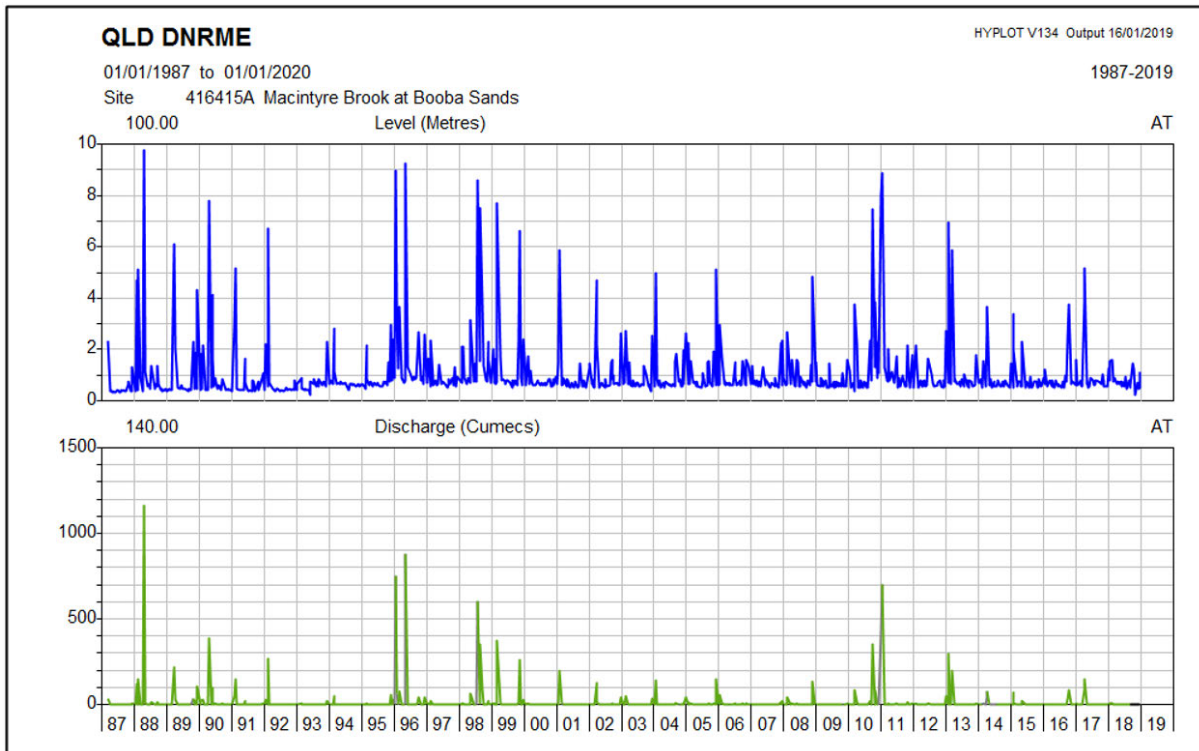


Figure 5.6 Historical stream water level and discharge at Macintyre Brook at Booba Sands (416415A) (1987 to 2019)

Figure note:

Grey plot lines denotes unvalidated data value for discharge

Source: DNRME (2020)

The stream water level for all gauging stations tends to fluctuate with general flow recorded as relatively low with periods of high flow instances. However, in more recent years all stations have experienced prolonged periods of low to no stream discharge. Of the four DNRME gauging stations, the Gowrie Creek at Oakey (422332B) has recorded the lowest comparative stream discharge.

Historic gauging station data for each of the sites indicated a paucity of water quality data for total nitrogen and phosphorus (when separated into season). Noting this, the data was used conservatively to identify any trend of concentrations against discharge. For graphical plots of the water quality data for electrical conductivity, total suspended solids, total nitrogen and total phosphorous refer to Appendix E: Gauging station seasonality plots.

Electrical conductivity values typically adhered to stream discharge patterns across seasons. As discharge decreased towards the drier seasons, water quality decreased with an increase in conductivity values. This was observed across each of the four gauging stations and followed the field assessment snapshot across the impact assessment area. Typically, summer and autumn months had lower electrical conductivity concentrations than those from winter and spring, following a progressively decreasing channel discharge.

Total suspended solids for Condamine River at Tummaville and Macintyre Brook at Booba Sands decreased with a decrease in discharge during winter and spring. In contrast, a trend of increased in total suspended solids was noted during periods of decreased flow (winter and spring) at Macintyre Brook at Inglewood while total suspended solids did not display clear trends with varying discharge at the Gowrie Creek at Oakey station.

Total nitrogen and phosphorous concentration followed the similar trend for suspended total solids for the Condamine River at Tummaville and Macintyre Brook at Booba Sands gauging stations. Decreases in nutrient concentrations (and an increase in water quality) across winter and spring, coinciding with decrease in channel discharge were noted in these two stations and also in Gowrie Creek at Oakey. Similarly to the total suspended solid, within the Macintyre Brook at Inglewood gauging station, no trend in total nitrogen and phosphorus concentrations was evident with decreasing channel discharge.

5.4.5 Climate change

Climate change resilience with explicit regard to water quality, is derived from expected climate change 1% AEP pattern change.

Climate change impacts of the Project have been assessed in accordance with Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball et al., 2016) (ARR 2016) requirements with the representative concentration pathway 8.5 (2090 horizon) scenario adopted. The impacts resulting from changes in peak water levels under the 1% AEP event with climate change are generally similar to those seen under the 1% AEP event, with some additional impacts on flood sensitive receptors. As such, water quality values would not be expected to be significantly impacted (in terms of differential from current values against current WQOs) from construction or operation of the Project.

For full details, refer to Appendix Q1 and Q2: Hydrology and Flooding Technical Report of the Border to Gowrie EIS.

5.5 Key geology, soils and topography

5.5.1 Geological and topographic setting

The impact assessment area features two distinct areas of high elevation along flat to undulating terrain as the Project alignment passes through the floodplains of the Border Rivers and Condamine River basins (BoM, 2017a). The Project's lowest point of elevation occurs at the southern end of the Project alignment at the Macintyre River with an approximate elevation of 227 m. From this point, elevation along the Project alignment generally increases steadily in a northward direction towards Mount Domville and Commodore Peak, south of Millmerran. The Project alignment peaks at 482 m at Ch 122.2 km as it passes through the Clontarf and Millmerran area before dropping into the Condamine River floodplain, a shallow topographical parabola between Millmerran and Yarranlea with a low point of 377 m. From Yarranlea, the Project alignment increases in elevation until Ch 178.5 km near Southbrook, where a maximum elevation of 595 m is reached. From this high point, elevation of the Project alignment decreases to an end point at Ch 206.9 km of 458 m. Topography of the impact assessment area is shown on Figure 5.7.

Surface geology mapping of Queensland at 1:100,000 scale (DNRME 2017) shows 12 geological layers underlie the impact assessment area. The Project is underlain at depth by the depositional Permo-Triassic-aged Bowen Basin. Overlying the Bowen Basin are the Jurassic to Cretaceous-aged Surat and Clarence-Moreton Basins which are separated by the north-south trending Kumbarella Ridge. This ridge forms a subsurface bedrock high which the Project alignment encounters at Ch 117.0 km. Geological mapping of the impact assessment area is shown on Figure 5.8.



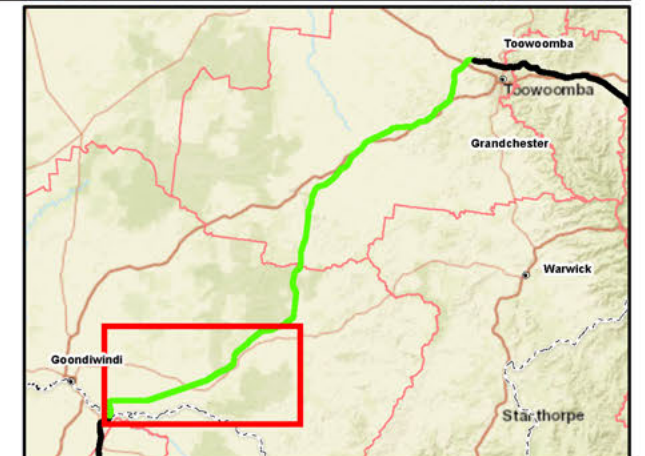
Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Defined watercourses (Water Act 2000)
- NSW/QLD border

- Catchment boundaries
- Surface water assessment impact area

Elevation (mA HD)

- | | | |
|-----|-----|------|
| 50 | 350 | 700 |
| 100 | 400 | 750 |
| 150 | 450 | 800 |
| 200 | 500 | 850 |
| 250 | 550 | 900 |
| 300 | 600 | 950 |
| | 650 | 1000 |



A3 scale: 1:200,000
0 1.5 3 4.5 6 7.5 km



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Border to Gowrie

Figure 5.7a:

Project impact assessment area topography

Map by: <msd author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\0101214_SurfaceWaterQuality\310-EAP-2019\0101214_FF_V_Fig7_Topography_Rev2.mxd Date: 30/04/2020 10:25



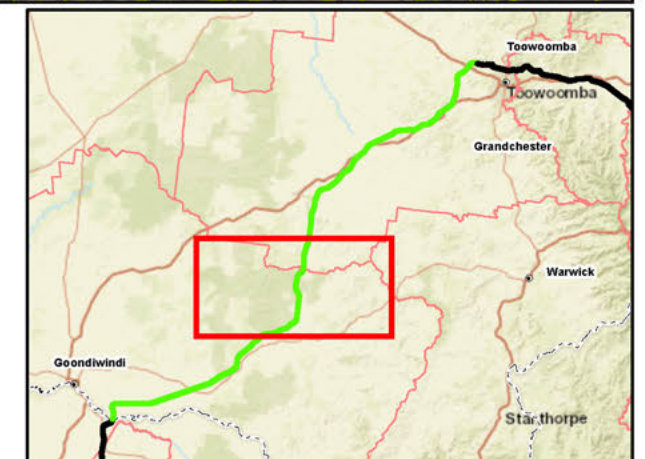
Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Defined watercourses (Water Act 2000)

- Catchment boundaries
- Surface water assessment impact area

Elevation (mA HD)

— 50	— 350	— 700
— 100	— 400	— 750
— 150	— 450	— 800
— 200	— 500	— 850
— 250	— 550	— 900
— 300	— 600	— 950
	— 650	— 1000



A3 scale: 1:200,000
0 1.5 3 4.5 6 7.5 km



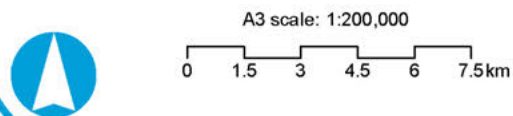
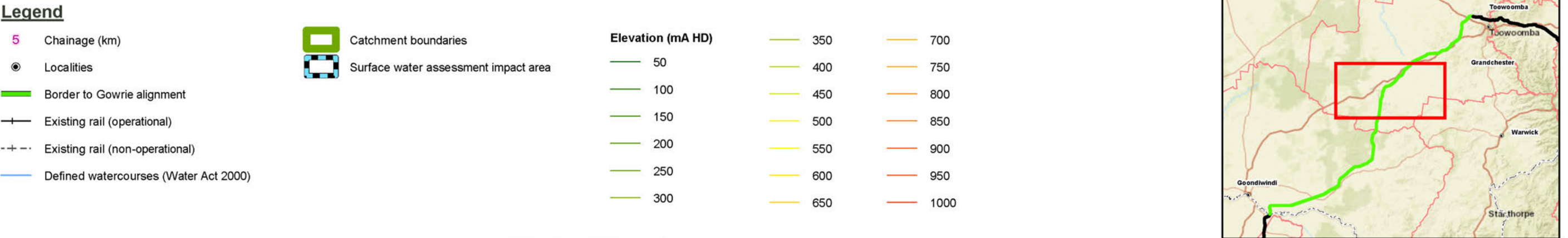
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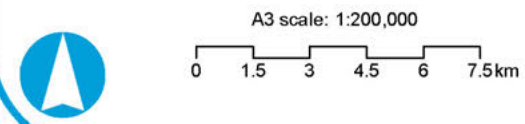
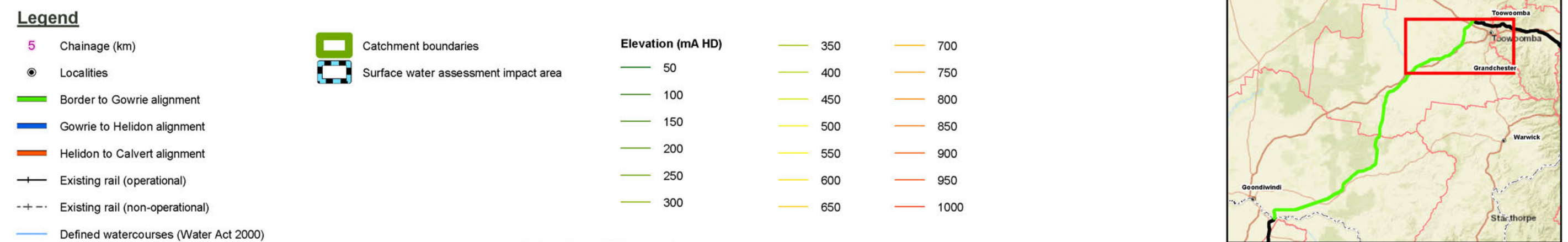
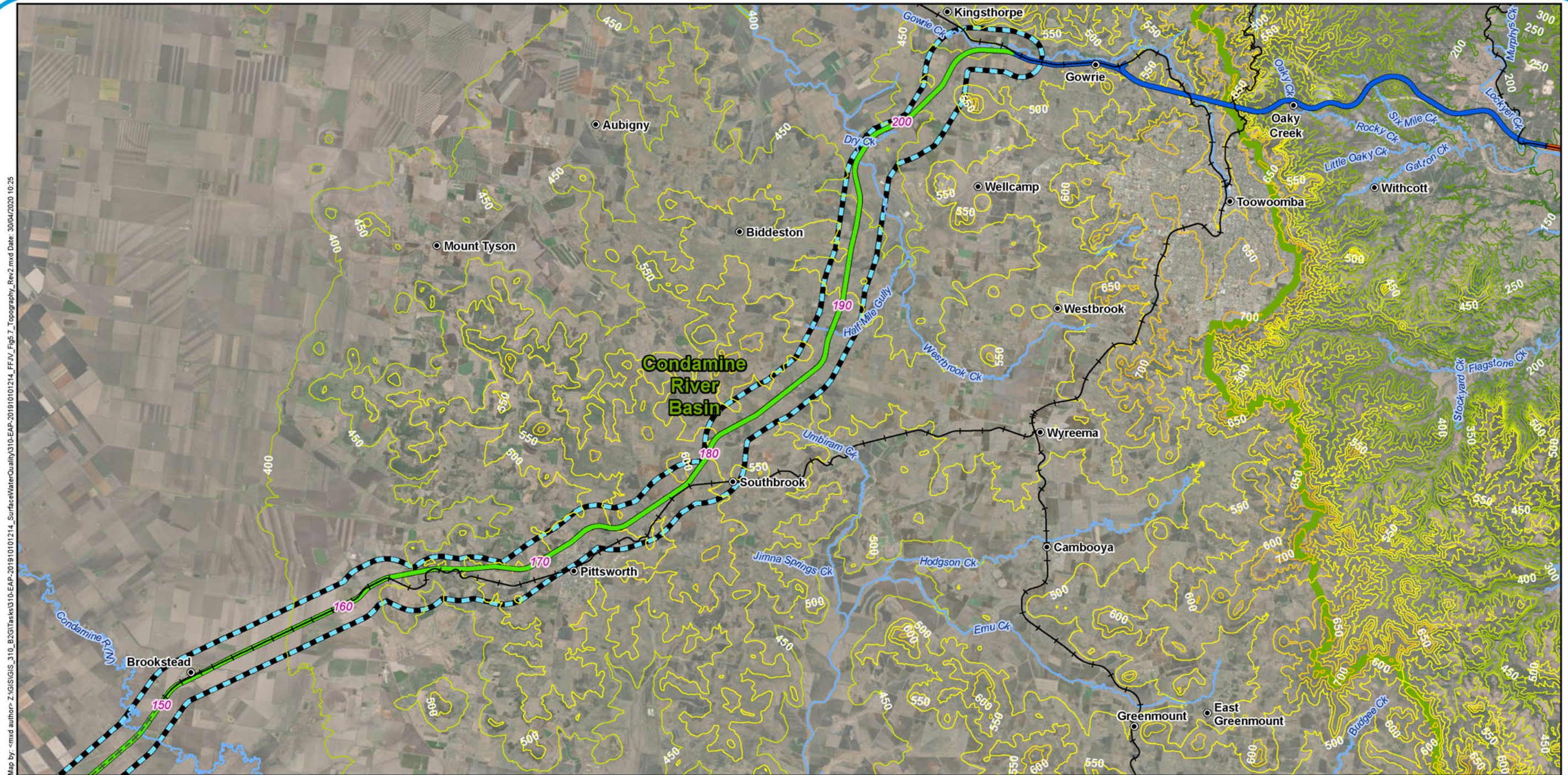
Issue date: 7/04/2020 Version: 1
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

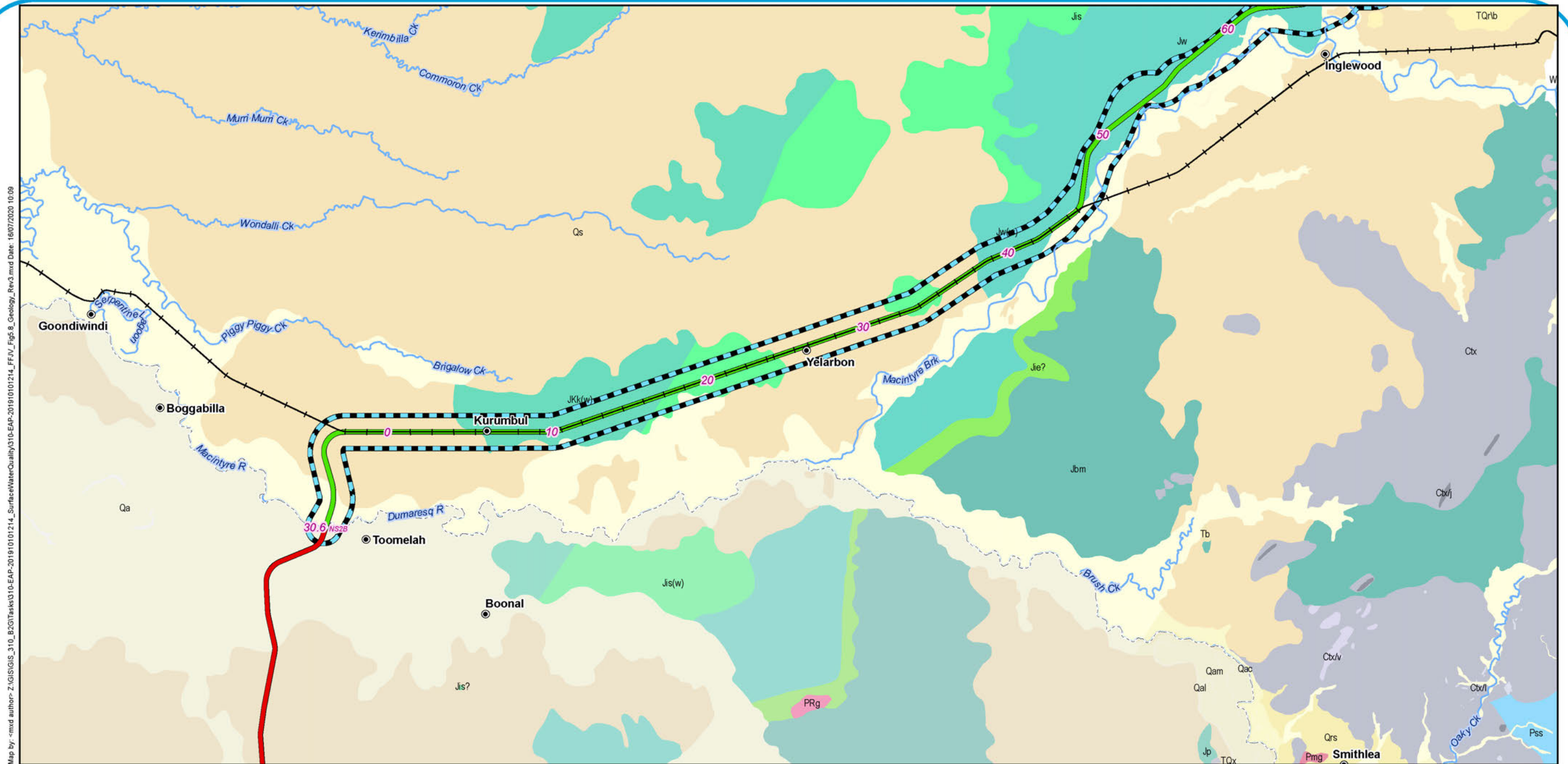
Figure 5.7b:

Project impact assessment area topography





Border to Gowrie
Figure 5.7d:
Project impact assessment area topography



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Defined watercourses (Water Act 2000)
- NSW/QLD border
- Surface water impact assessment area

Jurassic

- Eurombah Formation? (Jie?)
- Marburg Subgroup (Jbm)
- Late Jurassic**
- Springbok Sandstone (w) (Jis(w))
- Springbok Sandstone? (Jis?)
- Late Jurassic - Early Cretaceous**
- Kumbarilla beds(w) (JKk(w))
- Middle Jurassic**
- Walloon Coal Measures (Jw)

Quaternary

- Qa-QLD (Qa)
- Qs-SQ (Qs)

Tertiary

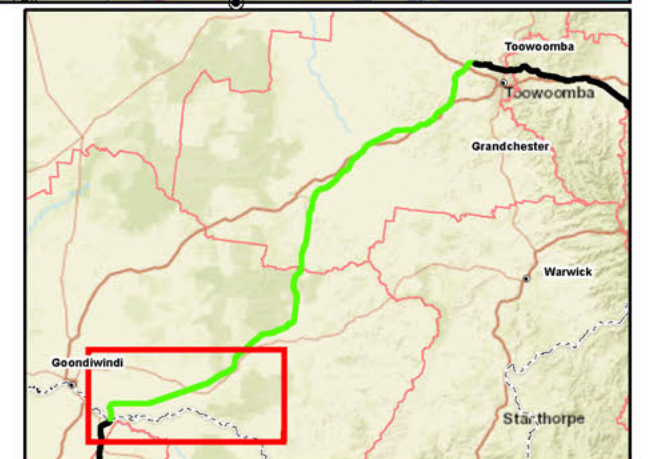
- Tb-QLD (Tb)

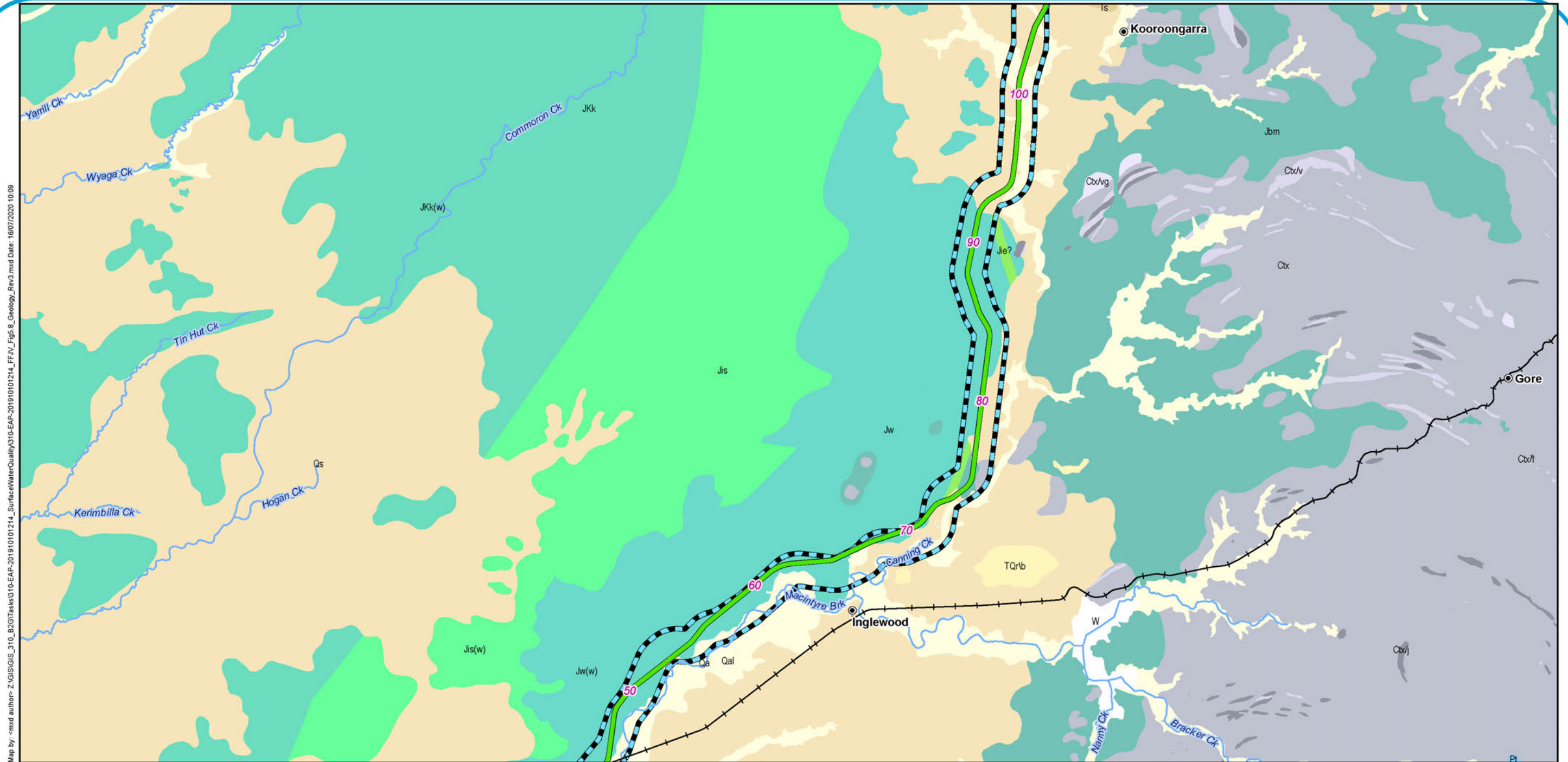
Ungrouped

- Boxwell Granodiorite (Pmg)
- PRg-SEQ (PRg)
- Pilliga Sandstone (Jp)
- Qac-QLD (Qac)
- Qal-SEQ (Qal)

Qam-QLD (Qam)

- Qrs-SEQ (Qrs)
- Silver Spur beds (Pss)
- Springbok Sandstone (Jis)
- TQr/b-SEQ (TQr/b)
- TQx-Texas (TQx)
- Texas beds (Ctx)
- Texas beds/j (Ctx/j)
- Texas beds/l (Ctx/l)
- Texas beds/v (Ctx/v)
- Walloon Coal Measures(w) (Jw(w))
- Water body (unspecified) (W)





Map by: <msd author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\0101214_SurfaceWaterQuality\310-EAP-2019\0101214_FF_V_Fig_8_Geology_Rev3.mxd Date: 16/07/2020 10:09

Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- +— Existing rail (operational)
- Defined watercourses (Water Act 2000)
- Surface water impact assessment area

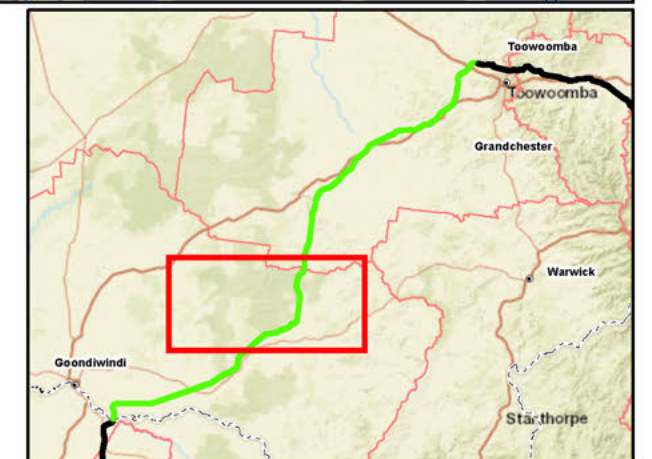
Jurassic

- Eurombah Formation? (Jie?)
- Marburg Subgroup (Jbm)
- Late Jurassic**
- Springbok Sandstone (w) (Jis(w))
- Late Jurassic - Early Cretaceous**
- Kumbarilla beds(w) (JKk(w))
- Middle Jurassic**
- Walloon Coal Measures (Jw)

Quaternary

- Qa-QLD (Qa)
- Qs-SQ (Qs)
- Ungrouped**
- Kumbarilla beds (JKk)
- Qal-SEQ (Qal)
- Springbok Sandstone (Jis)
- TQrlb-SEQ (TQrlb)
- Terrica beds (Pt)

- Texas beds (Ctx)
- Texas beds/j (Ctx/j)
- Texas beds/l (Ctx/l)
- Texas beds/v (Ctx/v)
- Texas beds/vg (Ctx/vg)
- Ts-SEQ (Ts)
- Walloon Coal Measures(w) (Jw(w))
- Water body (unspecified) (W)



A3 scale: 1:250,000
0 1.5 3 4.5 6 7.5km



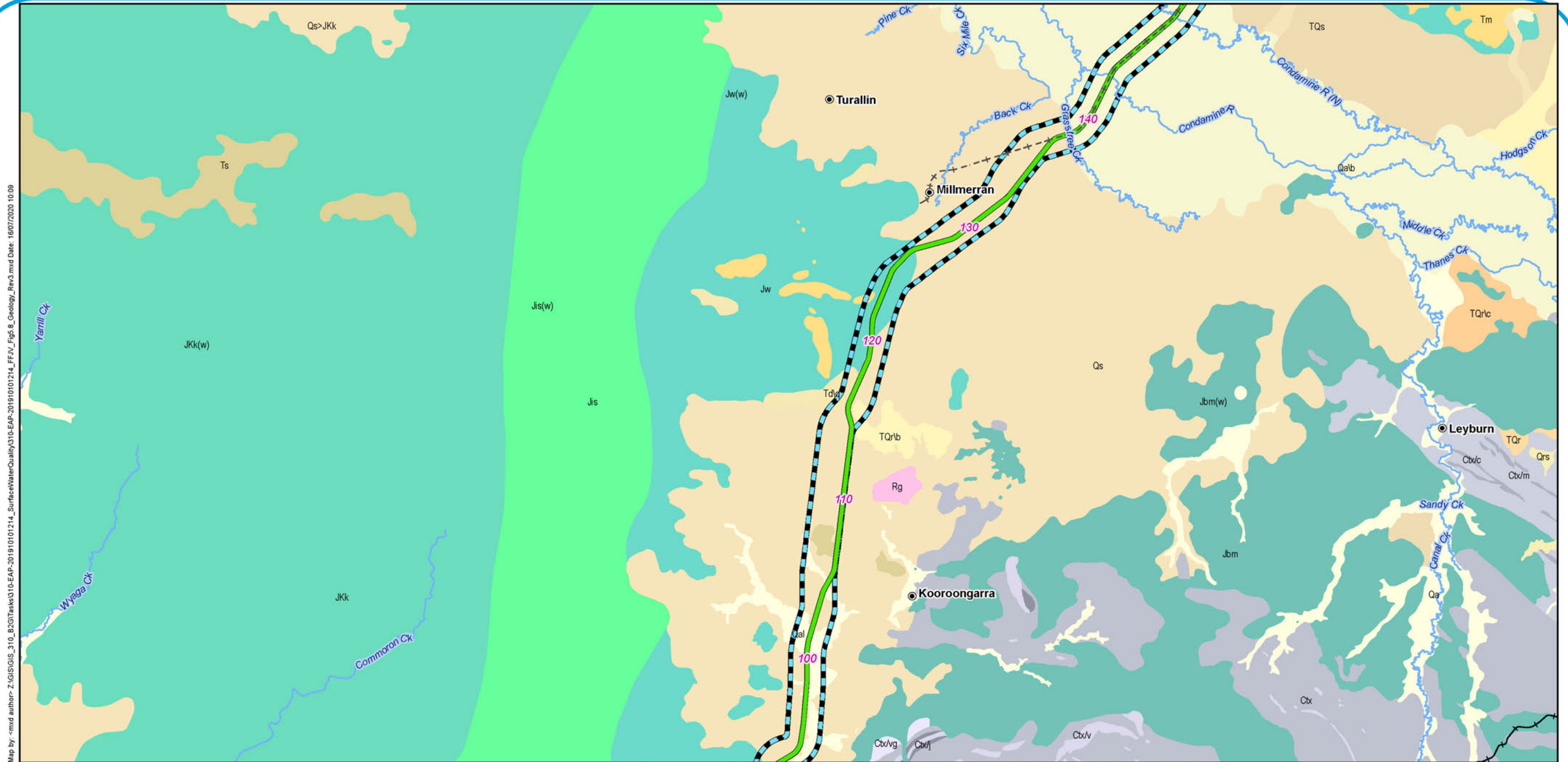
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Border to Gowrie

Figure 5.8b:

Project impact assessment area geology



Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Surface water impact assessment area

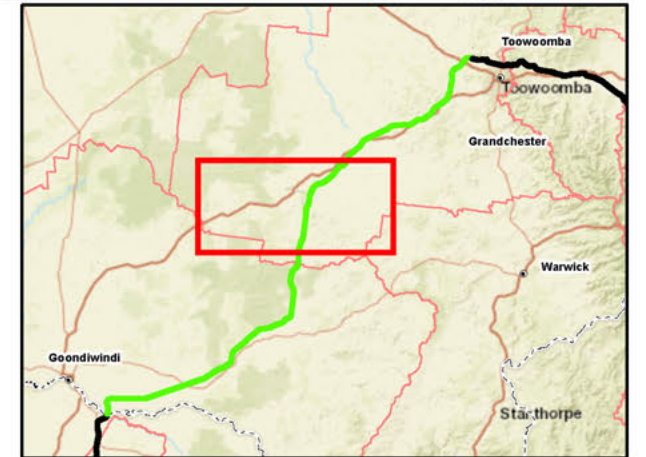
Jurassic

- Marburg Subgroup (Jbm)
- Late Jurassic**
- Springbok Sandstone (w) (Jis(w))
- Late Jurassic - Early Cretaceous**
- Kumbarilla beds(w) (JKk(w))
- Middle Jurassic**
- Walloon Coal Measures (Jw)
- Quaternary**
- Qa-QLD (Qa)
- Qs-SQ (Qs)

Ungrouped

- Kumbarilla beds (JKk)
- Main Range Volcanics (Tm)
- Marburg Subgroup(w) (Jbm(w))
- Qalb-QLD (Qalb)
- Qal-SEQ (Qal)
- Qrs-SEQ (Qrs)
- Qs-SQ>Kumbarilla beds (Qs>JKk)
- Rg-Texas-SEQ (Rg)
- Springbok Sandstone (Jis)
- TQr-QLD (TQr)
- TQrb-SEQ (TQrb)

- TQr/c-SEQ (TQr/c)
- TQs-QLD (TQs)
- Tdlq-QLD (Tdlq)
- Texas beds (Ctx)
- Texas beds/c (Ctx/c)
- Texas beds/j (Ctx/j)
- Texas beds/m (Ctx/m)
- Texas beds/v (Ctx/v)
- Texas beds/vg (Ctx/vg)
- Ts-QLD (Ts)
- Ts-SEQ (Ts)
- Walloon Coal Measures(w) (Jw(w))



A3 scale: 1:250,000
0 1.5 3 4.5 6 7.5km



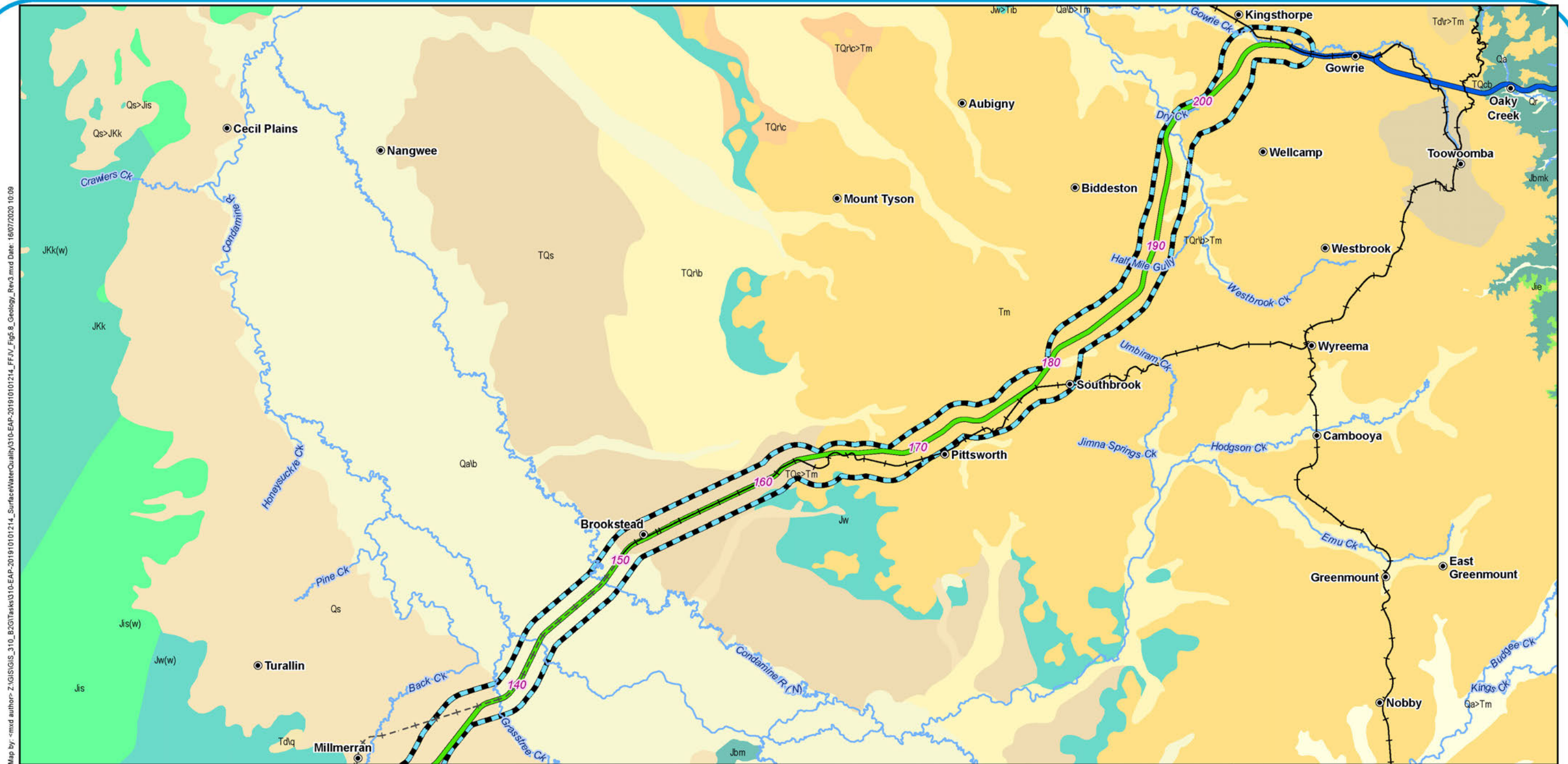
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Border to Gowrie

Figure 5.8c:

Project impact assessment area geology



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Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Surface water impact assessment area

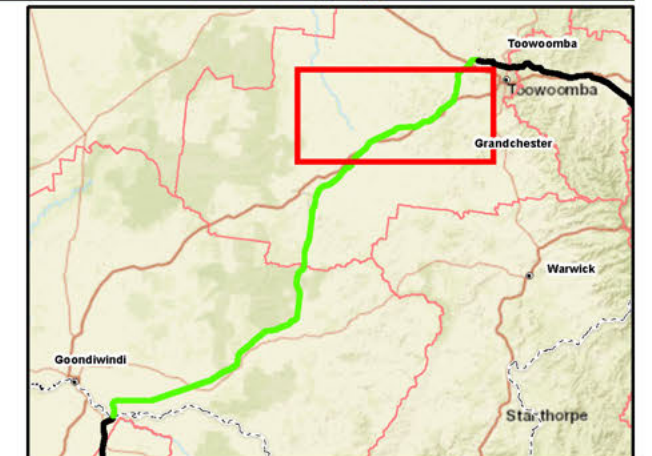
Jurassic

- Marburg Subgroup (Jbm)
- Late Jurassic**
- Springbok Sandstone (w) (Jis(w))
- Late Jurassic - Early Cretaceous**
- Kumbarilla beds(w) (JKk(w))
- Middle Jurassic**
- Walloon Coal Measures (Jw)
- Quaternary**
- Qa-QLD (Qa)
- Qs-SQ (Qs)

Ungrouped

- Eurombah Formation (Jie)
- Koukandowie Formation (Jbmk)
- Kumbarilla beds (JKk)
- Main Range Volcanics (Tm)
- Qa-QLD>Main Range Volcanics (Qa>Tm)
- Qalb-QLD (Qalb)
- Qalb-QLD>Main Range Volcanics (Qalb>Tm)
- Qr-QLD (Qr)
- Qs-SQ>Kumbarilla beds (Qs>JKk)
- Qs-SQ>Springbok Sandstone (Qs>Jis)
- Springbok Sandstone (Jis)

- TQcb-SEQ (TQcb)
- TQrb-SEQ (TQrb)
- TQrb-SEQ>Main Range Volcanics (TQrb>Tm)
- TQrc-SEQ (TQrc)
- TQrc-SEQ>Main Range Volcanics (TQrc>Tm)
- TQrc-SEQ>Walloon Coal Measures (TQrc>Jw)
- TQs-QLD (TQs)
- TQs-QLD>Main Range Volcanics (TQs>Tm)
- Td-QLD (Td)
- Tdlq-QLD (Tdlq)
- Tdlr-QLD>Main Range Volcanics (Tdlr>Tm)
- Walloon Coal Measures(w) (Jw(w))
- Walloon Coal Measures>Tib-QLD (Jw>Tib)



A3 scale: 1:250,000
0 1.5 3 4.5 6 7.5km



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Border to Gowrie

Figure 5.8d:

Project impact assessment area geology

Table 5.5 Geological units

Geological unit	Location	Age	Description
Quaternary sediments (Qs-SQ)	- Northern edge of Rainbow Reserve to Kurumbul - Yelarbon - Canning Creek to Yandilla	Quaternary	Red sandy soil, silt and some gravel, floodout on sheet sand with alluvium deposit. Miscellaneous unconsolidated sediments are the dominant rock type
Kumbarilla Beds	Kurumbul	Late Jurassic to Early Cretaceous	Sandstone, siltstone, mudstone and conglomerate with kaolinized deeply weathered sediments. Arenite-mudrock is the dominant rock type
Springbok Sandstone	- West of Yelarbon - South of the Whetstone State Forest	Late Jurassic	Deeply weathered labile sandstone, siltstone, mudstone and potential of some coal. Arenite-mudrock is the dominant rock type
Walloon Coal Measures	- Northern extent of impact assessment area crossing Whetstone State Forest - West of Domville	Middle Jurassic	Shale, siltstone, sandstone and coal seam dominated by arenite-mudrock.
Quaternary alluvium (Qa-QLD)	- Macintyre River to northern edge of Rainbow Reserve - Southern extent of impact assessment area bordering Whetstone State Forest - Canning Creek to Glenroy	Quaternary	Clay, silt, sand and gravel on a flood-plain dominated by alluvium.
Eurombah Formation	West of Avondale	Jurassic	Clayey sub-labile sandstone, some conglomerate, siltstone and mudstone dominated by sedimentary rock types.
TS-SEQ	South of Millwood	Tertiary	Quartzose to sub-labile sandstone, claystone, conglomerate with minor olivine basalt.
TQR/B-SEQ	South of Clontarf	Late Tertiary to Quaternary	Residual deposits and pediment slope wash consisting of clay, scree and soil developed from basalt. Dominated by colluvium.
QA/B-QLD	Pampas	Quaternary	Silt and mud (black soil) with basalt-derived alluvium. Dominated by alluvium.
TQS-QLD	Brookstead	Late Tertiary to Quaternary	Clayey sand, gravel, silt and mud passing into semi-consolidated clayey sandstone, conglomerate and claystone consisting of local ironstone nodules and siltstone. Dominated by poor, consolidated sediments.
Main Range Volcanics	Yarranlea to Gowrie	Eocene to Miocene	Olive basalt dominated by basalt rock.
TQR/B-SEQ>Main Range Volcanics	Wellcamp	Late Tertiary to Quaternary	Residual deposits on weathered Crows Nest Granite, dominated by miscellaneous and unconsolidated sediments.
Marburg Subgroup (Koukandowie Formation)	- South of Millmerran - Southwest of Grays Gate	Early to Middle Jurassic	Lithofeldspathic labile to sublabile sandstone, siltstone, shale, minor coal, ferruginous marker bed dominated by arenite mudrock.

Geological unit	Location	Age	Description
QAL-SEQ	- Northeast of Inglewood - Bringalily	Quaternary	Silt and clay lakes in alluvial plains with stratified units including volcanic and metamorphic rock.
Texas Beds	Northeast of Inglewood	Early Carboniferous	Thin to thick-bedded, volcanoclastic arenite, siltstone, mudstone and slate; local phyllite; sporadic lenses of jasper, chert, limestone and mafic volcanics; rare conglomerate.
QA/B-QLD	Pampas	Quaternary	Silt, mud (black soil); basalt-derived alluvium.
TD/Q-QLD	Southwest of Grays Gate	Tertiary	Silcrete and silicified quartz sandstone; duricrust.
TQS-QLD>Main Range Volcanics	South of Pittsworth	Late tertiary to Quaternary	Clayey sand, gravel, silt and mud passing into semi-consolidated clayey sandstone, conglomerate and claystone; local ironstone nodules, siltstone.

5.5.2 Soil condition

5.5.2.1 Soil description

Australian Soil Classification mapping (2016) indicates a high variability in soil type along the Project alignment, including the occurrence of vertosols, dermosols, chromosols, kandosols and sodosols (refer Figure 5.9).

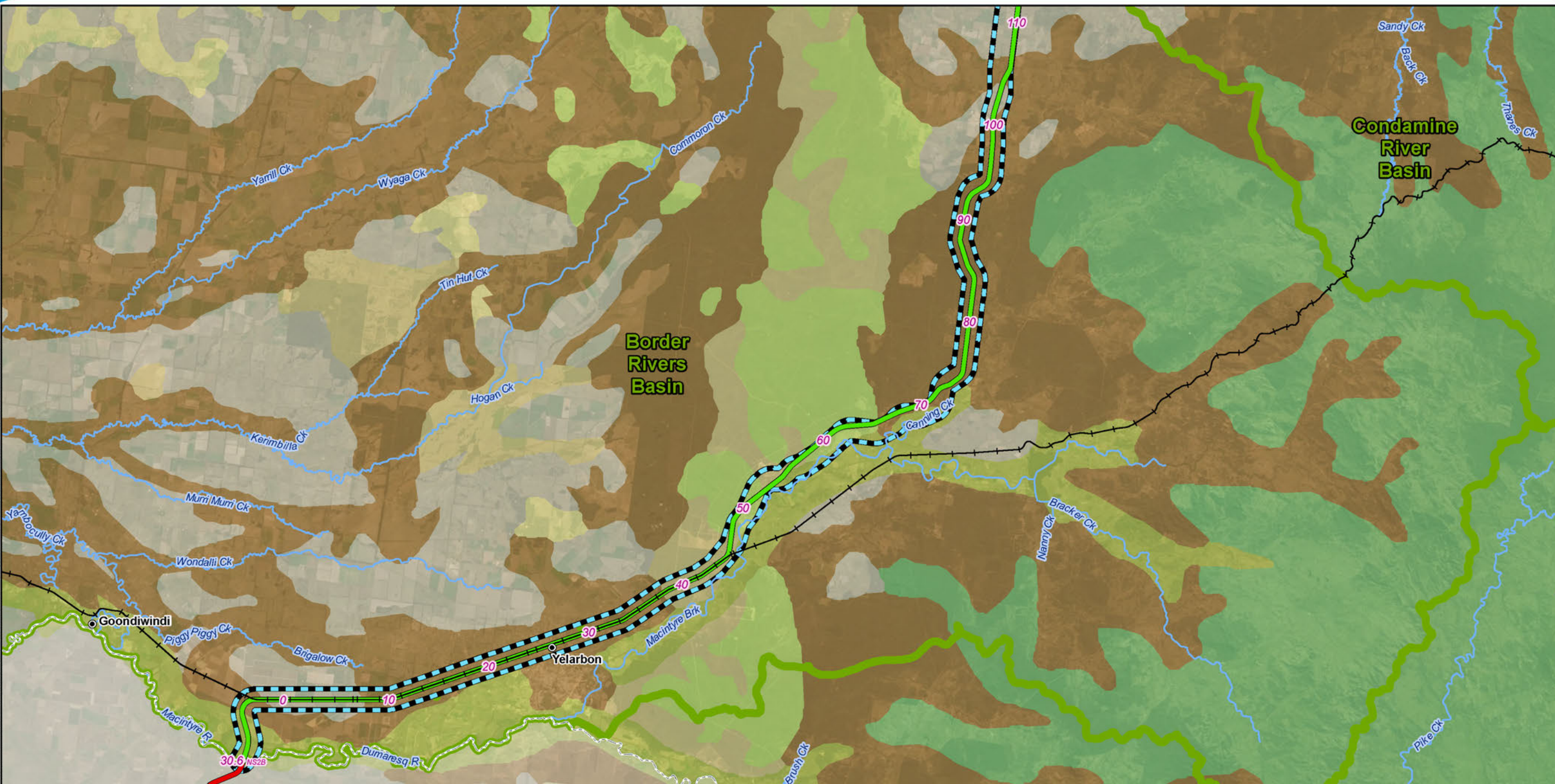
Vertosols are mapped as the dominant types in several areas along the Project alignment, including the open plains west of Koorongara to Commodore Mine (Ch 100.0 km to Ch 135.0 km) as well as the entire extent of the impact assessment area from Yandilla to Gowrie (Ch 140.0 km to Ch 206.9 km), where land for grazing and cropping is prominent. A small area of vertosols are also mapped underlying the section of Project alignment between the northern edge of Rainbow Reserve and Kurumbul (Ch 36.0 km (NS2B) to Ch 8.0 km).

Vertosols are identifiable as a cracking clay soil with a clay field texture and a crusty surface horizon at a depth of 0.03 m or less in thickness (Isbell & National Committee on Soil and Terrain 2016). Vertosols are often found in imperfectly drained sites with annual rainfall up to 1,150 mm and in well-drained sites with annual rainfall up to 900 mm. As the soil has a strong water holding capacity and high chemical fertility, the soil is considered to have a high agricultural potential (Gray & Murphy 2002). A majority of vertosols have neutral or alkaline soil pH and generally have high cation exchange capacity between 30 and 80 milliequivalents per 100 grams (meq/100 g) (Gray & Murphy 2002).

Sodosols are the dominant soil type along the Project alignment between the Macintyre River (Ch 30.6 km (NS2B) and the semi-arid region of Yelarbon (Ch 30.0 km), as well as along the fertile lands north of Inglewood (Ch 65.0 km) to the west of Koorongarra (Ch 100.0 km), with a small area also mapped east of Millmerran (Ch 133.0 km to Ch 138.0 km).

Sodosols are predominately found in poorly drained sites with annual rainfall between 50 mm and 1,100 mm. The soil is defined by a clear or abrupt textural B horizon with a major part of the upper 0.2 m of the B horizon being sodic and not strongly acidic (pH > 5.5) (Isbell & National Committee on Soil and Terrain 2016). The high sodicity of the soil makes it highly erodible with poor structure and low permeability and is often associated with saline soils. As such, sodosols have very low agricultural potential (Gray & Murphy 2002).

An approximate 25 km stretch of dermosols intermittently underlies the Project alignment between Yelarbon (Ch 30.0 km) and Whetstone (Ch 55.0 km).

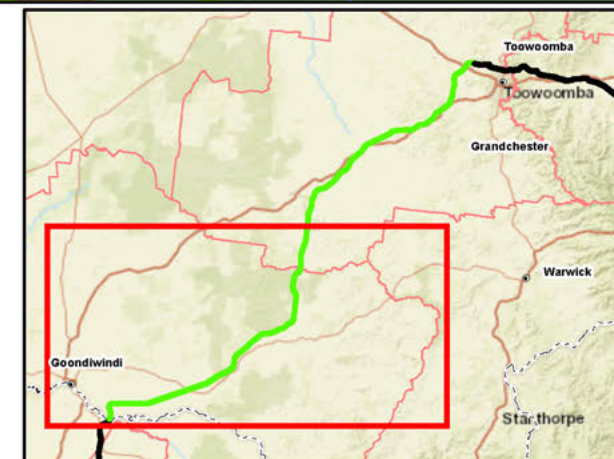


Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Defined watercourses (Water Act 2000)
- Catchment boundaries
- NSW/QLD border
- Surface water impact assessment area

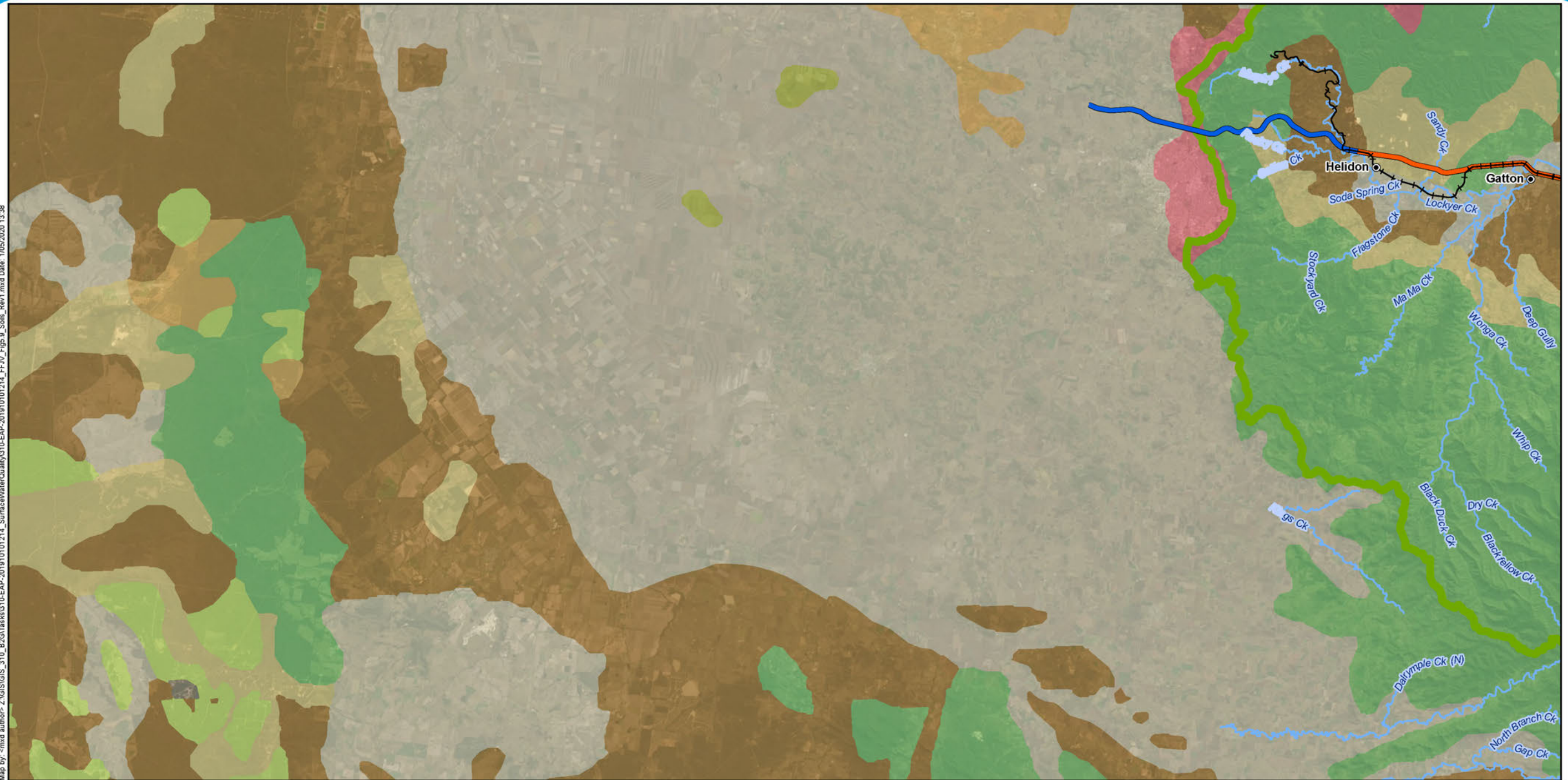
Dominant Soil Type

- Dermosol
- Kandosol
- Kurosol
- Rudosol
- Sodosol
- Tenosol
- Vertosol



A3 scale: 1:400,000
 0 3 6 9 12 15 km

Map by: <md author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\0101214_SurfaceWaterQuality\310-EAP-2019\0101214_FFIV_Figs_9_Soils_Rev1.mxd Date: 10/02/2020 13:38

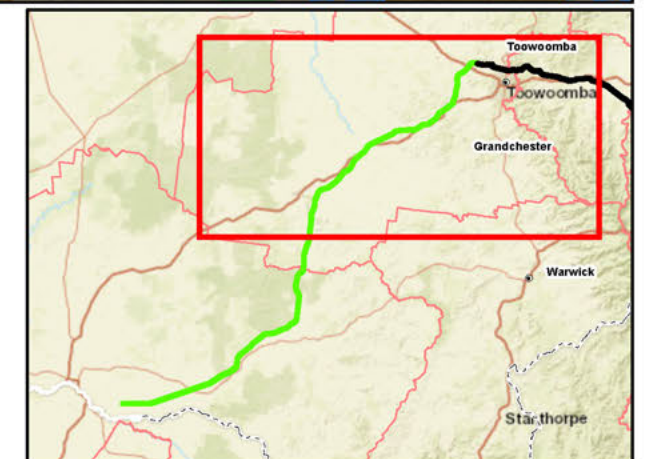


Legend

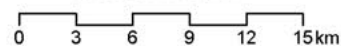
- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- +— Existing rail (operational)
- - - Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Catchment boundaries
- Surface water impact assessment area

Dominant Soil Type

- Chromosol
- Dermosol
- Ferrosol
- Kurosol
- Rudosol
- Sodosol
- Tenosol
- Vertosol



A3 scale: 1:400,000



Dermosols are red, brown, yellow, grey or black and have loam to clay textures with a well-structured B2 horizon containing low levels of free iron. The soils are normally found in areas of imperfectly drained sites with annual rainfall between 550 mm and 1,350 mm and in well-drained sites, annual rainfall between 450 mm and 1,200 mm. Dermosols generally have a high agricultural potential given their good structure, moderate to high chemical fertility and high water holding capacity (Gray & Murphy 2002).

The Project alignment intersects a small area of chromosols, from Ch 37.0 km to Ch 41.0 km, between occurrences of dermosols at the southern edge of the Whetstone State Forest.

Chromosols are soils with moderate agricultural potential due to moderate chemical fertility, water holding capacity and susceptibility to soil acidification causing structural decline (Gray & Murphy 2002). The soil is also defined as strong textural contrast soils that are neither strongly acidic or sodic in the upper B horizon. In imperfectly drained sites, chromosols can be found in areas of annual rainfall between 250 mm and 900 mm, whilst in well-drained sites, annual rainfall between 350 mm and 1,400 mm is necessary for chromosols to be present.

Areas of mapped kandosols occur intermittently along the Project alignment, aligned with the southern edge of Bringalily State Forest (Ch 47.0 km to Ch 65.0 km).

Kandosols are soils with weak texture contrast between the A and B horizon, which is also identified as having a weak structure and not calcareous. Parent materials of kandosols range from highly siliceous to intermediate in composition and found usually in areas of poorly drained sites (yellow and grey kandosols) with rainfall between 300 mm and 1,400 mm. In well-drained site, considered as areas with 250 mm to 1,400 mm rainfall, will likely contain brown and red kandosols. The soil is known to have low to moderate agricultural potential with moderate chemical fertility as well as water holding capacity. Kandosols are not very dispersive and have neutral to strongly acidic (pH 5.5) soils which increase in acidity with depth (Gray & Murphy, 2002).

5.5.2.2 Acid sulfate soils and acid rock

Acid sulfate soil (ASS) are predominantly a coastal and near-coastal soil, sediment or other materials containing iron sulfides which generate acidic conditions when exposed to oxygen. ASS, in general, have a field pH of 4 or less and can be visually identified through the presence of jarosite or iron oxide in the soil horizon. They are often associated with low lying areas below 5 metres Australian Height Datum (mAHD), such as alluvial plains where groundwater is generally close to the surface and materials are in reducing condition along coastal regions. ASS in non-coastal areas are commonly known as inland ASS (DSITIA 2014).

In Queensland, inland ASS can also be found in parts of central Queensland at elevations above 5 mAHD if an anoxic, aqueous environment which consists of sulfate-reducing bacteria and available sulfate ions exist (DSITIA 2014; EPHC and NRMMC 2011). Inland ASS is generally associated with poorly drained inland basins with stagnant water bodies in distinctly seasonal, arid climates but are not widely distributed in Queensland. However, inland ASS are known to occur in landscapes with high levels of salt, where significant concentrations of sulfate reside.

ASS have been found in effluent ponds and in several north-draining streams and wetlands just north of the Granite Belt, in the uppermost reaches of the Condamine River catchment (EPHC and NRMMC 2011).

The *National guidance for the management of acid sulfate soils in inland aquatic ecosystems* (EPHC and NRMMC 2011) (National Guidance on Acid Sulfate Soils) provides a protocol for assessing the likelihood of an aquatic ecosystem containing acid sulfate soils. This assessment protocol requires consideration to be given to presence and permanency of surface water in an area, in addition to the pH and salinity of those waters.

An assessment, consistent with assessment protocol in the National Guidance on Acid Sulfate Soils, has been undertaken using surface water sampling data collected to inform the development of the EIS. This assessment is presented in Table 5.6. Application of the assessment protocol indicates that, based on the pH and salinity of the surface waters in the area and the known flooding history of the region, there is a low risk of presence of ASS in the majority of the inland aquatic ecosystems within the impact assessment area.

Table 5.6 Summary of acid sulfate soil parameters at select aquatic ecosystems

Sub-catchment, basin and sample location ID	pH	Electrical Conductivity (µS/cm)	Hydrological characteristics	Comments
Sub-catchment: Macintyre Barwon Floodplain Basin: Queensland Border Rivers Basin Sample sites: 1R, 2 and 2R	6.77 to 7.76	211 to 299	Permanent waterway	Based on water quality data, low ASS risk for the aquatic ecosystem. except for within permanent waterways
Sub-catchment: Lower Macintyre Brook Basin: Queensland Border Rivers Basin Sample sites: Site 3 to 8	5.58 to 7.97	334 to 449	Permanent waterway	Based on water quality data, low ASS risk for the aquatic ecosystem. except for within permanent waterways
Sub-catchment: Canning Creek Basin: Queensland Border Rivers Basin Sample sites: 9 to 20	7.00 to 8.39	160 to 1,255	Include several ephemeral watercourses, found dry at time of survey	Low or no ASS risk for the aquatic ecosystem except for within permanent waterways
Sub-catchment: Southern Condamine Basin: Condamine River Basin Sample sites: 21 to 26	7.18 to 8.18	267 to 580	Include several ephemeral watercourses, found dry at time of survey	Low or no ASS risk for the aquatic ecosystem except for within permanent waterways
Sub-catchment: Central Condamine Basin: Condamine River Basin Sample sites: 27 to 33	7.70 to 9.13	212 to 588	Include several ephemeral watercourses, found dry at time of survey	Low or no ASS risk for the aquatic ecosystem except for within permanent waterways
Sub-catchment: Oxley Creek Basin: Condamine River Basin Sample sites: 34 to 43	8.12 to 8.54	680 to 2,632	Include several ephemeral watercourses, found dry at time of survey	Low or no ASS risk for the aquatic ecosystem except for within permanent waterways

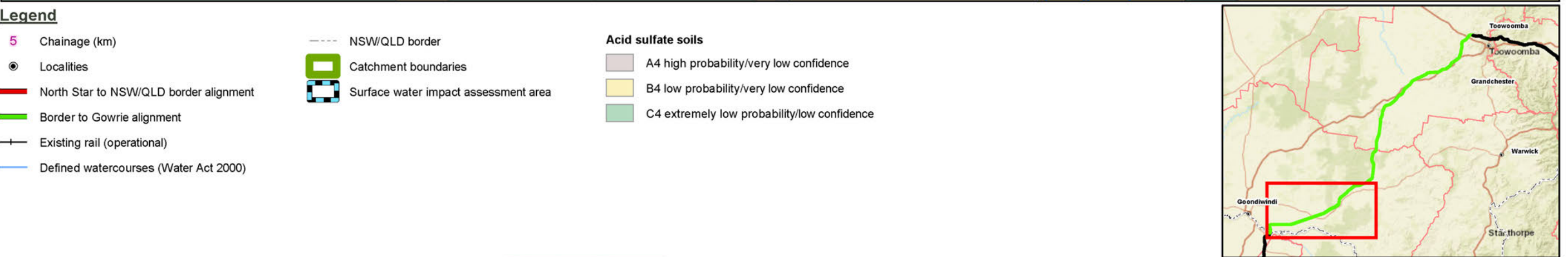
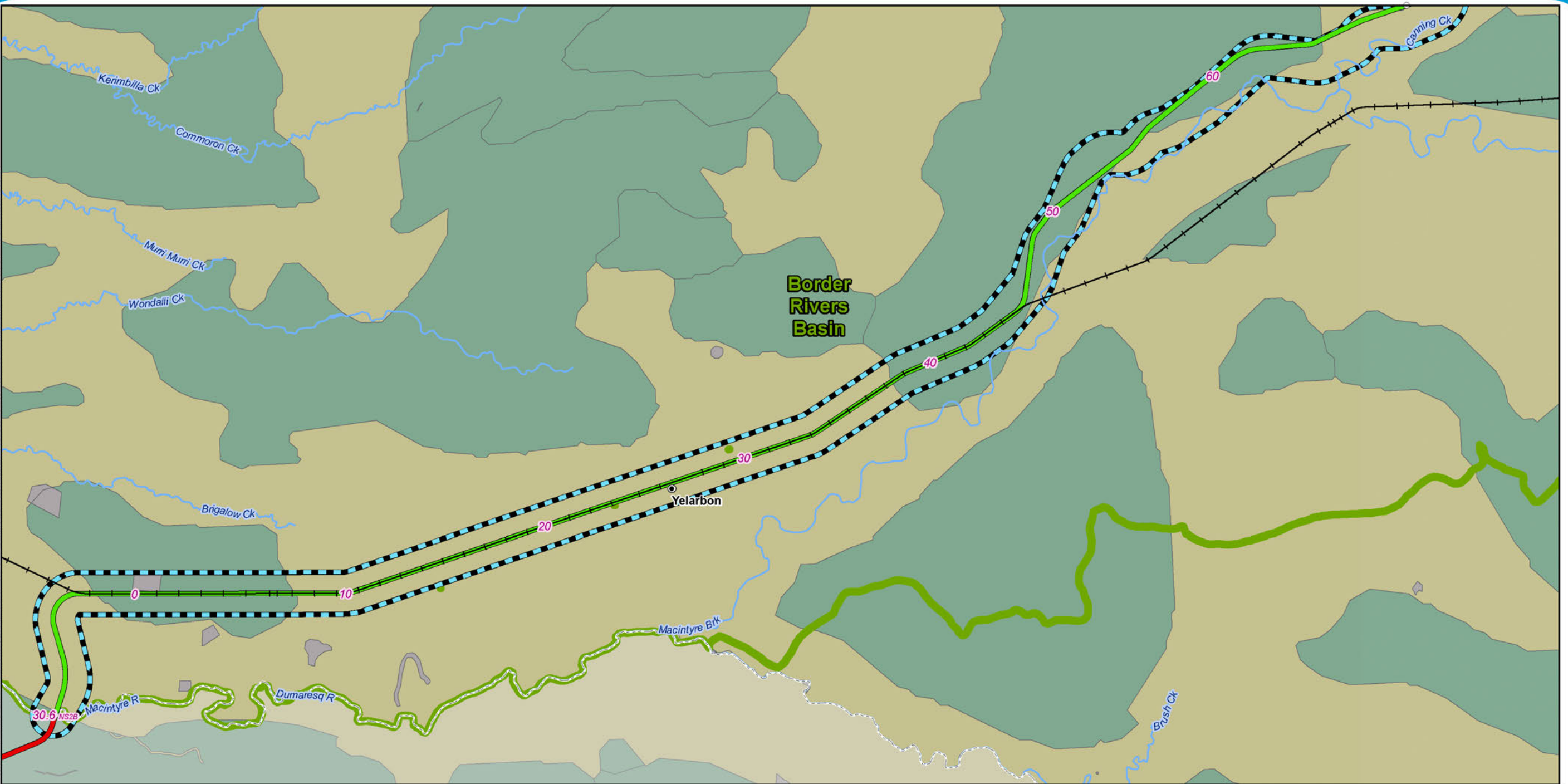
Additionally, an assessment of ASS using the ASRIS Atlas of Australian Sulfate Soils (CSIRO, 2014b) has been undertaken, with mapping presented on Figure 5.10. indicated a 'low probability' of ASS to occur within the floodplain of Macintyre River and Macintyre Brook, as well as between Millmerran and Yandilla.

Isolated areas of 'high probability' ASS occur throughout the impact assessment area. These localised occurrences are, for the most part, associated with natural and man-made surface water storages or impoundments.

Based on the underlying geology of the impact assessment area, the surface water quality data as well as existing ASS mapping, there is considered to be a low risk of inland ASS or potential inland ASS present within the majority of the impact assessment area. Further sediment assessment will be necessary to establish the location-specific risk of ASS occurrence where construction activities are required within permanent waterways along the Project alignment.

Acid rock occurs when sulphide minerals are exposed to air and water. This process is accelerated through excavation activities which increase rock exposure to air, water, and microorganisms. Acid rock has potential to produce neutral to acidic drainage, which may occur with dissolved heavy metals and significant sulfate levels. Based on the geological conditions within the impact assessment area, the likelihood of encountering acid rock is considered to be low.

No visual indications of presence of ASS or acid rock were identified during geotechnical investigations for the Project, which included site walkovers.



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5km



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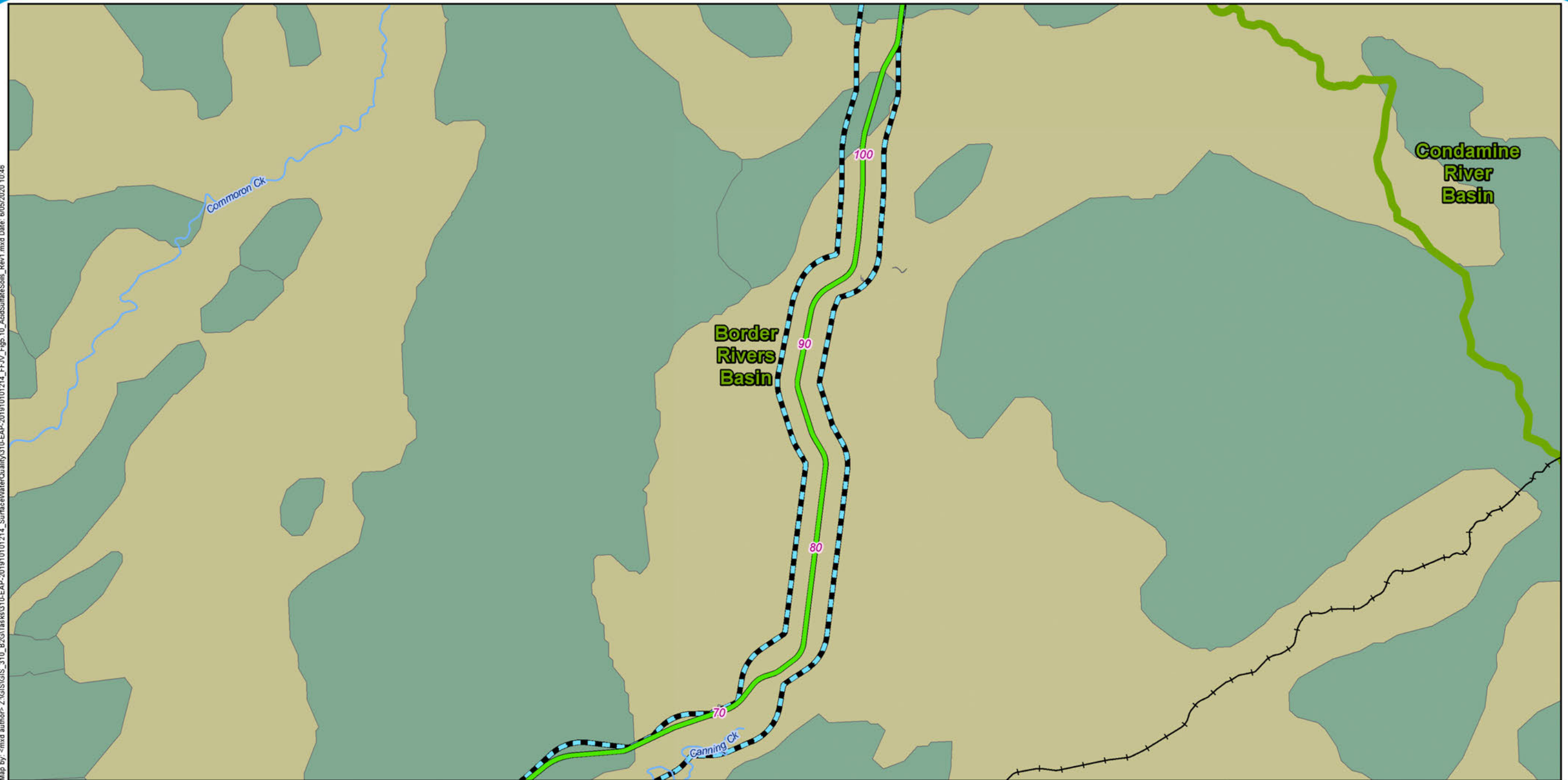
Issue date: 7/04/2020 Version: 1
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.10a:

Acid sulfate soils relative to the impact assessment area

Map by: <msd author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\0101214_SurfaceWaterQuality\310-EAP-2019\0101214_FF\FF_Figs\10_AcidSulfateSoils_Rev1.mxd Date: 8/05/2020 10:46

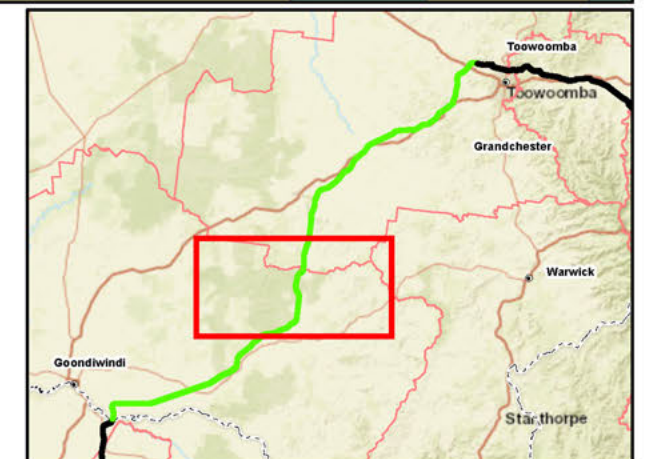


Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- +— Existing rail (operational)
- Defined watercourses (Water Act 2000)
- Catchment boundaries
- - - Surface water impact assessment area

Acid sulfate soils

- A4 high probability/very low confidence
- B4 low probability/very low confidence
- C4 extremely low probability/low confidence



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5km



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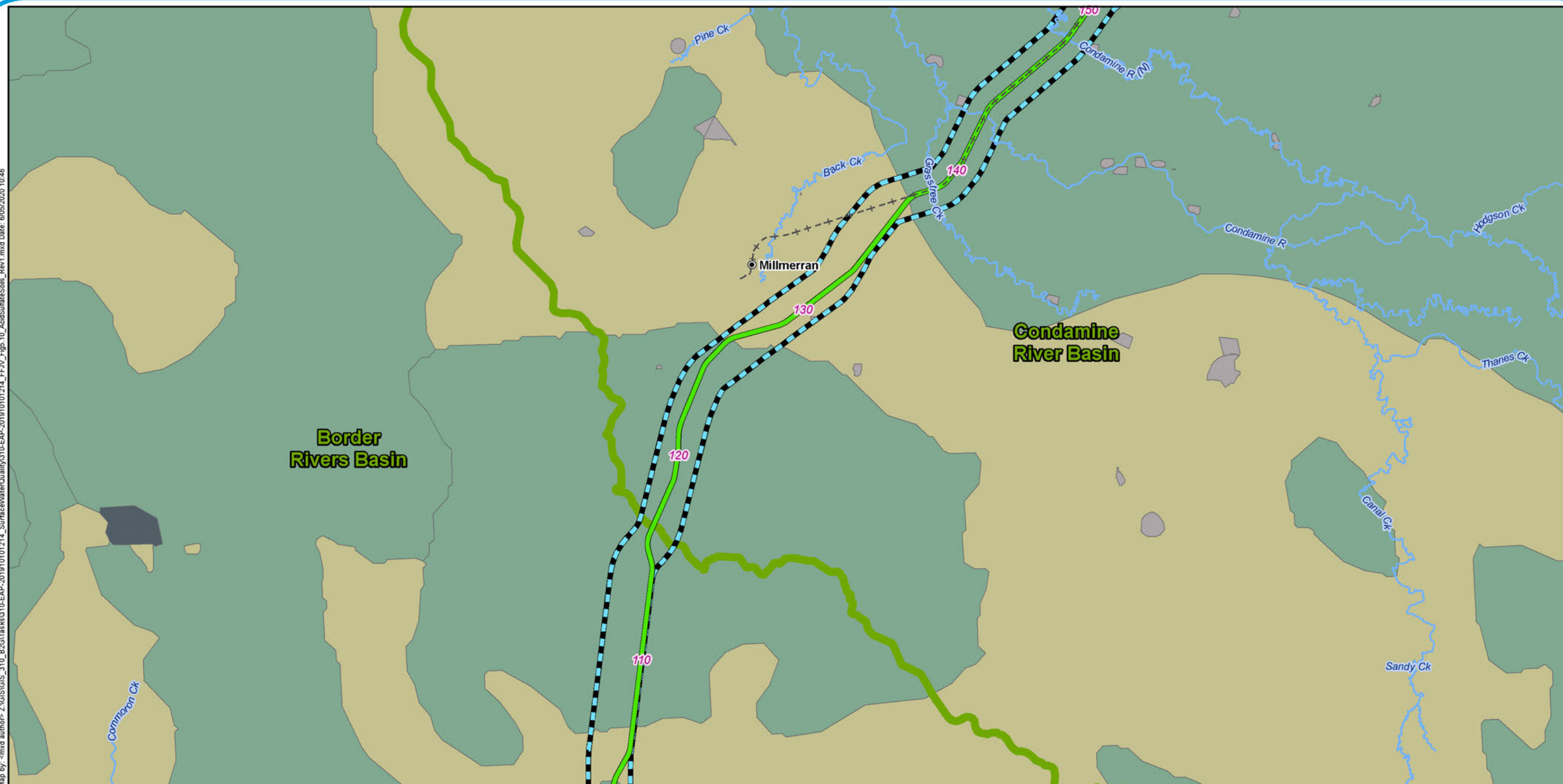
Issue date: 7/04/2020 Version: 1
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.10b:

Acid sulfate soils relative to the impact assessment area

Map by: <mxid author= Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\0101214_SurfaceWaterQuality\310-EAP-2019\0101214_FF\FF_Figs\10_AcidSulfateSoils_Rev1.mxd Date: 8/05/2020 10:46

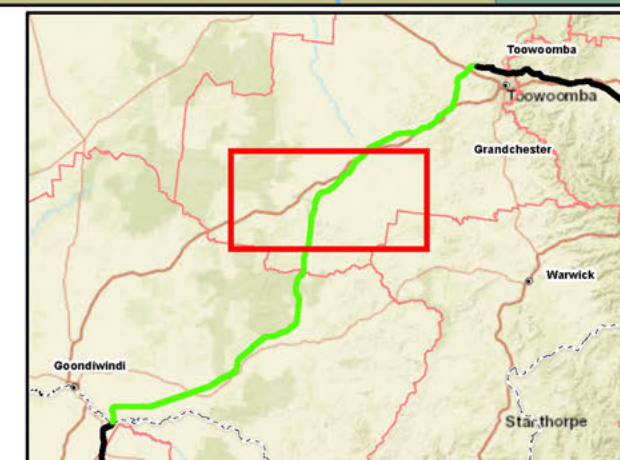


Legend

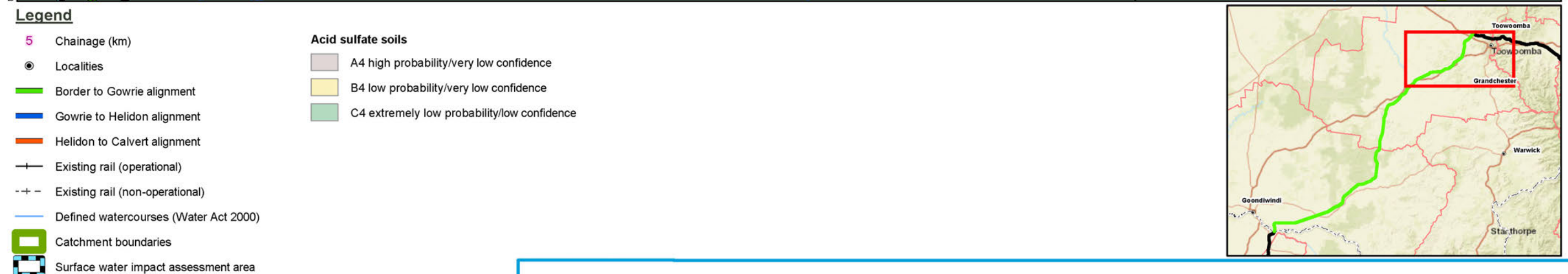
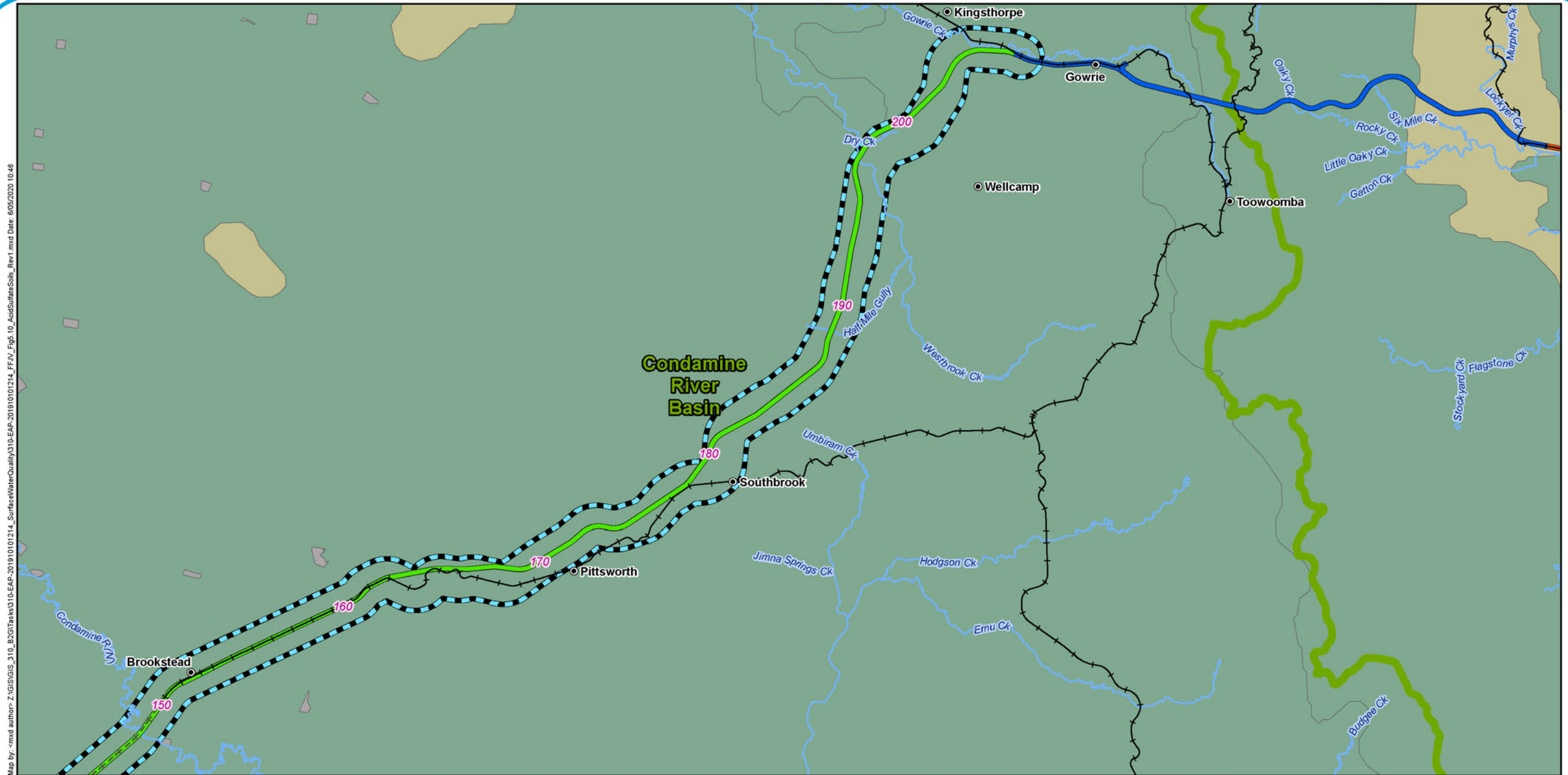
- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Catchment boundaries
- Surface water impact assessment area

Acid sulfate soils

- A4 high probability/very low confidence
- B4 low probability/very low confidence
- C4 extremely low probability/low confidence



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5km



5.5.2.3 Soil acidity

Queensland has more than 500,000 hectares of agricultural and pastoral land that has acidified or is at risk of acidification. Soils most at risk are lighter-textured sands and loams with low organic matter levels, and the naturally acidic red clay loam soils. Soils least at risk are the neutral to alkaline clay soils (e.g. brigalow soils and the black clay soils of the Darling Downs and Central Queensland) (Soil Quality, 2020).

Many soils are naturally acid, but agricultural practices have contributed to the increasing acidification of many neutral to slightly acid soils (NSW Agriculture, 2000). These practices include:

- Use of some ammonium fertilisers, particularly ammonium sulfate
- The production of legumes that fix nitrogen, if that nitrogen is leached, rather than being taken up by plants
- The removal of nutrients in the form of produce.

Acidic soils cause significant losses in production, and where the choice of crops is restricted to acid tolerant species and varieties, production opportunities may be reduced. In pastures grown on acidic soils, production will be reduced and some legume species may fail to persist (Soil Quality, 2020).

Soil pH is a measure of the concentration of hydrogen ions in the soil solution. The lower the pH of soil, the greater the acidity. A soil with a pH of 4 has 10 times more acid than a soil with a pH of 5 and 100 times more acid than a soil with a pH of 6. Plant growth and most soil processes, including nutrient availability and microbial activity, are favoured by a soil pH range of 5.5 to 8.0 (Soil Quality, 2020).

Assessment of surface soil acidity within the impact assessment area has been undertaken in reference ARIS soil pH mapping (CSIRO 2014a). Surface soil pH values along the Project alignment are presented in Table 5.7 by chainage range.

Table 5.7 Soil acidity along the Project alignment

Approximate chainage start (km)	Approximate chainage end (km)	Soil pH ¹
30.6 (NS2B)	34.9 (NS2B)	4.8-5.5
34.9 (NS2B)	19.9	5.5-6.0
19.9	20.0	6.0-6.5
20.0	25.0	5.5-6.0
25.0	28.0	7.0-7.5
28.0	28.5	5.5-6.0
28.5	30.0	6.5-7.0
30.0	33.5	5.5-6.0
33.5	35.3	4.8-5.5
35.3	37.0	6.5-7.0
37.0	42.8	4.8-5.5
42.8	46.2	6.0-6.5
46.2	49.0	4.8-5.5
49.0	51.7	3.0-4.8
51.7	55.0	6.0-6.5
55.0	98.0	4.8-5.5
98.0	100.0	6.5-7.0
100.0	102.0	4.8-5.5
102.0	104.2	6.5-7.0
104.2	105.3	4.8-5.5
105.3	114.0	6.5-7.0

Approximate chainage start (km)	Approximate chainage end (km)	Soil pH ¹
114.0	114.2	7.0-7.5
114.2	126.3	6.5-7.0
126.3	129.0	6.0-6.5
129.0	133.0	6.5-7.0
133.0	138.0	6.0-6.5
138.0	148.2	6.5-7.0
148.2	160.0	5.5-6.0
160.0	165.5	6.5-7.0
165.5	196.9	6.0-6.5
196.9	198.9	6.5-7.0
198.9	204.8	6.0-6.5
204.8	206.9	6.5-7.0

Table note:

¹ Source: ARIS soil pH mapping (CSIRO 2014a)

The lowest soil pH, 3.0 to 4.8, occurs over a distance of 2.7 km of Project alignment, south of the Yarranbrook Feedlot, bordering Whetstone State Forest (Ch 49.0 km to Ch 51.7 km).

Soils with low pH (4.8 to 5.5) also occur within the Macintyre River floodplain (Ch 30.6 km (NS2B) to Ch 34.9 km (NS2B) and intermittently from Ch 33.5 km to Ch 105.3 km. The mapping of acidic soils over this 71.8 km section of the Project alignment are closely correlate with areas of production forestry, associated with Whetstone and Bringalily State forests.

Soils with the highest pH are only mildly alkaline in nature (pH 7.0 to 7.5) and are encountered in two isolated locations; for 3 km in the Yelarbon area (Ch 25.0 km to Ch 28.0 km) and for 200 m between Millwood and Clontarf (Ch 114.0 km to Ch 114.2 km).

The Yelarbon area (approximately from Ch 20 km to Ch 30 km) is known for its alkaline, sodosol soils attributed to the upwelling of sodium bicarbonate rich groundwater (Biggs et al. 2010).

5.6 Watercourses and waterbodies

5.6.1 Defined watercourses, waterways and waterbodies

Waterways are defined under the *Fisheries Act 1994* and include a river, creek, stream, watercourse or inlet of the sea. The definition includes freshwater and tidal waters, both permanent and ephemeral waterways, and includes drainage features. It also includes channels along which fish are expected to move if they connect isolated water bodies to defined waterways during times of flow. However, it does not include isolated waterbodies where no connectivity is available.

Watercourses are defined under the Water Act as a river, creek or other stream which includes a stream in the form of an anabranch or a tributary where water flows either permanently or intermittently regardless of flow frequency. However, a watercourse does not include any section of a feature that has a tidal influence or is upstream or downstream from a defined limit between potential estuarine and fresh water. Therefore, by definition, all watercourses are waterways but not all waterways are watercourses.

The reference design includes full width crossings of 15 major waterways (stream order ≥ 3) and 66 minor waterways (stream order < 3).

Defined watercourses within the impact assessment area are listed below and shown on Figure 1.1. Where the watercourse is intersected by the Project alignment, the approximate chainage is given:

- Macintyre River
- Macintyre Brook
- Canning Creek
- Grasstree Creek – at Ch 13.5 km
- Pariagara Creek – at Ch 67.2 km
- Cattle Creek - at Ch 88.2 km
- Back Creek – at Ch 97.4 km
- Bringalily Creek – at Ch 100.1 km
- Nicol Creek – at Ch 104.3 km
- Back Creek drainage feature – at Ch 126.7 km and Ch 127.9 km
- Condamine River (Main Branch) – at Ch 142.9 km
- Condamine River (North Branch) – at Ch 148.7 km
- Umbiram Creek drainage feature - at Ch 185.9 km
- One Mile Creek drainage feature – at Ch 191.8 km
- Westbrook Creek – at Ch 188.7 km and Ch 197.2 km
- Dry Creek – at Ch 197.8 km
- Gowrie Creek.

Defined watercourses within the impact assessment area have been identified in reference to DNRME's *Water identification map – watercourses – Queensland*, last published 01 April 2020. DNRME were requested by ARTC to provide confirmatory determination of the classification of waterways within the impact assessment area. Through this verification process, DNRME determined the occurrence of additional defined watercourses within the impact assessment area, not shown as such on the water identification mapping. The addition of these newly defined watercourses (refer Table 5.8) have been included as part of the impact assessment, however, have not been included in the Figures denoting defined watercourses (validated against 1 April 2020).

Table 5.8 Additional defined watercourses after Department of Natural Resources, Mines and Energy consultation

Name	Chainage range	Verification advice from DNRME
Pariagara Creek	Ch 67.2 – Ch 67.5 km	Considered a defined watercourse for impact assessment
Cattle Creek	Ch 88.2 – Ch 88.4 km	Yet to be determined with certainty, considered a defined watercourse for impact assessment
Back Creek	Ch 97.4 – Ch 97.7 km	Considered a defined watercourse for impact assessment
Bringalily Creek	Ch 100.1 – Ch 100.7 km	Considered a defined watercourse for impact assessment
Nicol Creek	Ch 104.3 – Ch 104.1 km	Tributary of Bringalily Creek and considered a defined watercourse for impact assessment
Back Creek drainage feature	Ch 126.7 – Ch 127.1 km	Yet to be determined with certainty, considered a defined watercourse for impact assessment
Back Creek drainage feature	Ch 127.9 – Ch 128.2 km	Considered a defined watercourse for impact assessment
Un-named drainage feature	Ch 183.5 – Ch 183.7 km	Yet to be determined with certainty, considered a defined watercourse for impact assessment
Umbiram Creek drainage feature	Ch 185.9 km	Yet to be determined with certainty, considered a defined watercourse for impact assessment

Name	Chainage range	Verification advice from DNRME
One Mile Creek drainage feature	Ch 191.8 km	Yet to be determined with certainty, considered a defined watercourse for impact assessment

Further details of intersection of watercourses and artificial waterbodies and the Project alignment are provided in Sections 5.6.2, 5.6.3 and 5.6.4.

Table 5.9 provides a summary of the major watercourses crossed by the proposed Project alignment. Further details of the watercourses and water quality monitoring sites are presented in Appendix C.

Table 5.9 General summary of watercourses within the impact assessment area

Watercourse	Description
Macintyre River	The Macintyre River is the major river that begins in the Northern Tablelands between Glen Innes and Guyra. The river is 321 km long and is a tributary of the Barwon River. The proposed rail crossing location is situated between the confluence of the Dumaresq River and Macintyre River and Boggabilla. The Macintyre River was the only permanent waterway within the impact assessment area. There is a broad well vegetated riparian flood plain on both sides of the river. Impacts of human disturbance were high. There is an extensive riparian cover along both banks with an over story of <i>Eucalyptus sp.</i> and <i>Melaleuca sp.</i> The banks were 50 to 100 m wide and have a substantial cover of weedy species. The river bed includes gravel and sand beds with some mud banks and snags. The river level was low but flowing at the time of the survey and provides high value fish habitat. Emergent (<i>Phragmites australis</i>) macrophytes were present along the banks.  Macintyre River
Macintyre Brook (Border Rivers basin)	The Macintyre Brook is a tributary off the Macintyre River that forms part of the Border Rivers catchment within the Murray-Darling basin. Macintyre Brook consisted of several ephemeral watercourse, some of which were dry at the time of field surveys. When water was present, small standing pools were common along with larger deeper stream sections. The poorly defined, low, sloped banks were consistent with a low potential for erosion. Adjacent land consisted of native forest as well as cropping (grain fed cattle and irrigation). Therefore, a moderate to high level of disturbance exists, particularly in areas where irrigation and agricultural runoff occurs. A eucalypt riparian woodland vegetation community was observed along the overland flow drainage with evidence of floodplain clearing.

Watercourse	Description
	 Macintyre Brook upstream of Project alignment
Grasstree Creek (Border Rivers)	Grasstree Creek is a tributary off the Condamine River and is part of the Condamine River basin which is part of the Murray Darling basin. Typical land use surrounding the Westbrook Creek vary between modified landscapes consisting of agricultural land used or grazing and non-remnant areas. This generally consisted of scattered non-remnant vegetation with sparse cover and often dominant exotic species. The riparian zone was particularly wide in some sections with a mix of native and exotic vegetation cover. Large trees such as eucalypts were often scattered, and the abundance of aquatic flora was variable. Areas which contained deeper channels and larger water bodies have the potential to support some aquatic flora and fauna species.  Grasstree Creek upstream of the Project alignment

Watercourse	Description
Condamine River (Condamine River basin)	The Condamine River is part of the Condamine River basin which is part of the Murray Darling basin. The Condamine River is approximately 500 km long. The Condamine River rises on the Darling Downs in the Queensland. The river flows north-west past Dalby and onward to Chinchilla. It then flows south-west to the plains, where it meets the Dogwood Creek and becomes the Balonne River, near Surat. The Condamine River basin includes several ephemeral watercourses, most of which were dry at the times of assessment, with the exception of Site 24, which had water present. The majority of streams exhibited poorly defined, low sloped banks which were assessed as moderately stable. Adjacent land was utilised for agricultural practices such as cattle grazing, which has resulted in some bank erosion. Further the river winds through the Great Diving Range. The riparian zone was particularly wide in some sections with a mix of native and exotic vegetation cover. Large trees such as eucalypts were often scattered, and the abundance of aquatic flora was variable. Areas which contained deeper channels and larger water bodies have the potential to support some aquatic flora and fauna species.  Condamine River
Condamine River (North Branch) (Condamine River basin)	The Condamine River (North Branch) is a tributary of the main Condamine River. The Condamine River (North Branch) is approximately 50 km long and starts at Cecil Plains and re-joins the Condamine River 16 km south of Pittsworth. Condamine River (North Branch) consisted of several ephemeral watercourses, some of which were dry at the time of field surveys (Sites 29, 31 and 32). Some small pools of water appear sustained throughout the dry periods (Site 30), while others varied with season (Site 27 and 33). There was very little water in the channel, with water generally present in small pools with infrequent deeper stands. Poorly-defined, low-sloped banks were present with moderate stability. Small areas of severe erosion were present, particularly adjacent to agricultural cropping activities. Typical land use surrounding the Condamine River (North Branch) predominantly consisted of grazing, irrigated cropping and non-remnant areas. Riparian zones consisted of Eucalypt woodlands, which were scattered and were sparse along some sections of the Condamine River. Native vegetation was dominant (with exotics were also readily found), and aquatic flora was particularly abundant and diverse.

Watercourse	Description
	 Condamine River (North Branch) downstream of the Project alignment
Westbrook Creek (Condamine River basin)	Westbrook Creek is located in south east Queensland and the catchment covers an area of 24,043 ha. The Westbrook Creek is approximately 6 km in length. The area is relatively flat with some undulating hills. Westbrook Creek is a tributary off Oakey Creek which starts north of Oakey and finishes south of Westbrook. There are several tributaries that come off the Westbrook Creek including Gowrie Creek, Dry Creek, Spring Creek and Half Mile Gully. Typical land use surrounding the Westbrook Creek varies between modified landscapes consisting of agricultural land or grazing and non-remnant areas. This generally consisted of scattered non-remnant vegetation with sparse cover and often dominant exotic species. The riparian zone has been severely reduced in some parts of Oakey Creek and Westbrook Creek.  Westbrook Creek downstream of the Project alignment

Watercourse	Description
Dry Creek (Condamine River basin)	Dry Creek is a tributary off the Westbrook Creek in the Condamine River basin. Dry Creek comprised primarily of ephemeral watercourses. Some small pools were sustained throughout drier periods. During wet periods, large deep stream channels would be common. Stream bank slopes ranged from low to moderate, with a high potential for erosion during flood events. Typical land use surrounding the Westbrook Creek vary between modified landscapes consisting of agricultural land used or grazing and non-remnant areas. This generally consisted of scattered non-remnant vegetation with sparse cover and often dominant exotic species. The riparian zone has been severely reduced in some parts of Oakey Creek and Westbrook Creek.  Dry Creek upstream of the Project alignment

5.6.2 Waterways for waterway barrier works mapping

Waterways for waterway barrier works are regulated under the Fisheries Act and the Planning Act when barriers to fish movement including partial barriers are installed across waterways. Barrier works include construction, raising, replacement and some maintenance works on structures such as culverts, crossings, bed level and low-level crossings, weirs and dams, both permanent and temporary. In addition to affecting connectivity for aquatic fauna, water quality risk to species is considered with waterway barrier works due to the potential impact it may have on water passage.

A review of the DAF Queensland Waterways for Waterway Barrier Works mapping was undertaken, identifying a total of 86 waterways for waterway barrier works which are intersected by the Project alignment. Of the 86 waterways, several of the waterways are crossed by the Project alignment in multiple locations. These waterways are classified as follows:

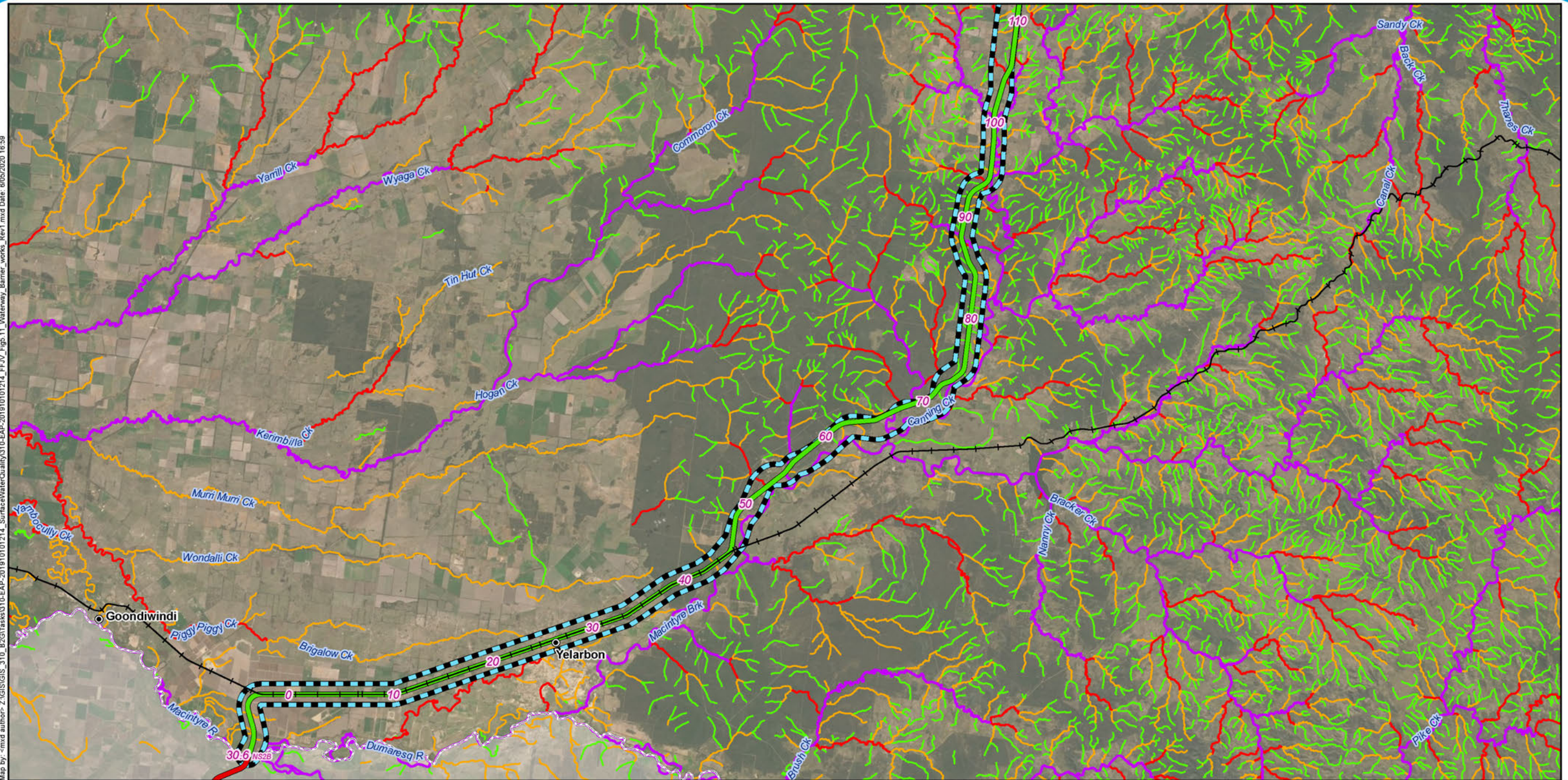
- Low risk of impact (category 1) – The Project alignment intersects forty-three (43) waterways mapped as 'Low'
- Moderate risk of impact (category 2) – The Project alignment intersects twenty-seven (28) waterways mapped as 'Moderate'
- High risk of impact (category 3) – The Project alignment intersects seven (7) waterways mapped as 'High'
- Major risk of impact (category 4) – The Project alignment intersects nine (9) waterways mapped as 'Major'.

Table 5.10 identifies the locations where the Project alignment crosses waterways for waterway barrier works, including the relevant waterway impact risk.

Table 5.10 Waterways for waterway barrier works that are intersected by the Project alignment

Waterway impact risk (DAF)	Waterway and approximate chainage of intersection (km)
Major (Category 4)	■ Un-named tributary of Macintyre Brook (Ch 55.6) ■ Pariagara Creek (Ch 67.3) ■ Cattle Creek (Ch 88.3) ■ Bringalily Creek (Ch 100.5) ■ Back Creek drainage feature (Ch 127.0, Ch 128.0) ■ Condamine River (Ch 142.9) ■ Condamine River (Northern Branch) (Ch 148.7) ■ Westbrook Creek drainage feature (Ch 197.2)
High (Category 3)	■ Un-named tributary of Macintyre Brook (Ch 52.6) ■ Un-named tributary of Canning Creek (Ch 87.4) ■ Native Dog Creek (Ch 93.9) ■ Nicol Creek (Ch 104.4) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 117.3) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 119.4) ■ Dry Creek drainage feature (Ch 197.9 km)
Moderate (Category 2)	■ Un-named tributary of Macintyre Brook (Ch 32.6, Ch 34.7, Ch 48.4, Ch 43.2) ■ Un-named tributary of Macintyre Brook (Ch 61.9) ■ Un-named tributary of Canning Creek (Ch 66.2) ■ Un-named tributary of Canning Creek (Ch 92.0, Ch 90.9) ■ Back Creek (Ch 97.6, Ch 96.9, Ch 96.4, Ch 96.2, Ch 95.4) ■ Un-named tributary of Canning Creek (Ch 107.2) ■ Un-named tributary of Canning Creek (Ch 109.5) ■ Un-named tributary of Canning Creek (Ch 114.4) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 118.5, Ch 117.7, Ch 117.6) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 124.5, Ch 120.3) ■ Grasstree Creek (Ch 138.6, Ch 139.7) ■ Half Mile Creek – drainage feature (Ch 188.7, Ch 183.6) ■ Un-named tributary of Westbrook Creek (Ch 193.4, Ch 191.8) ■ Un-named tributary of Westbrook Creek (Ch 196.0)
Low (Category 1)	■ Un-named tributary of Macintyre Brook (Ch 61.5, Ch 60.4) ■ Un-named tributary of Macintyre Brook (Ch 63.1, Ch 62.8) ■ Un-named tributary of Canning Creek (Ch 86.6, Ch 85.2, Ch 84.4, Ch 83.4, Ch 82.3, Ch 80.6, Ch 80.6, Ch 78.9, Ch 77.7, Ch 73.7) ■ Un-named tributary of Canning Creek (Ch 88.5) ■ Un-named tributary of Canning Creek (Ch 93.4) ■ Un-named tributary of Canning Creek (Ch 108.5) ■ Un-named tributary of Canning Creek (Ch 113.1, Ch 110.9) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 116.2, Ch 115.6, Ch 115.5, Ch 114.9) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 119.0) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 121.5, Ch 121.4, Ch 120.8) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 124, Ch 123.4) ■ Un-named tributary of Leonard (Back Creek) Gully (Ch 125.5) ■ Un-named tributary of Condamine River (North Branch) (Ch 168.6, Ch 169.7, Ch 169.3, Ch 170.9, Ch 170.6) ■ Un-named tributary of Upper Tributary Umbiram Creek (Ch 181.7) ■ Un-named tributary of Upper Tributary Umbiram Creek (Ch 185.9, Ch 184.8) ■ Un-named tributary of Westbrook Creek (Ch 190.7) ■ Un-named tributary of Westbrook Creek (Ch 195.7) ■ Un-named tributary of Dry Creek (Ch 201.4 km) ■ Un-named tributary of Gowrie Creek (Ch 205.8 km, Ch 205 km)

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Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- NSW/QLD border
- Surface water impact assessment area

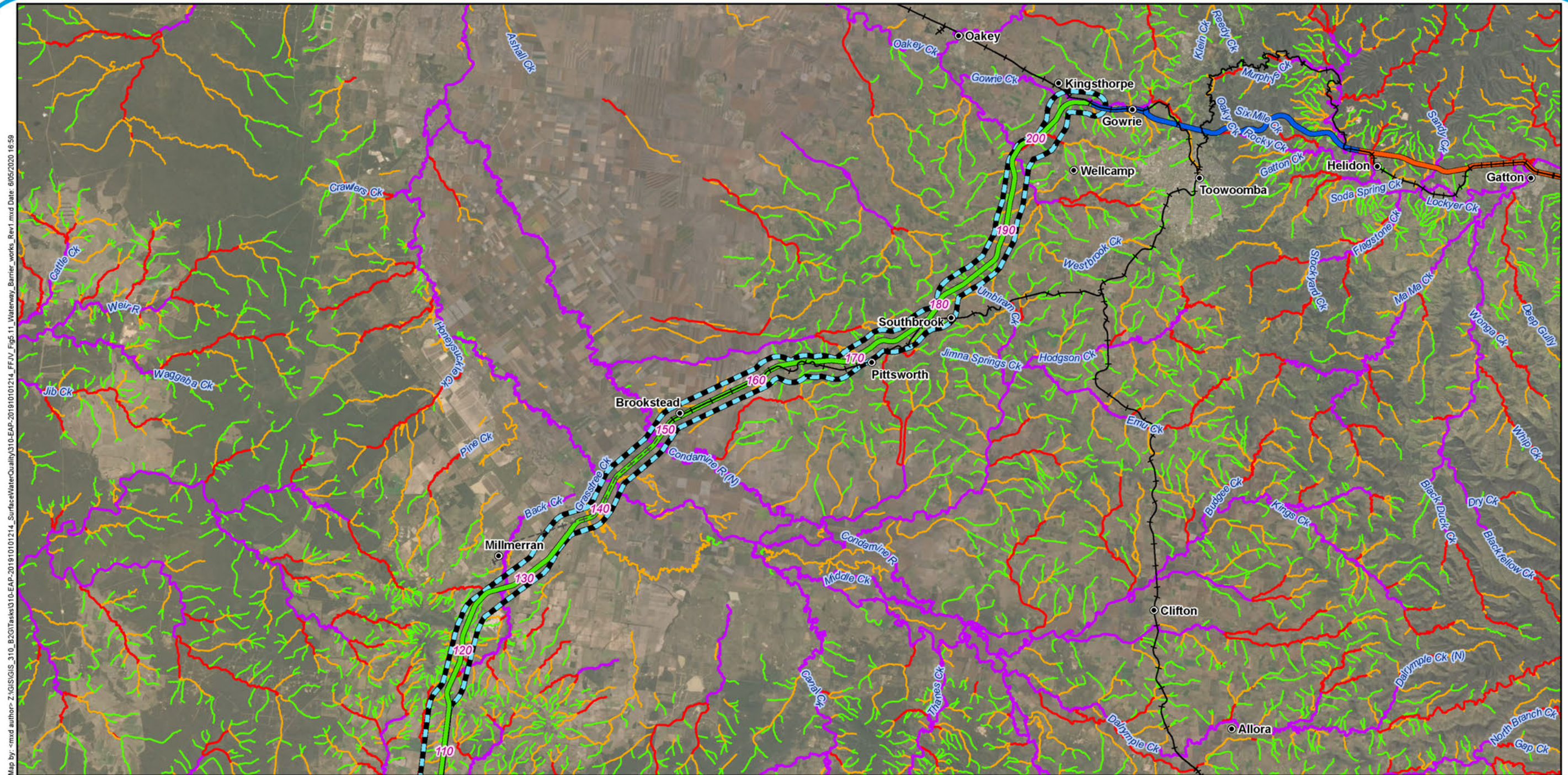
Queensland waterways for waterway barrier works

Risk of Impact

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major



A3 scale: 1:400,000
 0 3 6 9 12 15 km

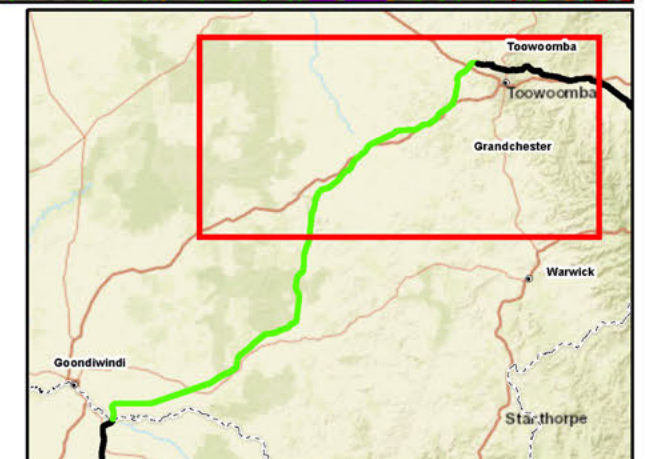


Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Surface water impact assessment area

Queensland waterways for waterway barrier works

- Risk of Impact
- 1 - Low
 - 2 - Moderate
 - 3 - High
 - 4 - Major



A3 scale: 1:400,000
 0 3 6 9 12 15 km

5.6.3 Stream order

A stream order spatial assessment was conducted in order to identify intersections with watercourses not yet defined under the Water Act. As noted in Section 5.6.1, watercourse determinations will be required for those unmapped waterways impacted by diversions for the Project and potentially requiring approvals under the Water Act.

Queensland uses the stream ordering system adopted from Strahler (1952) in which waterways are given an 'order' according to the number of additional tributaries are associated with each waterway. This system is used to provide an indication on waterway complexity and therefore the potential aquatic habitat present. Headwaters or 'new' flow paths are given a stream order of one (or 'first order'), where two first order flow paths converge, the new stream is referred to as a second order stream. Where two second order streams join, a third order stream is formed. Third order streams and above are considered likely to reflect valuable fish habitat, capable of supporting viable population.

The stream order of intersecting waterways was used to further inform the existing environment and potential impacts to maintain the conservation approach to identifying water quality receptor sensitivity throughout the assessment. The stream orders for watercourses intersected by the Project alignment are outlined in Table 5.11.

Table 5.11 Stream orders present within the impact assessment area

Stream order (DNRME)	Waterway (approximate chainage)
9	Macintyre River
6	Condamine River (Ch 142.9)
5	- Bringalily Creek (Ch 100.5) - Un-named tributary of Leonard (Black Creek) Gully (Ch 128.0)
4	- Un-named tributary of Macintyre Brook (Ch 55.5) - Pariagara Creek (Ch 67.2) - Cattle Creek (Ch 88.2) - Back Creek drainage feature (Ch 127.1) - Condamine River (North Branch) (Ch 148.7) - Westbrook Creek drainage feature (Ch 197.2)
3	- Un-named tributary of Macintyre Brook (Ch 52.6) - Un-named tributary of Canning Creek (Ch 87.3) - Native Dog Creek (Ch 93.9) - Nicol Creek (Ch 104.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 117.3) - Un-named tributary of Leonard (Black Creek) Gully (Ch 119.4) - Dry Creek drainage feature (Ch 197.9)
2	- Un-named tributary of Macintyre Brook (Ch 48.3, Ch 43.2) - Un-named tributary of Canning Creek (Ch 66.2, Ch 61.9) - Un-named tributary of Canning Creek (Ch 92.0, Ch 90.9) - Un-named tributary of Canning Creek (Ch 95.4) - Back Creek (Ch 97.6) - Un-named tributary of Canning Creek (Ch 107.2) - Un-named tributary of Canning Creek (Ch 109.4) - Un-named tributary of Canning Creek (Ch 114.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 118.4, Ch 117.7, Ch 117.6) - Un-named tributary of Leonard (Black Creek) Gully (Ch 120.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 124.5) - Grasstree Creek (Ch 138.5) - Un-named tributary of Umbiram Creek (Ch 183.6) - Half Mile Creek drainage feature (Ch 188.7) - One Mile Creek drainage feature (Ch 193.4, Ch 191.8) - Un-named tributary of Westbrook Creek (Ch 196.0)

Stream order (DNRME)	Waterway (approximate chainage)
1	■ Un-named tributary of Macintyre Brook (Ch 63.1, Ch 62.8, Ch 61.5, Ch 60.4, Ch 34.7, Ch 32.6) ■ Un-named tributary of Canning Creek (Ch 86.6, Ch 85.3, Ch 84.4, Ch 83.4, Ch 82.3, Ch 81.0, Ch 80.6, Ch 78.9, Ch 77.7, Ch 73.6) ■ Un-named tributary of Canning Creek (Ch 88.5) ■ Un-named tributary of Canning Creek (Ch 93.4) ■ Un-named tributary of Canning Creek (Ch 96.9, Ch 96.4, Ch 96.2) ■ Un-named tributary of Canning Creek (Ch 108.5) ■ Un-named tributary of Canning Creek (Ch 113.1, Ch 110.9) ■ Un-named tributary of Canning Creek (Ch 116.2, Ch 115.6, Ch 115.5, Ch 114.9) ■ Un-named tributary of Leonard (Black Creek) Gully (Ch 119.0) ■ Un-named tributary of Leonard (Black Creek) Gully (Ch 124.0, Ch 123.3, Ch 121.5, Ch 121.1, Ch 120.8) ■ Un-named tributary of Leonard (Black Creek) Gully (Ch 125.5) ■ Un-named tributary of Grasstree Creek (Ch 139.7) ■ Un-named tributary of Condamine River (North Branch) (Ch 170.9, Ch 170.6, Ch 169.7, Ch 169.3, Ch 168.6) ■ Un-named tributary of Umbiram Creek (Ch 181.75) ■ Un-named tributary of Umbiram Creek (Ch 185.9, Ch 184.8) ■ Un-named tributary of Westbrook Creek (Ch 190.7) ■ Un-named tributary of Westbrook Creek (Ch 195.7) ■ Un-named tributary of Dry Creek (Ch 201.5) ■ Un-named tributary off Gowrie Creek (Ch 205.8, Ch 205)

5.6.4 Artificial/constructed waterbodies

Dams and weirs are constructed barriers that hold back water to provide a reservoir for water supply. Various dams and weirs are located in the vicinity of the Project and are listed in Table 2.9. These dams have, subject to climatic conditions, the ability to supply the required volume for construction water for the Project. However, the transportation cost of sourcing all construction water from these locations is prohibitive. Therefore, other sources will need to be accessed to meet the full construction water demand for the Project.

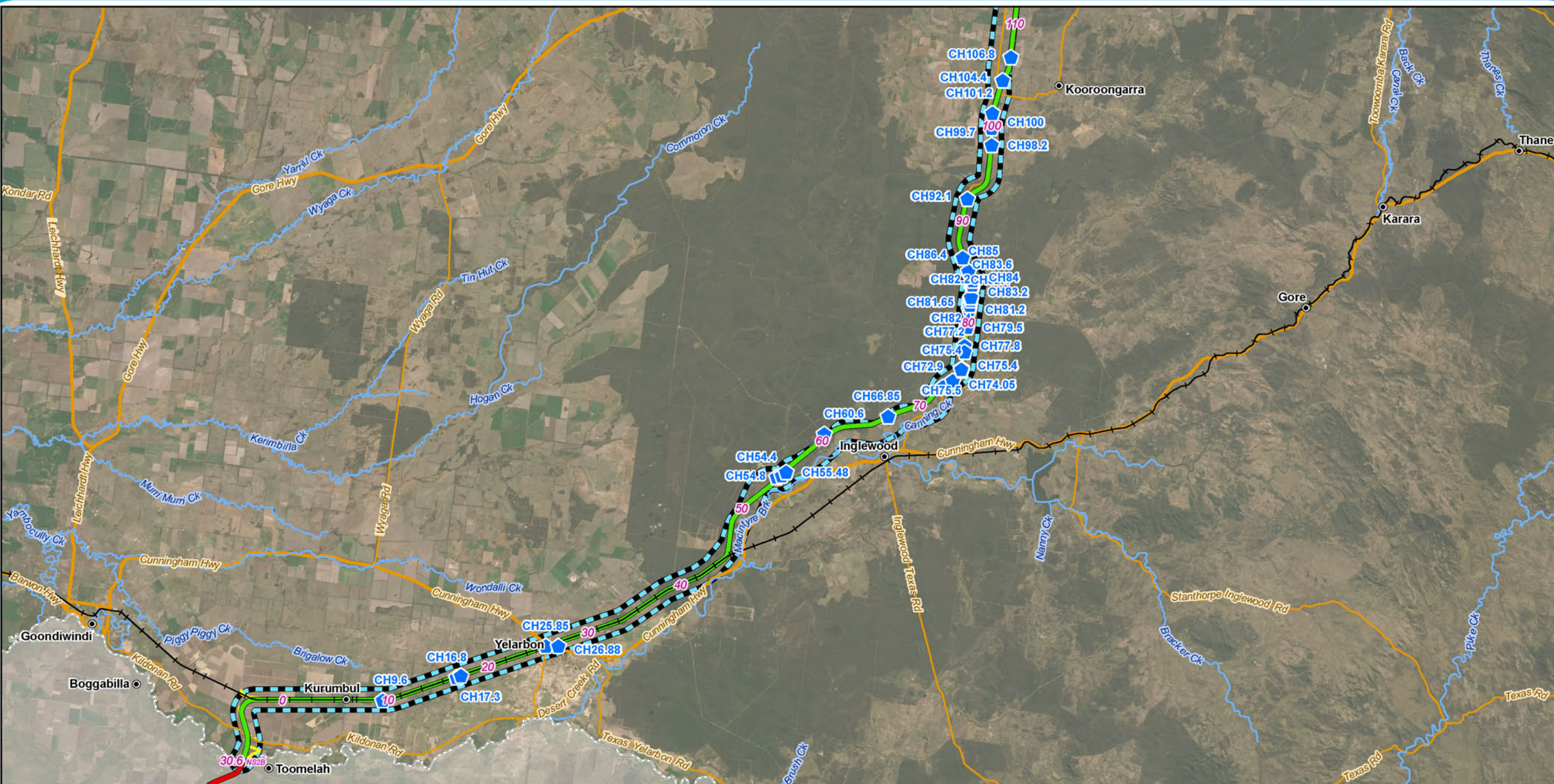
In addition to the managed water storages listed in Table 2.9, there are several artificial/constructed waterbodies located within the impact assessment area and that are intersected by the Project alignment. These artificial/constructed waterbodies are predominantly rural farm dams used for agricultural purposes and typically occur along unnamed drainage watercourses. Table 5.12 identifies artificial waterbodies which intersect the Project alignment.

Table 5.12 Artificial waterbodies intersected by the Project alignment

Artificial waterbody (approximate chainage, in km)	Associated waterway
Ch 9.70 km	Named drainage feature of Dumaresq River
Ch 16.85 km	Named drainage feature of Dumaresq River
Ch 17.30 km	Named drainage feature of Dumaresq River
Ch 21.05 km	Named drainage feature of Dumaresq River
Ch 25.85 km	Named drainage feature of Dumaresq River
Ch 54.4 km	Un-named drainage feature of Macintyre Brook
Ch 54.80 km	Un-named drainage feature of Macintyre Brook
Ch 55.50 km	Un-named drainage feature of Macintyre Brook
Ch 60.60 km	Un-named drainage feature of Macintyre Brook
Ch 66.85 km	Pariagara Creek

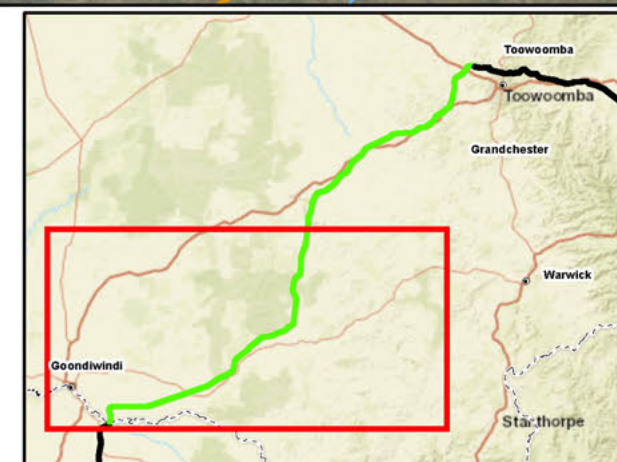
Artificial waterbody (approximate chainage, in km)	Associated waterway
Ch 72.90 km	Un-named drainage feature of Canning Creek
Ch 74.05 km	Un-named drainage feature of Canning Creek
Ch 75.45 km	Un-named drainage feature of Canning Creek
Ch 75.60 km	Un-named drainage feature of Canning Creek
Ch 76.45 km	Un-named drainage feature of Canning Creek
Ch 77.20 km	Un-named drainage feature of Canning Creek
Ch 77.80 km	Un-named drainage feature of Canning Creek
Ch 79.50 km	Un-named drainage feature of Canning Creek
Ch 81.20 km	Un-named drainage feature of Canning Creek
Ch 81.65 km	Un-named drainage feature of Canning Creek
Ch 82.20 km	Un-named drainage feature of Canning Creek
Ch 82.40 km	Un-named drainage feature of Canning Creek
Ch 83.20 km	Un-named drainage feature of Canning Creek
Ch 83.60 km	Un-named drainage feature of Canning Creek
Ch 84.00 km	Un-named drainage feature of Canning Creek
Ch 85.00 km	Un-named drainage feature of Canning Creek
Ch 86.40 km	Un-named drainage feature of Canning Creek
Ch 88.20 km	Cattle Creek
Ch 92.10 km	Native Dog Creek
Ch 98.20 km	Back Creek
Ch 99.80 km	Named drainage feature of Canning Creek
Ch 100.00 km	Named drainage feature of Canning Creek
Ch 101.20 km	Bringalily Creek
Ch 104.40 km	Nicol Creek
Ch 106.80 km	Named drainage feature of Canning Creek
Ch 117.40 km	Back Creek
Ch 121.40 km	Back Creek
Ch 123.30 km	Back Creek
Ch 124.00 km	Un-named drainage feature of Back Creek
Ch 126.80 km	Back Creek drainage feature
Ch 133.50 km	Un-named drainage feature of Grasstree Creek
Ch 135.40 km	Un-named drainage feature of Grasstree Creek
Ch 135.60 km	Un-named drainage feature of Grasstree Creek
Ch 139.70 km	Un-named drainage feature of Grasstree Creek
Ch 158.80 km	Un-named drainage feature of Condamine River (North Branch)
Ch 161.60 km	Un-named drainage feature of Condamine River (North Branch)
Ch 167.30 km	Named drainage feature of Condamine River (North Branch)
Ch 168.30 km	Named drainage feature of Condamine River (North Branch)
Ch 169.30 km	Named drainage feature of Condamine River (North Branch)
Ch 172.50 km	Named drainage feature of Condamine River (North Branch)
Ch 174.30 km	Un-named drainage feature of Spring Creek

Artificial waterbody (approximate chainage, in km)	Associated waterway
Ch 174.60 km	Un-named drainage feature of Spring Creek
Ch 175.60 km	Un-named drainage feature of Spring Creek
Ch 177.80 km	Un-named drainage feature of Spring Creek
Ch 179.00 km	Un-named drainage feature of Umbiram Creek
Ch 181.70 km	Un-named drainage feature of Umbiram Creek
Ch 187.00 km	Un-named drainage feature of Westbrook Creek
Ch 187.20 km	Un-named drainage feature of Westbrook Creek
Ch 192.10 km	Un-named drainage feature of Westbrook Creek
Ch 193.40 km	Un-named drainage feature of Westbrook Creek

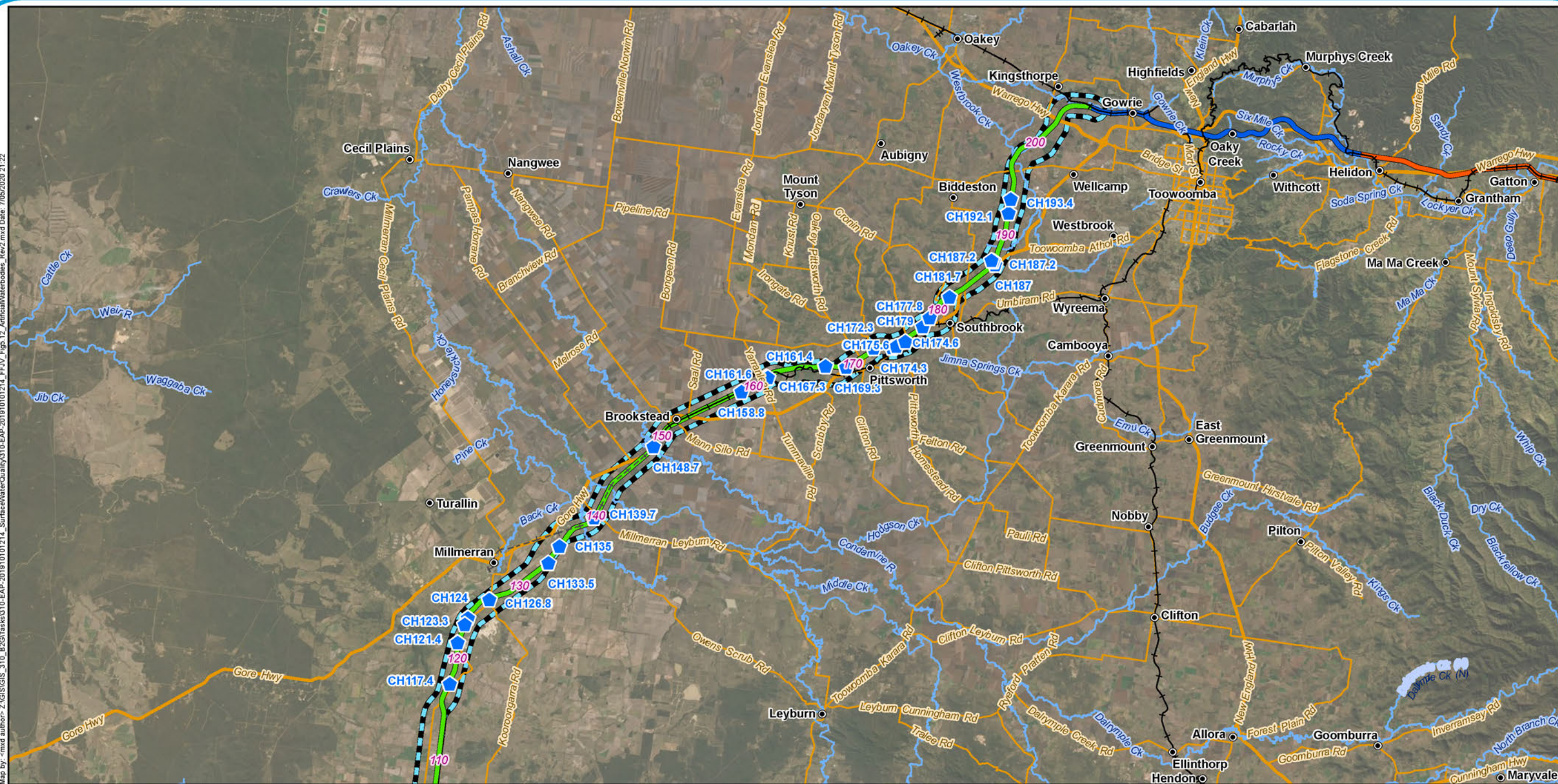


Legend

- ◆ Artificial waterbodies (location)
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Defined watercourses (Water Act 2000)
- NSW/QLD border
- Surface water impact assessment area

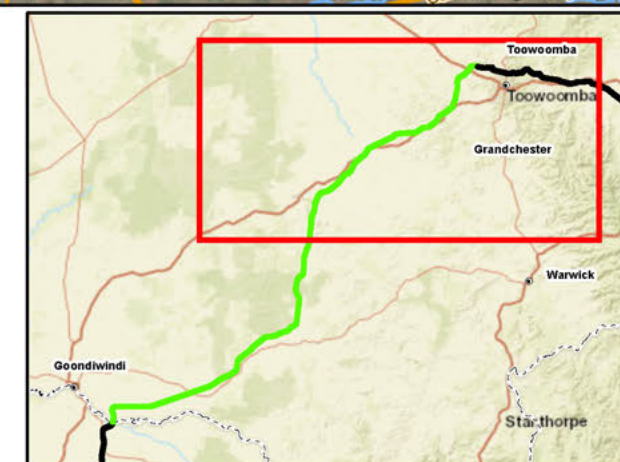


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Legend

- Artificial waterbodies (location)
- Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Defined watercourses (Water Act 2000)
- Surface water impact assessment area



A3 scale: 1:400,000
 0 3 6 9 12 15 km



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 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.12b:

Artificial / constructed waterbodies

5.7 Aquatic ecosystem values

A summary of the aquatic ecosystem values at each monitoring site is provided in the Chapter 10: Flora and fauna and Appendix K: Aquatic Ecology Technical Report of the Border to Gowrie EIS, including a description of the physical environment, aquatic habitat, flora and fauna at the site and existing local impacts.

The impact assessment area includes the following aquatic habitats, as defined by EPA (2005):

- Riverine wetlands– Wetlands contained within channel that are not dominated by trees, shrubs, persistent emergent and emergent mosses or lichens
- Palustrine – Wetlands dominated by trees, shrubs, persistent emergent and emergent mosses or lichens
- Lacustrine – Wetlands contained within a topographic depression or dammed river channel, lacking trees, shrubs, persistent emergent and emergent mosses or lichens and covering more than eight hectares.

Whilst some of these aquatic habitats contained no surface water at the time of assessment they do provide habitat value for several aquatic species that are likely to occur in the landscape. Habitats with permanent water are likely to support the most diverse and abundant aquatic communities, however areas with seasonal water provide periodically available habitat and act as pathways for fauna.

Aquatic ecosystem values were identified to confirm the habitat values aligned with predictive habitat mapping of MNES species, Murray Cod (*Maccullochella peelii*), MSES species, Fringing rush (*Fimbristylis vagans*), and Agassiz's Glassfish (*Ambassis agassizii*) and MSES wetlands within the impact assessment area.

Waterways to be intersected by the Project alignment are mostly ephemeral and were assessed to be in fair condition overall. Other land uses in the region, particularly agriculture, are likely to have resulted in some degradation of surface water quality and aquatic ecology values in local waterways.

5.8 AquaBAMM aquatic conservation assessment

The aquatic conservation assessment using Aquatic Biodiversity Assessment Mapping Method (AquaBAMM) assesses the conservation and ecological value of wetland systems based on a series of national and international criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species/ecosystems, priority species/ecosystems, special features, connectivity and representativeness (EHP 2015).

The results of an Aquascore riverine assessment against each water quality monitoring site are presented in Table 5.13. The majority of water quality monitoring sites scored at a moderate or above indicating a moderate environmental condition.

Table 5.13 AquaBAMM score for all water quality monitoring sites

Aquascore	Monitoring site
Very Low	-
Low	16, 27
Medium	18, 20R, 23, 24, 32, 33, 39, 40, 42
High	14
Very High	2, 2R, 3, 6, 7, 11, 29, 30

Source: Queensland Globe (2018)

5.9 Sensitive environmental areas

This section provides a summary of sensitive environmental areas that occur within the impact assessment area. These sensitive environmental areas are wetlands areas, identified fish habitat and groundwater dependent areas within receiving waters. Additionally, the endangered aquatic ecological community – Lowland Darling River aquatic ecological community is known to occur from the New South Wales Border Rivers basin (DPI, 2007). This basin includes the Macintyre River, which is recognised as a high sensitivity receptor due to the presence of the Lowland Darling River Aquatic Ecological Community. While not addressed within this water quality assessment (due to jurisdictional boundaries), it is considered that the healthy waterways plans of the Queensland Border Rivers and Condamine River basin will capture protective measures under *Water Act 2017* (Cth) – Basin Plan accreditation.

5.9.1 Wetlands

There are no wetlands of International Importance (Ramsar wetlands) within, or within 10 km of the impact assessment area.

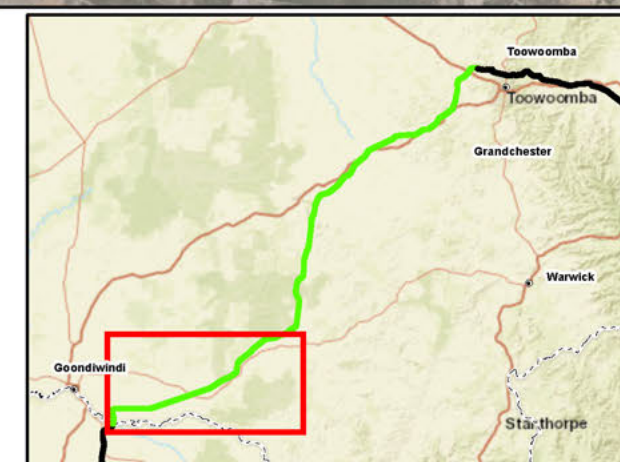
The *Map of Queensland wetland environmental values* identifies multiple palustrine (non-riverine) wetlands along the Project alignment, which are recognised as HES as recognised under the EPP (Water and Wetland Biodiversity). These wetlands are also recognised as MSES under State legislation. The HES wetlands within the impact assessment area are associated with Brigalow Creek, Canning Creek and the Condamine River. While the wetlands are within the overall impact assessment area there is limited intersection between the actual Project alignment and any HES wetland. The HES wetlands are considered an MSES under the Planning Act.

Ecologically significant wetlands in proximity to the impact assessment area are shown on Figure 5.13.



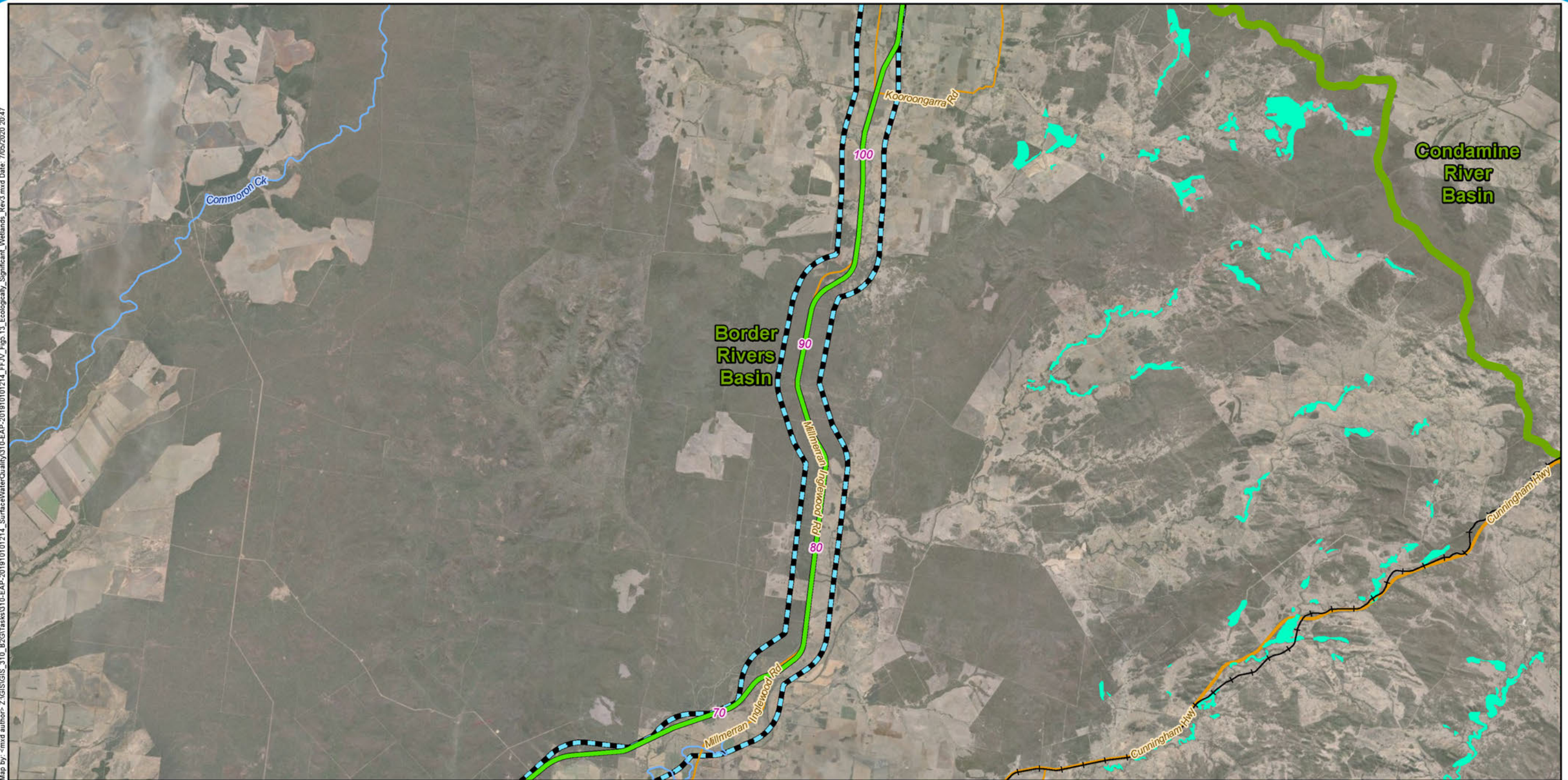
Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Defined watercourse (Water Act 2000)
- NSW/QLD border
- High ecological significance wetlands
- Surface water impact assessment area
- Catchment boundaries



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5 km

Map by: <mxd author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\10101214_SurfaceWaterQuality\310-EAP-2019\10101214_FF\Fig 5.13_Ecologically_Significant_Wetlands_Rev3.mxd Date: 7/05/2020 20:47



Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Defined watercourse (Water Act 2000)

- High ecological significance wetlands
- Surface water impact assessment area
- Catchment boundaries



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5 km

Map by: <msd author> Z:\GIS\GIS_310_B2G\Tasks\310-EAP-2019\10101214_SurfaceWaterQuality\310-EAP-2019\10101214_FF_V_Figs\13_Ecologically_Significant_Wetlands_Rev3.mxd Date: 7/05/2020 20:47



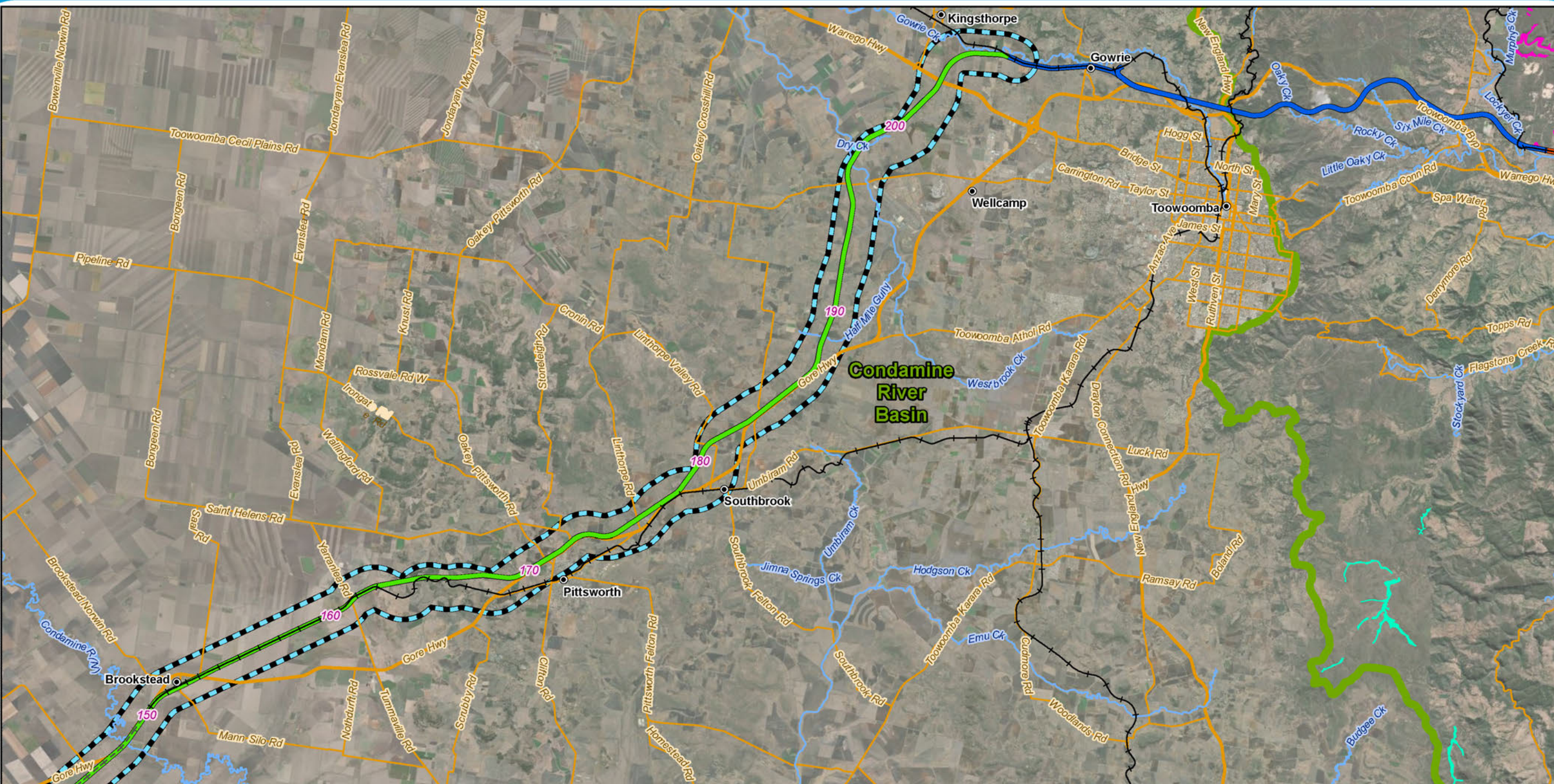
Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Defined watercourse (Water Act 2000)

- High ecological significance wetlands
- Surface water impact assessment area
- Catchment boundaries

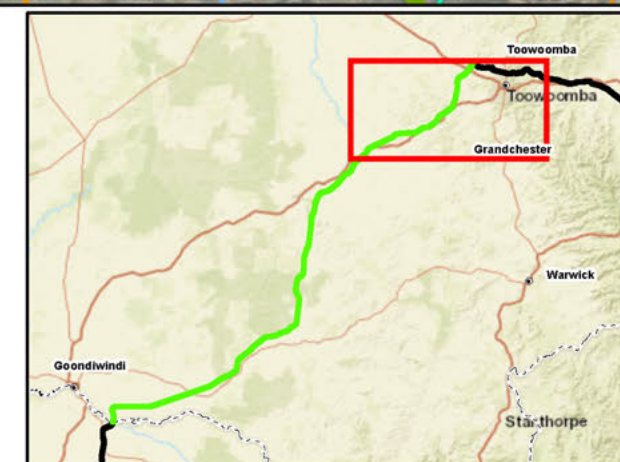


A3 scale: 1:200,000
0 1.5 3 4.5 6 7.5 km



Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Defined watercourse (Water Act 2000)
- High ecological significance wetlands
- High ecological value wetlands
- Surface water impact assessment area
- Catchment boundaries



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5 km

5.9.2 Fish habitat area

Under the Fisheries Act a declared fish habitat area is an area protected against physical disturbance from coastal development, while still allowing legal fishing.

There are no declared fish habitat areas mapped within the impact assessment area.

5.9.3 Groundwater dependent ecosystems

Groundwater-dependent ecosystems (GDEs) are ecosystems that rely upon groundwater for their continued persistence noting that some GDEs are 100 per cent dependent on groundwater quality while others may be only intermittently dependent.

The GDE Atlas (BoM, 2019a) identifies three types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which may have a groundwater component (i.e. rivers, wetland and springs)
- Terrestrial ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems
- Subterranean ecosystems - this includes caves and aquifer ecosystems.

As the assessment using the BoM atlas is modelled at a large scale, the identification of potential GDEs in the Atlas therefore does not confirm that a particular ecosystem is groundwater dependant. Noting this, the Atlas has identified several potential aquatic and terrestrial groundwater dependant systems including wetland systems and watercourses.

Further assessment using the finer scale DES GDE modelling was conducted. Aquatic GDEs have been mapped by DES along the Project alignment from approximately halfway along the section to the NSW/QLD border. Aquatic GDEs are scattered towards the NSW/QLD border end of alignment. The terrestrial GDEs are associated with the watercourses Canning Creek and Macintyre Brook, both of which are intersected by the Project alignment. Several ephemeral springs (sourced from bedrock aquifer systems) have been mapped by DES at the Gowrie end of the Project alignment.

Low potential Aquatic GDEs are located within the impact assessment area towards the NSW/QLD border end of Project alignment (Ch 0.0 to 50.0), some of which are associated with the Macintyre Brook. From Ch 65.0 to Ch 69.0, the aquatic GDEs are associated with Canning Creek (refer Table 5.14 and Figure 5.14).

Table 5.14 Summary of aquatic groundwater dependent ecosystem springs

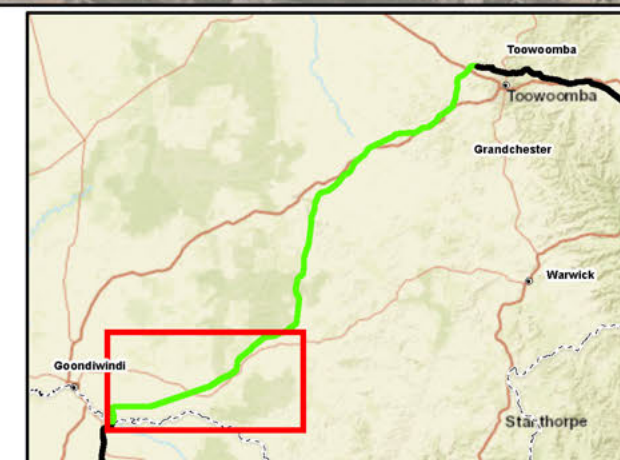
Spring name/site #	Distance from alignment (km)	Direction from alignment	Spring type	Source aquifer
Stone Spring/1145	2	NW of Ch 173.0 km	Active and non-permanent	MRV
Jimna Springs/1147	5.3	SE of Ch 178.0 km		MRV
Springside/1146	5.7	N of Ch 168.0 km		MRV
Wellcamp Spring/1150	7.4	E of Ch 195.0 km		MRV
Leigh Spring/1144	8.8	NW of Ch 173.0 km		MRV
Merigandan Creek/1155	9.4	NE of Ch 206.0 km		MRV
Eustondale Spring/1154	11.6	E of Ch 195.0 km		MRV
Lilligren Spring/1156	12.1	NE of Ch 206.0 km		MRV
Westbrook Creek/1153	14.4	E of Ch 195.0 km		MRV
Kearneys Spring/1139	17.5	E of Ch 195.0 km	Active - Permanent	MRV

Source: DSITI (2017)



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Defined watercourses (Water Act 2000)
- NSW/QLD border
- Surface Areas: known, high confidence and moderate confidence GDEs
- Catchment boundaries
- Surface water impact assessment area



A3 scale: 1:200,000
0 1.5 3 4.5 6 7.5km



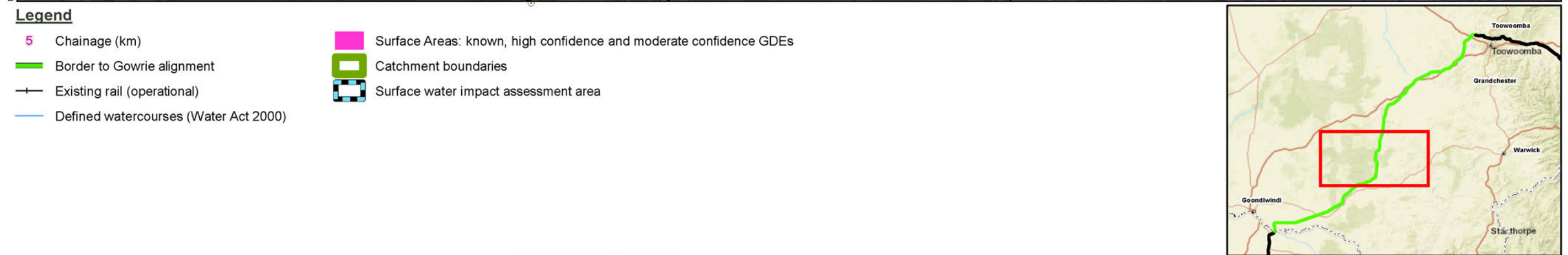
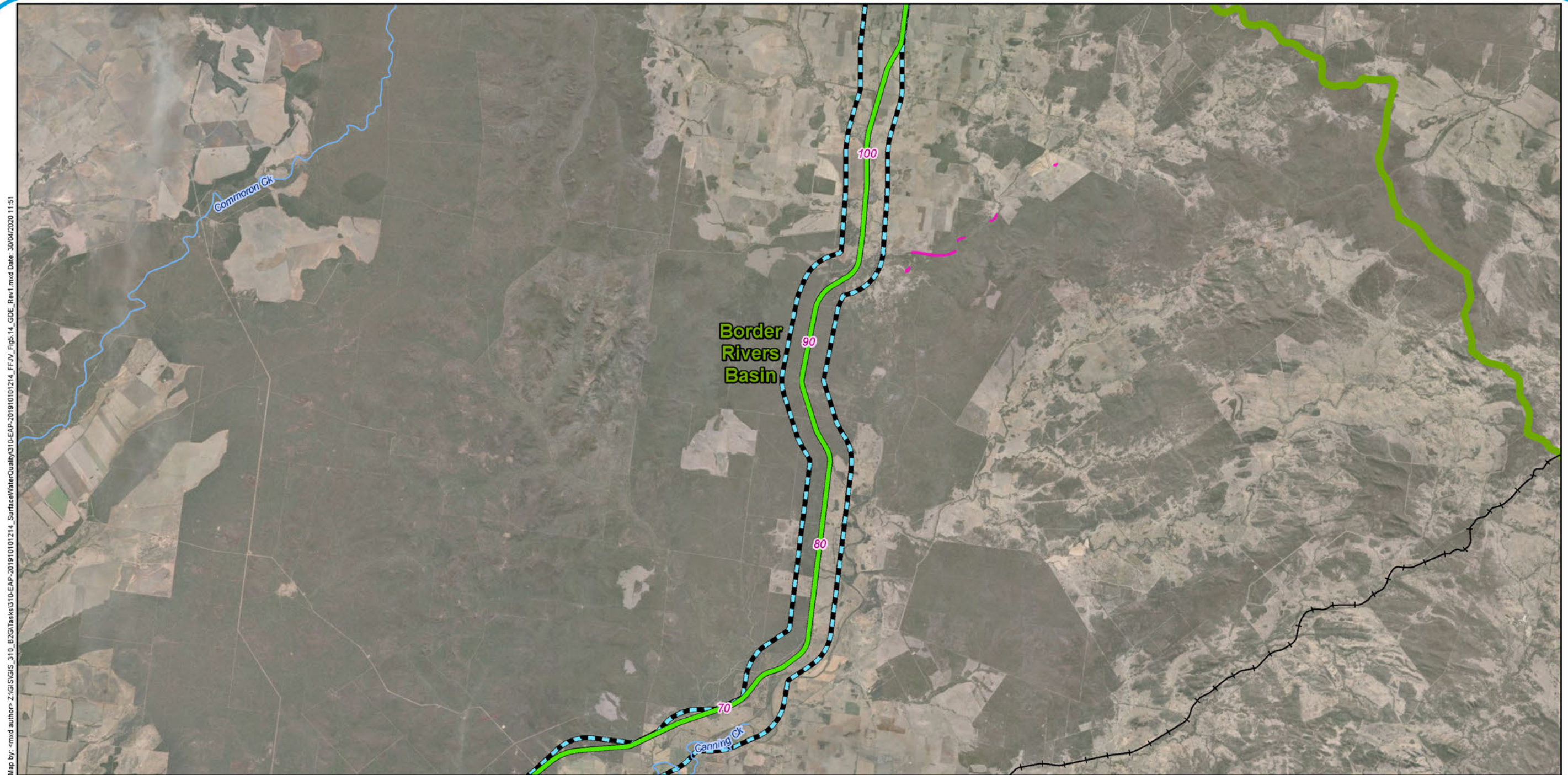
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Border to Gowrie

Figure 5.14a:

Aquatic groundwater dependant ecosystems in the vicinity of the Project impact assessment area



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5km



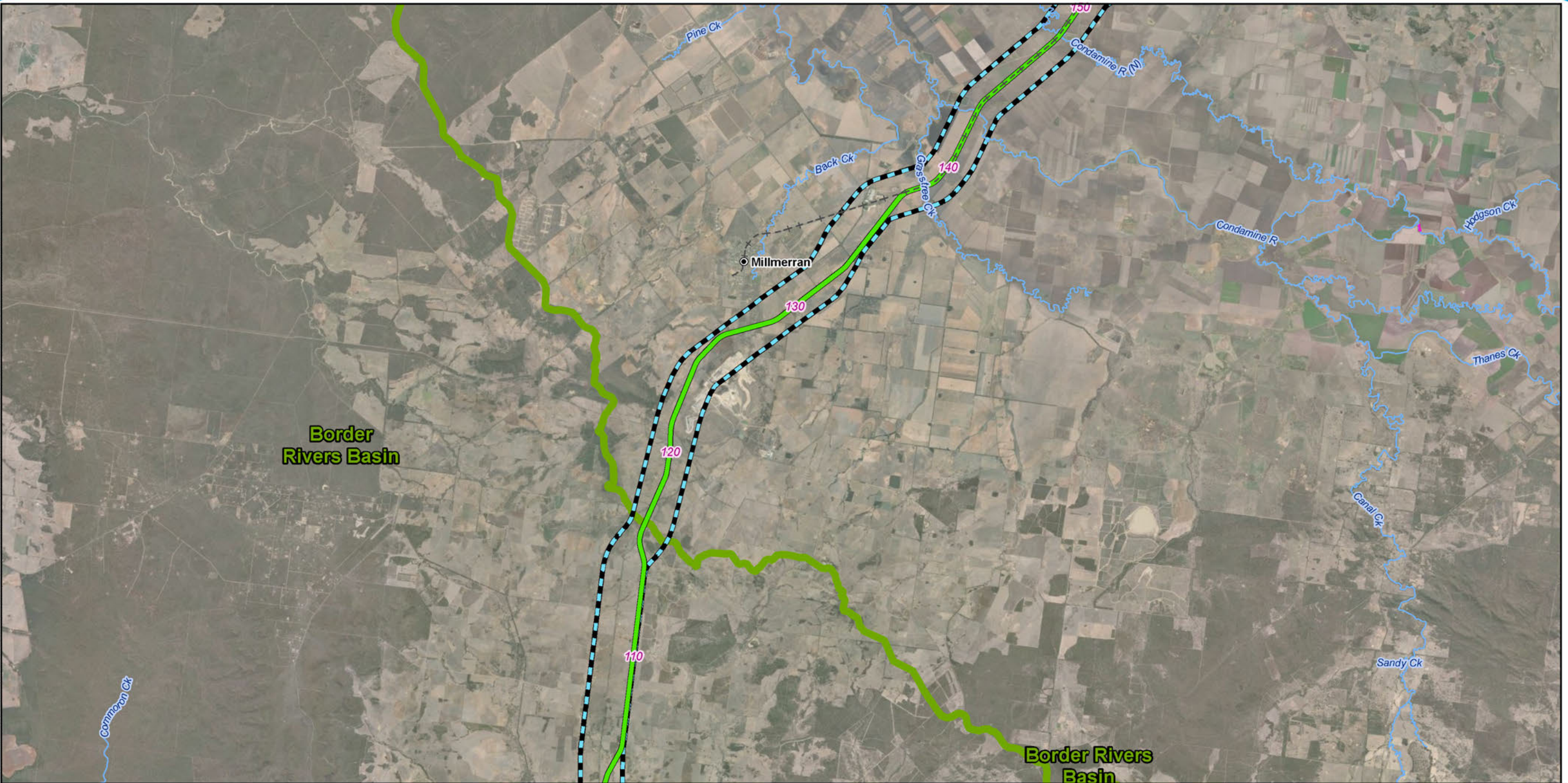
Future Freight
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Issue date: 7/04/2020 Version: 1
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

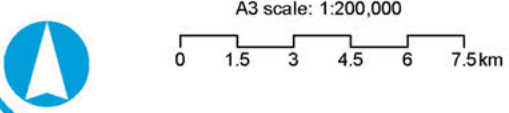
Figure 5.14b:

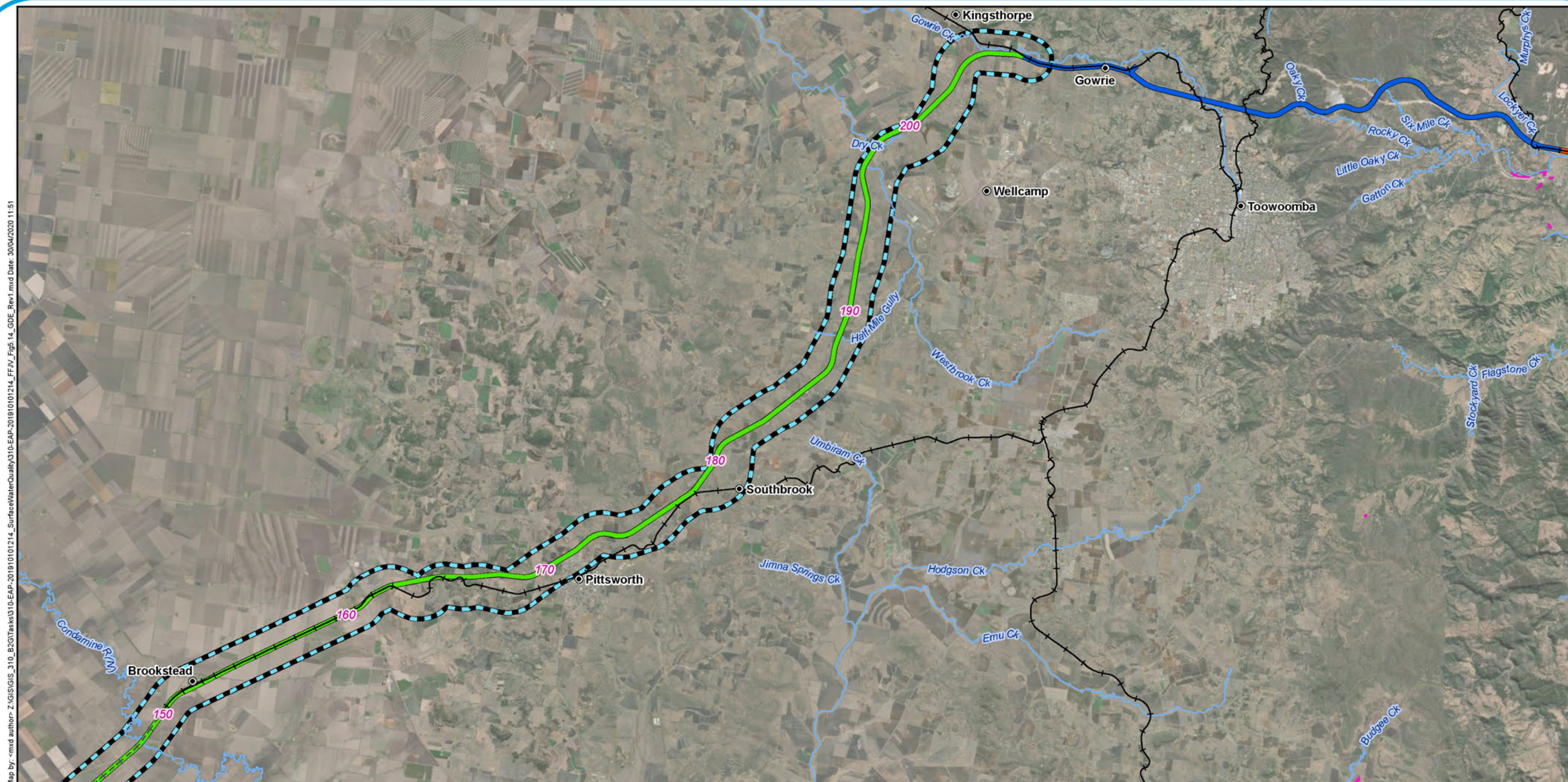
Aquatic groundwater dependant ecosystems in the vicinity of the Project impact assessment area



Legend

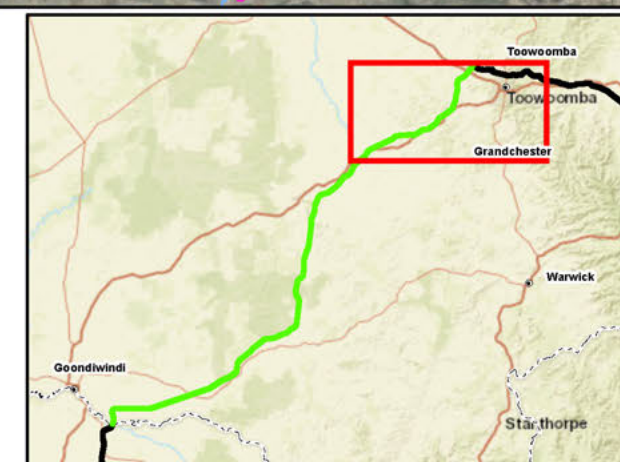
- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Surface Areas: known, high confidence and moderate confidence GDEs
- Catchment boundaries
- Surface water impact assessment area





Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Defined watercourses (Water Act 2000)
- Surface Areas: known, high confidence and moderate confidence GDEs
- Catchment boundaries
- Surface water impact assessment area



A3 scale: 1:200,000
 0 1.5 3 4.5 6 7.5km



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 Integrating Community, Environment and Engineering

Issue date: 7/04/2020 Version: 1
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.14d:

Aquatic groundwater dependant ecosystems in the vicinity of the Project impact assessment area

5.10 Salinity hazard

Existing salinity expressions within the impact assessment area and the potential for new expressions of salinity have been assessed in Chapter 8: Land resources, in reference to published literature and the results of soil sample analysis as part of geotechnical investigations for the Project.

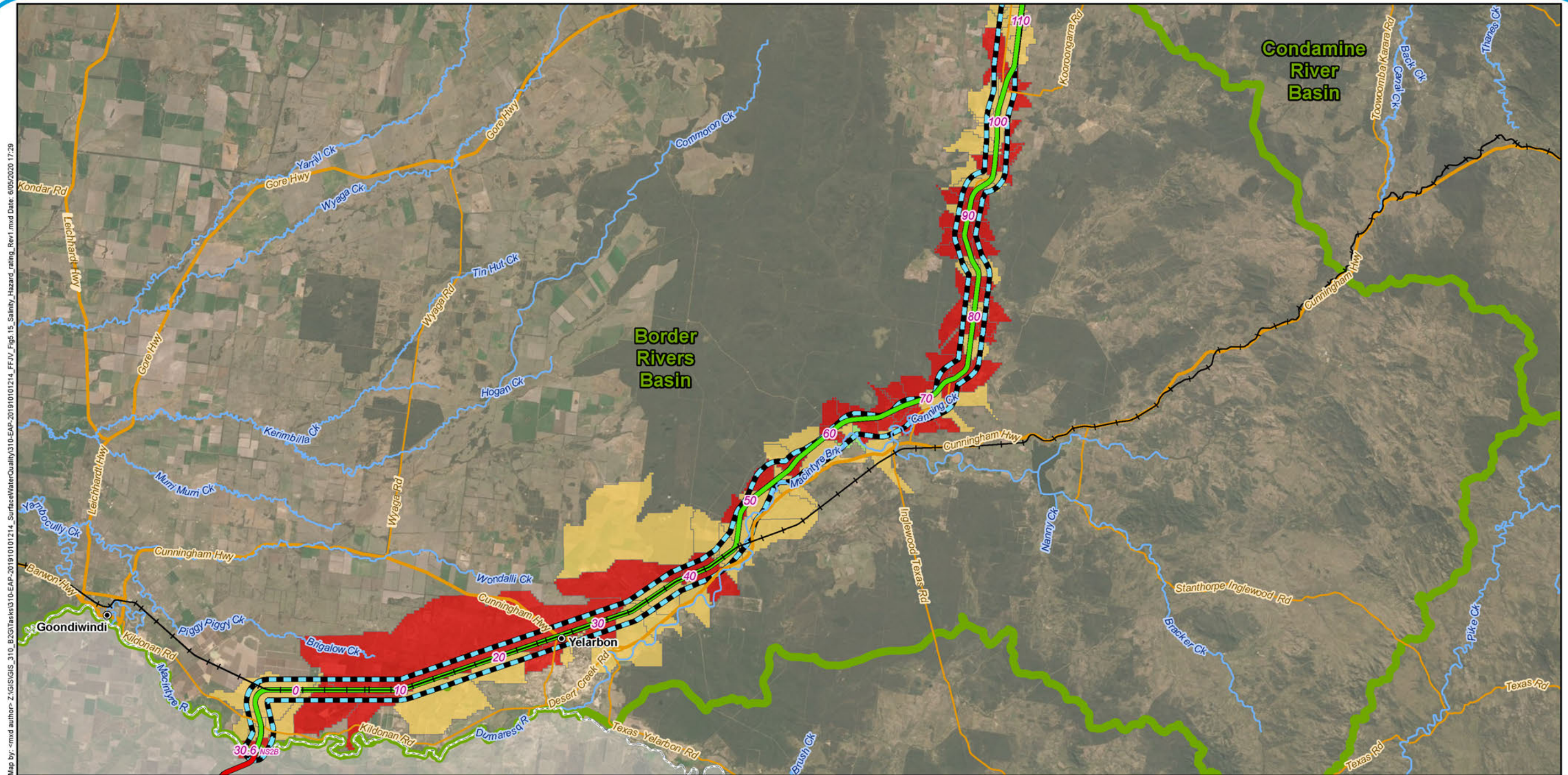
Two salinity risk assessments have previously been undertaken within the impact assessment area. The Salinity Risk Assessment for the Queensland Murray-Darling Region (Biggs et al. 2010b) provides coverage of the impact assessment area between the Macintyre River and east of Millmerran State Forest and the Strategic Salinity Risk Assessment in the Condamine Catchment (Searle et al. 2007) provides coverage of the impact assessment area from east of Millmerran State Forest to Gowrie.

The Salinity Risk Assessment for the Queensland Murray-Darling Region identified 58 known salinity expression areas affected by secondary salinity, including the Yelarbon Desert in the Border Rivers basin. The Yelarbon area is known for its extremely alkaline, sodic sodosol soils strongly attributed to upwelling of sodium bicarbonate rich groundwater (Biggs et al. 2010a).

The salinity risk assessment identified the use of saline groundwater, leaking dams and dissolution of salts as the most common salinity types within the Border Rivers basin. The risk assessment concluded that salinity in the region will have a low risk to rail infrastructure, although it acknowledged that more research is required regarding secondary salinity formation and the impact of salinity on infrastructure assets (Biggs et al. 2010b).

The Strategic Salinity Risk Assessment in the Condamine Catchment (Searle et al. 2007) identified more than 170 salinity expression sites, with most influenced by climatic conditions. The Strategic Salinity Risk Assessment identified that a return to typical long-term weather patterns will likely increase the size and number of dryland salinity expressions in the region and increase salt load exported from the catchment. The impact assessment area intersects sub-catchment areas that are considered by the Strategic Salinity Risk Assessment to contain a very low to high overall salinity risk. The Millmerran area is considered to have a very low to low risk of secondary salinity, whilst the Pittsworth and Gowrie area are considered to have a moderate risk. An area of high salinity risk occurs within the impact assessment area near Southbrook and presents a 'Current' threat to infrastructure assets in the area (Searle et al. 2007).

The salinity hazard rating of land within the impact assessment area has been assessed in Chapter 8: Land resources of the Border to Gowrie EIS and is shown in Figure 5.15).



Legend

- | | | |
|--|---------------------------------------|------------------------------------|
| 5 Chainage (km) | Defined watercourses (Water Act 2000) | Mean salinity hazard rating |
| Localities | NSW/QLD border | |
| North Star to NSW/QLD border alignment | Catchment boundaries | Low: 0.00 - 1.00 |
| Border to Gowrie alignment | Surface water impact assessment area | Moderate: 1.01 - 2.00 |
| Existing rail (operational) | | High: 2.01 - 3.00 |
| Major roads | | |
| Minor roads | | |



A3 scale: 1:400,000
0 3 6 9 12 15 km



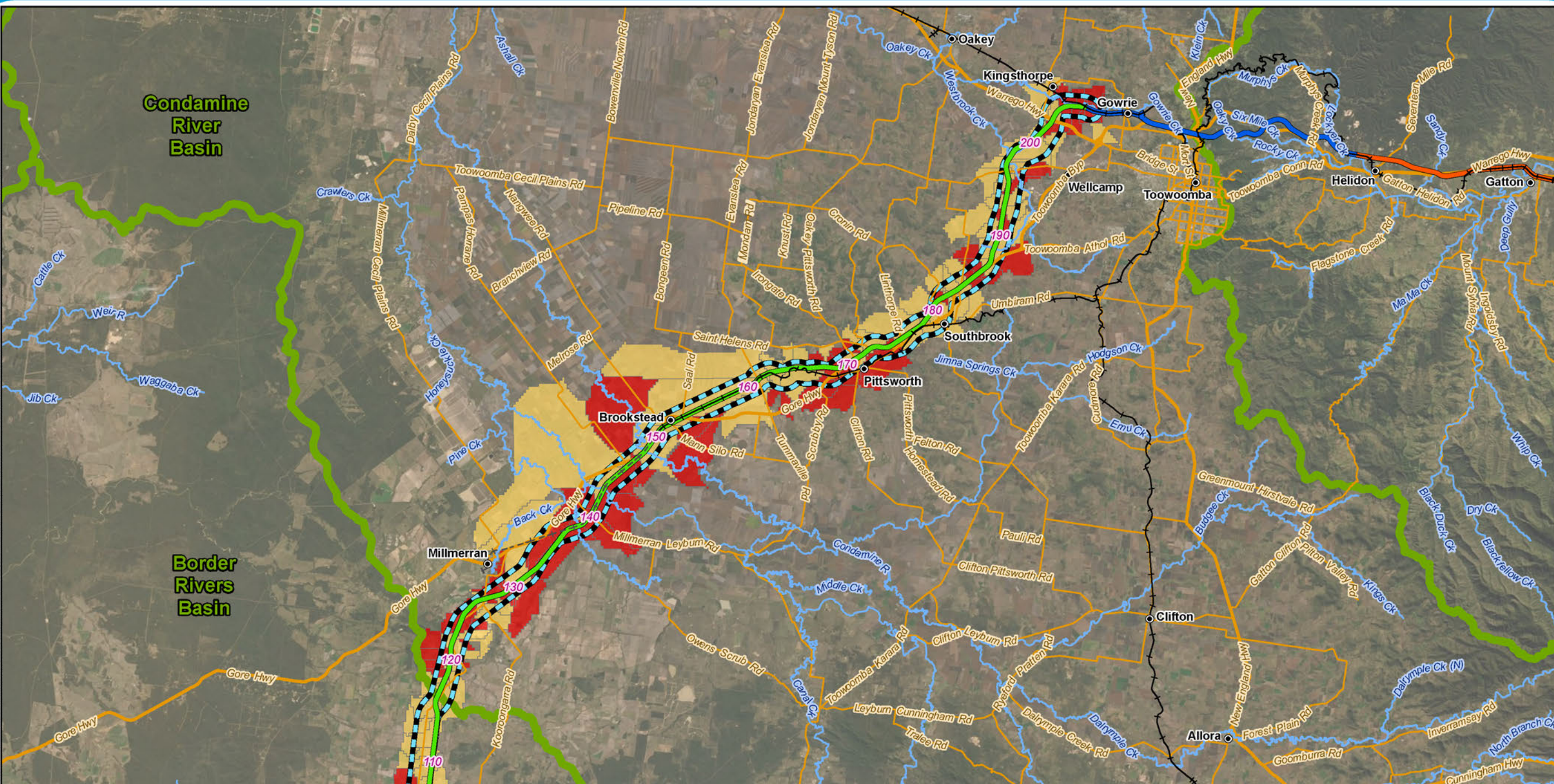
Future Freight
Integrating Community, Environment and Engineering

Issue date: 7/04/2020 Version: 1
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.15a:

Salinity hazard rating for the region relative to the Project impact assessment area



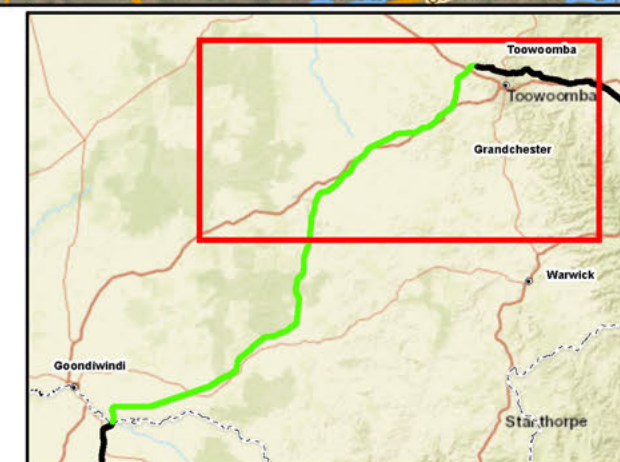
Legend

- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads

- Defined watercourses (Water Act 2000)
- Catchment boundaries
- Surface water impact assessment area

Mean salinity hazard rating

- Low: 0.00 - 1.00
- Moderate: 1.01 - 2.00
- High: 2.01 - 3.00



A3 scale: 1:400,000
 0 3 6 9 12 15 km



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 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.15b:

Salinity hazard rating for the region relative to the Project impact assessment area

5.11 Surface water resources and use

The Water Act provides a framework under which catchment-based Water Plans and Water Management Protocols (previously Resource Operations Plans) are developed in Queensland. Water Plans are part of the Murray-Darling Basin Plan and set new rules on how much water can be taken from the system (as licenced water harvesting), ensuring the sustainable diversion limit is not exceeded over time.

Surface water quality within the impact assessment area is primarily managed by the Water Plan (Condamine and Balonne) and Water Plan (Border Rivers). Both Water Plans include performance indicators and objectives such as:

- Environmental flow objectives
- Water allocation security objectives.

Water management protocols for the Condamine and Balonne Rivers basin are implemented under the Condamine-Balonne Water Plan (Condamine and Balonne) 2019 while the water management protocol for the Border Rivers basin are implemented under the Water Plan (Border Rivers and Moonie) 2019.

Significant changes to the hydraulic regime of the watercourses are not expected to occur with design practices which account for typical hydrological flow to which the water plans pertain, and it is expected that the Project will comply with the relevant water plans. Ecological and general outcomes for the Water Plan (Condamine and Balonne) 2019 and Water Plan (Border Rivers and Moonie) 2019 (i.e. achieving ecological outcomes consistent with supporting natural outcomes by minimising changes to natural flow regimes) will not be impacted with minimal variance to typical hydrological flow. As such, the Project is expected to comply with the Condamine and Balonne and Border Rivers and Moonie basin water plans.

Within the impact assessment area, water allocation licence data indicates that 285,999 ML per year is allocated within the water management areas intersecting the impact assessment area (refer Table 5.15). The review of water allocation licence data was obtained for 2018/2019 water access and are relevant only to the impact assessment area. The search for water allocations are limited to this area as identified impacts to water quality would be expected to primarily impact these users.

Table 5.15 Summary of 2018-2019 Water Licence data for major watercourses and nominal allocations relevant to the impact assessment area

Water source	No. of WLs issued and current	Water made available (ML/yr)
Canning Creek (Surface Water Source)	20	N/A
Condamine River (Surface Water Source)	264	124,665
Condamine River (Alluvial Water Source)	21	N/A
Condamine River-North Branch (Surface Water Source)	28	24,763
Dry Creek (Surface Water Source)	2	N/A
Macintyre Brook (Surface Water Source)	90	109,877
Macintyre Brook (Alluvial Water Source)	15	2,535
Macintyre River (Surface Water Source)	6	N/A
Macintyre River (Alluvial Water Source)	3	1,490
Westbrook Creek (Surface Water Source)	14	762
Oakey Creek (Surface Water Source)	50	12,247
Other surface water sources	77	9,660

Source: DNRME (2019b)

5.12 Water quality receptors

A receptor is a feature, area or structure that may be affected by direct or indirect changes to the environment. Water quality receptors within the impact assessment area have been identified in reference to EPP (Water and Wetland Biodiversity) and relevant EVs for the relevant basins (refer Section 3.2). Subsequently, water quality receptors of relevance to the impact assessment area have been identified to be the following:

- Queensland's natural environment (including utilisation by native flora and fauna)
- Finite natural resources, with specific regard to wetlands
- Watercourses conducive to the maintenance of existing land forms, ecological health and biodiversity.

Due to the interconnected nature of the watercourses that occur within the impact assessment area, the water quality receptors for the existing environment (as a whole of package) are considered to be of moderate sensitivity due to several factors, including:

- Protected by State legislation (Water Act, Fisheries Act and NC Act), with acknowledgement of potential habitat for MNES species
- Important for biodiversity
- Existing sensitivity, with high exposure to impacts.

To be conservative, all waterways within the impact assessment area have been regarded as being moderate sensitivity water quality receptors, as a minimum, for the purpose of assessment.

High sensitivity water quality receptors were identified where a waterway was known to support another matter identified and protected under legislation, for example MNES species (Fringing rush (*Fimbristylis vagans*), Murray Cod (*Maccullochella peelii*), and Agassiz's Glassfish (*Ambassis agassizii*)) and MSES wetlands (refer Appendix K: Aquatic Ecology Technical Report of the Border to Gowrie EIS). The Macintyre River, Macintyre Brook, Canning Creek and the Condamine River were all identified as being high sensitivity water quality receptors for the purpose of this assessment.

6 Surface water quality assessment

6.1 Desktop review of surface water quality within the Border Rivers and Condamine River basins

Water quality within the Border Rivers and Condamine River basin is typically monitored across a variety of flows. A deficiency in available data throughout the catchment basins has resulted in an increase in uncertainty if water quality thresholds are being upheld (DES, 2018b). Noting this, turbidity is typically high throughout both catchments, with relatively high levels of electrical conductivity within the upper reaches of the catchments (DES, 2018b). Ecosystem health within both catchments has been identified as poor under the most recent sustainable rivers audit 2 (MDBA, 2012). Key risks (identified under the Q-catchments program (Negus *et al.* 2015 in DES, 2018)) to the catchment include: instream pest fauna, sedimentation, hydrology regime change, climate change, riparian disturbance and connectivity barriers.

Indicative water quality within the Borders Rivers and Condamine River basins has been collected in some manner since 1981, 1986 and 1963, respectively at the DNRME stream gauging stations of Macintyre Brook at Inglewood (416402C), Macintyre Brook at Booba Sands (416415A) and the Condamine River at Tummaville (422323A) (refer Table 6.1). As the sites have been operating for different periods of time, Table 6.1 further includes the number of samples collected for each parameter for each site. Limitations in the number of non-continuous samples are present within the current dataset, appearing principally due to limited hydrological flow.

Noting the limitations in sampling intensity within the data (67 samples between 1987 and 2018), current parameters within the selected gauging stations for the Border Rivers basin typically comply with WQOs. Exceedances in electrical conductivity in both high and low flow were noted in the lower end of the Macintyre Brook catchment and turbidity exceedances during high flow further upstream in the Macintyre Brook catchment. Notably, total nitrogen concentrations were typically elevated beyond other nutrient parameters. At the Condamine gauging station at Tummaville, conductivity and suspended solids were outside WQO guidelines while other parameters were within the objectives.

Table 6.1 Gauging station median water quality data with respective Water Quality Objectives (high and low flow, moderately disturbed)

Water parameter	DNRME gauging station			
	Macintyre Brook at Inglewood (416402C) (1981 to 2018)	Macintyre Brook at Booba Sands (416415A) (1987 to 2018)	Condamine River at Tummaville (422323A) (1963 to 2018)	Gowrie Creek at Oakey (422332B)
Conductivity (µs/cm) (n = 80, 67, 76, 179)	355 (250 to 370)	379.4 (180 to 245)	395.5 (240 to 320)	496 (375 to 510)
Turbidity (NTU) (n = 80, 67, 76, 105)	8.05 (11 to 25)	11 (30 to 110)	44.5 (25 to 165)	34 (13 to 55)
pH (n = 82, 70, 126, 180)	7.56 (7.2 to 8.0)	7.56 (7.0 to 8.0)	7.79 (7.2 to 8.1)	7.54 (6.5 to 7.5)
Total suspended solids (n = 74, 63, 100, 172)	14.5 (10 to 25)	19 (10 to 25)	47.5 (20 to 140)	875.5 (12 to 55)
Total nitrogen (mg/L) (n = 35, 36, 36, 98)	0.86 (0.71 to 0.91)	0.92 (0.58 to 0.9)	0.84 (0.74 to 1.21)	3.32 (1.00 to 1.28)

Water parameter	DNRME gauging station			
	Macintyre Brook at Inglewood (416402C) (1981 to 2018)	Macintyre Brook at Booba Sands (416415A) (1987 to 2018)	Condamine River at Tummaville (422323A) (1963 to 2018)	Gowrie Creek at Oakey (422332B)
Ammonia (mg/L) (n = 24, 26, 23, 48)	0.0055 (0.08)	0.0195 (0.2)	0.007 (0.02)	0.06 (<0.01)
Total phosphorus (mg/L) (n = 41, 41, 45, 153)	0.063 (0.06 to 0.07)	0.074 (0.07 to 0.15)	0.239 (0.14 to 0.47)	2.97 (0.11 to 0.34)

Table notes:

Due to the typical flow patterns of Macintyre Brook and the Condamine River, the median values were considered to be based on data analysis of a majority of sub base flow data (i.e. low flow condition).

Highlighted data indicate median value are outside of WQO objective at either high or low flow. 'n' denotes number of samples from gauging station records.

Source: DNRME (WMIP) (2020)

6.2 Field assessment of surface water quality

6.2.1 General conditions

To capture representative stream flow behaviour from the impact assessment area, stream flow data was retrieved from the Macintyre Brook, Condamine River and Gowrie Creek gauging stations.

The weather conditions leading up to the first sampling event (June 2018) were generally clear and dry. Table 6.2 identifies that there was minimal rainfall recorded at either BoM weather station in the week leading up to the first sampling event. Stream flow rates (in terms of passage over the gauging station control), indicate that no surface base flow was observed downstream of the gauging station preceding the first water quality sampling event within the Condamine River. Continual discharge was evident within Gowrie Creek and Macintyre Brook.

Table 6.2 Rainfall and stream flow prior to and including the first sampling event (11 to 20 June 2018)

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Monday 4 June 2018	0.0	13.48	0.0	0.00	20.57
Tuesday 5 June 2018	0.0	13.12	0.0	0.00	18.81
Wednesday 6 June 2018	0.0	11.71	0.0	0.00	12.68
Thursday 7 June 2018	0.0	18.86	6.0	0.00	11.01
Friday 8 June 2018	0.0	17.46	0.0	0.00	12.70
Saturday 9 June 2018	0.0	42.19	0.0	0.00	18.50
Sunday 10 June 2018	0.0	112.49	1.0	0.00	18.49
Monday 11 June 2018	0.0	120.03	0.0	0.00	20.22
Tuesday 12 June 2018	0.0	103.97	0.0	0.00	18.05
Wednesday 13 June 2018	0.0	52.54	0.0	0.00	16.22
Thursday 14 June 2018	0.0	29.11	0.0	0.00	15.94
Friday 15 June 2018	0.0	24.41	0.0	0.00	14.01
Saturday 16 June 2018	0.0	20.07	0.0	0.00	11.36
Sunday 17 June 2018	0.0	16.56	0.0	0.00	10.85

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Monday 18 June 2018	0.0	19.33	0.0	0.00	10.36
Tuesday 19 June 2018	0.0	28.36	0.0	0.00	11.25
Wednesday 20 June 2018	0.0	16.15	0.0	0.00	10.63

Source: BoM (2020), DNRME (WMIP) (2020)

The weather conditions leading up to the second sampling event (Nov/Dec 2018) were generally hot with some rainfall occurring across both BoM weather stations. Table 6.3 indicates that 33 mm and 11.4 mm, respectively of rain was recorded in the week from the Booba Sands and the Pittsworth BoM stations leading up to the second sampling event. Although higher rainfall was observed prior to the second sampling event, streamflow mirrored the first water quality assessment within no flow in the Condamine River. Continual discharge was evident within Gowrie Creek and Macintyre Brook.

Table 6.3 Rainfall and stream flow prior to and including the second sampling event (26 November and 3 December 2018)

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Monday 19 November 2018	1.0	33.48	0.0	0.00	17.74
Tuesday 20 November 2018	0.0	31.36	0.0	0.00	12.62
Wednesday 21 November 2018	0.0	33.51	0.0	0.00	11.62
Thursday 22 November 2018	32.0	48.15	5.0	0.00	92.52
Friday 23 November 2018	0.0	43.53	6.4	0.00	64.43
Saturday 24 November 2018	0.0	31.36	0.0	0.00	26.42
Sunday 25 November 2018	0.0	17.30	0.0	0.00	21.82
Monday 26 November 2018	0.0	12.10	0.0	0.00	18.06
Tuesday 27 November 2018	0.0	14.14	0.0	0.00	17.22
Wednesday 28 November 2018	0.0	14.97	5.0	0.00	67.02
Thursday 29 November 2018	0.0	24.26	0.0	0.00	27.88
Friday 30 November 2018	0.0	26.13	0.0	0.00	17.59
Saturday 01 December 2018	0.0	28.40	0.0	0.00	11.36
Sunday 02 December 2018	0.0	25.91	0.0	0.00	5.99
Monday 03 December 2018	0.0	59.55	0.0	0.00	3.68

Source: BoM (2020), DNRME (WMIP) (2020)

The weather conditions leading up to the third sampling event (February 2019) were clear and dry. Table 6.4 indicates 1 mm of rain was recorded across both BoM weather stations in the week leading up to the third sampling event. Stream discharge within the Condamine River remained absent. Continual discharge was evident within Gowrie Creek and Macintyre Brook.

Table 6.4 Rainfall and stream flow prior to and including the third sampling event (11 – 19 February 2019)

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Monday 04 February 2019	0.0	27.54	0.0	0.00	5.22
Tuesday 05 February 2019	0.0	15.08	0.0	0.00	3.84
Wednesday 06 February 2019	0.0	23.24	0.0	0.00	0.53

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Thursday 07 February 2019	0.0	24.34	0.0	0.00	28.59
Friday 08 February 2019	0.0	31.91	0.0	0.00	9.79
Saturday 09 February 2019	0.0	30.21	0.0	0.00	5.31
Sunday 10 February 2019	1.0	24.32	0.0	0.00	3.87
Monday 11 February 2019	0.0	16.22	0.0	0.00	8.00
Tuesday 12 February 2019	0.0	6.79	0.0	0.00	5.81
Wednesday 13 February 2019	0.0	6.95	0.0	0.00	5.45
Thursday 14 February 2019	0.0	25.49	0.0	0.00	4.69
Friday 15 February 2019	0.0	19.29	0.0	0.00	4.19
Saturday 16 February 2019	0.0	29.54	0.0	0.00	3.55
Sunday 17 February 2019	0.0	47.57	0.0	0.00	2.08
Monday 18 February 2019	0.0	59.95	0.0	0.00	0.01
Tuesday 19 February 2019	0.0	65.39	0.0	0.00	2.18

Source: BoM (2020), DNRME (WMIP) (2020)

The weather conditions leading up to the fourth sampling event (April/May 2019) were generally clear and dry. Table 6.5 indicates no rainfall was recorded at either BoM weather station the week leading up to the fourth sampling event. Stream discharge within the Condamine River remained absent. Continual discharge was evident within Macintyre Brook and relatively higher (in comparison to previous assessments) in Gowrie Creek.

Table 6.5 Rainfall and stream flow prior to and including the fourth sampling event (29 April – 2 May 2019)

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakey stream flow (average M/L per day)
Monday 22 April 2019	0.0	21.58	0.0	0.00	31.42
Tuesday 23 April 2019	0.0	26.28	0.0	0.00	21.85
Wednesday 24 April 2019	0.0	24.47	0.0	0.00	31.42
Thursday 25 April 2019	0.0	32.37	0.0	0.00	21.48
Friday 26 April 2019	0.0	28.60	0.0	0.00	21.49
Saturday 27 April 2019	0.0	28.46	0.0	0.00	27.42
Sunday 28 April 2019	0.0	38.65	0.0	0.00	30.53
Monday 29 April 2019	0.0	33.31	0.0	0.00	27.31
Tuesday 30 April 2019	0.0	28.83	0.0	0.00	27.07
Wednesday 01 May 2019	0.0	27.17	0.0	0.00	42.86
Thursday 02 May 2019	0.0	25.64	0.0	0.00	46.11

Source: BoM (2020), DNRME (WMIP) (2020)

The weather conditions leading up to the fifth sampling event (May 2019) were generally clear and dry. Table 6.6 indicates no rainfall was recorded at either BoM weather station the week leading up to the fifth sampling event. Stream discharge within the Condamine River remained absent. Continual discharge was evident within Macintyre Brook and relatively higher (in comparison to previous assessments) in Gowrie Creek.

Table 6.6 Rainfall and stream flow prior to and including the fifth sampling event (15 May – 19 May 2019)

Day/date	Rainfall at Booba Sands (mm daily)	Macintyre Brook stream flow (average M/L per day)	Rainfall at Pittsworth (mm daily)	Condamine River stream flow (average M/L per day)	Gowrie Creek at Oakley stream flow (average M/L per day)
Wednesday 08 May 2019	0.00	4.77	0.00	0.00	14.59
Thursday 09 May 2019	0.00	2.19	0.00	0.00	20.19
Friday 10 May 2019	0.00	1.77	0.00	0.00	24.86
Saturday 11 May 2019	0.00	1.58	0.00	0.00	26.15
Sunday 12 May 2019	0.00	0.77	0.00	0.00	27.43
Monday 13 May 2019	0.00	0.32	0.00	0.00	26.14
Tuesday 14 May 2019	0.00	0.43	0.00	0.00	22.71
Wednesday 15 May 2019	0.00	3.74	0.00	0.00	17.80
Thursday 16 May 2019	0.00	3.58	0.00	0.00	15.92
Friday 17 May 2019	0.00	3.50	0.00	0.00	15.20
Saturday 18 May 2019	0.00	1.60	0.00	0.00	23.95
Sunday 19 May 2019	0.00	4.75	0.00	0.00	27.08

Source: BoM (2020), DNRME (WMIP) (2020)

6.2.2 Summary of field and laboratory assessed water quality data

A summary of the surface water quality assessments is provided below alongside water quality assessments separated into each of the relevant water type zones under the Border Rivers basin and the Condamine River basin (refer Section 6.2.3).

Water quality results are presented in the following sections and are grouped to facilitate assessment of sites consistent with the six water type zones of the Border Rivers basin and the Condamine River basin.

Generally, the results of water quality analysis can be summarised as follows:

- The pH values of water samples from waterways within the Border Rivers and Condamine River basins were typically neutral. Where WQO guidelines were exceeded, the magnitude of exceedance was typically minimal, with 18 exceedances across the Border Rivers basin and 13 exceedances across the Condamine River basin. The majority of pH exceedances were noted in Spring/Summer across both basins.
- Nineteen exceedances of the WQO guidelines for turbidity were recorded across the Border Rivers basin and 20 exceedances were recorded across the Condamine River basin. The majority of turbidity exceedances were noted in Summer/Autumn across both basins.
- Twenty-three exceedances of electrical conductivity WQO guidelines were recorded across the Border Rivers basin and 16 exceedances were recorded across the Condamine River basin. The majority of electrical conductivity exceedances were noted in Autumn within the Border Rivers basin and distributed evenly across seasons within the Condamine River basin.
- Eighteen exceedances of dissolved oxygen saturation WQO guidelines were recorded across the Border Rivers basin and 12 exceedances were recorded across the Condamine River basin. The majority of dissolved oxygen saturation exceedances were noted in Summer/Autumn within the Border Rivers basin and Summer within the Condamine River basin.
- Only five exceedances of the chlorophyll *a* WQO guideline were noted across the Border Rivers basin, principally due to insufficient data being available for calculation of a WQO under the Border Rivers Healthy Waterways targets. High chlorophyll *a* concentrations (> 50 µg/L) were recorded in Autumn samples from sites 3, 11 and 16 (refer Table 4.4). Sixteen exceedances were noted across the Condamine River basin. The majority of dissolved oxygen saturation exceedances were noted in Summer/Autumn within the Border Rivers basin and the Condamine River basin.

- Patterns of water quality degradation were noted within several of the waterways across the sampling period, indicating the likelihood of influence from adjoining land use practices. Specifically:
 - Within both Border Rivers and Condamine River basins, nutrient (primarily TP and TN) concentrations were recorded as exceeding WQOs, indicating limited improvement of water quality with an increase from low flow conditions to higher flow.
 - Twenty-five exceedances in total phosphorous were recorded across the Border Rivers basin and 16 exceedances were recorded across the Condamine River basin. The majority of TP exceedances were noted in Summer/Autumn across both basins.
 - Twenty-two TN exceedances were recorded across the Border Rivers basin and 18 exceedances were recorded across the Condamine River basin. The highest number of TN exceedances were noted in Summer/Autumn across both basins.
 - Twenty-seven ammonia exceedances were recorded across the Border Rivers basin and 28 exceedances were recorded across the Condamine River basin. The highest number of ammonia exceedances were noted in Summer/Autumn across both basins.
- In general, WQO guidelines for metals were typically met across all assessable water quality monitoring sites for the survey period. Exceedances within five specific dissolved metals (arsenic, copper, lead, nickel and zinc) across the sampling were recorded. Four arsenic, four copper and one zinc exceedances were recorded in the Border River basin and 13 copper, one lead and four nickel exceedances were recorded in the Condamine River basin.
- Laboratory analysis of PAH concentrations at all sites were below detection limits, indicating no continued point source contamination of sampled sites. However, it is recognised that these compounds are volatile and do not maintain persistence in surface waters.

Typically, exceedances in WQO guidelines were most notable during Summer/Autumn (as the end of the wet season). Noting the lack of precipitation and surface water flow during the sampling period, the highest exceedances and nature of exceedances indicate continuing degradation of standing pools in low flow, or no flow conditions.

Surface water quality site investigation results are provided in Appendix B and a general description of each site is provided in Appendix C, Table C-1.

6.2.3 Field and laboratory assessed water quality results

6.2.3.1 Queensland Border Rivers basin

Macintyre Barwon Floodplain (Sites 1 to 2)

Water quality at Macintyre Barwon Floodplain water type sites was considered to be relatively good, with pH ranging from 6.77 to 7.76 and low electrical conductivity (refer Table 6.7). Turbidity and total suspended solids were typically within WQO, with intermittent exceedances. Similarly, nutrient concentrations had intermittent exceedances of WQO with Site 2 consistently exceeding total nitrogen and phosphorus, chlorophyll *a* and reactive phosphorus concentrations (refer Table 6.8).

Dissolved metal concentrations were consistently low, with cadmium, chromium, copper, lead, zinc and mercury below laboratory detection limits. A single exceedance for copper at site 2 in November 2018 was noted against ANZG 95% aquatic system protection WQO guidelines (refer Table 6.9). The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Table 6.7 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – physico-chemical

Physico-chemical		pH	Temp (°C)	DO (% Sat)	EC (µS/cm)	Salinity (mg/L)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25	-	-	-	-
Basin Plan											
Low flow		7.4 to 8.0	-	60 to 110	240	-	30	25	-	-	-
High flow		7.0 to 7.5	-	60 to 110	180	-	110	70	-	-	-
Site	Field Trip										
1R	Jun 2018	7.45	13.5	52.5	283	0.14	25.9	28	13	11	78
2	Jun 2018	Not sampled									
	Nov 2018	7.74	25.5	83.8	224	0.10	53.2	27	12	10	71
	Feb 2019	6.77	28.7	101.6	211	0.11	22.9	23	13	11	78
	Apr 2019	7.23	21.6	76.2	216	0.10	11.2	10	16	13	93
	May 2019	7.76	16.8	84.6	299	0.14	13.0	12	15	8	70
2R	Jun 2018	7.61	14.0	57.5	239	0.12	13.4	<5	10	8	58
	Nov 2018	7.27	25.0	90.2	223	0.1	96.0	43	12	9	67
	Feb 2019	7.31	28.9	89.5	211	0.11	25.7	24	13	11	78
	Apr 2019	7.68	22.3	71.6	215	0.10	12.2	7	16	13	93

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.8 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – nutrients

Nutrients (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan											
Low flow		0.02	-	-	0.010	-	-	0.575	0.07	0.02	3
High flow		ID	-	-	0.195	-	-	0.9	0.15	ID	ID
Site	Trip										
1R	Jun 2018	0.02	<0.01	<0.01	<0.01	0.6	0.6	0.6	0.1	<0.01	<2
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									
2	Jun 2018	Not sampled									
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.12	0.04	9
	Feb 2019	0.07	<0.01	0.17	0.17	0.5	0.6	0.8	0.16	0.13	2
	Apr 2019	0.03	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.08	0.04	5
	May 2019	0.02	<0.01	<0.01	0.02	0.7	0.7	0.7	0.03	<0.01	7
2R	Jun 2018	0.02	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.05	0.01	<1
	Nov 2018	<0.01	<0.01	0.02	0.02	0.5	0.5	0.5	0.015	0.04	5
	Feb 2019	0.03	<0.01	0.16	0.16	0.6	0.6	0.8	0.16	0.13	2
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.4	0.4	0.4	0.06	0.03	4

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.9 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – dissolved metals

Dissolved metals (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
1R	Jun 2018	0.002	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	Not sampled							
	Feb 2019	Not sampled							
	Apr 2019	Not sampled							
2	Jun 2018	Not sampled							
	Nov 2018	0.003	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.004	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.003	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	May 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
2R	Jun 2018	0.002	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	0.003	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.004	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.003	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG 2018, ELA 2019

Lower Macintyre Brook (Sites 3 to 8)

Water quality at sites in the Lower Macintyre Brook water type zone was characterised by low dissolved oxygen saturation, higher electrical conductivity and simultaneously elevated turbidity and total suspended solids (refer Table 6.10). In contrast to the Macintyre Barwon Floodplain water type sites, the Lower Macintyre Brook water type sites demonstrated higher impact from the reduced flow environmental conditions throughout the impact assessment area. Nutrient data also demonstrated low flow conditions, with exceedances ammonia and total nitrogen through the majority of samples (refer Table 6.11). Total phosphorus and oxidised nitrogen exceedances were also noted in May 2019 at Site 7.

Dissolved metal concentrations were consistently low, with arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury below laboratory detection limits (refer Table 6.12). The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Canning Creek (Sites 9 to 20)

Water quality at sites in the Canning Creek water type zone was characterised by elevated electrical conductivity and instances of alkaline pH observations exceeding local WQO guidelines (refer Table 6.13). Turbidity and total suspended solids were elevated, with Sites 14 and 16 demonstrating a continuing increase in turbidity and suspended solids (exceeding WQO guidelines) from initial water quality samples in June 2018 to the final sample in April 2019. Adherence to nutrient WQO guidelines were typically poor, with exceedances in ammonia, total nitrogen and total phosphorus occurring for all sites (refer Table 6.14).

Dissolved metal concentrations were consistently low, with cadmium, chromium, lead, zinc and mercury below laboratory detection limits. Exceedances for copper at site 16 during November 2018, February 2019 and April 2019 was noted against ANZG 95% aquatic system protection WQO guidelines (refer Table 6.15). The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Table 6.10 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – physico-chemical

Guideline		pH	Temp (°C)	DO (% Sat)	EC (µS/cm)	Salinity (mg/L)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25		-	-	-
Basin Plan											
Low Flow		7.4 to 8.0	-	60 to 110	370	-	11	10	-	-	-
High Flow		7.2 to 8.0	-	60 to 110	250	-	25	25	-	-	-
Site	Trip										
3	Jun 2018	5.58	10.7	46.1	383	0.2	9.7	<5	11	10	69
	Nov 2018	7.33	23.8	89.1	406	0.19	6.5	<5	14	10	76
	Feb 2019	6.65	25.1	50.1	357	0.19	6.9	8	15	10	79
	Apr 2019	7.77	19.6	63.4	423	0.20	14.7	12	20	12	99
6	Jun 2018	7.97	10.2	52.7	334	0.17	17.2	20 ¹	9	8	55
	Nov 2018	7.08	21.0	51.4	427	0.2	20.8	14	15	10	79
	Feb 2019	7.20	25.1	49.7	389	0.20	15.1	12	16	10	81
	Apr 2019	7.45	18.4	53.1	433	0.21	13.7	10	20	12	99
7	Jun 2018	7.80	10.3	48.7	337	0.17	18.0	18	9	9	60
	Nov 2018	7.46	25.2	76.3	434	0.2	15.0	9	15	10	79
	Feb 2019	7.29	26.6	55.3	409	0.21	12.2	12	17	11	88
	Apr 2019	7.64	19.2	51.2	430	0.21	8.2	6	21	12	102
	May 2019	7.55	16.8	79.3	449	0.21	7.3	6	19	11	93

Table notes:

Values outside of all guidelines are shaded orange.

All units mg/L unless stated otherwise.

- = No values available

¹ Result was outside the relative percent difference criterion of 35%.

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.11 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan											
Low Flow		0.008	-	-	0.018	-	-	0.71	0.055	0.011	ID
High Flow		ID	-	-	ID	-	-	0.91	0.07	ID	ID
Site	Trip										
3	Jun 2018	0.04	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	<2
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.6	0.04	<0.01	7
	Feb 2019	0.04	<0.01	<0.01	<0.01	1	1	1	0.06	<0.01	12
	Apr 2019	0.02	<0.01	<0.01	<0.01	1.6	1.6	1.6	0.08	<0.01	65
6	Jun 2018	0.03	<0.01	0.05	0.05	0.8	0.8	0.8	0.04	<0.01	<2.0
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.7	0.05	<0.01	4
	Feb 2019	0.05	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.06	<0.01	5
	Apr 2019	0.03	<0.01	<0.01	<0.01	1.1	1.1	1.1	0.04	<0.01	10
7	Jun 2018	0.04	<0.01	0.15	0.15	0.9	0.9	1	0.04	<0.01	<2
	Nov 2018	<0.01	<0.01	0.02	0.02	0.7	0.7	0.7	0.06	<0.01	5
	Feb 2019	0.05	<0.01	0.03	0.03	1	1	1	0.04	<0.01	6
	Apr 2019	0.03	<0.01	0.09	0.09	1.1	1.1	1.2	0.04	<0.01	14
	May 2019	0.05	<0.01	0.24	0.24	1	1	1.2	0.02	<0.01	7

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.12 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
3	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
6	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
7	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	May 2019	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable.

All units mg/L unless stated otherwise.

- = No values available

Source: ANZG 2018, ELA 2019

Table 6.13 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – physico-chemical

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25		-	-	-
Basin Plan											
Low Flow		7.2 to 7.8	-	60 to 110	200	-	35	25	-	-	-
High Flow		6.9 to 7.9	-	60 to 110	165	-	50	60	-	-	-
11	Jun 2018	8.18	10.4	67.6	213	0.15	17	15	11	7	56
	Nov 2018	8.21	23.7	103.1	286	0.13	21	14	13	6	57
	Feb 2019	7.00	25.7	65.0	236	0.12	25	23	12	6	55
	Apr 2019	7.27	16.6	66.0	297	0.14	64	104	16	8	73
14	Jun 2018	7.70	14.7	64.30	160	0.10	44	20	4	7	39
	Nov 2018	8.09	22.5	86.60	248	0.11	37	<5	5	9	50
	Feb 2019	8.19	28.0	101.40	307	0.16	74	39	6	12	64
	Apr 2019	7.46	19.2	61.70	353	0.17	104	44	7	16	83
16	Jun 2018	7.66	12.6	56.30	184	0.11	147	32	14	4	51
	Nov 2018	7.82	18.8	82.30	382	0.17	161	56	27	8	100
	Feb 2019	8.39	29.4	120.00	636	0.33	259	170	25	12	112
	Apr 2019	7.62	19.5	32.00	1255	0.62	>1000	2170	42	18	179
18	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	7.22	28.4	57.9	311	0.16	60.6	18	28	7	99
	Apr 2019	7.52	19.4	53.7	320	0.15	23.8	8	34	8	118
	May 2019	7.84	16.0	39.7	332	0.15	36.3	14	29	7	101

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25		-	-	-
Basin Plan											
Low Flow		7.2 to 7.8	-	60 to 110	200	-	35	25	-	-	-
High Flow		6.9 to 7.9	-	60 to 110	165	-	50	60	-	-	-
20R	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	Not Sampled									
	Apr 2019	7.31	19.9	32.8	154	0.08	8.63	10	19	6	72

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

- = No values available

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.14 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan		0.001	-	-	0.006	-	-	0.52	0.03	0.008	ID
Low Flow		ID	-	-	ID	-	-	0.60	0.04	ID	ID
11	Jun 2018	0.02	<0.01	0.02	0.02	0.9	0.9	0.9	0.06	<0.01	<2
	Nov 2018	<0.01	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.11	<0.01	40
	Feb 2019	0.04	<0.01	<0.01	<0.01	2.2	2.2	2.2	0.15	<0.01	23
	Apr 2019	0.02	<0.01	<0.01	<0.01	5.7	5.7	5.7	0.33	<0.01	460
14	Jun 2018	0.25	<0.01	<0.01	<0.01	1.0	1.2	1.2	0.03	<0.01	<1
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.7	0.03	<0.01	3
	Feb 2019	0.05	<0.01	<0.01	<0.01	1.6	1.6	1.6	0.07	<0.01	6
	Apr 2019	0.03	<0.01	<0.01	<0.01	2.3	2.3	2.3	0.10	<0.01	16
16	Jun 2018	0.02	<0.01	<0.01	<0.01	1.0	1.0	1.0	0.11	<0.01	<4
	Nov 2018	0.06	<0.01	0.01	0.01	1.3	1.4	1.4	0.17	<0.01	8
	Feb 2019	0.06	<0.01	0.02	0.02	4.1	4.2	4.2	0.31	<0.01	54
	Apr 2019	1.50	0.05	0.02	0.07	29.6	31.1	31.2	3.93	<0.01	545
18	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	0.03	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.10	<0.01	7
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	4
	May 2019	0.02	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	5

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan											
Low Flow		0.001	-	-	0.006	-	-	0.52	0.03	0.008	ID
High Flow		ID	-	-	ID	-	-	0.60	0.04	ID	ID
20R	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	Not Sampled									
	Apr 2019	0.02	<0.01	<0.01	<0.010	1.6	1.6	1.6	0.32	0.10	21

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019a; ELA 2019

Table 6.15 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
11	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
14	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
16	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Apr 2019	0.004	<0.0001	<0.001	0.002	<0.001	0.009	<0.005	<0.0001
18	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001
	May 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
20R	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	Not Sampled							
	Apr 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.004	0.008	<0.0001

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG 2018, ELA 2019

6.2.3.2 Condamine River basin

Southern Condamine (Sites 21 to 26)

Water quality at sites in the Southern Condamine River water type zone was characterised by elevated electrical conductivity and instances of diminished dissolved oxygen saturation (refer Table 6.16). Turbidity and total suspended solids were elevated in exceedance of WQO guidelines for the majority of instances where assessable water was present. Adherence to nutrient WQO guidelines were typically poor, with exceedances in ammonia, total nitrogen and total phosphorus occurring for both of the Southern Condamine River water type zone sites (refer Table 6.17), with additional exceedances in chlorophyll *a* WQO guidelines noted.

Dissolved metal concentrations were consistently low, with cadmium, chromium, zinc and mercury below laboratory detection limits. Single exceedances against ANZG 95% aquatic system protection WQO guidelines were noted for copper and lead from Site 24 during November 2018 and February 2019 (refer Table 6.18). The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Table 6.16 Water quality results for Site 23 and 24 in the Southern Condamine – physico-chemical

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25	-	-	-	-
Basin Plan		7.2 to 7.9	-	60 to 110	170	-	9	8	-	-	-
Low Flow		7.0 to 7.6	-	60 to 110	160	-	25	17	-	-	-
High Flow											
Site	Trip										
23	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	7.18	32.0	84.70	267	0.14	8.0	8	23	8	90
	Apr 2019	7.38	19.3	68.60	290	0.14	31.1	18	30	10	116
24	Jun 2018	7.77	7.9	45.90	345	0.16	239	98	14	11	80
	Nov 2018	8.18	30.9	89.50	580	0.27	251	194	27	18	142
	Feb 2019	7.42	27.2	47.80	281	0.14	135	60	13	8	65
	Apr 2019	Not Sampled									

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

- = No values available

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.17 Water quality results for Site 23 and 24 in the Southern Condamine – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan											
Low Flow		0.006	-	-	0.003	-	-	0.595	0.045	0.015	5
High Flow		ID	-	-	ID	-	-	0.830	0.060	0.020	ID
Site	Trip										
23	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	0.03	<0.01	<0.01	<0.01	1.4	1.4	1.4	0.10	0.02	2
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.9	0.9	0.9	0.06	<0.01	7
24	Jun 2018	0.04	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.07	<0.01	<4
	Nov 2018	0.08	<0.01	0.01	0.01	4.1	4.2	4.2	0.51	0.03	28
	Feb 2019	0.04	<0.01	<0.01	<0.01	1.8	1.8	1.8	0.35	0.07	9
	Apr 2019	Not Sampled									

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.18 Water quality results for Site 23 and 24 in the Southern Condamine – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
23	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	0.003	<0.005	<0.0001
24	Jun 2018	<0.001	<0.0001	<0.001	0.001	<0.001	0.005	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.004	<0.001	0.006	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	0.001	0.006	<0.001	<0.005	<0.0001
	Apr 2019	Not Sampled							

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG 2018, ELA 2019

Central Condamine (Sites 27 to 33)

Water quality at sites in the Central Condamine River water type sites was characterised by elevated variable dissolved oxygen saturation, instances of alkaline pH and significant turbidity and total suspended solid WQO guideline exceedances (refer Table 6.19). Significant oversaturation of dissolved oxygen and an increase in chlorophyll *a* concentration (refer Table 6.20) was noted from Sites 27 and 28 during February 2019 indicating potential diurnal fluxes in surface water dissolved oxygen concentrations due to algal growth. Exceedances in chlorophyll *a* across most of the sampled Sites aligns with the majority exceedances noted in ammonia, total nitrogen and total phosphorus (refer Table 6.20).

Dissolved metal concentrations were consistently low for arsenic, cadmium, chromium, lead, zinc and mercury with numerous exceedances noted for copper and nickel (refer Table 6.21). Exceedances in copper concentrations were noted for Site 27 during June 2018 and April 2019, Site 28 during February 2019 and April 2019, Site 29 during April 2019, Site 30 during November 2018 and Site 33 during November 2018. Exceedances in nickel concentrations were noted from Site 28 in February 2018 and April 2019, Site 29 during April 2019 and Site 32 during February 2019. The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Table 6.19 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – physico-chemical

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25	-	-	-	-
Basin Plan		7.4 to 8.3	-	60 to 110	890	-	25	25	-	-	-
Low Flow		7.0 to 7.6	-	60 to 110	290	-	220	130	-	-	-
High Flow											
Site	Trip										
27	Jun 2018	8.50	10.0	85.0	352	0.28	51.8	28	40	24	199
	Nov 2018	Not sampled									
	Feb 2019	8.34	30.3	134.1	503	0.26	87.5	74	37	25	195
	Apr 2019	7.72	17.2	50.6	233	0.11	671	214	21	12	102
28	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	9.13	35.2	233.6	519	0.27	75.6	73	26	22	156
	Apr 2019	7.93	23.1	21.1	315	0.15	477	175	30	18	149
29	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	8.04	22.0	35.0	307	0.14	77.8	48	33	23	177
30	Jun 2018	-	14.3	65.5	356	0.22	30.0	11	29	18	146
	Nov 2018	8.83	28.8	104.6	507	0.24	98.1	63	22	19	133
	Feb 2019	8.45	25.1	59.6	365	0.19	43.0	35	25	16	128
	Apr 2019	7.71	18.7	70.4	449	0.21	95.6	70	34	26	192

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25	-	-	-	-
Basin Plan											
Low Flow		7.4 to 8.3	-	60 to 110	890	-	25	25	-	-	-
High Flow		7.0 to 7.6	-	60 to 110	290	-	220	130	-	-	-
32	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	7.80	23.4	82.2	588	0.30	11.5	95	37	27	204
	Apr 2019	Not sampled									
33	Jun 2018	Not sampled									
	Nov 2018	7.70	25.2	106.8	212	0.10	42.9	15	12	7	59
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.20 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan		0.004 ID	-	-	0.004	-	-	0.86	0.17	0.02	9
Low Flow			-	-	0.480	-	-	2.2	0.95	0.50	4
High Flow											
Site	Trip										
27	Jun 2018	0.03	<0.01	<0.01	<0.01	0.90	0.9	0.9	0.11	<0.01	5
	Nov 2018	Not sampled									
	Feb 2019	0.05	<0.01	0.01	0.01	2.20	2.2	2.2	0.23	<0.01	53
	Apr 2019	0.08	<0.01	<0.01	<0.01	1.40	1.5	1.5	0.51	0.04	24
28	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	0.07	<0.01	<0.01	<0.01	5.10	5.2	5.2	0.43	0.02	56
	Apr 2019	0.04	<0.01	<0.01	<0.01	1.50	1.5	1.5	0.31	0.01	26
29	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	0.03	<0.01	<0.01	<0.01	1.80	1.8	1.8	0.66	0.37	18
30	Jun 2018	0.02	<0.01	<0.01	<0.01	0.50	0.5	0.5	0.07	<0.01	<2
	Nov 2018	0.10	0.01	0.03	0.04	4.50	4.6	4.6	0.39	0.05	57
	Feb 2019	0.06	<0.01	<0.01	<0.01	5.10	5.2	5.2	0.43	0.02	50
	Apr 2019	0.03	<0.01	<0.01	<0.01	3.30	3.3	3.3	0.38	<0.01	72

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan		0.004 ID	-	-	0.004	-	-	0.86	0.17	0.02	9
Low Flow			-	-	0.480	-	-	2.2	0.95	0.50	4
32	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	0.09	<0.01	<0.01	<0.01	3.70	3.8	3.8	0.43	0.03	90
	Apr 2019	Not sampled									
33	Jun 2018	Not sampled									
	Nov 2018	0.03	<0.01	<0.01	<0.01	1.00	1.0	1.0	0.23	0.05	3
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.21 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine –dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
27	Jun 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.006	<0.005	<0.0001
	Nov 2018	Not sampled							
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	0.007	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.002	<0.001	0.008	<0.005	<0.0001
28	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	0.005	<0.0001	<0.001	0.002	<0.001	0.012	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.005	<0.001	0.011	<0.005	<0.0001
29	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	Not sampled							
	Apr 2019	0.003	<0.0001	<0.001	0.005	<0.001	0.015	<0.005	<0.0001
30	Jun 2018	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.003	<0.001	0.004	<0.005	<0.0001
	Feb 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.003	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.006	<0.005	<0.0001
32	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.011	<0.005	<0.0001
	Apr 2019	Not sampled							

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033 [#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
33	Jun 2018	Not sampled							
	Nov 2018	<0.001	<0.0001	<0.001	0.004	<0.001	0.008	<0.005	<0.0001
	Feb 2019	Not sampled							
	Apr 2019	Not sampled							

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable

All units mg/L unless stated otherwise.

- = No values available

Source: ANZG 2018, ELA 2019

Oakey Creek (Sites 34 to 43)

Water quality at sites in the Oakey Creek water type sites was characterised by alkaline pH and elevated electrical conductivity (refer Table 6.22). Turbidity and total suspended solids were typically within WQO, with intermittent exceedances. Adherence to nutrient WQO guidelines were typically poor, with exceedances in ammonia, total nitrogen and total phosphorus occurring for the three Sites (refer Table 6.23).

Exceedances in chlorophyll *a* WQO guidelines noted for Sites 39 during November 2018, February 2019 and April 2019 and Site 40 during November 2018.

Dissolved metal concentrations were consistently low for arsenic, cadmium, chromium, lead, nickel, zinc and mercury with several exceedances noted for copper (refer Table 6.24). Exceedances in copper concentrations were noted for Site 39 during November 2018 and April 2019, Site 40 during November 2018 and Site 42 during November 2018. The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

Table 6.22 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – physico-chemical

Guideline		pH units	Temp (°C)	DO (%Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness as CaCO ₃ (mg/L)
ANZG WQO		6.5 to 7.5	-	90 to 110	30 to 350	-	2 to 25	-	-	-	-
Basin Plan											
Low flow		7.7 to 8.3	-	60 to110	510	-	13	14	-	-	-
High flow		7.4 to 8.1	-	60 to110	375	-	55	65	-	-	-
Site	Trip										
39	Jun 2018	8.12	14.0	75.5	2318	1.25	11.3	8	73	137	746
	Nov 2018	8.36	28.2	121.6	1731	0.86	20.5	14	65	94	549
	Feb 2019	8.54	29.4	148.2	2632	1.48	35.2	30	42	169	801
	Apr 2019	8.24	20.3	106.2	1843	0.92	21.9	20	87	122	720
40	Jun 2018	8.42	10.4	74.6	1320	0.69	8.1	10	51	82	465
	Nov 2018	8.25	24.8	92.0	692	0.33	12.5	9	32	38	236
	Feb 2019	Not Sampled									
	Apr 2019	8.13	20.4	88.6	680	0.33	40.6	26	37	48	290
42	Jun 2018	8.52	9.80	72.8	1287	0.69	4.6	6	55	81	471
	Nov 2018	8.30	32.5	116.7	1157	0.56	6.1	10	49	67	398
	Feb 2019	8.44	30.8	146.6	1339	0.73	10.3	8	43	91	482
	Apr 2019	8.15	22.9	85.0	850	0.41	14.6	12	48	60	367
	May 2019	8.25	16.2	105.4	1339	0.64	5.5	<5	62	86	509

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.23 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll a (µg/L)
ANZG WQO		0.013	-	-	0.015	-	-	-	0.03	0.015	-
Basin Plan											
Low flow		0.010	-	-	0.005	-	-	1.000	0.110	0.045	5
High flow		ID	-	-	ID	-	-	1.280	0.340	0.09	ID
Site	Trip										
39	Jun 2018	0.04	0.01	0.51	0.52	0.3	0.3	0.8	0.02	<0.01	<1
	Nov 2018	0.05	<0.01	<0.01	<0.01	0.4	0.5	0.5	0.11	<0.01	13
	Feb 2019	0.06	<0.01	<0.01	<0.01	0.9	1.0	1.0	0.08	<0.01	12
	Apr 2019	0.04	<0.01	0.07	0.07	0.6	0.6	0.7	0.06	<0.01	31
40	Jun 2018	0.02	<0.01	<0.01	<0.01	0.3	0.3	0.3	0.02	<0.01	<1
	Nov 2018	0.06	0.02	0.72	0.74	0.3	0.4	1.1	0.20	0.02	7
	Feb 2019	Not Sampled									
	Apr 2019	0.02	0.02	0.90	0.92	0.3	0.3	1.2	0.06	0.02	4
42	Jun 2018	0.02	<0.01	1.25	1.25	0.2	0.2	1.4	0.01	<0.01	<1
	Nov 2018	0.05	<0.01	0.82	0.82	0.2	0.2	1.0	0.17	0.01	<1
	Feb 2019	0.06	0.02	0.69	0.71	0.3	0.4	1.1	0.02	<0.01	3
	Apr 2019	0.05	0.02	1.25	1.27	0.2	0.2	1.5	0.04	0.02	2
	May 2019	0.03	0.02	1.38	1.4	0.2	0.2	1.6	<0.01	<0.01	1

Table notes:

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

- = No values available

ID = Insufficient data for determination of water quality objective

Source: ANZG, 2018; DES, 2019b; ELA, 2019

Table 6.24 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
ANZG WQO		0.024	0.0002	0.0033#	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan		-	-	-	-	-	-	-	-
Site	Trip								
39	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.004	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.007	<0.005	<0.0001
	Feb 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.006	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.002	<0.001	0.010	<0.005	<0.0001
40	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.003	<0.001	0.004	<0.005	<0.0001
	Feb 2019	Not Sampled							
	Apr 2019	<0.001	<0.0001	<0.001	0.002	<0.001	0.003	<0.005	<0.0001
42	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	May 2019	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001

Table notes:

Orange shading where value is above WQO or outside WQO range where applicable

All units mg/L unless stated otherwise.

- = No values available

Source: ANZG ,2018

6.3 Summary of existing water quality conditions

Water quality data from collected samples has been compared to historical water quality data from DNRME's Macintyre Brook, Condamine River and Gowrie Creek gauging stations, as a general proxy for the impact assessment area. This comparison has identified that water quality values recorded during sampling for the Project are typically consistent with similar data obtained from the corresponding gauging stations.

Historic water quality was typically outside of WQOs with TSS exceeding WQOs both historically and within the current assessment. Total nitrogen and phosphorus as a typical anthropogenic contaminant was also consistent with historical data, with WQO exceedances recorded across all sampling events. Water quality across the impact assessment area was typically considered average to poor with typical patterns of alkaline pH, high electrical conductivity, elevated concentrations of suspended sediment, nutrients and instances of diminished dissolved oxygen concentrations.

Data from the gauging stations showed that the majority of water quality parameters (i.e. TSS, ammonia, total nitrogen and total phosphorus) did not meet WQOs. The gauging station data indicates that discharge within Macintyre Brook and Gowrie Creek was variable. Similarly, the Condamine River exhibited no flow conditions for much of the sampling period.

Due to the continued dry conditions, an assessment of sampling data obtained from a high flow period was not possible. Therefore, the summary of the existing conditions is limited to low – no flow conditions. Although water quality is expected to degrade under 'first flush' conditions with a return to high flow, it is expected that water quality during high-flow (post first flush) would have highest receiving assimilative capacity to reduced water quality from inflow.

Low, medium and high Aquascore riverine wetlands are modelled along the Project alignment. Alongside the poor condition noted under the sustainable rivers audit, the scores suggest that connectivity remains the degrading factor for the health of both basins. The water quality monitoring sites with Low Aquascores were those associated with sections of the Canning Creek and the Central Condamine water type zones. Those with Medium Aquascores were on sections of the Canning Creek, Southern Condamine, Central Condamine and Oakey Creek water type zones. Those with High and Very High Aquascores were on sections of the Canning Creek, Macintyre Barwon Floodplain, Lower Macintyre Brook, Canning Creek, Central Condamine and Oakey Creek.

In summary, water quality conditions observed within the impact assessment area are considered to be consistent with, and typical of, those expected during a period of extended dry conditions. Water quality impacts due to the diminished flow conditions were observed throughout the assessment. The existing water quality within the impact assessment area is considered average, with expectation of a period of poorer water quality coinciding with an initial return to base flow due to catchment run-off after an extended drier period.

6.4 Potential impacts

Potential surface water quality impacts will be avoided/minimised through initial mitigation through design responses and proposed in situ mitigation measures as required (refer Section 7.1 and Section 7.2, respectively). Potential impacts were assessed with consideration of the existing surface water quality condition, sensitivity of water quality receptors (including acknowledgment of downstream impacts and the assimilative capacity of the surrounding catchment).

The assessment of surface water quality impacts has also included consideration of the assimilative capacity of the receiving environment through historic and existing compliance with existing WQOs. Currently, the existing water quality conditions do not meet all the WQO values for each catchment. As such, the assimilative capacity was assessed within qualitative risk of degradation of water quality (against WQO) from potential Project impacts.

It generally considered likely that the assimilative capacity of the waterways within the impact assessment area will be greater during higher flow conditions (refer Appendix E). In contrast, the lowest assimilative capacity and highest realisation of impact would occur during periods of extended low flow (such as those currently experienced).

Potential impacts from the Project are expected to have the highest risk during periods of higher flow condition. However, this aligns with the highest assimilative capacity of the waterway, reducing overall impact magnitude.

The following sections provide a summarised discussion of the potential direct and indirect impacts to surface water quality as a consequence of Project activities.

6.4.1 Impacts to surface water quality

6.4.1.1 Construction impacts

Potential direct and indirect impacts to surface water quality that may arise due to construction activities for the Project are discussed in Table 6.25. Impacts include those to the water feature itself, in addition to receptors that may be indirectly impacted due to alterations in water quality, such as fish species, riparian vegetation etc.

Table 6.25 Potential construction impacts to water quality and impacting processes

Potential impact	Impacting process
Increased debris load in waterways, thereby reducing the aesthetic quality of downstream waterway systems. Debris may also impact on the health of aquatic and terrestrial fauna, particularly if ingested.	Potential for rubbish and debris from construction sites to be blown off or washed away from a construction area into nearby waterways, due to poor housekeeping or loss of containment.
Altered water quality, principally from increased water turbidity and sedimentation. Suspended sediments can clog fish and invertebrate gills, decrease light availability for aquatic plants and reduce visibility for fish. Furthermore, localised high sediment contamination can become a barrier to migration of some species that then decline in abundance due to restriction in range or loss of seasonal habitat above the contaminated reach (ANZECC, 2000).	Increased sediment loading of waterways may arise due to: - Construction activities that involved the clearance of vegetation and disturbance of topsoil, thereby leaving subsoils exposed to erosional processes. In turn, this may result in elevated sediment concentrations in surface runoff - Construction works involving disturbance to the riparian corridor (e.g. removal of riparian vegetation, alterations to the profile of banks) may indirectly result in erosion and scouring of streambanks - Physical disturbance of stream beds and banks during the establishment of culverts and bridges, leading to a reduction in stability during construction of creek crossings - Dewatering associated with the decommissioning of artificial waterbodies that intersect the Project alignment may cause an increase in erosion and sedimentation of waterways if the discharge of that water is not adequately managed.
Altered water chemistry, including an increase in salinity. Alterations to water chemistry may impact on the aquatic ecosystem condition of the downstream waterway system, as well as affect the useability of downstream waters for purposes such as irrigation, farm supply, stock use, recreation etc.	Water chemistry may be altered due to the following processes: - Salinity: - Disturbance and exposure of saline soils during construction, which could increase salinity in overland flows. The Project alignment directly intersects moderate to high salinity hazard rating areas (refer Figure 5.15), which may result in discharge of saline runoff into proximal waterways. The risk is considered to be low where there is existing disturbance at points where the Project alignment crosses the waterways, e.g. existing rail corridor. - Changes to riparian vegetation communities, stockpiling of sediment and Project-associated earthworks may result in saline discharge at drainage points into watercourses proximal to high salinity hazard areas.

Potential impact	Impacting process
	■ Nutrient loading: – Nutrient s may migrate into waterways with sediment lost from cleared areas and from stockpiles. This has the potential to: ■ Change light conditions and water temperature ■ Smother aquatic life and prevent photosynthesis for aquatic flora ■ Affect downstream environments ■ Impact upon breeding and lifecycle of aquatic fauna. ■ Contaminants and toxicants: – Accidental spills and leaks of chemicals or fuels from construction equipment or fuel storages, which could introduce chemicals into overland flows – Chemical spills, due to inappropriate storage controls resulting in an introduction into waterways of fuels and oils used for construction machinery – Contaminants may also leach from the following sources during construction: ■ Residual heavy metals from rail grinding and welding, ■ Compounds adhered to ballast materials – Dewatering activities leading to liberation of toxicants from potentially contaminated land – Contaminated land disturbance – if any nearby contaminated lands are disturbed near waterways, there is the potential for contamination from runoff on these waterways.

Wastewater consists of:

- Domestic wastewater, i.e. water used in toilets, showers, baths, kitchen sinks and laundries
- Industrial or trade waste, i.e. from manufacturing and industrial operations. This includes liquid waste from any process (e.g. water used to cool machinery or clean plant and equipment).
- Stormwater (including discharge from dewatering), i.e. water that would flow, without intervention, untreated into waterways.

Quantities of wastewater that may be generated during construction of the Project cannot be established as the construction methodology is subject to confirmation. For example, volumes of wastewater generated through activities such as dewatering of excavations and pier holes will be dependent on the Principal Contractor's approach to constructing Project elements such as bridge piers. The following sections discuss each of the potential sources of wastewater during construction and provide details on the proposed management approach for each.

Domestic wastewater

Sources of domestic wastewater during construction will be restricted to the following:

- Toilets and kitchenette facilities provided in site office locations along the Project footprint
- Portaloos established at work fronts
- Operation of up to three non-resident workforce accommodation facilities.

It is expected that each of these potential sources of domestic wastewater will be self-contained and will not require discharge of wastewater to sewer or to waterways.

Wastewater generated through the use of toilets and kitchenette facilities in office sites and work fronts will be captured and containerised. It is expected that this wastewater will be collected by a licensed waste contractor and taken offsite for disposal at an appropriately licensed wastewater facility.

Each non-resident workforce accommodation facility will have a 300 bed capacity, with occupancy expected to vary from 150 to 300 persons depending on the construction schedule. Based on an average dry weather flow (ADWF) sewage input of 150 litres per person per day (L/EP/d), between 22.5 and 45.0 kilolitres of wastewater may be generated on each accommodation facility, per day. This ADWF volume is the lower end of the 150-275 L/EP/d suggested by the Water Services Association of Australia Sewerage Code (WSAA 2002). However, the lower ADWF value is considered appropriate for a non-resident workforce accommodation as the accommodation residents will not be in residency during construction hours. Wastewater generated from non-resident workforce accommodation will be treated in temporary package sewage treatment plants located on site (estimated capacity of 300 equivalent population).

Industrial or trade waste

Sources of industrial or trade waste during construction will be limited, but may include:

- Precast concrete facility and concrete batch plant
- Vehicle and plant washdown facilities, located in laydown areas, non-resident workforce accommodation or concrete batching facilities.

Two locations have been identified for the temporary siting of a precast concrete facility and concrete batch plant for the Project (refer Table 6.26). Whilst two locations have been nominated, only one plant is expected to be necessary to supplement the supply of concrete from established plants. The proposed locations are immediately north and south of the Condamine River floodplain outside the 1% AEP flood line.

Table 6.26 Precast concrete facility and concrete batch plant locations

ID ¹	Location	Chainage	Description
B2G-LDN150.5	Gore Highway and Dieckmann Road	Ch 150.5 km	Precast concrete facility and concrete batch plant - north
B2G-LDN137.0	Gore Highway	Ch 137.0 km	Precast concrete facility and concrete batch plant - south

Table note:

1 Refer to drawings in Volume 3 of the draft EIS

Once appointed, the Principal Contractor will assess the need for a concrete batching facility and will be responsible for applying for and obtaining the necessary approvals to establish and operate the precast concrete facility and concrete batch plant.

Where industrial or trade waste may be generated by construction activities, the resultant wastewater will be captured and, where possible, recycled. Where recycling is not feasible, the captured wastewater will be collected by a licensed contractor and taken offsite for disposal at an appropriately licensed wastewater facility.

Stormwater

Sources of stormwater and other wastewater during construction may include:

- Stormwater runoff from construction sites
- Water that is discharged from dewatered excavations and trenches
- Water that accumulates in cuts due to groundwater seepage.

Temporary site drainage and water management controls will be installed in order to minimise the impacts of runoff and sedimentation from construction activities on adjacent receptors. Temporary site drainage and water runoff management will be in line with the International Erosion Control Association's Best Practice Erosion and Sediment Control Document and will:

- Minimise runoff and sedimentation from Project activities to existing watercourses and drainage features
- Minimise disturbance to the water quality of existing watercourses and drainage features along the Project alignment.

The reference design includes 17 sediment basins, as identified in Table 2.4. All of the proposed sediment basins are passive which allows surface runoff from a catchment to flow into the sediment basin without the need for pumping. The locations of sediment basins are shown in working plans and longitudinal sections presented in Volume 3 of the draft EIS.

The placement and sizing of sediment basins for the Project has been established based on the landform and earthworks required to construct the reference design. Therefore, the placement and sizing of sediment basins will need to be reassessed and revised, as required, as part of the detail design process. Sufficient allowance has been included in the Project footprint for sediment basins to be relocated and/or resized, as required to support the detail design.

Other temporary stormwater retention structures, other than those listed in Table 2.4, may be required in order to prevent the direct discharge of stormwaters leaving the construction site directly into waterways.

In addition to sediment basins, construction sites will be set out, through a combination of landform and use of temporary erosion and sediment control measures, in a manner to minimise the volume of surface runoff that flows across the cleared areas within the construction footprint. Construction sites will also be established to ensure that potential sources of contamination (e.g. fuels and other hazardous materials) are appropriately stored and bundled.

In the first instance, stormwater and water that is dewatered from excavations (i.e. trenches and pits) or private storages within the Project footprint that are being decommissioned will be directed to a temporary retention structure where the water will be retained in order to allow suspended solids to settle out of suspension and for evaporation to occur. If waters are to be discharge from site, either directly or indirectly, it will done in a manner that ensures the discharged water is compliant with the relevant WQOs for the receiving waterway (refer Section 3.2).

Predictive modelling for groundwater seepage has determined that seepage may occur from the face of deep cuts (>10 m) where groundwater is intersected. However, the assessment has concluded that seepage water, in general, will evaporate due to local climate conditions and relatively small volumes when considered with the length of the cuts. For example, cut 310-C37 is predicted to encounter seepage volumes of 0.23 L/s and 3.3 L/s across the entire surface of a 2.29 km cut, to 29.7 m depth. As such, there it is not anticipated that a means of capturing, treating and depositing of seepage water will be required during construction.

6.4.1.2 Operation and maintenance impacts

Potential direct and indirect impacts to surface water quality that may arise due to operation and maintenance activities for the Project are discussed here. Impacts include those to the water feature itself, in addition to receptors that may be indirectly impacted due to alterations in water quality, such as fish species, riparian vegetation etc. Many of the potential impacts, and impacting processes, are consistent with those that may occur during construction (refer Table 6.25) and full duplication of details has not been provided.

Operation and maintenance impacts to surface water quality may include:

- Increased debris due to rubbish and debris from operations blown off or washed away from the rail corridor into proximal watercourses
- Introduction of contaminants from a variety of sources during operation and maintenance due to:
 - Oil and grease spills – there is the potential for oil and grease from rolling stock to enter the waterways after heavy rainfall events
 - Residual heavy metals from maintenance rail grinding and welding
 - Leaching of compounds that are adhered to ballast materials
 - Leaching of materials from within the rail formation, if localised material encapsulation or embankment zoning were to fail

- Accidental spills from freight carriages during routine operations
- Chemicals, including fuels and oils used for maintenance machinery
- Structural failure – with the introduction of bridge or culverts within waterways, should these structures fail, there is the potential for impacts to water quality either from potential contaminants (debris) or from detained water flushing from collapsed structures. Furthermore, structural failure has the capacity to alter flow regimes and increase potential secondary salinity issues, with flow on issues resulting in surface water quality degradation.
- Maintenance – maintenance of the rail line or machinery near waterways (such as the crossing loops associated with Macintyre Brook at approximate Ch 50.20 km to Ch 52.40 km) has the potential to mobilise sediments from disturbed areas and increase the potential for litter or rubbish to enter waterways. Furthermore, oils and greases and other contaminants such as metals have the potential to enter waterways from spills, and for impact from the use of environmental toxicants (such as biocides) to maintain operating infrastructure areas. These activities have the potential to impact nearby waterways, through discharge points without appropriate mitigation.
- Increase in rates of erosion and resultant sedimentation of waterways, due where soils are exposed as a consequence of unsuccessful site rehabilitation.

Operation phase wastewater volumes cannot be established as the frequency and nature of maintenance activities, and rate of wastewater generation, will vary between Project components and be in response to asset age and condition. In any event, wastewater generated during operation and maintenance will be infrequent and small in volume.

Point source discharge of stormwater for the Project is anticipated only to occur where longitudinal drainage connects to location of cross-drainage. The purpose of longitudinal or track drainage is to remove water that has percolated through the track ballast, and to divert surface runoff to the nearest bridge or culvert location before it reaches the subgrade. Without adequate track drainage, the subgrade may become saturated leading to weakening and subsequent failure of the subgrade.

Two types of track drainage are proposed:

- Embankment drains – longitudinal drains that run parallel to the railway and are located within the rail corridor, at the foot of the railway embankment
- Catch drains – longitudinal drains that run parallel to the railway and are located within the rail corridor, on the up-slope side of cuttings.

Track drainage is proposed at specific locations along the Project alignment where the gradient is steep enough to divert surface runoff to the nearest bridge or culvert location. The design and location of track drainage will be refined, if required, during the detail design phase.

Discharges of stormwater from the rail corridor are only likely to occur during weather events that contribute to inputs to the local waterway system from other sources at the same time, e.g. agricultural properties, road surfaces. Therefore, the impact of stormwater discharges into the local water system during such events are likely to be negligible.

As a means of verifying this, theoretical stormwater quality modelling was undertaken using MUSIC modelling to compare the existing discharge conditions within the impact assessment area with the discharge conditions due to longitudinal drainage infrastructure included in the reference design. The modelling compared total suspended solids, total phosphorous and total nitrogen levels in existing discharge conditions against stormwater discharged from longitudinal drains that were applied with 3.5 m buffer strips within 100 m swales before the point of discharge. Swales are grassed or vegetated broad, shallow channels used to collect and convey stormwater flows, promote infiltration, reduce stormwater peak flow rates and discharge volumes, and remove sediments. Swales use a combination of physical and biochemical processes to treat stormwater (Department of Water, 2011). Buffer strips are vegetated areas that reduce sediment loads from water flowing through them. Buffer strips are aligned perpendicular to the water flow. They are commonly used in conjunction with swales (Department of Water, 2011).

The modelling indicated that impacts to rural areas associated with potential stormwater discharges are expected to be negligible with buffering from swales producing discharge of a better quality (reduced concentrations) than typical for rural areas. Therefore, with proposed treatment measures in place, water quality leaving the rail corridor is expected to be like or better than runoff from the existing condition of the rural environments. The proposed Project treatment requirements are considered adequate for water quality receptors provided sufficient buffer strips and swales are provided.

Modelled operational discharge along the Project alignment is predicted to contain suspended solids and nutrients in concentrations higher than forested conditions. However, these pollutant loads would be expected to be discharged from a comparable area of nearby rural catchment. It is expected that these will be contained within the areas of targeted rehabilitation zones and be limited in impact. Although impacts to water quality are theoretically possible, these will be mitigated with the provision of grassed rehabilitation strips along the length of the rail formation. Any impacts are likely to be minor and associated with highly constrained sites where a buffer strips and swales cannot be provided.

6.4.2 Impacts to waterway morphology

The reference design does not require permanent diversion of any watercourses, as defined under the Water Act. However, three drainage features (not mapped watercourses under the Water Act) defined as waterways under the Fisheries Act are expected to require diversion based on the reference design (refer Section 5.6.3 and Figure 2.1).

One trapezoidal diversion drain is required from Ch 120.77 km to Ch 121.92 km to divert runoff from the west away from the rail alignment, which is located in cut in this chainage range. The rail in cut intersects two waterway flow paths at Ch 120.77 km and Ch 121.43 km. The diverted flow returns to the original flow path 750 m downstream of the rail at Ch 120.77 km. The diversions from Ch 120.77 km to Ch 121.92 km are identified as low risk-of-impact waterways under the DAF Queensland Waterways for Waterway Barrier Works spatial mapping.

An additional trapezoidal diversion drain is proposed where the rail embankment overlays an existing flow path. This affected flow path runs for 150 m from Ch 190.66 km to Ch 190.81 km. The diversion from Ch 190.66 km to Ch 190.81 km is identified as a low risk of impact waterway under the DAF Queensland Waterways for Waterway Barrier Works spatial mapping. Where waterway diversions are necessary for unmapped waterways following the finalisation of design, then a watercourse determination will need to be made in order to confirm approval requirements.

The level of risk relating to each waterway will be considered during detail design of all structures located within the bankfull width of waterways, such as culverts, bridges (piers and abutments) and other potential barriers. A list of cross-drainage infrastructure points along the Project alignment is provided in Appendix P: Surface Water Technical Report. Designs will need to be in accordance with the DAF factsheet 'What is not a waterway barrier work?', or accepted development requirements for operational work that is constructing or raising waterway barrier works, or under a relevant development approval.

In-stream works will need to be undertaken in accordance with Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works (DAF, 2018) for lower risk watercourses. In-stream works for higher risk watercourses will be planned and undertaken in accordance with applicable assessment benchmarks for assessable development. Where in-stream works are developed in accordance with applicable accepted development requirements or acceptable outcomes within relevant codes, works are expected, at a minimum, to reduce increases in barriers for water movement during construction.

In-stream works will also need to be undertaken in accordance with the requirements of the Riverine Protection Permit Exemption Requirements (DNRME, 2018a). ARTC is an 'approved entity' for exemption from the requirement for Riverine Protection Permit applications. As such activities associated with in-stream disturbance works will be exempt from requiring approval as long as the exemption requirements are adhered to.

6.4.3 Impacts to surface water availability and users

The construction and operation water requirements of the Project have been discussed in Section 2.6.1.

Extraction of water from a watercourse typically requires:

- A water entitlement, water allocation, water licence or water permit. Applications for resource entitlements are assessed against relevant criteria in the Water Act and relevant water resource plan and resource operations plan.
- A development permit for use of water that is assessable development under the Planning Act.

Water allocation licence data indicates that 285,999 ML per year is allocated within several management areas (under Water Regulation 2016) that intersect the impact assessment area. For further information regarding surface water licencing within the impact assessment area, refer to Appendix P: surface water quality technical report.

There is the potential to impact upon licenced users of surface water if the quality of water or the flow of water changes within offtake locations on, or associated with:

- Canning Creek
- Condamine River
- Macintyre River
- Westbrook Creek
- Oakey Creek.

The hydrological modelling indicated minimal changes to the existing hydrological regime in relation to surface water resource use and was considered as representative of both local and regional risk of impact in regard to changes to riparian vegetation and channel alteration from interference with existing waterways and wetlands.

In a worst case, impacts to water quality as a result of Project activities during construction may have temporary impacts to local water users, potentially restricting access to human drinking water, stock water and crop irrigation.

Aquatic ecosystems have the most stringent WQOs of the EVs that are of relevance to the impact assessment area. Therefore, implementing mitigation measures to ensure protection of aquatic ecosystems, protection of other EVs and water users downstream of the Project will be achieved.

The detail design will be developed to ensure that, where possible:

- Private water storages are avoided
- Affected landowners retain access to existing natural resources.

If impacts to either of the above cannot be avoided through design, appropriate compensation arrangements will be discussed and agreed with the relevant impacted landowner.

7 Mitigation measures

This section provides discussion of mitigation measures and controls that have been incorporated into the reference design development process, as appropriate and where possible (refer Section 7.1), as well as those measures that are proposed to be adopted for future phases of Project delivery (refer Section 7.2).

7.1 Mitigation through the reference design phase

Development of the reference design for the Project has progressed in parallel with the impact assessment process. As a consequence, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the reference design as appropriate and where possible.

Mitigation measures and controls that have been factored into the design, or otherwise implemented during the reference design phase for impacts to surface water quality and resources, are as follows:

- The Project utilises the existing South Western Line and Millmerran Branch Line rail corridors as much as possible to avoid introducing a new linear infrastructure corridor across watercourses and floodplains, where possible
- The reference design has been developed to minimise impacts to watercourses, riparian vegetation and in-stream flora and habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts
- Watercourse crossing structures (including culverts and bridges) are designed to minimise the need for ongoing maintenance and inspection to maintain aquatic fauna passage (e.g. fish and turtles) and minimise the risk of blockages in reference to *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (1 October 2018) (DAF, 2018)
- Bridges and waterway crossings are designed to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements (as per requirements of DAF and the Fisheries Act)
- The reference design has been developed to avoid the need to permanently divert watercourses, as defined and mapped under the Water Act. Three drainage features (not mapped under the Water Act) defined as waterways under the Fisheries Act may require diversions based on the reference design
- Bridge structures are provided in the reference design over the following watercourses, to minimise disturbance of aquatic habitats:
 - Macintyre River
 - Macintyre Brook
 - Pariagara Creek
 - Cattle Tree Creek
 - Native Dog Creek
 - Bringalily Creek
 - Nicol Creek
 - Back Creek
 - Grasstree Creek
 - Condamine River
 - Condamine River North Branch
 - Westbrook Creek
 - Dry Creek

- Scour protection measures have been included around culvert entrances and exits, on disturbed stream banks and on land bound by a watercourse to avoid erosion. Scour protection or energy dissipation measures have been specifically designed and sized for each culvert location in accordance with Austroads Guide to Road Design Part 5B: Drainage – Open Channels, Culverts and Floodways (Austroads, 2013b) (AGRD) with consideration for flow velocity, soil type and vegetation cover. Scour protection measures incorporated into the reference design for culverts include:
 - Concrete apron
 - Concrete wingwalls
 - Rock mattress scour protection, with geotextile underlay
- Scour protection measures for culvert outlets have been designed to ensure that the maximum allowable flow velocities in a 1% AEP, as specified in Table 3.1 of AGRD, are not exceeded. Maximum allowable flow velocities in Table 3.1 of AGRD are specific to the soil type at each culvert location, as follows:
 - Stable rock – 4.5 m/s
 - Stones 150 mm diameter or larger – 3.5 m/s
 - Gravel 100 mm or grass cover – 2.5 m/s
 - Firm loam or stiff clay – 1.2 to 2 m/s
 - Sandy or silty clay – 1.0 to 1.5 m/s
- The scour protection length and minimum rock size (d50) have been determined from Figure 3.15 and Figure 3.17 in AGRD. All required scour lengths are predicted to fit within the rail corridor.
- The reference design includes 17 sediment basins. All sediment basins are passive which allows surface runoff from a catchment to flow into the sediment basin without the need for pumping.
- Longitudinal drains have been designed to include 3.5 m buffer strips within 100 m swales before the point of discharge into the local waterway system.

7.2 Proposed mitigation measures

In order to manage and mitigate project risks, several mitigation measures have been proposed for implementation in future phases of project delivery. These proposed mitigation measures have been identified to address Project specific issues and opportunities.

Table 7.1 identifies the relevant Project phase, the aspect to be managed and the proposed mitigation measure. The mitigation measures presented in Table 7.1 have then been factored into the assessment of residual impact significance, as documented in Table 8.1.

In addition to the mitigation measures identified in Table 7.1 and as part of the detail design stage, when finalised positions of infrastructure elements (e.g. abutments/piers etc.) are known and detailed soil surveys are complete, geomorphological assessment of identified risk locations will be undertaken.

Chapter 22: Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

Table 7.1 Surface water mitigation measures for future phases of Project delivery

Delivery phase	Aspect	Mitigation and management measures
Detail design	Erosion and sediment control	■ Develop a Soil Management Sub-plan which includes the following procedures and protocols relevant to potential impacts on land resources: – Soil/land conservation objectives for the Project – Management of problem soils, such as: ■ Acid sulfate soils, which may occur in proximity to wetland features and water storages ■ Erosive or dispersive soils, such as sodosols that are expected to be encountered between the Macintyre River and Yelarbon as well as along the fertile lands north of Inglewood to the west of Kooroongarra ■ Cracking clays (vertosols) that are expected to be encountered between Koorongara and Millmerran and from Yandilla to Gowrie ■ Saline soils, particularly in high salinity hazard areas such as between Kurumbul and Yelarbon. – Specification of the type and location of erosion and sediment controls. The erosion and sediment control measures will be developed by a Certified Professional in Erosion and Sediment Control and be in accordance with the International Erosion Control Association Best Practice Erosion and Sediment Control (2008). The Soil Management Sub-plan will include: ■ Locations for specific temporary/permanent erosion and sediment control measures, such as: – Sediment retention basins – Scour protection (included in the reference design) – Sediment fencing – Berms and other surface flow diversions. ■ Nomination of location-specific erosion controls will include consideration of site conditions, proximity to environmental receptors, adjoining land uses, climatic and seasonal factors, and will be based on an erosion risk assessment. ■ Minimise the area of disturbance during each stage to that required to enable the safe construction, operation and maintenance of the rail corridor: ■ Scheduling of works with consideration to periods of higher rainfall (summer months) ■ Establish and specify the monitoring and performance objectives for handover on completion of construction ■ Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material ■ Vehicle, machinery and imported fill hygiene protocols and documentation, in accordance with the requirements of the <i>Biosecurity Act 2014</i> – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction.
	Interference with existing surface water	■ The detail design will be developed to ensure that the potential for diversion of watercourses, (as defined under the Water Act), and waterways (as defined under the Fisheries Act) are minimised. ■ The detail design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with the intent of: – <i>Riverine protection permit exemption requirements</i> (WSS/2013/726) – <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> (DAF, 2018)

Delivery phase	Aspect	Mitigation and management measures
		- Where the Project is unable to comply with the <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> (DAF, 2018), a development approval for operational work that is constructing or raising waterway barrier works will be required. - Where the Project is unable to comply with the exemption requirements, a riverine protection permit will be required for works within a watercourse.
	Water quality	- A Surface Water Management Sub-plan will be developed as a component of the CEMP. The Sub-plan will provide a surface water monitoring framework for the Project that establishes: - Additional monitoring and sampling required to establish baseline water quality conditions, as a continuation of data collected during development of the draft EIS. Baseline water quality conditions will preferentially utilise water quality monitoring sites used within the draft EIS, with consideration of construction activities, seasonality and watercourse sensitivity. These will be monitored, at a minimum monthly, for a period of 12 months prior to commencement of construction to determine baseline conditions as a reference for monitoring of impact (as per QWQG). - Watercourse-specific water quality values, based on baseline data, ANZG, QWQG and relevant WQOs - Frequency and location of surface water sampling during construction of the Project, with consideration for: - Construction activities with potential to impact water quality - Seasonality - Sensitivity of receiving watercourse - In situ water quality parameters (pH, EC, dissolved oxygen, temperature, ORP and TDS) and laboratory analysis required for samples collected at each sampling location - QA/QC requirements for surface water sampling and analysis - A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment - Responses to impact threshold exceedances (to be determined after the establishment of baseline water quality conditions) - Data management and reporting requirements - The Surface Water Management Sub-plan will be developed in consultation with DNRME and DES prior to implementation for construction, after the establishment of location specific impact thresholds.
	Availability of water to users	- The detail design will be developed to ensure that, where possible, private water storages are avoided and that affected landowners retain access to existing natural resources - If impacts to access to existing natural resources cannot be avoided through design, appropriate compensation arrangements will be discussed and agreed with the relevant impacted landowner. - Where the Project will result in disturbance to private surface water storages (e.g. dams), ARTC will consult with the owners of relevant, legal storage structures prior to works commencing to agree an approach to decommissioning or relocation of the structure. This may also include the usage or relocation of stored water and compensation (if applicable).

Delivery phase	Aspect	Mitigation and management measures
	Construction water	■ The construction water requirements (volumes, quality, demand curves, approvals requirements and lead times) will be confirmed through the construction approach refinement process. The refinement process will utilise a hierarchical approach to confirming the suitability of water sources, with a focus on utilising existing sustainable allocated water entitlements from private water-holders. The ultimate water sourcing strategy for the Project will be documented in a Construction Water Plan and be dependent on: – Climatic conditions in the lead up to construction – Confirmation of private water sources made available to the Project by landowners under private agreement – Confirmation of access agreements with local governments for sourcing of mains water. ■ Licenses, approvals and agreements to access water from sources identified in the finalised Construction Water Plan will be obtained. These may include water licenses under the Water Act or access agreements with bulk water suppliers or private landowners. ■ ARTC to review the ability for the take of water to be done in accordance with the <i>Exemption requirements for construction authorities for the take of water without a water entitlement (WSS/2013/666)</i>
	Rehabilitation	■ A Rehabilitation and Landscaping Management Sub-plan will be developed for the Project, as a component of the CEMP. This Sub-plan will be based on the Inland Rail Landscape and Rehabilitation Strategy, in addition to location and property specific reinstatement commitments. The Plan will include and clearly identify: – Location-specific objectives for rehabilitation, reinstatement and/or stabilisation. – Objectives and timeframes for rehabilitation and/or reinstatement/stabilisation works (including biodiversity, vegetation establishment and erosion and sediment control outcomes to be achieved) – Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, whilst minimising the duration of exposure in disturbed areas – Include rehabilitation requirements such as: ■ Milling and removal of bitumen pavement ■ Removal of any decommissioned culverts ■ Tying and ripping of base and sub-base material ■ Application of soil ameliorants ■ Topsoiling and/or compost blanket ■ Stabilisation and rehabilitation (e.g. planting and or seeding). – Consideration for maintenance or performance issues of rehabilitation – Sourcing of water for rehabilitation and landscaping purpose from a sustainable, under applicable permits or licences, or in accordance with exemption requirements – Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas – Corrective actions if the outcomes of rehabilitation and/or reinstatement/stabilisation are not achieved. ■ Where temporary construction facilities/borrow pits are required, land will be returned to a stable condition that complies with the conditions of applicable landowner agreements and regulatory approvals (e.g. development approval and/or EA).
Pre-construction	Erosion and sediment control	■ Install initial erosion and sediment controls in support of pre-construction minor civil works, e.g. establishing laydown areas, in accordance with the Soil Management Sub-plan

Delivery phase	Aspect	Mitigation and management measures
Construction	Erosion and sediment control	- Implement the Soil Management Sub-plan, including erosion and sediment controls. - Install permanent erosion control measures, such as sediment retention basins and scour protection, in accordance with the detail design and erosion and sediment control plans - Monitor the effectiveness of erosion controls installed as part of the environmental inspection schedule for the Project, as prescribed in the CEMP. - Controls that are found to be failing or not performing as intended will either be modified or replaced, as required - Clearing extents are limited to the Project footprint, and clearing is scheduled to minimise the exposure time of unprotected earth to prevent sedimentation of receiving waterways. - Where practical, vegetation clearing, and ground disturbing works will be staged sequentially across the Project to minimise areas exposed to erosion and sediment risk of receiving waterways.
	Dewatering	- Where the dewatering of excavations (e.g. trenches, pier holes etc.) is required, water will need to meet the established WQOs for receiving waterways before being released/discharged into local waterways. - If dewatering of existing storages is required, dewatering strategies will be required to comply with the <i>Biosecurity Act 2014</i> to take reasonable measures to avoid the spread of pest species, e.g. screening of pump intake.
	Construction water	- The extraction of water will occur in accordance with licenses, approvals and/or agreements - Volume monitoring during extraction will be required for each source point, with extraction logs maintained - If the <i>Exemption requirements for construction authorities for the take of water without a water entitlement (WSS/2013/666)</i> are considered to be applicable to ARTC and the Project, then the take of water will occur in accordance with the exemption requirements - Extraction reporting will occur, as required, in accordance with requirements of relevant licenses, approvals and/or agreements obtained to cover this activity.
	Water quality	- Implementation of the Surface Water Management Sub-plan (refer above). - Water will need to meet the established WQOs for receiving waterways before being released/discharged into local waterways. Water that does not comply with relevant water quality objectives will either be: - Treated on-site to enable discharge - Used for construction water purposes that is not quality dependent, if safe to do so (e.g. dust suppression) - Removed from site for disposal at an appropriately licensed facility. - Bulk storage areas for dangerous goods and hazardous materials will be located away from areas of social and environmental receptors such that offsite impacts or risks from any foreseeable hazard scenario will not exceed the dangerous dose for the defined land use zone, i.e. either sensitive, commercial/community, or industrial, in accordance with the intent of the SPP. - Licensed transporters operating in compliance with <i>Australian Code for the Transport of Dangerous Goods by Road & Rail</i> will be utilised for the transportation of dangerous goods - Chemicals stored and handled as part of construction activities will be managed in accordance with: - The <i>Work Health Safety Act 2011</i> (Qld) and Regulation, - AS 2187 Explosives – storage, transport and use - AS 1940:2017 Storage and Handling of Flammable and Combustible Liquids

Delivery phase	Aspect	Mitigation and management measures
		– AS 3780:2008 The Storage and Handling of Corrosive Substances – The requirements of chemical safety data sheets. ■ Procedures will be established for safe and effective fuel, oil and chemical storage and handling. This includes storing these materials within roofed, bunded areas. The bunding will have floors and walls that are lined with an impermeable material to prevent leaching and spills. ■ Construction tasks will be scheduled to avoid, where possible, bulk earthwork activities within the 1% AEP during periods of elevated flood risk. Where works cannot be scheduled outside of this time period, activity-specific flood readiness and response planning will be required. This planning will be developed in consultation with the relevant local government and QFES. ■ Laydown areas and other construction facilities that are located within the 1% AEP will be temporary. Their planning and function in supporting construction will reflect the local flood risk. For example, hazardous goods will not be bulk stored in these locations. ■ Mobile plant will not be stored in the 1% AEP when not scheduled to be in use for construction purposes. ■ Plant maintenance and refuelling will be carried out a minimum of 50 m from riparian vegetation and waterways, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. Appropriate spill control materials including booms and absorbent materials will be onsite at refuelling facilities at all times. ■ Appropriate waste bins will be located in laydown areas to facilitate segregation and appropriate containment of waste materials
	Rehabilitation	■ Reinstatement, stabilisation and rehabilitation of disturbed areas will be undertaken progressively, consistent with the Rehabilitation and Landscaping Management Sub-plan.
Operation	Water quality	■ Cross drainage structures will be inspected to assess physical condition and performance, structural integrity and corrective measures in accordance with ARTC's engineering codes of practice ■ Plant maintenance and refuelling will be carried out in accordance with ARTC work instructions, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater.
	Erosion and sediment control	■ The effectiveness of permanent erosion controls (e.g. scour protection or vegetated swales) will be monitored as part of the maintenance inspection schedule for the Project, as prescribed in the Operation EMP. ■ Controls that are found to be failing or not performing as intended will either be modified or replaced, as required. ■ The integrity of rail embankments will be maintained to prevent slope face scour and degradation. ■ Maintenance of surface and subsurface drains will be required to ensure continued effectiveness and to minimise risk of impact to surrounding and downstream environments and structures.

7.3 Monitoring

7.3.1 Baseline monitoring

Additional monitoring and sampling of surface water within the impact assessment area will be conducted prior to the commencement of construction to:

- Determine baseline conditions as a reference for monitoring of impact
- Enable location specific guideline values to be developed
- Inform finalisation of the Surface Water Management Sub-plan.

Baseline water quality conditions will preferentially be undertaken at water quality monitoring sites previously monitored for development of the EIS (refer Table 4.4). These will be monitored at quarterly intervals (minimum), for a period of 12 months prior to commencement of construction (as per QWQG). Additional monitoring and sampling may also be undertaken in response to large rain events.

Surface water quality data will be collected at accessible sites in accordance with the DES Monitoring and Sampling Manual (DES, 2018e).

At each sampling location, the following in-situ parameters will be recorded

- Dissolved oxygen (mg/L) and saturation (per cent)
- pH
- Electrical conductivity (µs/cm)
- Temperature (°C)
- Turbidity (NTU)
- Total dissolved solids (ppm)
- Oxidation reduction potential (mV).

Samples will also be collected from each site for laboratory analysis for the following analytes:

- Conductivity and salinity
- Total suspended solids
- Total hardness as CaCO₃ (Alkalinity)
- Nutrient suite (ammonia, nitrite, nitrate, total nitrogen, TKN, nitrogen oxides, reactive P and total P)
- Organic nitrogen
- Dissolved metals (eight metals suite: arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury)
- PAHs
- Chlorophyll *a*.

Samples will be submitted for analysis to a National Association of Testing Authorities accredited laboratory.

Monitoring data will be used to establish baseline water conditions prior to the commencement of construction. WQOs for waterways within the Project footprint, against which changes to water quality will be assessed, will be determined in reference to the relevant water quality guidelines, ANZECC/ARMCANZ 2000/2018 guidelines and baseline data. Where alternate guidelines are used to establish water quality objectives, justification for this will be provided.

Adopted WQOs will be documented in the Surface Water Management Sub-plan, as a component of the CEMP.

7.3.2 Construction monitoring

A Surface Water Management Sub-plan will be prepared as a component of the CEMP to establish the framework for the monitoring and management of water quality during construction of the Project. The Surface Water Management Sub-plan will be developed after the establishment of location specific WQOs. The Sub-plan will specify:

- Frequency and location of surface water sampling during construction of the Project, with consideration for:
 - Baseline conditions of waterways within the Project footprint, e.g. monitoring requirements for ephemeral waterways may differ for permanently flowing waterways
 - Construction activities with potential to impact water quality, such as those listed above
 - Seasonality
 - Sensitivity of receiving watercourse.
- Contingency and ameliorative measures in the event that adverse impacts to water quality are identified, with reference to the impact triggers defined as part of the water quality monitoring program, based on baseline data
- Quality assurance and quality control requirements for surface water sampling and analysis
- Data management and reporting requirements.

8 Impact assessment summary

Potential impacts on surface water associated with the Project in the construction and operation phases are outlined in Table 8.1. These impacts have been subjected to risk assessment as per the methodology in Section 4.2.

The initial risk assessment assumes that the design considerations (or initial mitigation measures) factored into the reference design for the Project (refer Section 7.1) have been implemented.

Additional mitigation and management measures (refer Table 7.1) were then applied to future phases of the Project to further reduce the level of potential impact and derive a residual significance of impact

The initial and residual significance of potential impacts are presented in Table 8.1 to demonstrate the effectiveness of mitigation measures.

Each potential impact is assessed for moderate and high sensitivity receptors. High sensitivity receptors being waterways with habitat values that support MNES and MSES, i.e. sections of Macintyre River, Macintyre Brook, Canning Creek and the Condamine River that intersect with the Project footprint. All other waterways are regarded as moderate sensitivity receptors.

Impacts on water quality are based on a model of expected occurrences, regarding projected impacts (potential and specific) from Project activities. As such, critical failure of infrastructure is not considered a viable impact for impact significance assessment.

Table 8.1 Initial and residual impact significance assessment for surface water

Aspect	Potential impact	Specific impact	Phase	Sensitivity	Initial impact significance ¹		Residual impact significance of risk ²	
					Magnitude	Significance	Magnitude	Significance
Erosion and sediment control	Increased debris	Contamination of waterway from debris from the Project to be blown into or washed into waterway	Pre-construction and construction	Moderate	Low	Low	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Low	Moderate	Negligible	Low
			Operation					
		Restriction of flow within the waterways if too much debris is introduced to waterway or is stuck in culverts or creek crossings	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
			Operation					
Water quality Waterways	Changes to receiving water quality and hydrology	Changes to receiving water quality from dewatering of artificial waterbodies	Pre-construction and construction	Moderate	Low	Moderate	Low	Low
Erosion and sediment control Water quality	Increase in salinity	Increased salinity in proximal watercourses from land disturbance	Pre-construction and construction	Moderate	High	High	Negligible	Low
				High ³	High	Major	Negligible	Low
Erosion and sediment control Water quality Waterways	Increase in contaminants	Contamination of waterway from inadequate storage of fuels, oils and contaminants	Pre-construction and construction	Moderate	Low	Low	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Low	Moderate	Negligible	Low
			Operation					
		Runoff from areas of disturbed contaminated lands nearby waterways	Pre-construction and construction	Moderate	Low	Low	Negligible	Low
			Pre-construction and construction	High ³	Low	Moderate	Negligible	Low
		Introduction of contaminants from stockpiled areas	Pre-construction and construction	Moderate	Low	Low	Negligible	Low
			Pre-construction and construction	High ³	Low	Moderate	Negligible	Low
		Contaminants can enter waterways after rainfall events from rolling stock or after weed control activities	Operation	Moderate	Moderate	Moderate	Negligible	Low
			Operation	High ³	Moderate	High	Negligible	Low

Aspect	Potential impact	Specific impact	Phase	Sensitivity	Initial impact significance ¹		Residual impact significance of risk ²	
					Magnitude	Significance	Magnitude	Significance
		Potential contamination of waterways from failed equipment or from failed infrastructure	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
			Operation					
Erosion and sediment control General interference with existing surface water	Increases in erosion and sedimentation	Disturbance of the bed, banks and riparian zone of waterways	Pre-construction and construction	Moderate	High	High	Negligible	Low
			Operation		Moderate	Moderate	Negligible	Low
			Pre-construction and construction	High ³	High	Major	Negligible	Low
			Operation		Moderate	High	Negligible	Low
		Increased turbidity and sedimentation; and potential mobilisation of contaminants through erosion from disturbance activities near waterways	Pre-construction and construction	Moderate	High	High	Negligible	Low
			Operation		Moderate	Moderate	Negligible	Low
			Pre-construction and construction	High ³	High	Major	Negligible	Low
			Operation		Moderate	High	Negligible	Low
		Increased turbidity and potential mobilisation of contaminants from stockpiled areas	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
		Increased turbidity and potential mobilisation of contaminants from dewatering activities near excavations	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
		Increased sedimentation can impact the function of culverts/creek crossing and impede flow of the waterway	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Operation		Low	Low	Negligible	Low
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
			Operation		Low	Moderate	Negligible	Low

Aspect	Potential impact	Specific impact	Phase	Sensitivity	Initial impact significance ¹		Residual impact significance of risk ²	
					Magnitude	Significance	Magnitude	Significance
Erosion and sediment control	Exacerbation of listed impacts above, from inadequate rehabilitation processes	Potential for sedimentation and increased turbidity within waterways if areas are either not rehabilitated or inadequate rehabilitation occurs	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
			Operation					
		Inadequate rehabilitation increasing erosion and sedimentation within waterways impacting the function of culverts/creek crossing and impeding flow of the waterway	Pre-construction and construction	Moderate	Moderate	Moderate	Negligible	Low
			Operation					
			Pre-construction and construction	High ³	Moderate	High	Negligible	Low
			Operation					
Waterway morphology	Alteration to the structure and function of waterways	Alteration to the structure of waterways, through diversions or introduction of infrastructure elements into the bankfull width, has potential to impact the physical characteristic of a waterway	Pre-construction and construction	Moderate and High ³	Moderate	High	Negligible	Low
			Operation		N/A	N/A	N/A	N/A
Water availability	Extraction of water for construction	Extraction of water, from multiple surface water sources, for the purpose of supporting construction activities has the potential to reduce the availability of water for other users within the relevant basins, if not planned and managed appropriately	Pre-construction and construction	Moderate and High ³	Moderate	High	Negligible	Low
			Operation		N/A	N/A	N/A	N/A

Table notes:

- 1 Includes implementation of design mitigation specified in Section 7.1
- 2 Includes proposed mitigation measures specified in Table 7.1
- 3 Macintyre River, Macintyre Brook, Canning Creek and the Condamine River

9 Cumulative impacts

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered. This section provides a discussion on the potential for cumulative impacts in relation to surface water quality. Details on the assessment methodology for cumulative impacts is presented in Section 4.3.

Projects with spatial and/or temporal overlap can result in cumulative impacts. Cumulative impacts may:

- Differ from those of an individual project when considered in isolation
- Be positive or negative
- Differ in severity and duration depending on the spatial and temporal overlap of projects occurring in an area.

Twenty three projects were initially identified as having potential to contribute to cumulative impacts in combination with the Border to Gowrie project. These projects are either currently operational, expected to undergo future expansion or are currently going through an approval process.

For the purposes of surface water quality, projects that will have temporal overlap in construction or expansion activities and may cause impacts to existing environmental values that are additive to impacts from the Project are considered to have potential to result in cumulative impacts. Only seven of the initial 23 projects identified meet these criteria. These projects are listed in Table 9.1.

Table 9.1 Projects considered within the cumulative assessment

Projects	Location	Description	Construction dates
New Acland Coal Mine Stage 3	35 km northwest of Toowoomba 18 km north of the Project footprint	Expansion of the existing New Acland open-cut coal mine to up to 7.5 million tonnes/annum.	The mine is operational. Stage 3 expansion works will proceed if legal proceeding end favourably for New Acland Coal
InterLinkSQ	13 km west of Toowoomba The northern limit of the Project is situated adjacent to the InterLinkSQ site	200 ha of new transport, logistics and business hub. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways.	2018 to unknown. Assumed to continue development until Inland Rail is operational
Asterion Medicinal Cannabis Facility	Wellcamp, QLD Adjoins the Project footprint 1 km south of Toowoomba-Cecil Plains Road	A high-tech medicinal cannabis cultivation, research and manufacturing facility. The project involves construction of a 40 ha glasshouse to produce 20,000 plants per day at full capacity. Medicinal grade cannabis grown at the facility will be manufactured into a range of medicinal products, including single patient packs, cannabis oils, gels, salts and related products, destined solely for the medicinal market. This facility is anticipated to be the largest facility of its kind in the world.	2020-2021
Commodore Mine and Millmerran Power Station	Domville, Queensland The Project is aligned adjacent to potential future coal reserves for the mine	The Commodore Mine is an open cut coal mine which provides coal for the 850 MW Millmerran Power Station. The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 million homes.	2001 to 2003 Subject to annual maintenance shutdown and continual pit expansion. Also potential for coal reserves to be accessed beyond the current footprint

Projects	Location	Description	Construction dates
Goondiwindi Abattoir	Goondiwindi, QLD 13 km north of the Project footprint	A new beef abattoir located on the outskirts of Goondiwindi with beef processing of up to 72,000 tonnes per year.	Unknown
North Star to Border (Inland Rail) – ARTC	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project at its southern limit	37 km single-track dual-gauge freight rail line as part of the ARTC Inland Rail Program.	2021 to 2024
Gowrie to Helidon (Inland Rail) – ARTC	Rail alignment from Gowrie to Helidon, QLD Adjoins the Project at its northern limit	26 km single-track dual-gauge freight railway as part of the ARTC Inland Rail Program	2021 to 2025

Water quality sampling has been undertaken to inform the baseline water quality conditions for the impact assessment area. Therefore, existing developments operating at their current scale and intensity have been factored into the establishment of background water quality conditions and the assessment of Project impacts.

Each of the projects listed in Table 9.1 has potential to result in one or more of the following impacts, which may overlap with those from that could occur due to the Project:

All of these projects may result in an extent of:

- Riparian vegetation loss reducing ecosystem services to water quality
- Impacts to aquatic fauna species through water quality and barrier works
- Reduction in waterway connectivity
- Increase in erosion and sedimentation of waterways
- Increase in contamination of waterways
- Saline discharge into proximal waterway (intra-catchment)
- Increase in surface expression within alluvial waterways.

An assessment of cumulative impacts that may arise from these projects in combination with the Project is presented in Table 9.2, with a summary of how potential cumulative impacts would be managed. This assessment has concluded that the cumulative surface water impacts of the Project are expected to be of **Low to Medium Significance**. The following factors contributed to this determination:

- Riparian vegetation loss from vegetation clearing/removal – loss of ecosystem service to water quality:

A potential exists for a cumulative impact from the loss of sensitive receptors (riparian vegetation communities) with works involving waterways and associated crossings across the projects. Impacts may be compounded with interface between the Project and other listed projects in regard to decreased resilience to biotic and abiotic factors. Potential consequences include loss of bank stability, loss of diversity and reduction in water quality values due to decreased performance of ecosystem services to water quality. The proximity of other projects to watercourses and inadequate rehabilitation on those projects and the Border to Gowrie Project would result in the highest risk of significant cumulative impact.

Interaction of impacts leading to a loss of ecosystem services or water quality are considered possible between the Project and the New Acland Coal Mine Stage 3 expansion, Asterion Medicinal Cannabis Facility, InterLinkSQ, Commodore Mine and Millmerran Power Station operations, and construction of the North Star to NSW/QLD Border and Gowrie to Helidon sections of Inland Rail.

- Potential impacts to aquatic fauna species both through impacts to water quality and barrier works:

There is potential for cumulative downstream impacts from water quality issues associated with overland works and waterway barrier works, if not appropriately managed. Cumulative impacts would be expected to occur in relatively short spatial distances (as cumulative point-source impacts) and would be expected to 'dilute' with increasing distance downstream from point source impact.

It is expected that cumulative impacts would be expected to occur between projects linked spatially and temporally during construction. As such, the current Project and North Star to NSW/QLD Border and Gowrie to Helidon sections of Inland Rail are expected to generate cumulative impacts, as well as Asterion Medicinal Cannabis Facility and InterLinkSQ.

- Permanent reduction in the connectivity of waterways:

There is potential for impact if not appropriately managed due to multiple permanent crossings, or temporary disturbances of waterways. If left unmanaged, these impacts would progressively accumulate between projects. Whole catchments may be impacted from separate projects on separate waterways. However, the greatest cumulative impacts would be expected where there is spatial interface between separate projects. Water quality degradation may arise from reduced waterway connectivity and the associated decrease in ecosystem resilience.

Cumulative impacts are most likely to arise due to projects in proximity to waterways that are crossed by the Border to Gowrie project, being the New Acland Coal Mine Stage 3 expansion, Asterion Medicinal Cannabis Facility, InterLinkSQ, Commodore Mine and Millmerran Power Station operations and construction of the North Star to NSW/QLD Border and Gowrie to Helidon sections of Inland Rail. Note that the Goondiwindi Abattoir is removed from this potential cumulative impact due to sub-catchment separation from the Project.

- Increase in erosion and sedimentation in waterways during construction:

Cumulative impacts may arise due to increase in waterway sedimentation from simultaneous construction activities within catchments. Cumulative impacts in regard to erosion may arise from impaction of waterway structure/hydrological regimes and may be further impacted by cumulative riparian vegetation loss.

Table 9.2 Summary of the cumulative impact assessment for surface water

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
New Acland Coal Mine Stage 3	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726) - Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply - The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Reduction in waterway connectivity	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Increase in surface salinity around alluvial waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Asterion Medicinal Cannabis Facility	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726) - Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works.	Probability of the impact	Medium (2)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
	Reduction in waterway connectivity	Probability of the impact	Low (1)	4	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Low (1)	4	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
Increase in waterway contamination	Probability of the impact	Low (1)	4	Low		
	Duration of the impact	Low (1)				
	Magnitude/intensity of the impact	Low (1)				
	Sensitivity of the receiving environment	Low (1)				

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
InterLinkSQ	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726) - Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works.	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Reduction in waterway connectivity	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Increase in surface salinity around alluvial waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Commodore Mine and Millmerran Power Station	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726) - Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works.	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Reduction in waterway connectivity	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low		
	Duration of the impact	Low (1)				
	Magnitude/intensity of the impact	Low (1)				
	Sensitivity of the receiving environment	Medium (2)				

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in surface salinity around alluvial waterways	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Goondiwindi Abattoir	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Low (1)	6	Low	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726) - Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Reduction in waterway connectivity	Probability of the impact	Low (1)	4	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low	The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in surface salinity around alluvial waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
North Star to Border (Inland Rail)	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts during construction will be managed through development and implementation of the following, as part of the CEMP: - Rehabilitation and Landscaping Management Sub-plan - Surface Water Management Sub-plan, including the establishment of baseline conditions and construction phase monitoring - Soil Management Sub-plan, including erosion and sediment control measures - Hazardous Materials Management Sub-plan The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: - Riverine protection permit exemption requirements (WSS/2013/726)
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Reduction in waterway connectivity	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Increase in erosion and sedimentation of waterways	Probability of the impact	Medium (2)	6	Low	- Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) - Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in surface salinity around alluvial waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Gowrie to Helidon (Inland Rail)	Riparian vegetation loss from vegetation clearing and /or removal	Probability of the impact	Medium (2)	7	Medium	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Potential impacts to aquatic fauna species both through impacts to water quality and barrier works	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
	Reduction in waterway connectivity	Probability of the impact	Medium (2)	6	Low	The potential for cumulative impacts during construction will also be managed through adherence to the following through detail design and construction: ■ Riverine protection permit exemption requirements (WSS/2013/726) ■ Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) ■ Permit/approval conditions if either of the previous two listed requirements cannot be adhered to or do not apply The success of riparian rehabilitation for the Project will be monitored to ensure that its contribution to riparian vegetation loss is appropriately rectified.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in erosion and sedimentation of waterways	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in waterway contamination	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Saline discharge into proximal waterways (intra-catchment scope)	Probability of the impact	Medium (2)	6	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increase in surface salinity around alluvial waterways	Probability of the impact	Low (1)	5	Low	
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Table notes:

- a Relevance factors between 1 and 3 were determined using professional judgement to select most appropriate relevance factor for each aspect and summing the relevance factors.
Sum of relevant factors definition:
- Low (1-6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program.
 - Medium (7-9): Mitigation measure likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
 - High (10-12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.
- b Impact significance is considered the residual impact after implementation of avoidance strategies and mitigation measures outlined in the comments and management measures.

10 Conclusions

The Project alignment traverses the Border Rivers and Condamine River basins. Existing surface water conditions within the impact assessment area have been established based on a review of published data and data which was collected for the Project through surface water monitoring and sampling. This sampling occurred over four separate sampling events between June 2018 and May 2019.

Review of historic and field assessed water quality data identified that surface waters within the impact assessment area do not currently achieve all WQOs for the protection of aquatic ecosystems within each basin.

All waterways within the impact assessment area have been identified as sensitive receptors within the receiving environment. Of these, a number of high sensitivity water quality receptors with associated EVs were identified within the impact assessment area. Associated EVs included MNES species and MSES wetlands. High sensitivity water quality receptors include the Macintyre River, Macintyre Brook, Canning Creek and the Condamine River.

It has been identified that the construction and operation the Project has the potential to impact on surface water quality through:

- Increased debris
- Change to water quality and hydrology
- Increase in salinity
- Increase in contaminants
- Increases in erosion and sedimentation
- Exacerbation of listed impacts above, from inadequate rehabilitation processes.

Additionally, the Project has potential to result in impacts to waterway morphology and the availability of surface waters for existing users.

A significance assessment was undertaken and assessed the residual impact of identified potential impacts after assessment of design considerations and additional mitigation measures. The assessment identified:

- During the construction phase, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate most potential impacts, such that the residual significance would be low
- For the operation phase, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate most potential impacts, such that the residual significance would be low.

The significance impact assessment has identified that with design considerations and mitigation measures in place, the risk of significance of impact from construction phase (including pre-construction) and operation phase activities is low. It is not expected that significant residual impact on surface water quality will be a result of Project activities.

A cumulative impact assessment considering the impact of five other Projects was carried out. The cumulative impacts of several projects within the impact assessment area included:

- Riparian vegetation loss from vegetation clearing/removal
- Potential impacts to aquatic fauna species both through impacts to water quality and barrier works
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of waterways
- An increase in erosion and sedimentation in the waterways
- An increase in litter (waste)

- Saline discharge into proximal waterways
- An increase in surface salinity around alluvial waterways.

These potential impacts were all considered to have carry on impacts to surface water quality within the cumulative impact assessment area.

The cumulative impact assessment identified a medium risk of potential impact occurring during construction activities due to riparian vegetation loss from vegetation clearing/removal. It is considered that the potential for these impacts will be appropriately managed through application of the suite of mitigation measures proposed for the Project in its own right.

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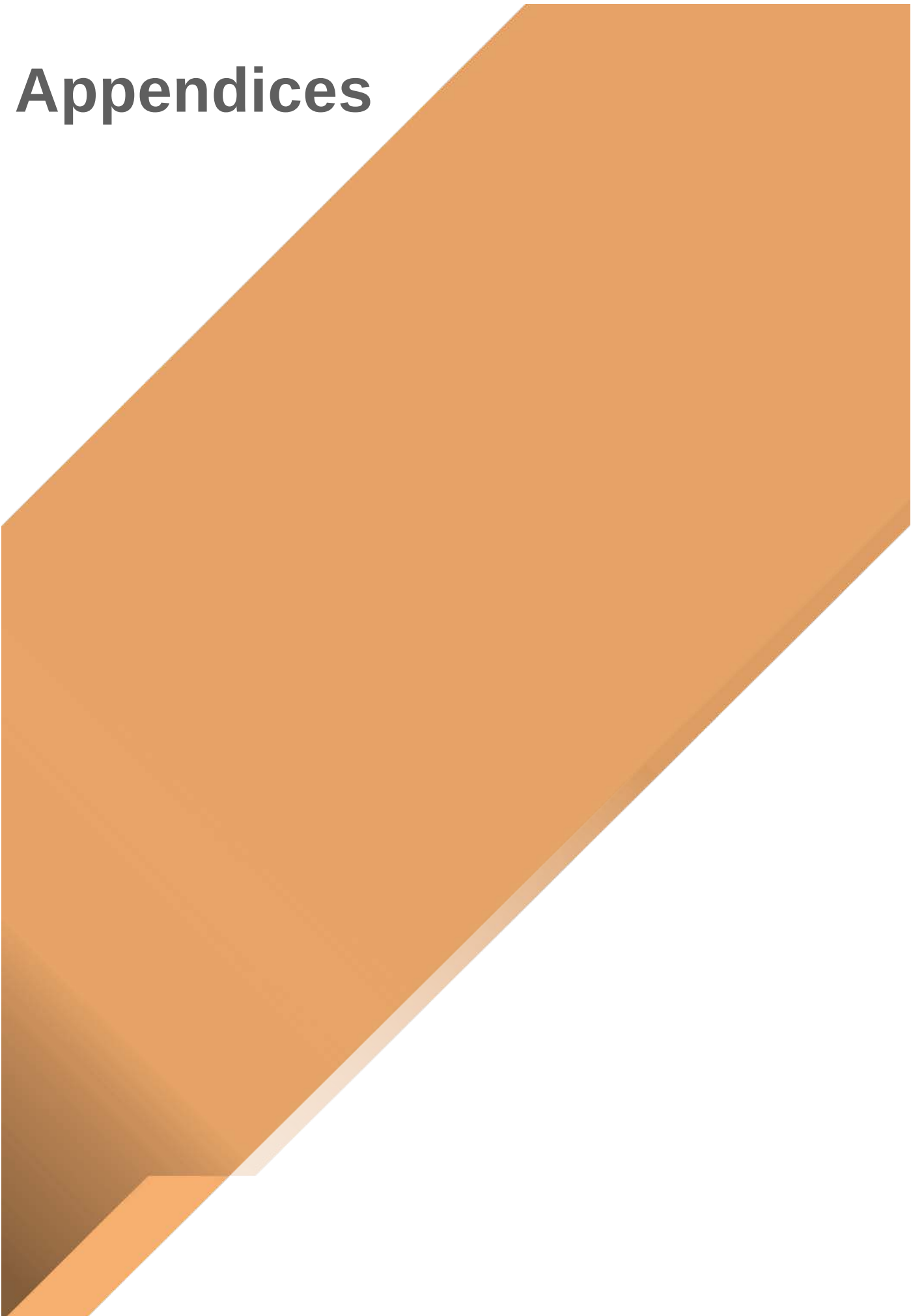
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Appendices



APPENDIX

P

Surface Water Quality Technical Report

Appendix A Surface Water Quality Monitoring Equipment Calibration Certificates

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Appendix A

Surface water quality monitoring equipment calibration certificates

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.):	DPM18004 (BZA) - TRIP 1 START
Date calibrated:	11/06/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	19.4
pH 4	Dec 18	pH units	4.00	3.89	4.00	4.00
pH 7	Dec 18	pH units	7.02	6.84	7.02	7.02
pH 10	Dec 18	pH units	10.06	9.97	10.06	10.06
ORP	May 20	mV	240.2	239.2	240.2	240.2
SPC	Jan 19	µS/cm	1413	1340	1413	1413
Barometric pressure	N/A	mmHg		765.7	765.7	765.7
DO (zero)	N/A	%S	0.0	0.0	0.0	0.0
DO (sat.)	N/A	%S	100.0	94.5	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument in good condition. New batteries installed.

Signed: _____

Date: _____

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.):	DPM18004 (B26) - TRIP 1 FINISH
Date calibrated:	18/6/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	18.0
pH 4	Dec 18	pH units	4.00	4.03	4.00	4.00
pH 7	Dec 18	pH units	7.03	7.00	7.03	7.03
pH 10	Dec 18	pH units	10.08	9.97	10.08	10.08
ORP	May 20	mV	241.2	240.3	241.2	241.2
SPC	Jan 19	µS/cm	1413	1414	1413	1413
Barometric pressure	N/A	mmHg		765.5	765.5	765.5
DO (zero)	N/A	%S	0.0	0.4	0.0	0.0
DO (sat.)	N/A	%S	100.0	104.4	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument maintained calibration. In good condition.

Signed: D. Moore

Date: 18/6/2018

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	P. HANCOCK
Calibrated for (job no.):	APM18004 (BZC) - TRIP 2 START
Date calibrated:	26/11/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	—
pH 4	Apr 20	pH units	4.00	3.99	4.00	4.00
pH 7	Jun 20	pH units	7.01	7.29	7.01	7.01
pH 10	May 20	pH units	10.01	9.96	10.01	10.01
ORP	May 20	mV	230.7	305.6	230.7	230.7
SPC	Apr 20	µS/cm	1413	1324	1413	1413
Barometric pressure	N/A	mmHg	—	717.7	717.7	717.7
DO (zero)	N/A	%S	0.0	-0.4	0.0	0.0
DO (sat.)	N/A	%S	100.0	78.9	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument in good condition. Battery level adequate. Spare batteries inside case.

Signed: J. More

Date: 26/11/2018

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. Moore
Calibrated for (job no.):	DPM18004 (B2a) - TRIP 2 FINISH
Date calibrated:	2/12/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	23.8
pH 4	Apr 20	pH units	4.00	4.00	4.00	4.00
pH 7	Jun 20	pH units	7.01	6.91	7.01	7.01
pH 10	May 20	pH units	10.01	10.05	10.01	10.01
ORP	May 20	mV	233.4	231.7	233.4	233.4
SPC	Apr 20	µS/cm	1413	1408	1413	1413
Barometric pressure	N/A	mmHg	716.7	716.7	716.7	716.7
DO (zero)	N/A	%S	0.0	-0.2	0.0	0.0
DO (sat.)	N/A	%S	100.0	104.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. Instrument in good condition.

Signed: D. Moore

Date: 2/12/2018



Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.):	DPM18004 (B2G) - TRIP 3 START
Date calibrated:	10/2/2019

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	25.3
pH 4	Apr 20	pH units	4.01	3.97	4.01	4.01
pH 7	Jun 20	pH units	7.00	6.92	7.00	7.00
pH 10	May 20	pH units	9.98	9.96	9.98	9.98
ORP	May 20	mV	227.7	227.5	227.7	227.7
SPC	Apr 20	µS/cm	1413	1509	1413	1413
Barometric pressure	N/A	mmHg	745.6	745.6	745.6	745.6
DO (zero)	N/A	%S	0.0	0.0	0.0	0.0
DO (sat.)	N/A	%S	100.0	100.6	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument in good condition. Batteries replaced.

Signed:

D. Moore

Date:

10/2/2019



Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (B2G) - Trip 3 finish
Date calibrated:	15/2/2019

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	28.0
pH 4	Apr 20	pH units	4.01	4.06	4.01	4.01
pH 7	Jun 20	pH units	6.99	7.04	6.99	6.99
pH 10	Apr 20	pH units	9.97	9.99	9.97	9.97
ORP	May 20	mV	224.6	222.3	224.6	224.6
SPC	Apr 20	µS/cm	1413	1414	1413	1413
Barometric pressure	N/A	mmHg	754.7	754.7		
DO (zero)	N/A Mar 20	%S	0.0	-0.2	0.0	0.0
DO (sat.)	N/A	%S	100.0	101.6	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration.
In good condition. Cleaned and stored for next use.

Signed: D. Moore

Date: 15/2/2019



Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004
Date calibrated:	28/4/2019 - Commencement of Trip 4

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.1
pH 4	10/20	pH units	4.00	4.21	4.00	4.00
pH 7	10/20	pH units	7.01	7.17	7.01	7.01
pH 10	10/20	pH units	10.03	10.21	10.03	10.03
ORP	2/21	mV	233.8	225.8	233.8	233.8
SPC	1/21	µS/cm	1413	2268	1413	1413
Barometric pressure	N/A	mmHg		—	758.84	758.84
DO (zero)	N/A	%S	0.0	-0.1	0.0	0.0
DO (sat.)	N/A 3/20	%S	100.0	109.0	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Last calibrated and used by Blue Earth Environmental. Advise BEE that their cal. solution for SPC needs replacing. Checked with two SPC cal. solution batches. Instrument in good condition.

Signed: J. Moore

Date: 28/4/2019



Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. Moore
Calibrated for (job no.)	DPR18004
Date calibrated:	3/5/2019 - Completion of Trip 4

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.3
pH 4	10/20	pH units	4.00	4.09	4.00	4.00
pH 7	10/20	pH units	7.01	7.05	7.01	7.01
pH 10	10/20	pH units	10.03	10.01	10.03	10.03
ORP	2/21	mV	253.0 ^{235.0}	239.5	235.0	235.0
SPC	1/21	µS/cm	1413	1402	1413	1413
Barometric pressure	N/A	mmHg		753.6	753.6	753.6
DO (zero)	N/A 3/20	%S	0.0	-0.3	0.0	0.0
DO (sat.)	N/A 3/20	%S	100.0	98.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. In good condition. Cleaned and stored for next use.

Signed: D. Moore

Date: 3/5/2019



Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate
Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.):	DPM18004
Date calibrated:	15/5/2019 - Commencement of Trip 5

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.2
pH 4	10/20	pH units	4.00	4.01	4.00	4.00
pH 7	10/20	pH units	7.01	7.01	7.01	7.01
pH 10	10/20	pH units	10.03	10.02	10.03	10.03
ORP	2/21	mV	235.0	236.1	235.0	235.0
SPC	1/21	µS/cm	1413	1410	1413	1413
Barometric pressure	N/A	mmHg	769.6	769.6	769.6	769.6
DO (zero)	3/20	%S	0.0	-0.1	0.0	0.0
DO (sat.)	N/A	%S	100.0	99.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

In good condition. Calibrated and ready for use.

Signed: J. Moore

Date: 15/5/2019



Form: FRM-001

Title: Water Quality Meter Calibration Certificate

Instrument make: YSI Professional Plus

Display serial number: 14M100367

Sonde serial number: 14M100051

Calibrated by:

Calibrated for (job no.)

Date calibrated:

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	
pH 4	10/20	pH units	4.00	4.03	4.00	4.00
pH 7	10/20	pH units	7.00	7.04	7.00	7.00
pH 10	10/20	pH units	10.05	10.09	10.05	10.05
ORP	2/21	mV	1413	1438	1413	1413
SPC	1/21	µS/cm	238.0	237.4	238.0	238.0
Barometric pressure	N/A	mmHg	763.4	763.5	763.4	763.4
DO (zero)	3/20	%S	0.0	-0.8	0.0	0.0
DO (sat.)	N/A	%S	100.0	98.8	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. In good condition. Cleaned and stored for next use.

Signed:

J. Moore

Date:

19/5/2019

APPENDIX

P

Surface Water Quality Technical Report

Appendix B Surface Water Quality Site Investigation Results

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Appendix B

Surface water quality site investigation results

Matrix: Workgroup: Project name/number:	WATER EB1814715 10558 Inland Rail - Border to G	Sample Type: S Sample Number: Sample Date: Int sample ID (1st): Int sample ID (2nd): Depth (m): Site: Purchase Order:	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG
			EB1814715001	EB1814715002	EB1814715003	EB1814715004	EB1814715005	EB1814715006	EB1814715007	EB1814715008	EB1814715009	EB1814715010	EB1814715011	EB1814715012	EB1814715013	EB1814715014	EB1814715015	EB1814715016
			13/06/2018	12/06/2018	12/06/2018	12/06/2018	14/06/2018	15/06/2018	13/06/2018	16/06/2018	16/06/2018	17/06/2018	16/06/2018	17/06/2018	15/06/2018	16/06/2018	16/06/2018	18/06/2018
			Site 14	Site 42	Site 40	Site 39	Site 30	Site 27	Site 16	Site 1R	Site 2R	Site 3	Site 6	Site 7	Site 11	DUP	FB	Site 24
Analyte grouping/Analyte	CAS Number	Unit	Limit of reporting															
EA010P: Conductivity by PC Titrator																		
Electrical Conductivity @ 25°C		µS/cm	1	---	---	---	---	---	---	298	251	410	352	356	315	352	2	339
EA020EC: Salinity																		
Salinity		g/kg	0.01	---	---	---	---	---	---	0.14	0.12	0.20	0.17	0.17	0.15	0.17	0.01	0.16
EA028: Total Suspended Solids dried at 104 ± 2°C																		
Suspended Solids (SS)		mg/L	5	---	---	---	---	---	---	28	<5	<5	20	18	15	11	<5	98
EA065: Total Hardness as CaCO3																		
Total Hardness as CaCO3		mg/L	1	---	---	---	---	---	---	78	58	89	55	60	56	60	<1	80
ED093F: Dissolved Major Cations																		
Calcium	7440-70-2	mg/L	1	---	---	---	---	---	---	13	10	11	9	9	11	9	<1	14
Magnesium	7439-95-4	mg/L	1	---	---	---	---	---	---	11	9	10	8	9	7	9	<1	11
EG020F: Dissolved Metals by ICP-MS																		
Arsenic	7440-38-2	mg/L	0.001	---	---	---	---	---	---	0.002	0.002	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001
Cadmium	7440-43-9	mg/L	0.0001	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	mg/L	0.001	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	mg/L	0.001	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Lead	7439-92-1	mg/L	0.001	---	---	---	---	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	mg/L	0.001	---	---	---	---	---	---	0.002	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.006
Zinc	7440-66-6	mg/L	0.005	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS																		
Mercury	7439-97-6	mg/L	0.0001	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser																		
Ammonia as N	7664-41-7	mg/L	0.01	---	---	---	---	---	---	0.02	0.02	0.04	0.03	0.04	0.02	0.04	<0.01	0.04
EK057G: Nitrite as N by Discrete Analyser																		
Nitrite as N	14797-65-0	mg/L	0.01	---	---	---	---	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser																		
Nitrate as N	14797-55-8	mg/L	0.01	---	---	---	---	---	---	<0.01	<0.01	<0.01	0.05	0.15	0.02	0.05	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser																		
Nitrite + Nitrate as N		mg/L	0.01	---	---	---	---	---	---	<0.01	<0.01	<0.01	0.05	0.15	0.02	0.05	<0.01	<0.01
EK060G: Organic Nitrogen as N (TKN-NH3) By Discrete Analyser																		
Organic Nitrogen as N		mg/L	0.1	---	---	---	---	---	---	0.6	0.5	0.8	0.8	0.9	0.9	0.8	<0.1	0.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser																		
Total Kjeldahl Nitrogen as N		mg/L	0.1	---	---	---	---	---	---	0.6	0.5	0.8	0.8	0.9	0.9	0.8	<0.1	0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser																		
Total Nitrogen as N		mg/L	0.1	---	---	---	---	---	---	0.6	0.5	0.8	0.8	1.0	0.9	0.8	<0.1	0.5
EK067G: Total Phosphorus as P by Discrete Analyser																		
Total Phosphorus as P		mg/L	0.01	---	---	---	---	---	---	0.10	0.05	0.04	0.04	0.04	0.06	0.03	0.01	0.07
EK071G: Reactive Phosphorus as P by discrete analyser																		
Reactive Phosphorus as P	14265-44-2	mg/L	0.01	---	---	---	---	---	---	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a																		
Chlorophyll a		mg/m³	1	<1	<1	<1	<1	<2	5	<2	<1	<2	<2	<2	<2	---	---	<4
Volume		L	0.01	1	1	1	1	5	425	275	5	8	6	475	6	4	---	25
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons																		
Naphthalene	91-20-3	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	209-96-9	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)anthracene	56-55-3	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b)fluoranthene	205-99-2 205-82-1	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	µg/L	0.5	---	---	---	---	---	---	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1,2,3-cd)pyrene	193-39-5	µg/L	1.0	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Dibenz(a,h)anthracene	53-70-9	µg/L	1.0	---	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	µg/L	1.0	---	---	---	---	---	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons		µg/L	0.5	---	---	---	---	---	---	---	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)		µg/L	0.5	---	---	---	---	---	---	---	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP07&(SIM)S: Phenolic Compound Surrogates																			
Phenol-d6	13127-89-3	%	1.0	---	---	---	---	---	---	---	29.5	24.4	25.2	23.2	20.2	21.0	22.4	21.7	21.2
2-Chlorophenol-D4	93951-73-6	%	1.0	---	---	---	---	---	---	---	66.8	67.9	69.3	63.0	57.2	58.6	64.5	61.7	60.3
2,4,6-Tribromophenol	118-79-6	%	1.0	---	---	---	---	---	---	---	43.0	39.7	39.2	36.0	32.4	32.9	36.2	36.9	32.3
EP07&(SIM)T: PAH Surrogates																			
2-Fluorobiphenyl	321-60-8	%	1.0	---	---	---	---	---	---	---	76.3	80.3	80.7	73.6	70.4	71.2	78.6	68.2	72.2
Anthracene-d10	1719-06-8	%	1.0	---	---	---	---	---	---	---	77.6	78.4	77.2	72.6	68.3	69.3	78.5	69.2	72.1
4-Terphenyl-d14	1718-51-0	%	1.0	---	---	---	---	---	---	---	86.2	91.6	90.0	85.1	78.9	82.4	94.3	85.0	82.4

Matrix:	WATER	Sample Type:	REG											
			REG											
			REG											
			REG											
Workgroup:	EB1829378	ALS Sample Number:	EB1829378001	EB1829378002	EB1829378003	EB1829378004	EB1829378005	EB1829378006	EB1829378007	EB1829378008	EB1829378009	EB1829378010	EB1829378011	
Project name/number:	Inland Rail - Border to Gowrie E	Sample Date:	29/11/2018	27/11/2018	29/11/2018	28/11/2018	28/11/2018	27/11/2018	27/11/2018	29/11/2018	27/11/2018	26/11/2018	27/11/2018	
		lient sample ID (1st):	14	2R	2	16	11	3	DUP	FB	6	33	7	
		ient sample ID (2nd):												
		Depth Type:												
		Depth (m):												
		Site:												
		Purchase Order:	10558	10558	10558	10558	10558	10558	10558	10558	10558	10558	10558	
Analyte grouping/Analyte	CAS Number	Unit	Limit of reporting											
EA010P: Conductivity by PC Titrator														
Electrical Conductivity @ 25°C		µS/cm	1	232	214	213	359	274	386	388	<1	411	198	416
EA020EC: Salinity														
Salinity		g/kg	0.01	0.11	0.10	0.10	0.17	0.13	0.19	0.19	<0.01	0.20	0.10	0.20
EA025: Total Suspended Solids dried at 104 ± 2°C														
Suspended Solids (SS)		mg/L	5	<5	43	27	56	14	<5	<5	<5	14	15	9
EA065: Total Hardness as CaCO3														
Total Hardness as CaCO3		mg/L	1	50	67	71	100	57	76	76	<1	79	59	79
ED093F: Dissolved Major Cations														
Calcium	7440-70-2	mg/L	1	5	12	12	27	13	14	14	<1	15	12	15
Magnesium	7439-95-4	mg/L	1	9	9	10	8	6	10	10	<1	10	7	10
EG020F: Dissolved Metals by ICP-MS														
Arsenic	7440-38-2	mg/L	0.001	0.001	0.003	0.003	0.001	0.001	0.002	0.002	<0.001	0.002	<0.001	0.002
Cadmium	7440-43-9	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	mg/L	0.001	<0.001	<0.001	0.002	0.002	<0.001	0.001	<0.001	<0.001	<0.001	0.004	<0.001
Lead	7439-92-1	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	mg/L	0.001	0.001	0.002	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001
Zinc	7440-66-6	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS														
Mercury	7439-97-6	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser														
Ammonia as N	7664-41-7	mg/L	0.01	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	0.03	<0.01	0.03	<0.01
EK057G: Nitrite as N by Discrete Analyser														
Nitrite as N	14797-65-0	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser														
Nitrate as N	14797-55-8	mg/L	0.01	<0.01	0.02	<0.01	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser														
Nitrite + Nitrate as N		mg/L	0.01	<0.01	0.02	<0.01	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser														
Organic Nitrogen as N		mg/L	0.1	0.7	0.5	0.5	1.3	1.2	0.6	0.7	<0.1	0.7	1.0	0.7
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser														
Total Kjeldahl Nitrogen as N		mg/L	0.1	0.7	0.5	0.5	1.4	1.2	0.6	0.7	<0.1	0.7	1.0	0.7
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser														
Total Nitrogen as N		mg/L	0.1	0.7	0.5	0.5	1.4	1.2	0.6	0.7	<0.1	0.7	1.0	0.7
EK067G: Total Phosphorus as P by Discrete Analyser														
Total Phosphorus as P		mg/L	0.01	0.03	0.15	0.12	0.17	0.11	0.04	0.04	<0.01	0.05	0.23	0.06
EK071G: Reactive Phosphorus as P by discrete analyser														
Reactive Phosphorus as P	14265-44-2	mg/L	0.01	<0.01	0.04	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01

EP075(SIM)B: Polynuclear Aromatic Hydrocarbons

Naphthalene	91-20-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons		µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)		µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

EP075(SIM)S: Phenolic Compound Surrogates

Phenol-d6	13127-88-3	%	1.0	28.7	26.6	21.4	22.9	20.0	23.5	29.6	24.3	26.0	26.8	29.3
2-Chlorophenol-D4	93951-73-6	%	1.0	76.6	69.6	62.1	61.7	55.8	63.3	73.6	67.7	70.0	65.3	71.8
2,4,6-Tribromophenol	118-79-6	%	1.0	58.3	52.3	47.0	44.7	42.0	48.8	55.2	54.2	53.8	57.6	54.4

EP075(SIM)T: PAH Surrogates

2-Fluorobiphenyl	321-60-8	%	1.0	97.9	73.9	85.2	82.1	75.9	68.3	71.5	81.2	73.9	76.1	71.9
Anthracene-d10	1719-06-8	%	1.0	95.9	90.7	80.6	79.9	74.3	88.1	89.0	76.0	107	84.0	90.6
4-Terphenyl-d14	1718-51-0	%	1.0	115	93.3	97.0	93.7	89.0	91.0	92.2	92.2	110	88.1	96.2

[illegible]

Matrix:		Sample Type:		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG	
Workgroup:		S Sample Number:		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG	
Project name/number:		Sample Date:		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG		REG	
10558 Inland Rail - Border to G		29/04/2019		29/04/2019		30/04/2019		30/04/2019		30/04/2019		30/04/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019		01/05/2019	
		Site 2		Site 2R		Site 3		Site 6		Site 7		Site 11		Site 14		Site 16		Site 18		Site 20R		Site 23		Site 27		Site 28		Site 29		Site 30	
		nt sample ID (1st):		nt sample ID (2nd):																											
		Depth (m):		Depth (m):																											
		Site:		Site:																											
		Purchase Order:		Purchase Order:																											
Analyte grouping/Analyte		CAS Number		Unit		Limit of reporting																									
EAD10P: Conductivity by PC Titrator				µS/cm		210		211		419		428		425		293		349		1240		314		162		286		230		307	
EAD20EC: Salinity				g/kg		0.01		0.10		0.10		0.20		0.21		0.21		0.14		0.17		0.62		0.15		0.08		0.14		0.11	
EAD25: Total Suspended Solids dried at 104 ± 2 °C				mg/L		5		10		7		12		10		6		104		44		2170		8		10		18		214	
EAD65: Total Hardness as CaCO3				mg/L		1		93		93		99		99		102		73		83		179		118		72		116		102	
EAD93P: Dissolved Major Cations				mg/L		1		16		16		20		20		21		16		7		42		34		19		30		21	
Calcium		7440-70-2		mg/L		1		16		16		20		20		21		16		7		42		34		19		30		21	
Magnesium		7439-95-4		mg/L		1		13		13		12		12		12		8		16		18		8		6		10		12	
EAD20P: Dissolved Metals by ICP-MS				mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Arsenic		7440-39-2		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Cadmium		7440-43-9		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Chromium		7440-47-3		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Copper		7440-50-8		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Lead		7439-92-1		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Nickel		7440-02-0		mg/L		0.001		0.003		0.002		0.001		0.002		0.001		0.001		0.004		0.001		0.003		0.002		0.001		0.003	
Zinc		7440-66-6		mg/L		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005		0.005	
EGD31P: Dissolved Mercury by PIMS				mg/L		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001	
Mercury		7439-97-6		mg/L		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001	
EKD55G: Ammonia as N by Discrete Analyser				mg/L		0.01		0.03		0.02		0.03		0.03		0.02		0.03		1.50		0.02		0.02		0.02		0.08		0.04	
Ammonia as N		7464-41-7		mg/L		0.01		0.03		0.02		0.03		0.03		0.02		0.03		1.50		0.02		0.02		0.02		0.08		0.04	
EKD57G: Nitrate as N by Discrete Analyser				mg/L		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.05		0.01		0.01		0.01		0.01		0.01	
Nitrate as N		14797-65-0		mg/L		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.05		0.01		0.01		0.01		0.01		0.01	
EKD58G: Nitrate as N by Discrete Analyser				mg/L		0.01		0.01		0.01		0.01		0.09		0.01		0.01		0.02		0.01		0.01		0.01		0.01		0.01	
Nitrate as N		14797-55-8		mg/L		0.01		0.01		0.01		0.01		0.09		0.01		0.01		0.02		0.01		0.01		0.01		0.01		0.01	
EKD59G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser				mg/L		0.01		0.01		0.01		0.01		0.09		0.01		0.01		0.07		0.01		0.01		0.01		0.01		0.01	
Nitrite + Nitrate as N				mg/L		0.01		0.01		0.01		0.01		0.09		0.01		0.01		0.07		0.01		0.01		0.01		0.01		0.01	
EKD60G: Organic Nitrogen as N (TKN-NH4) by Discrete Analyser				mg/L		0.1		0.5		0.4		1.6		1.1		1.1		5.7		2.3		29.6		0.8		1.6		0.9		1.4	
Organic Nitrogen as N				mg/L		0.1		0.5		0.4		1.6		1.1		1.1		5.7		2.3		29.6		0.8		1.6		0.9		1.4	
EKD61G: Total Kjeldahl Nitrogen By Discrete Analyser				mg/L		0.1		0.5		0.4		1.6		1.1		1.1		5.7		2.3		31.1		0.8		1.6		0.9		1.5	
Total Kjeldahl Nitrogen as N				mg/L		0.1		0.5		0.4		1.6		1.1		1.1		5.7		2.3		31.1		0.8		1.6		0.9		1.5	
EKD62G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser				mg/L		0.1		0.5		0.4		1.6		1.1		1.2		5.7		2.3		31.2		0.8		1.6		0.9		1.5	
Total Nitrogen as N				mg/L		0.1		0.5		0.4		1.6		1.1		1.2		5.7		2.3		31.2		0.8		1.6		0.9		1.5	
EKD67G: Total Phosphorus as P by Discrete Analyser				mg/L		0.01		0.08		0.06		0.08		0.04		0.04		0.33		0.10		3.93		0.04		0.32		0.06		0.51	
Total Phosphorus as P				mg/L		0.01		0.08		0.06		0.08		0.04		0.04		0.33		0.10		3.93		0.04		0.32		0.06		0.51	
EKD71G: Reactive Phosphorus as P by discrete analyser				mg/L		0.01		0.04		0.03		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.10		0.01		0.04	
Reactive Phosphorus as P		14265-44-2		mg/L		0.01		0.04		0.03		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.10		0.01		0.04	
EPD08: Chlorophyll a & Pheophytin a				mg/m³ L		1		5		4		65		10		14		460		545		4		21		7		24		26	
Chlorophyll a Volume				mg/m³ L		0.01		0.85		0.85		0.25		0.8		0.75		0.25		0.25		0.012		1		0.6		0.125		0.075	
EPD75(SIMB): Polynuclear Aromatic Hydrocarbons				µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Naphthalene		91-20-3		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Acenaphthylene		208-96-8		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Acenaphthene		83-32-9		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Fluorene		86-73-7		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Phenanthrene		85-61-8		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Anthracene		120-12-7		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Fluoranthene		206-44-0		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Pyrene		129-00-0		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Benz(a)anthracene		56-55-3		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Chrysene		218-01-9		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Benzo(b)fluoranthene		205-99-2 205-92-1		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Benzo(k)fluoranthene		207-08-9		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Benzo(a)pyrene		50-32-8		µg/L		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5	
Indeno(1,2,3-cd)pyrene		155-29-5		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Dibenz(a,h)anthracene		53-70-3		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Benzo(g,h,i)perylene		191-24-2		µg/L		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Sum of polycyclic aromatic hydrocarbons				µg/L		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5	
Benzo(a)pyrene TEQ (zero)				µg/L		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5	

[illegible]

Appendix B - Raw laboratory results for three sampling round 5

Nitrite + Nitrate as N	mg/L	0.01	0.02	<0.01	0.24	<0.01	1.40	0.24	<0.01
EK060G: Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	mg/L	0.1	0.7	1.1	1.0	0.8	0.2	1.0	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.7	1.1	1.0	0.8	0.2	1.0	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
Total Nitrogen as N	mg/L	0.1	0.7	1.1	1.2	0.8	1.6	1.2	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	mg/L	0.01	0.03	0.03	0.02	0.04	<0.01	0.02	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2 mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	mg/m ³	1	7	11	7	5	1	----	----
Volume	L	0.01	0.65	0.5	1	1	1	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)anthracene	56-55-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-1	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons		µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)		µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	%	1.0	30.4	28.9	25.5	34.0	27.9	25.6
2-Chlorophenol-D4	93951-73-6	%	1.0	84.6	80.4	68.5	93.3	69.9	70.1
2,4,6-Tribromophenol	118-79-6	%	1.0	60.0	54.1	40.3	51.4	25.2	39.0
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	%	1.0	82.5	80.7	79.6	95.6	84.0	72.4
Anthracene-d10	1719-06-8	%	1.0	57.3	57.4	77.9	104	83.3	57.3
4-Terphenyl-d14	1718-51-0	%	1.0	60.8	61.4	82.5	112	89.7	63.3

Surface Water Quality Results— Round 1 (June 2018)

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Surface water quality results – Round 1 (June 2018)



CHAIN OF CUSTODY

ALS Laboratory: please tick →

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Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

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Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 76 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

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Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090
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SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bottle QLD 4818
Ph: 07 4795 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 1/19-21 Ralph Black Drive Nth Wollongong NSW 2500
Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Eco Logical Australia		TURNAROUND REQUIREMENTS : ☒ Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle)	
OFFICE: Brisbane		(Standard TAT may be longer for some tests e.g., Ultra Trace Organics)		Custody Seal Intact? Yes No N/A	
PROJECT: Inland Rail - Border to Gowrie EIS		PROJECT NO: 10558		Free ice / frozen ice bricks present upon receipt? Yes No N/A	
ORDER NUMBER:		PURCHASE ORDER NO.:		Random Sample Temperature on Receipt: °C	
PROJECT MANAGER: Miles Yeates		CONTACT PH: 0467 738 954		Other comment:	
SAMPLER: David Moore and Peter Hancock		SAMPLER MOBILE:		RECEIVED BY:	
COC Emailed to ALS? (YES / NO)		EDD FORMAT (or default):		RELINQUISHED BY:	
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		DATE/TIME:		DATE/TIME:	
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		DATE/TIME:		DATE/TIME:	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-3A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	ophyll a (filter paper)	These samples are Batch 1 of a nine day field trip. A second batch of samples will follow in 5-6 days time. All metals samples are field filtered. Frozen Chlorophyll a filter paper samples will be included in Batch 2 (not in this batch).	
1	Site 14	13/6/18 noon	W		4	X	X	X	X	X	X	X			
2	Site 42	12/6/18 noon	W		4	X	X	X	X	X	X	X			
3	Site 40	12/6/18 noon	W		4	X	X	X	X	X	X	X			
4	Site 39	12/6/18 noon	W		4	X	X	X	X	X	X	X			
5	Site 30	14/6/18 noon	W		4	X	X	X	X	X	X	X			
6	Site 27	15/6/18 noon	W		4	X	X	X	X	X	X	X			
7	Site 16	13/6/18 noon	W		4	X	X	X	X	X	X	X			
TOTAL					28										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

Environmental Division
Brisbane

Work Order Reference
EB1814632



Telephone: +61 7 3243 7222



CERTIFICATE OF ANALYSIS

Work Order : **EB1814632**
Client : **ECO LOGICAL AUSTRALIA PTY LTD**
Contact : **MILES YEATES**
Address : **PO BOX 1422**
FORTITUDE VALLEY QLD 4006
Telephone : **+61 02 8536 8667**
Project : **10558 Inland Rail - Border to Gowrie EIS**
Order number :
C-O-C number :
Sampler : **DAVID MOORE and PETER HANCOCK**
Site :
Quote number : **BN/142/18 V2**
No. of samples received : **7**
No. of samples analysed : **7**

Page : 1 of 7
Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : +61-7-3243 7222
Date Samples Received : 15-Jun-2018 15:00
Date Analysis Commenced : 15-Jun-2018
Issue Date : 21-Jun-2018 16:58



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Matt Frost	Senior Organic Chemist	Brisbane Organics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Matrix spike shows poor recovery. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a,h)anthracene (1.0), Benzo(g,h,i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 14	Site 42	Site 40	Site 39	Site 30
Client sampling date / time				13-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	14-Jun-2018 00:00	
Compound	CAS Number	LOR	Unit	EB1814632-001	EB1814632-002	EB1814632-003	EB1814632-004	EB1814632-005	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	207	1380	1380	2440	449	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.10	0.69	0.69	1.25	0.22	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	20	6	10	8	11	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	39	471	465	746	146	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	4	55	51	73	29	
Magnesium	7439-95-4	1	mg/L	7	81	82	137	18	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.002	0.004	0.003	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.25	0.02	0.02	0.04	0.02	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	1.25	<0.01	0.51	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	1.25	<0.01	0.52	<0.01	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	1.0	0.2	0.3	0.3	0.5	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.2	0.2	0.3	0.3	0.5	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 14	Site 42	Site 40	Site 39	Site 30
Client sampling date / time					13-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	14-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		EB1814632-001	EB1814632-002	EB1814632-003	EB1814632-004	EB1814632-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.2	1.4	0.3	0.8	0.5
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.03	0.01	0.02	0.02	0.07
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		26.6	29.0	25.7	26.1	29.8
2-Chlorophenol-D4	93951-73-6	1.0	%		74.9	74.4	69.9	69.2	76.1
2,4,6-Tribromophenol	118-79-6	1.0	%		61.2	52.6	48.6	46.4	52.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		79.1	78.2	75.7	79.4	82.1
Anthracene-d10	1719-06-8	1.0	%		105	103	95.9	101	108
4-Terphenyl-d14	1718-51-0	1.0	%		104	105	101	107	120

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 27	Site 16	----	----	----
Client sampling date / time				15-Jun-2018 00:00	13-Jun-2018 00:00	----	----	----	
Compound	CAS Number	LOR	Unit	EB1814632-006	EB1814632-007	-----	-----	-----	
				Result	Result	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	582	225	---	---	---	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.28	0.11	---	---	---	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	28	32	---	---	---	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	199	51	---	---	---	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	40	14	---	---	---	
Magnesium	7439-95-4	1	mg/L	24	4	---	---	---	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	---	---	---	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	---	---	---	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	---	---	---	
Copper	7440-50-8	0.001	mg/L	0.002	<0.001	---	---	---	
Nickel	7440-02-0	0.001	mg/L	0.006	0.001	---	---	---	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	---	---	---	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	---	---	---	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	---	---	---	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.02	---	---	---	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	---	---	---	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	---	---	---	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	---	---	---	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.9	1.0	---	---	---	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.9	1.0	---	---	---	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 27	Site 16	----	----	----
Client sampling date / time					15-Jun-2018 00:00	13-Jun-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB1814632-006	EB1814632-007	-----	-----	-----
				Result	Result		----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.9	1.0	---	---	---
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.11	0.11	---	---	---
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	---	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	---	---	---
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	---	---	---
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	---	---	---
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	---	---	---
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	---	---	---
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	---	---	---
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	---	---	---
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	---	---	---
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	---	---	---
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	---	---	---
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	---	---	---
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	---	---	---
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	---	---	---
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	---	---	---
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		28.2	26.8	---	---	---
2-Chlorophenol-D4	93951-73-6	1.0	%		73.3	74.3	---	---	---
2,4,6-Tribromophenol	118-79-6	1.0	%		46.5	53.2	---	---	---
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		84.1	82.7	---	---	---
Anthracene-d10	1719-06-8	1.0	%		103	101	---	---	---
4-Terphenyl-d14	1718-51-0	1.0	%		115	113	---	---	---



Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2,4,6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

Surface Water Quality Results— Round 2 (November/December 2018)

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Surface water quality results – Round 2 (xxxx 2018)



CHAIN OF CUSTODY

ALS Laboratory: please tick →

QADELAIDE 311 Burma Road Pooraka SA 5095
Ph: 08 8162 5130 E: adelaide@alsglobal.com

QBRISBANE 2 Byth Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

QLADSTONE 48 Callemondah Drive Gladstone QLD 4680
Ph: 07 4978 7944 E: gladstone@alsglobal.com

QMACRAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

QMELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

QMUDGEE 1/29 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mai@alsglobal.com

QNEWCASTLE 5/565 Maitland Road Mayfield West NSW 2304
Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

QNOWRA 4/13 Gairy Place North Nowra NSW 2541
Ph: 02 4423 2063 E: nowra@alsglobal.com

QPERTH 10 Hod Way Malaga WA 6000
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

QSYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

CLIENT: Eco Logical Australia

OFFICE: Brisbane

PROJECT: Inland Rail - Border to Gowrie EIS

PROJECT NO

10558

ALS QUOTE NO.: BN/142/18 V2

ORDER NUMBER:

PURCHASE ORDER NO.:

COUNTRY OF ORIGIN: Australia

PROJECT MANAGER: Miles Yeates

CONTACT PH: 0467 738 954

SAMPLER: David Moore and Peter Hancock

SAMPLER MOBILE:

COC Emailed to ALS? (YES / NO)

EDD FORMAT (or default):

Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au

Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au

TURNAROUND REQUIREMENTS :
(Standard TAT may be longer for some tests
e.g. Ultra Trace Organics)

☐ Standard TAT (List due date):

☐ Non Standard or urgent TAT (List due date):

FOR L

Custody

Free for receipt

Randor

Other c

RELINQUIS

DATE/TIME

RELINQUISHED BY:

DATE/TIME:

11.50am 30/11/18

RECEIVED BY:

DATE/TIME:

30-11-18 1245

Environmental Division
Brisbane

Work Order Reference

EB1829378

N/A

N/A



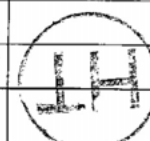
Telephone : + 61-7-3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP068 Chlorophyll a (filter paper method)		
1	Site 14	29/11/18	W		4	X	X	X	X	X	X	X			
2	Site 2R	27/11/18	W		4	X	X	X	X	X	X	X			
3	Site 2	29/11/18	W		4	X	X	X	X	X	X	X			
4	Site 16	28/11/18	W		4	X	X	X	X	X	X	X			
5	Site 11	28/11/18	W		4	X	X	X	X	X	X	X			
6	Site 3	27/11/18	W		4	X	X	X	X	X	X	X			
7	DUP	27/11/18	W		6	X	X	X	X	X	X	X			
8	FB	29/11/18	W		4	X	X	X	X	X	X	X			
9	Site 6	27/11/18	W		4	X	X	X	X	X	X	X			
10	Site 33	26/11/18	W		4	X	X	X	X	X	X	X			
11	Site 7	27/11/18	W		4	X	X	X	X	X	X	X			
TOTAL					46										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.



CERTIFICATE OF ANALYSIS

Work Order : **EB1829378**
Client : **ECO LOGICAL AUSTRALIA PTY LTD**
Contact : **MILES YEATES**
Address : **PO BOX 1422**
FORTITUDE VALLEY QLD 4006
Telephone : **+61 02 8536 8667**
Project : **Inland Rail - Border to Gowrie EIS**
Order number : **10558**
C-O-C number : **----**
Sampler : **DAVID MOORE, PETER HANCOCK**
Site :
Quote number : **BN/142/18 V2**
No. of samples received : **11**
No. of samples analysed : **11**

Page : **1 of 9**
Laboratory : **Environmental Division Brisbane**
Contact : **Customer Services EB**
Address : **2 Byth Street Stafford QLD Australia 4053**
Telephone : **+61-7-3243 7222**
Date Samples Received : **30-Nov-2018 12:45**
Date Analysis Commenced : **01-Dec-2018**
Issue Date : **07-Dec-2018 08:35**



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Tom Maloney	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Matrix spike shows poor recovery. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a,h)anthracene (1.0), Benzo(g,h,i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	14	2R	2	16	11
Client sampling date / time				29-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	28-Nov-2018 00:00	28-Nov-2018 00:00	
Compound	CAS Number	LOR	Unit	EB1829378-001	EB1829378-002	EB1829378-003	EB1829378-004	EB1829378-005	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	232	214	213	359	274	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.11	0.10	0.10	0.17	0.13	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	<5	43	27	56	14	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	50	67	71	100	57	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	5	12	12	27	13	
Magnesium	7439-95-4	1	mg/L	9	9	10	8	6	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.001	0.003	0.003	0.001	0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.002	0.002	<0.001	
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.002	0.002	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	0.06	<0.01	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.02	<0.01	0.01	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	<0.01	0.01	<0.01	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.7	0.5	0.5	1.3	1.2	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.5	0.5	1.4	1.2	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	14	2R	2	16	11
Client sampling date / time					29-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	28-Nov-2018 00:00	28-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EB1829378-001	EB1829378-002	EB1829378-003	EB1829378-004	EB1829378-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.7	0.5	0.5	1.4	1.2
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.03	0.15	0.12	0.17	0.11
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	0.04	0.04	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		28.7	26.6	21.4	22.9	20.0
2-Chlorophenol-D4	93951-73-6	1.0	%		76.6	69.6	62.1	61.7	55.8
2,4,6-Tribromophenol	118-79-6	1.0	%		58.3	52.3	47.0	44.7	42.0
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		97.9	73.9	85.2	82.1	75.9
Anthracene-d10	1719-06-8	1.0	%		95.9	90.7	80.6	79.9	74.3
4-Terphenyl-d14	1718-51-0	1.0	%		115	93.3	97.0	93.7	89.0

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	3	DUP	FB	6	33
Client sampling date / time				27-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	27-Nov-2018 00:00	26-Nov-2018 00:00	
Compound	CAS Number	LOR	Unit	EB1829378-006	EB1829378-007	EB1829378-008	EB1829378-009	EB1829378-010	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	386	388	<1	411	198	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.19	0.19	<0.01	0.20	0.10	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	14	15	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	76	76	<1	79	59	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	14	14	<1	15	12	
Magnesium	7439-95-4	1	mg/L	10	10	<1	10	7	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	<0.001	0.002	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	<0.001	<0.001	0.004	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.008	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.03	<0.01	0.03	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.01	<0.01	<0.01	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.01	<0.01	<0.01	<0.01	
EK060G: Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.6	0.7	<0.1	0.7	1.0	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.7	<0.1	0.7	1.0	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	3	DUP	FB	6	33
Client sampling date / time					27-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	27-Nov-2018 00:00	26-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EB1829378-006	EB1829378-007	EB1829378-008	EB1829378-009	EB1829378-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.6	0.7	<0.1	0.7	1.0
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.04	0.04	<0.01	0.05	0.23
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.05
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		23.5	29.6	24.3	26.0	26.8
2-Chlorophenol-D4	93951-73-6	1.0	%		63.3	73.6	67.7	70.0	65.3
2,4,6-Tribromophenol	118-79-6	1.0	%		48.8	55.2	54.2	53.8	57.6
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		68.3	71.5	81.2	73.9	76.1
Anthracene-d10	1719-06-8	1.0	%		88.1	89.0	76.0	107	84.0
4-Terphenyl-d14	1718-51-0	1.0	%		91.0	92.2	92.2	110	88.1

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	7	---	---	---	---
				Client sampling date / time	27-Nov-2018 00:00	---	---	---	---
Compound	CAS Number	LOR	Unit	EB1829378-011	---	---	---	---	---
				Result	---	---	---	---	---
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	416	---	---	---	---	---
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.20	---	---	---	---	---
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	9	---	---	---	---	---
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	79	---	---	---	---	---
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	15	---	---	---	---	---
Magnesium	7439-95-4	1	mg/L	10	---	---	---	---	---
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.002	---	---	---	---	---
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	---	---	---	---	---
Chromium	7440-47-3	0.001	mg/L	<0.001	---	---	---	---	---
Copper	7440-50-8	0.001	mg/L	<0.001	---	---	---	---	---
Nickel	7440-02-0	0.001	mg/L	<0.001	---	---	---	---	---
Lead	7439-92-1	0.001	mg/L	<0.001	---	---	---	---	---
Zinc	7440-66-6	0.005	mg/L	<0.005	---	---	---	---	---
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	---	---	---	---	---
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	---	---	---	---	---
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	---	---	---	---	---
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.02	---	---	---	---	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.02	---	---	---	---	---
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.7	---	---	---	---	---
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	---	---	---	---	---
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		7	----	----	----	----
		Client sampling date / time		27-Nov-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1829378-011	-----	-----	-----	-----
Result				----	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued								
^ Total Nitrogen as N	----	0.1	mg/L	0.7	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.06	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	----	----	----	----
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L	<1.0	----	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	29.3	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%	71.8	----	----	----	----
2,4,6-Tribromophenol	118-79-6	1.0	%	54.4	----	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	71.9	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%	90.6	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%	96.2	----	----	----	----



Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2,4,6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

Surface Water Quality Results— Round 3 (February 2019)

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Surface water quality results – Round 3 (February 2019)



CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADLAIDE 3/1 Burma Road Pooraka SA 5095
Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Gladstone QLD 4660
Ph: 07 4678 7944 E: gladstone@alsglobal.com

MACKEY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171
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MUDGE 1/26 Sydney Road Mudgee NSW 2850
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NEWCASTLE 5/585 Mt
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NOWRA 4/13 Geary Plac
Ph: 02 4423 2003 E: nowra

PFRTH 10 Hod Way Ma
Ph: 08 9239 7655 E: samp

Environmental Division
Brisbane
Work Order Reference
EB1903762

Road Smithfield NSW 2164
ydne@alsglobal.com

Court Bohle QLD 4818
environmental@alsglobal.com

Black Drive, Nth Wollongong NSW 2500
j@alsglobal.com

CLIENT: Eco Logical Australia

OFFICE: Brisbane

PROJECT: Inland Rail - Border to Gowrie EIS

PROJECT NO

10558

ORDER NUMBER:

PURCHASE ORDER NO.:

PROJECT MANAGER: Miles Yeates

CONTACT PH: 0467 738 954

SAMPLER: David Moore and Emma Blacklock

SAMPLER MOBILE:

COC Emailed to ALS? (YES / NO)

EDD FORMAT (or default):

Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au

Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au

TURNAROUND REQUIREMENTS:

☒ Standard TAT (List due date):

(Standard TAT may be longer for some tests
e.g. Ultra Trace Organics)

☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.: BN/142/18 V2

COC SEQUENCE

COUNTRY OF ORIGIN: Australia

COC: 1 2 3

OF: 1 2 3

RELINQUISHED BY:

David Moore

DATE/TIME:

16:50 14/2/2019

RECEIVED BY:

Liam C

DATE/TIME:

16:50 14/2/19

Telephone: + 61-7-3243 7222

Y (Circle)

Yes No

pon

Yes No

oeipt:

Yes No

RECEIVED BY:

DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).									Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)		
1	Site 2	11/2/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL	
2	Site 2R	11/2/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL	
3	Site 23	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL	
4	Site 18	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 700 mL	
5	Site 7	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 600 mL	
6	Site 6	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL	
7	Site 3	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL	
8	Site 14	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL	
9	Site 27	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 100 mL	
10	Site 16	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 50 mL	
11	Site 24	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL	
12	Site 11	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL	
13	Site 28	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 100 mL	
14	Site 30	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 210 mL	
15	Site 32	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 150 mL	
16	Site 39	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 350 mL	
17	Site 42	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL	
18	DUP	12/02/2019 - 7 am	W		6	X	X	X	X	X	X	X		2 extra amber bottles QA/QC	
19	FB	12/02/2019 - 7 am	W		4	X	X	X	X	X	X	X			
TOTAL					95										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; AV = VOA Vial Sulfuric Preserved; SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;

Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CERTIFICATE OF ANALYSIS

Work Order : **EB1903762**
Client : **ECO LOGICAL AUSTRALIA PTY LTD**
Contact : **MILES YEATES**
Address : **PO BOX 1422**
FORTITUDE VALLEY QLD 4006
Telephone : **+61 02 8536 8667**
Project : **10558 Inland Rail - Border to Gowie EIS**
Order number :
C-O-C number : **----**
Sampler : **DAVID MOORE AND EMMA BLACKLOCK**
Site :
Quote number : **BN/142/18 V2**
No. of samples received : **19**
No. of samples analysed : **19**

Page : **1 of 15**
Laboratory : **Environmental Division Brisbane**
Contact : **Customer Services EB**
Address : **2 Byth Street Stafford QLD Australia 4053**
Telephone : **+61-7-3243 7222**
Date Samples Received : **14-Feb-2019 16:50**
Date Analysis Commenced : **14-Feb-2019**
Issue Date : **21-Feb-2019 17:17**



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Sample EB1903762-018 (DUP) shows poor matrix spike recovery due to matrix interference. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a,h)anthracene (1.0), Benzo(g,h,i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: FILTER
 (Matrix: WATER)

Client sample ID

				Site 2	Site 2R	Site 23	Site 18	Site 7
Client sampling date / time				11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00
Compound	CAS Number	LOR	Unit	EB1903762-001	EB1903762-002	EB1903762-003	EB1903762-004	EB1903762-005
				Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m ³	2	2	2	7	6
Volume	----	0.01	L	.5	.5	1	.7	.6



Analytical Results

Sub-Matrix: FILTER
 (Matrix: WATER)

Client sample ID

				Site 6	Site 3	Site 14	Site 27	Site 16
Client sampling date / time				12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00
Compound	CAS Number	LOR	Unit	EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010
				Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m ³	5	12	6	53	54
Volume	----	0.01	L	.5	.5	.25	.1	.05



Analytical Results

Sub-Matrix: FILTER (Matrix: WATER)				Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
Client sampling date / time					13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-011	EB1903762-012	EB1903762-013	EB1903762-014	EB1903762-015
					Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		9	23	56	50	90
Volume	----	0.01	L		.25	.25	.1	.21	.15



Analytical Results

Sub-Matrix: FILTER (Matrix: WATER)				Client sample ID	Site 39	Site 42	----	----	----
				Client sampling date / time	14-Feb-2019 07:00	14-Feb-2019 07:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1903762-016	EB1903762-017	-----	-----	-----	-----
				Result	Result	----	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³	12	3	---	---	---	---
Volume	----	0.01	L	.35	1	---	---	---	---

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 2R	Site 23	Site 18	Site 7
Client sampling date / time				11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00	
Compound	CAS Number	LOR	Unit	EB1903762-001	EB1903762-002	EB1903762-003	EB1903762-004	EB1903762-005	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	228	230	289	339	450	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.11	0.11	0.14	0.16	0.21	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	23	24	8	18	12	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	78	78	90	99	88	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	13	13	23	28	17	
Magnesium	7439-95-4	1	mg/L	11	11	8	7	11	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.003	0.002	0.002	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.07	0.03	0.03	0.03	0.05	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.17	0.16	<0.01	<0.01	0.03	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.17	0.16	<0.01	<0.01	0.03	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.5	0.6	1.4	1.2	1.0	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.6	1.4	1.2	1.0	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 2R	Site 23	Site 18	Site 7
Client sampling date / time					11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-001	EB1903762-002	EB1903762-003	EB1903762-004	EB1903762-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.8	0.8	1.4	1.2	1.0
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.16	0.16	0.10	0.10	0.04
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.13	0.13	0.02	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		24.8	27.3	19.7	32.5	23.4
2-Chlorophenol-D4	93951-73-6	1.0	%		63.4	69.0	55.3	80.1	61.0
2,4,6-Tribromophenol	118-79-6	1.0	%		45.4	48.7	43.8	58.7	43.4
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		72.5	79.8	74.9	96.5	77.0
Anthracene-d10	1719-06-8	1.0	%		77.0	85.3	53.5	66.5	53.8
4-Terphenyl-d14	1718-51-0	1.0	%		78.0	85.3	53.7	66.4	54.8

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 3	Site 14	Site 27	Site 16
Client sampling date / time				12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	
Compound	CAS Number	LOR	Unit	EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	428	392	335	546	688	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.20	0.19	0.16	0.26	0.33	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	12	8	39	74	170	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	81	79	64	195	112	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	16	15	6	37	25	
Magnesium	7439-95-4	1	mg/L	10	10	12	25	12	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.002	0.002	0.003	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.007	0.002	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.05	0.04	0.05	0.05	0.06	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	0.01	0.02	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	0.01	0.02	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	1.2	1.0	1.6	2.2	4.1	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.2	1.0	1.6	2.2	4.2	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 3	Site 14	Site 27	Site 16
Client sampling date / time					12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.2	1.0	1.6	2.2	4.2
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.06	0.07	0.23	0.31
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		24.5	25.5	27.4	23.7	25.1
2-Chlorophenol-D4	93951-73-6	1.0	%		62.8	60.7	61.4	56.5	58.9
2,4,6-Tribromophenol	118-79-6	1.0	%		39.6	35.3	33.0	31.5	42.6
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		77.4	74.0	81.7	75.7	76.5
Anthracene-d10	1719-06-8	1.0	%		55.1	50.8	57.9	53.3	54.4
4-Terphenyl-d14	1718-51-0	1.0	%		56.2	52.2	59.0	53.5	54.3

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
Client sampling date / time				13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00	
Compound	CAS Number	LOR	Unit	EB1903762-011	EB1903762-012	EB1903762-013	EB1903762-014	EB1903762-015	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	306	259	557	406	614	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.14	0.12	0.27	0.19	0.30	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	60	23	73	35	95	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	65	55	156	128	204	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	13	12	26	25	37	
Magnesium	7439-95-4	1	mg/L	8	6	22	16	27	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.005	0.001	0.003	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	0.002	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	0.006	<0.001	0.012	0.003	0.011	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.07	0.06	0.09	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	1.8	2.2	5.1	1.4	3.7	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.8	2.2	5.2	1.5	3.8	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
Client sampling date / time					13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-011	EB1903762-012	EB1903762-013	EB1903762-014	EB1903762-015
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.8	2.2	5.2	1.5	3.8
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.35	0.15	0.43	0.18	0.43
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.07	<0.01	0.02	<0.01	0.03
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		25.9	25.7	21.6	19.8	25.4
2-Chlorophenol-D4	93951-73-6	1.0	%		65.7	66.7	38.5	49.0	63.0
2,4,6-Tribromophenol	118-79-6	1.0	%		43.0	50.6	19.8	23.5	49.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		79.3	79.1	68.8	69.7	75.2
Anthracene-d10	1719-06-8	1.0	%		56.6	54.1	45.6	49.1	52.7
4-Terphenyl-d14	1718-51-0	1.0	%		55.0	54.1	45.8	49.0	52.2

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		Site 39	Site 42	DUP	FB	----
Client sampling date / time				14-Feb-2019 07:00	14-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00	----
Compound	CAS Number	LOR	Unit	EB1903762-016	EB1903762-017	EB1903762-018	EB1903762-019	-----
				Result	Result	Result	Result	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	2850	1450	424	1	---
EA020EC: Salinity								
Salinity	----	0.01	g/kg	1.48	0.73	0.20	<0.01	---
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	30	8	14	<5	---
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	801	482	81	<1	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	42	43	16	<1	---
Magnesium	7439-95-4	1	mg/L	169	91	10	<1	---
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.002	<0.001	---
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	---
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	---
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	<0.001	<0.001	---
Nickel	7440-02-0	0.001	mg/L	0.006	0.002	<0.001	<0.001	---
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	---
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	---
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	---
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.06	0.06	0.06	0.01	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	<0.01	<0.01	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.69	<0.01	<0.01	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.71	<0.01	<0.01	---
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.9	0.3	0.9	<0.1	---
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.0	0.4	1.0	<0.1	---
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 42	DUP	FB	----
Client sampling date / time					14-Feb-2019 07:00	14-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00	----
Compound	CAS Number	LOR	Unit		EB1903762-016	EB1903762-017	EB1903762-018	EB1903762-019	-----
					Result	Result	Result	Result	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.0	1.1	1.0	<0.1	---
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.08	0.02	0.06	<0.01	---
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	---
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	---
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	---
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	---
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		21.8	25.4	25.8	28.6	---
2-Chlorophenol-D4	93951-73-6	1.0	%		47.1	57.4	62.8	68.1	---
2,4,6-Tribromophenol	118-79-6	1.0	%		31.7	40.5	55.4	77.7	---
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		64.9	75.5	74.3	74.8	---
Anthracene-d10	1719-06-8	1.0	%		44.9	52.1	50.4	84.6	---
4-Terphenyl-d14	1718-51-0	1.0	%		46.5	54.7	52.7	103	---



Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2,4,6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

Surface Water Quality Results— Round 4 (May 2019)

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Surface water quality results – Round 4 (May 2019)



CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burns Road Pooraka SA 5005
Ph: 08 8162 5130 E: adelaide@alsglobal.comBRISBANE 2 Byth Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.comGLADSTONE 48 Gallenondah Drive Gladstone QLD 4680
Ph: 07 4978 7944 E: gladstone@alsglobal.comMACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.comMELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 6549 9600 E: samples.melbourne@alsglobal.comMUDGEE 1/29 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee@alsglobal.comNEWCASTLE 5/85 Maitland Road Mayfield West NSW 2304
Ph: 02 4014 2500 E: samples.newcastle@alsglobal.comNOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 02 4423 2063 E: nowra@alsglobal.comPERTH 10 Hod Way Malaga WA 6060
Ph: 08 9209 7655 E: samples.perth@alsglobal.comSYDNEY 277-288 Woodstock Road North Sydney NSW 1585
Ph: 02 8784 7777

TOWNSVILLE 07 4796 1111

WOLLONGONG 02 4225 1111

Environmental Division
Brisbane
Work Order Reference
EB1911202

Telephone: +61-7-3243 7222

CLIENT: Eco Logical Australia		TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date):		FOR LABORATORY	
OFFICE: Brisbane		(Standard TAT may be longer for some tests e.g., Ultra Trace Organics)		Custody Seal Intact	
PROJECT: Inland Rail - Border to Gowrie EIS		PROJECT NO: 10558	ALS QUOTE NO.: BN/142/18 V2	Free ice / frozen ice receipt?	
ORDER NUMBER:		PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	Random Sample T	
PROJECT MANAGER: Miles Yeates		CONTACT PH: 0467 738 954		Other comment:	
SAMPLER: David Moore and Emma Blacklock		SAMPLER MOBILE:		RECEIVED BY:	
COC Emailed to ALS? (YES)		EDD FORMAT (or default):		DATE/TIME:	
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		RELINQUISHED BY: <i>DM</i>		DATE/TIME: <i>2/5/19 16:35</i>	
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		DATE/TIME: <i>2/5/19</i>		RELINQUISHED BY:	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

-18°C ± 4°C

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)	
1	Site 2	29/04/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	All metals samples are field filtered.
2	Site 2R	29/04/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Frozen Chlorophyll a filter paper samples are included in this work order. Filter paper is 47mm GFF -0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at minus 17°C up to delivery.
3	Site 3	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
4	Site 6	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
5	Site 7	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
6	Site 11	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
7	Site 14	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
8	Site 16	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
9	Site 18	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
10	Site 20R	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
11	Site 23	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
12	Site 27	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
13	Site 28	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
14	Site 29	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
15	Site 30	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
16	Site 39	2/05/2019 - 7 am	W		7	X	X	X	X	X	X	X	X	
17	Site 40	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
18	Site 42	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	
19	DUP	30/04/2019 - 7 am	W		4	X	X	X	X	X	X	X		
20	FB	30/04/2019 - 7 am	W		4	X	X	X	X	X	X	X		
TOTAL					100									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Disulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved; Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag; L = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles

05/01/2019

Page 1 of 1

Approved for: 05/01/2019

CERTIFICATE OF ANALYSIS

Work Order : **EB1911202**
Client : **ECO LOGICAL AUSTRALIA PTY LTD**
Contact : **MILES YEATES**
Address : **PO BOX 1422**
FORTITUDE VALLEY QLD 4006
Telephone : **+61 02 8536 8667**
Project : **10558 Inland Rail - Border to Gowrie EIS**
Order number :
C-O-C number : **----**
Sampler : **DAVID MOORE, EMMA BLACKLOCK**
Site :
Quote number : **BN/142/18 V2**
No. of samples received : **20**
No. of samples analysed : **20**

Page : **1 of 15**
Laboratory : **Environmental Division Brisbane**
Contact : **Customer Services EB**
Address : **2 Byth Street Stafford QLD Australia 4053**
Telephone : **+61-7-3243 7222**
Date Samples Received : **02-May-2019 16:35**
Date Analysis Commenced : **02-May-2019**
Issue Date : **10-May-2019 14:11**



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a,h)anthracene (1.0), Benzo(g,h,i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 2R	Site 3	Site 6	Site 7
Client sampling date / time					29-Apr-2019 12:00	29-Apr-2019 12:00	30-Apr-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-001	EB1911202-002	EB1911202-003	EB1911202-004	EB1911202-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.5	0.4	1.6	1.1	1.2
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.08	0.06	0.08	0.04	0.04
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.04	0.03	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		5	4	65	10	14
Volume	----	0.01	L		0.85	0.85	0.25	0.8	0.75
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		33.3	36.2	31.4	29.2	30.8
2-Chlorophenol-D4	93951-73-6	1.0	%		74.4	82.3	71.4	67.9	70.6
2,4,6-Tribromophenol	118-79-6	1.0	%		62.5	69.1	61.5	60.0	59.0
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		83.6	91.6	78.5	75.6	77.7
Anthracene-d10	1719-06-8	1.0	%		73.4	76.6	71.3	67.2	68.0



Analytical Results

Sub-Matrix: **WATER**
 (Matrix: **WATER**)

Client sample ID

				Site 2	Site 2R	Site 3	Site 6	Site 7
Client sampling date / time				29-Apr-2019 12:00	29-Apr-2019 12:00	30-Apr-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-001	EB1911202-002	EB1911202-003	EB1911202-004	EB1911202-005
				Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	1.0	%	81.8	88.2	78.5	73.6	73.6

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		Site 11	Site 14	Site 16	Site 18	Site 20R
Client sampling date / time				30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-006	EB1911202-007	EB1911202-008	EB1911202-009	EB1911202-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	293	349	1240	314	152
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.14	0.17	0.62	0.15	0.08
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	104	44	2170	8	10
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	73	83	179	118	72
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	16	7	42	34	19
Magnesium	7439-95-4	1	mg/L	8	16	18	8	6
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.004	0.001	0.003
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.002	0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.009	0.002	0.004
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	0.008
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.03	1.50	0.02	0.02
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.05	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	0.02	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.07	<0.01	<0.01
EK060G: Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	5.7	2.3	29.6	0.8	1.6
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	5.7	2.3	31.1	0.8	1.6
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 11	Site 14	Site 16	Site 18	Site 20R
Client sampling date / time					30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-006	EB1911202-007	EB1911202-008	EB1911202-009	EB1911202-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		5.7	2.3	31.2	0.8	1.6
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.33	0.10	3.93	0.04	0.32
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.10
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		460	16	545	4	21
Volume	----	0.01	L		0.25	0.25	0.012	1	0.5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		28.3	25.5	28.2	30.9	25.8
2-Chlorophenol-D4	93951-73-6	1.0	%		67.4	60.4	67.3	71.6	64.6
2,4,6-Tribromophenol	118-79-6	1.0	%		64.9	39.8	60.8	48.6	49.8
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		71.6	59.4	57.6	69.3	61.4
Anthracene-d10	1719-06-8	1.0	%		67.0	66.1	59.8	52.9	68.9



Analytical Results

Sub-Matrix: **WATER**
 (Matrix: **WATER**)

Client sample ID

				Site 11	Site 14	Site 16	Site 18	Site 20R
Client sampling date / time				30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-006	EB1911202-007	EB1911202-008	EB1911202-009	EB1911202-010
				Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued								
4-Terphenyl-d14	1718-51-0	1.0	%	74.0	75.4	67.6	85.6	77.7

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
Client sampling date / time				01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00	
Compound	CAS Number	LOR	Unit	EB1911202-011	EB1911202-012	EB1911202-013	EB1911202-014	EB1911202-015	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	286	230	307	300	445	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.14	0.11	0.15	0.14	0.21	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	18	214	175	48	70	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	116	102	149	177	192	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	30	21	30	33	34	
Magnesium	7439-95-4	1	mg/L	10	12	18	23	26	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.001	0.003	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	0.002	0.005	0.005	0.001	
Nickel	7440-02-0	0.001	mg/L	0.003	0.008	0.011	0.015	0.006	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.08	0.04	0.03	0.03	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.9	1.4	1.5	1.8	3.3	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.9	1.5	1.5	1.8	3.3	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
Client sampling date / time					01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-011	EB1911202-012	EB1911202-013	EB1911202-014	EB1911202-015
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.9	1.5	1.5	1.8	3.3
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.51	0.31	0.66	0.38
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	0.04	0.01	0.37	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		7	24	26	18	72
Volume	----	0.01	L		0.6	0.125	0.075	0.3	0.15
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		29.5	26.4	26.2	23.7	24.3
2-Chlorophenol-D4	93951-73-6	1.0	%		70.6	62.8	58.8	59.2	60.8
2,4,6-Tribromophenol	118-79-6	1.0	%		51.0	41.5	30.4	41.7	41.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		66.4	59.6	66.8	61.6	60.9
Anthracene-d10	1719-06-8	1.0	%		78.9	69.0	74.8	68.9	69.8



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
Client sampling date / time					01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-011	EB1911202-012	EB1911202-013	EB1911202-014	EB1911202-015
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		92.2	81.3	87.4	81.2	83.7

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 40	Site 42	DUP	FB
Client sampling date / time				02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00	
Compound	CAS Number	LOR	Unit	EB1911202-016	EB1911202-017	EB1911202-018	EB1911202-019	EB1911202-020	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	1810	673	835	433	<1	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.92	0.33	0.41	0.21	<0.01	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	20	26	12	9	<5	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	720	290	367	99	<1	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	87	37	48	20	<1	
Magnesium	7439-95-4	1	mg/L	122	48	60	12	<1	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	0.010	0.003	0.003	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.02	0.05	0.03	0.02	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	0.02	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.07	0.90	1.25	<0.01	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.92	1.27	<0.01	<0.01	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.6	0.3	0.2	1.0	<0.1	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.3	0.2	1.0	<0.1	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 40	Site 42	DUP	FB
Client sampling date / time					02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-016	EB1911202-017	EB1911202-018	EB1911202-019	EB1911202-020
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.7	1.2	1.5	1.0	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.06	0.04	0.04	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	0.02	0.02	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		31	4	2	---	---
Volume	----	0.01	L		0.7	0.55	1	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		28.2	23.5	28.8	30.9	32.6
2-Chlorophenol-D4	93951-73-6	1.0	%		65.5	58.5	66.4	70.2	79.1
2,4,6-Tribromophenol	118-79-6	1.0	%		36.8	32.8	49.2	57.8	64.5
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		72.8	60.7	69.6	76.4	86.3
Anthracene-d10	1719-06-8	1.0	%		84.2	70.3	66.0	71.8	81.4



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 40	Site 42	DUP	FB
Client sampling date / time					02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-016	EB1911202-017	EB1911202-018	EB1911202-019	EB1911202-020
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		100	87.3	75.1	75.8	93.3



Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2,4,6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

Surface Water Quality Results— Round 5 (May 2019)

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Surface water quality results – Round 5 (May 2019)



Telephone : + 61-7-3243 7222

CHAIN OF CUSTODY				ALS Laboratory: please tick →											
CLIENT: Eco Logical Australia OFFICE: Brisbane PROJECT: Inland Rail - Border to Gowrie EIS ORDER NUMBER: PROJECT MANAGER: Miles Yeates SAMPLER: David Moore and Emily Messer COC Emailed to ALS? (NO) Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au				TURNAROUND REQUIREMENTS : ☒ Standard TAT (List due date): (Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date): ALS QUOTE NO.: BN/142/18 V2 COUNTRY OF ORIGIN: Australia CONTACT PH: 0467 738 954 SAMPLER MOBILE: EDD FORMAT (or default): RELINQUISHED BY: <i>[Signature]</i> DATE/TIME: 20/5/14 7:50am											
ADLAIDE 3/1 Burns Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com BRISBANE 2 Byth Street Stelford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com GLADSTONE 48 Callimondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 9549 9500 E: samples.melbourne@alsglobal.com MUDGE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee@alsglobal.com NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com NOOWA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2003 E: nowra@alsglobal.com PERTH 10 Mod Way Malaga WA 6009 Ph: 08 9209 7655 E: samples.perth@alsglobal.com SYDNEY 277-289 Ph: 02 8784 8555 E: TOWNSVILLE 14- Ph: 07 4796 0600 E: WOLLONGONG 1 Ph: 02 4225 3125 E:				FOR LABORATOR Custody Seal Intact? Free ice / frozen ice bri: Random Sample Temperature on Receipt: °C Other comment: RECEIVED BY: <i>[Signature]</i> DATE/TIME: 20/5/14 7:50 RECEIVED BY: <i>[Signature]</i> DATE/TIME: 20/5/14 7:50											
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:															
ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)		
1	Site 2	16/5/19 12:00	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 650mL	
2	Site 6R	16/5/19 12:00	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL	
3	Site 7	16/5/19 12:00	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000mL	
4	Site 18	17/5/19 12:00	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL	
5	Site 42	18/5/19 12:00	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL	
6	DUP	16/5/19 12:00	W		6	X	X	X	X	X	X	X		+ 2 Q/A/QC bottles	
7	FB	16/5/19 12:00	W		4	X	X	X	X	X	X	X			
TOTAL					35										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; N = Polyethylene Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.



CERTIFICATE OF ANALYSIS

Work Order : **EB1912777**
Client : **ECO LOGICAL AUSTRALIA PTY LTD**
Contact : **MILES YEATES**
Address : **PO BOX 1422**
FORTITUDE VALLEY QLD 4006
Telephone : **+61 02 8536 8667**
Project : **10558 Inland Rail - Border to Gowrie EIS**
Order number :
C-O-C number : **----**
Sampler : **DAVID MOORE, EMILY MESSER**
Site :
Quote number : **BN/142/18 V2**
No. of samples received : **7**
No. of samples analysed : **7**

Page : **1 of 8**
Laboratory : **Environmental Division Brisbane**
Contact : **Customer Services EB**
Address : **2 Byth Street Stafford QLD Australia 4053**
Telephone : **+61-7-3243 7222**
Date Samples Received : **20-May-2019 07:50**
Date Analysis Commenced : **20-May-2019**
Issue Date : **28-May-2019 09:01**



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a,h)anthracene (1.0), Benzo(g,h,i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
Client sampling date / time				16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00	
Compound	CAS Number	LOR	Unit	EB1912777-001	EB1912777-002	EB1912777-003	EB1912777-004	EB1912777-005	
				Result	Result	Result	Result	Result	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	290	437	440	320	1290	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.14	0.21	0.21	0.15	0.64	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	12	11	6	14	<5	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	70	86	93	101	509	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	15	18	19	29	62	
Magnesium	7439-95-4	1	mg/L	8	10	11	7	86	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.001	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.002	0.002	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.03	0.05	0.02	0.03	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.02	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.02	<0.01	0.24	<0.01	1.38	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.02	<0.01	0.24	<0.01	1.40	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	0.7	1.1	1.0	0.8	0.2	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	1.1	1.0	0.8	0.2	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
Client sampling date / time					16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00
Compound	CAS Number	LOR	Unit		EB1912777-001	EB1912777-002	EB1912777-003	EB1912777-004	EB1912777-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		0.7	1.1	1.2	0.8	1.6
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.03	0.03	0.02	0.04	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m ³		7	11	7	5	1
Volume	----	0.01	L		0.65	0.5	1	1	1
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		30.4	28.9	25.5	34.0	27.9
2-Chlorophenol-D4	93951-73-6	1.0	%		84.6	80.4	68.5	93.3	69.9
2,4,6-Tribromophenol	118-79-6	1.0	%		60.0	54.1	40.3	51.4	25.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		82.5	80.7	79.6	95.6	84.0
Anthracene-d10	1719-06-8	1.0	%		57.3	57.4	77.9	104	83.3



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
Client sampling date / time					16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00
Compound	CAS Number	LOR	Unit		EB1912777-001	EB1912777-002	EB1912777-003	EB1912777-004	EB1912777-005
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		60.8	61.4	82.5	112	89.7

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP	FB	----	----	----
Client sampling date / time				16-May-2019 12:00	16-May-2019 12:00	----	----	----	
Compound	CAS Number	LOR	Unit	EB1912777-006	EB1912777-007	-----	-----	-----	
				Result	Result	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	435	<1	---	---	---	
EA020EC: Salinity									
Salinity	----	0.01	g/kg	0.21	<0.01	---	---	---	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	7	<5	---	---	---	
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L	93	<1	---	---	---	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	19	<1	---	---	---	
Magnesium	7439-95-4	1	mg/L	11	<1	---	---	---	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	---	---	---	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	---	---	---	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	---	---	---	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	---	---	---	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	---	---	---	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	---	---	---	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	---	---	---	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	---	---	---	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.05	<0.01	---	---	---	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	---	---	---	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.24	<0.01	---	---	---	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.24	<0.01	---	---	---	
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L	1.0	<0.1	---	---	---	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.0	<0.1	---	---	---	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP	FB	----	----	----
Client sampling date / time					16-May-2019 12:00	16-May-2019 12:00	----	----	----
Compound	CAS Number	LOR	Unit		EB1912777-006	EB1912777-007	-----	-----	-----
					Result	Result	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.2	<0.1	---	---	---
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.02	<0.01	---	---	---
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	---	---	---
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	---	---	---
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	---	---	---
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	---	---	---
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	---	---	---
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	---	---	---
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	---	---	---
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	---	---	---
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	---	---	---
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	---	---	---
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	---	---	---
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	---	---	---
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	---	---	---
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	---	---	---
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	---	---	---
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	---	---	---
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		25.6	29.6	---	---	---
2-Chlorophenol-D4	93951-73-6	1.0	%		70.1	78.5	---	---	---
2,4,6-Tribromophenol	118-79-6	1.0	%		39.0	34.8	---	---	---
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		72.4	82.0	---	---	---
Anthracene-d10	1719-06-8	1.0	%		57.3	89.2	---	---	---
4-Terphenyl-d14	1718-51-0	1.0	%		63.3	95.6	---	---	---



Surrogate Control Limits

Sub-Matrix: **WATER**

		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2,4,6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154