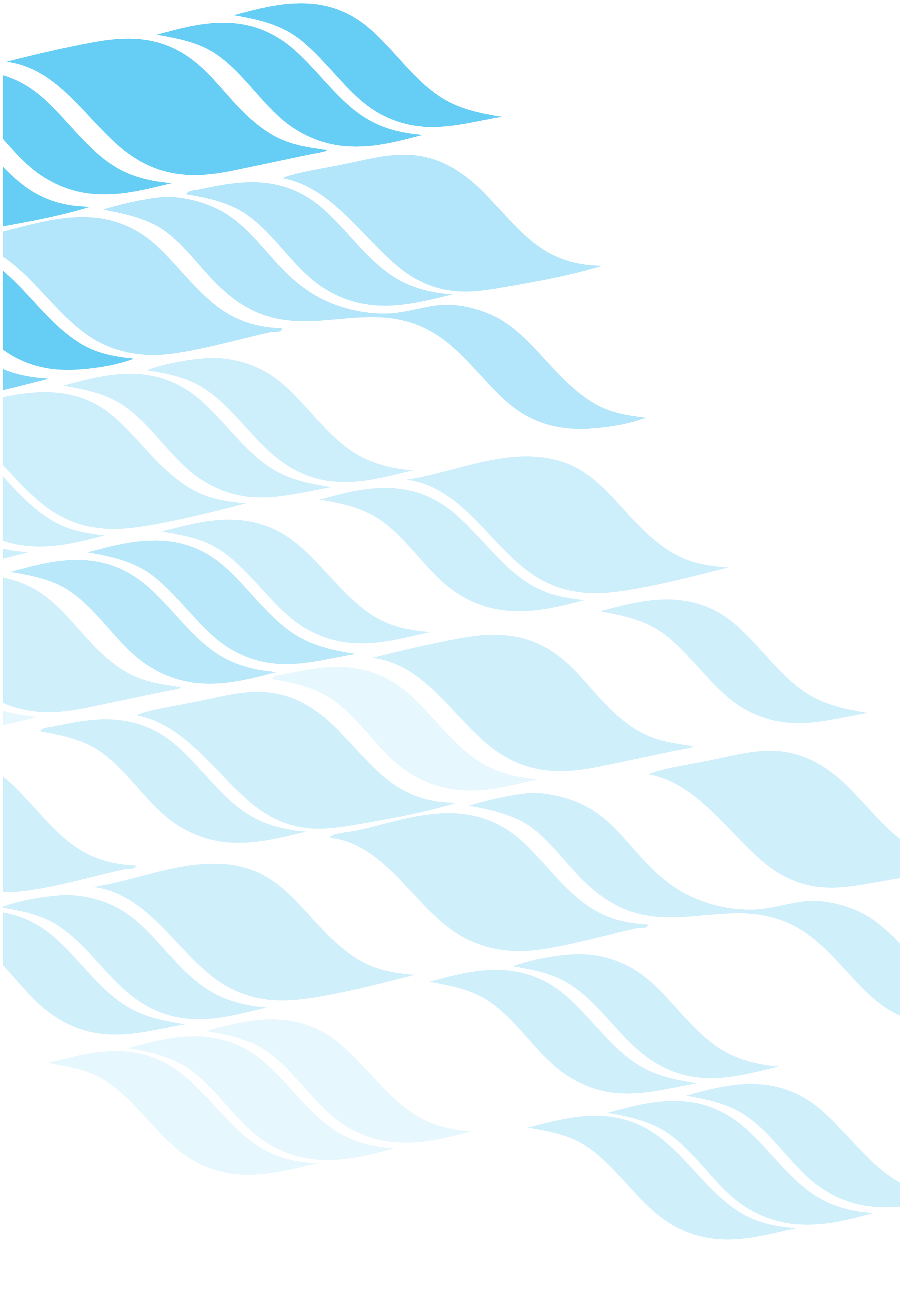
CHAPTER 9

GLADSTONE – FITZROY
PIPELINE PROJECT
Environmental Impact Statement

Water Resources and Water Qualty

Gladstone Area Water Board



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9.1 Introduction

The Gladstone-Fitzroy Pipeline project (the project) will cross a number of waterways including rivers, ephemeral streams and tidal streams. The project may also potentially have an impact on groundwater aquifers.

This chapter documents the baseline surface and groundwater environment in the project area, and considers possible impacts on water quality and quantity as a result of both the construction and operation of the project. Mitigation measures for the identified impacts are documented and an assessment is then made of the likely residual impact. The surface water component focuses on the perennial, ephemeral and tidal streams within the pipeline corridor. The groundwater component focuses on the aquifer system below ground.

This chapter does not address the allocation of water from the Fitzroy River or possible downstream impacts of this allocation, as this is managed through the Queensland Government water planning process (described in Chapter 1, Introduction) and is not included in the Terms of Reference (ToR) for this EIS.

For the purposes of this chapter the *project area* includes the generally 30 metre right-of-way (ROW) for the project, which is the area within which construction will occur, and also includes all sites for infrastructure such as the Fitzroy River intake and associated pump station, Alton Downs Water Treatment Plant (WTP) and Raglan Pump Station and Reservoir. Any relevant upstream or downstream water environments which may be impacted by the project are also considered. As with other chapters of the EIS, for the purpose of reporting the project area has been divided into two sections, Fitzroy to Bajool and Bajool to Gladstone.

Chapter 8, Aquatic Flora and Fauna also addresses the aquatic environment, with a focus on flora and fauna.

9.2 Methodology

9.2.1 Baseline

9.2.1.1 Surface Water Quality and Quantity

Data collection for the surface water component involved a desktop review of available information and a site visit in August 2007.

The desktop study for this chapter entailed the following tasks:

- A review of relevant legislation and policy (as outlined in Section 9.4)
- A review of available Geographical Information System (GIS) datasets including topographical information, watercourses, geology, vegetation and land use
- A review of background information for the project area including local government websites and other publications
- Identification of Department of Natural Resources and Water (DNRW) stream gauging stations in the project area that collect water quality data
- A review of information from the Bureau of Meteorology and local government websites to assess the flooding risk in the project area
- A review of relevant downstream environments based on a review of published information such as government databases.

The site visit provided an opportunity to develop an understanding of the local terrain, land cover and drainage patterns in the project area. Additional fieldwork was undertaken for the aquatic flora and fauna study (BMT WBM 2008) and yielded information relevant to water quality which has been included in this chapter. The methodology of the aquatic ecology fieldwork and sampling is included in Chapter 8, Aquatic Flora and Fauna.

In 2007 at the time of fieldwork and sampling, there were dry conditions in the area, which are reflected in the sampling results. The characteristics of the waterways in the project area would vary depending on weather conditions.

9.2.1.2 Groundwater Quality and Quantity

The methodology for the groundwater component of the project also involved a desktop review and a site visit. The desktop review involved research to characterise the baseline condition of groundwater resources along the pipeline corridor. This enabled the geographical extent of groundwater resources in the project area to be determined and existing groundwater quality and relevant environmental values to be identified.

The guiding premise behind the groundwater assessment is that the highest beneficial usage categories of the existing groundwater resources are maintained. These usage categories, as defined by the relevant health and water quality guidelines described in Section 9.4, attempt to classify the value of a groundwater resource in terms of its potential utilisation. It is an anthropocentric classification and, as such, usages such as provision of drinking water for humans are considered a higher classification than drinking by stock. The methodology of the groundwater assessment has therefore been to classify the existing or baseline conditions in these terms, and then identify if the project is likely to adversely affect this classification. If so, mitigation measures have been recommended and should be implemented to ensure the classification is not compromised.

Groundwater assessments in this chapter rely on data and water quality records from the DNRW database of registered bores, geological and land use mapping, and observations related to groundwater made during geotechnical fieldwork along the pipeline alignment.

Due to insufficient water quality data in the project area, the determination of beneficial use values of groundwater has been based on consideration of hydrogeological data, land use data and current groundwater usage. The dominant land use along the pipeline alignment is production on relatively natural environments, grazing and to a lesser extent dryland and irrigated agriculture. Analysis has concluded the beneficial use for groundwater systems relevant to the project area is agricultural water.

9.2.2 Impact Assessment

The impact assessment methodology identified the likely impacts of the project to surface and groundwater. Measures are then proposed to mitigate the likely impacts and an assessment is made of the residual impact using the significance criteria shown in Table 9.1. The significance criteria have been made specific to water resources & water quality.

Table 9.1 Impact Significance Criteria for Water Resources & Water Quality

Significance	Criteria for Water Resources
Major adverse	Moderate (or above) impact at a national or state scale, which results in > 60% loss of riparian vegetation and is likely to result in slumping of the stream banks. Change in surface water quality resulting in significant breaches of many of the parameters as documented in the Australia and New Zealand Environment Conservation Council (ANZECC) water quality guidelines and/or resulting in ecosystem collapse. Change in groundwater quality rendering it unsuitable for its current beneficial usage. Major change to existing regional drainage patterns and/or channel or bank form, and/or flooding and major change to groundwater table level rendering existing bores unusable.
High adverse	Minor impact at a national or state scale, and/or moderate (or above) impact at a regional scale, which results in 30-60% loss of riparian vegetation and results in stream bank erosion causing some slumping of the banks. Change in surface water quality with breaches to some parameters as documented in the ANZECC Water Quality Guidelines and medium-term ecosystem collapse. Short-term change in groundwater quality rendering it unsuitable for a period of a few months for its current beneficial usage. Alteration to existing drainage near site area and/or change to channel or bank. Change in groundwater table level with unacceptable changes to bore water pressure.
Moderate adverse	Major or high (medium to long-term) impact at site-specific scale, and/or high (short-term) or moderate impact at local scale, and/or minor impact at regional scale, which results in 5–30% of riparian vegetation removal and some localised scouring and potential for undermining bank stability. Short-term change in water quality with a few breaches of the ANZECC Water Quality Guidelines. Change in groundwater quality affecting water usage for a matter of days. Short-term change to groundwater table level affecting pressure in existing nearby bores.
Minor adverse	Moderate or high (short-term) impact at site-specific scale, or minor impact at local scale, which results in < 5% of riparian vegetation removal and potential for some short-term turbidity increases. Short-term water quality changes where ANZECC water quality guidelines are only exceeded within an initial mixing zone. Groundwater quality is only affected for a matter of hours and temporary changes to groundwater table resulting in slight changes in bore water pressure.
Negligible	Negligible impact at local, regional, state or national scale, or minor impact at or below a site-specific scale, which results in < 1% removal of riparian vegetation and/or no notable changes to surface water quality, groundwater quality, surface water drainage and/or groundwater levels.
Beneficial	The effects of a project can also be beneficial from an ecological perspective, and result in water quality improvements to either surface or groundwater. Revegetation activities proposed could improve current riparian habitat and reduce erosion capacity of the site.

9.3 Assumptions and Limitations

As discussed in Chapter 8, Aquatic Flora and Fauna, many waterways are ephemeral drainages and as such the review of surface water quality in this chapter is limited to data currently available in the public domain or where possible, data collected specifically for this project.

There is a paucity of groundwater quality data, relative to the extent required to accurately classify resources over the geographical extent of this project. The assessment of groundwater has therefore been based on the interpretation of the regional hydrogeological setting, land use and existing groundwater usage, as well as the available water quality data. This generalist approach is considered appropriate, given the nature of the project, and because it is perceived at the outset that potential risks to groundwater resources are relatively small.

The assessment of the downstream impacts due to the extraction of water from the Fitzroy River is not included in the scope of this chapter and is a separate issue considered by the Queensland Government water planning process undertaken by DNRW (as described in Chapter 1, Introduction).

9.4 Relevant Legislation and Policy

9.4.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) has been jointly developed since 1992 by the Australian Government in cooperation with state and territory governments.

The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

As part of this strategy the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) were developed and remain the default guideline for water quality values where local or regional guidelines have not been developed.

9.4.2 Environmental Protection Act 1994

Section 319 of the *Environmental Protection Act 1994* imposes a general duty of care, which specifies that a person must not undertake any activity that may harm the environment without taking reasonable and practical measures to prevent or minimise the harm. In Queensland the *Environmental Protection Act* and subordinate legislation the *Environmental Protection (Water) Policy 1997* form the legislative framework which regulates activities likely to affect both surface and groundwater.

Within this framework the key focus is to establish the Environmental Values (EV) attached to the watercourses and subsequently to determine the Water Quality Objectives (WQO) required to protect the EVs. Establishing EVs for Queensland waterways is the role of Queensland Environmental Protection Agency (EPA) but EVs have yet to be established for the Fitzroy Basin. Therefore in the absence of any sub-regional guidelines that would have locally determined environmental values, the default EV remains for the protection of aquatic ecosystems for "slightly to moderately disturbed (level 2) waters".

9.4.3 Queensland Water Quality Guidelines 2006 (QWQG)

The QWQG developed by the Queensland EPA are technical guidelines for the protection of aquatic ecosystems. These guidelines aim to further the goals of the NWQMS. The QWQG identifies three levels of ecosystem conditions for which different levels of protection can be applied:

- Level 1 – high conservation/ecological value systems
- Level 2 – slightly to moderately disturbed systems
- Level 3 – highly disturbed systems.

In setting WQOs for Aquatic Ecosystems, the QWQG (EPA, 2006) represents the most locally accredited guideline information. Under the process outlined in the *Environmental Protection (Water) Policy 1997*, these guidelines therefore take precedence over broader guidelines such as the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).

Seven major regions are defined in the QWQG that include the Central Coast of Queensland which extends from the Burnett River Basin to the Black River Basin and therefore encompasses the project area. Water quality objectives for Central Coast Queensland waters for the default EV are presented in Table 9.2. The water types shown in this table include those applicable to the study (i.e. lowland streams and enclosed coastal or lower estuary). The parameters in Table 9.2 include key physio-chemical indicators for the protection of aquatic ecosystems. However, for a number of indicators, notably toxicants, there is little or no applicable information for Queensland. For these indicators the ANZECC guidelines remain the principal source of information.

Table 9.2 Regional Guideline Values for Physio-chemical Indicators – Central Coast Region (EPA, 2006)

Water type	DO (% sat)	Turbidity (NTU)	TSS (mg/L)	pH	Nitrate (mg/L)	TN (mg/L)	TP (mg/L)
Enclosed coastal / lower estuary	90 to 105	6	15	8.0 to 8.4	0.003	0.20	0.020
Lowland streams	85 to 110	50	10	6.5 to 8.0	0.060	0.50	0.050

The QWQG does not refer to groundwater. Instead, the ANZECC guidelines are the principle source of groundwater information. The ANZECC guidelines stipulate a framework for identifying the environmental value of groundwater. This framework is based on the identification of an existing or potential beneficial use of a groundwater resource (ANZECC, 1995). The specific water quality and potential long-term value of the groundwater resource dictate the beneficial use classification.

The ANZECC guidelines further stipulate that the proponent of an activity likely to impact a groundwater resource will be responsible for maintaining the resource at or above its beneficial use classification. The beneficial use classification follows five broad categories:

- Ecosystem protection
- Recreation and aesthetics
- Raw water for drinking water supply
- Agricultural water
- Industrial water.

The beneficial use category for groundwater in the project area has been determined based on a review of hydrogeological data, land use data and current groundwater usage as agricultural water.

Further to the ANZECC guidelines, direction on what constitutes good quality drinking water is provided by the Australian Drinking Water Guidelines (2004) developed by the National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC).

9.4.4 Queensland *Water Act 2000*

The *Water Act 2000* aims to provide for the "sustainable management of water and other resources" in Queensland. *The Act* is administered by DNRW and primarily deals with the management of water quantity (rather than quality). This is undertaken through Water Resource Plans. The water resource planning process relevant to this project is described in Chapter 1, Introduction.

Water sourced for construction and hydrotesting of the pipeline is likely to be sourced from the Fitzroy River, existing council water sources, private farm dams or any other water-filled pits at quarries and extraction sites. The use of water from the Fitzroy River is administered by the Fitzroy Basin Water Resource Plan under the *Water Act 2000*, and if necessary a permit for the temporary taking of water for construction and hydrotesting will be obtained under this Act. Alternatively this water may be available through GAWB's existing water allocation.

9.5 Baseline Environment – Surface Water

9.5.1 Catchments

The majority of the project area is located within the Fitzroy River catchment (a sub-catchment of the Fitzroy Basin catchment), with the south eastern section of the project area located within the Calliope River catchment (Figure 9.1).

9.5.1.1 The Fitzroy River Catchment

The Fitzroy River catchment represents approximately 4 percent of the Fitzroy Basin catchment which is nearly 150,000 km^2, and is dominated by agriculture including grazing, dryland cropping, irrigated cotton and horticulture, and by mining (Coastal CRC 2000). The Fitzroy Basin catchment comprises six major sub-catchments – the Nogoa, Comet, Isaac-Connors, Mackenzie, Dawson and Fitzroy Rivers.

The Fitzroy River catchment is dominated by clay soils and highly episodic river flows. The catchment has degradation including erosion and soil fertility decline.

Land use in the Fitzroy River catchment is dominated by grazing which is likely to be the largest contributor to the water quality problems in the catchment as it results in soil erosion and related problems. The second largest land use in the catchment is dry land cropping. Other uses include irrigated cropping and mining which also result in water quality impacts from pesticides, nutrients, acidity and salinity (CRC for Catchment Hydrology 2004).

9.5.1.2 Calliope River Catchment

The Calliope River catchment covers an area of 2,236 km^2. Grazing is the dominant land use occupying approximately 2,032 km^2. State forest and timber reserves occupy 162 km^2 and protected areas cover less than 10 km^2.

Sediment export is classified as high risk, whilst total nitrogen and total phosphorus export are classified as medium risk in the Calliope River catchment.

Grazing land has been cleared on slopes and marginal areas resulting in erosion and salinity problems. Approximately 83 percent of the catchment has been cleared, mostly for grazing. There is also heavy industrial development in the catchment and significant mining interests (Great Barrier Reef Marine Park Authority 2007).

9.5.2 Fitzroy to Bajool

The largest waterway in this section of the project area is the Fitzroy River. The Fitzroy River intake is located within a weir pool formed upstream of the Fitzroy Barrage. Gavial Creek represents a semi-permanent pool environment in this section of the project area and there are several ephemeral drainages including Lion, Station and Oakey Creeks. Two floodplain lagoons (named Lagoons 1 and 2 as in Chapter 8, Aquatic Flora and Fauna) are also present within this section of the project area. Refer to Figure 9.2.

A large proportion of the water quality data available for the Fitzroy to Bajool section of the project area is for the Fitzroy River which is the largest waterway in the project area.

The sources of water quality data for the Fitzroy River and its tributaries have included DNRW, Fitzroy River Water (FRW), water quality sampling undertaken during aquatic flora and fauna investigations, and from a new baseline monitoring program commissioned for this project.

During investigations for the aquatic flora and fauna study (see Chapter 8, Aquatic Flora and Fauna) surveys were undertaken at key waterways traversed by the proposed pipeline corridor. Where possible, these surveys also included some "snap shot" sampling of water quality. For the Fitzroy to Bajool section of the project area, this sampling included Lagoons 1 and 2. Most of the other smaller creeks are ephemeral and were dry at the time of sampling therefore water quality monitoring was not undertaken.

9.5.2.1 Fitzroy River

There are a number of waterways in the project area, of which the Fitzroy River is the largest. Some major works are proposed within and adjacent to this perennial waterbody as part of the project. The Fitzroy River intake structure will be constructed in the river with the proposed Alton Downs WTP to be located approximately 2.5 km from the intake.

The Fitzroy River has a long and well documented history of flooding with flood records dating back to 1859. Flooding in 1991 reached the height of 9.3 m at Rockhampton and recent flooding in January 2008 reached levels of over 7 m, which is classified as a major flood event by the Bureau of Meteorology (BOM 2008). A major flood event is likely to cause inundation of large areas, isolation of towns and cities and major disruptions to road and rail links. In rural areas widespread flooding of farmland is likely in a major flood event.

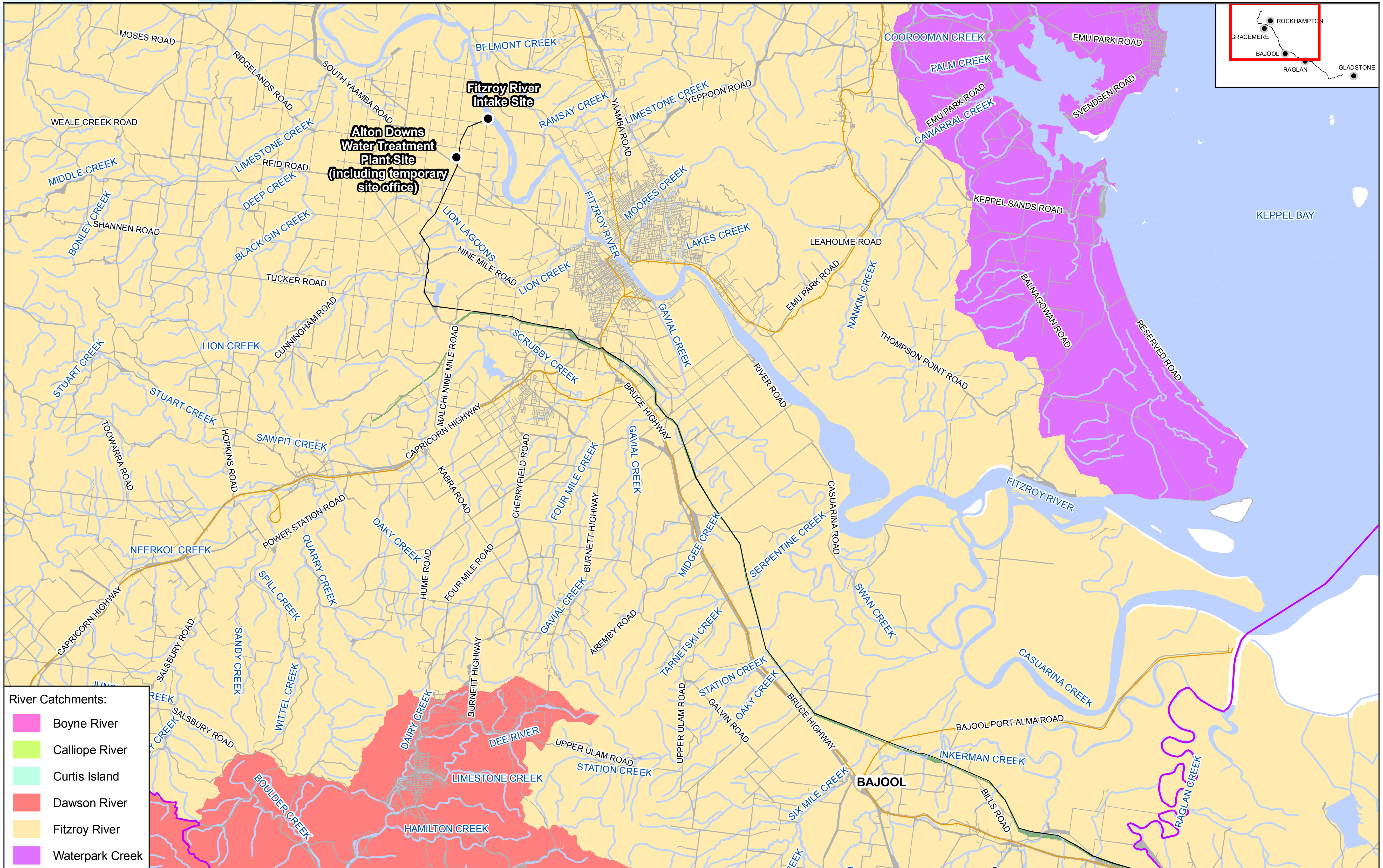
The following information summarises the available water quality data for the Fitzroy River.

DNRW Data

DNRW monitor water quality at various locations in the Fitzroy River catchment. These sites are monitored as part of the State-wide Surface Water Ambient Network (SWAN) with the objective of obtaining base line data and to determine long-term conditions of Queensland streams.

The closest of the recent monitoring sites is the Lower Fitzroy River at the Gap near Eden Bann (Site 130005A) which is approximately 60 km upstream of the intake site and for which data is available from 1964 to 2008. The other sites are further than 60 km from the project area and are therefore considered to have limited relevance to the project.

The frequency of the monitoring data however is very random for all sites and includes both flow-based sampling and scheduled monitoring. Monitoring has included an extensive range of parameters, the most relevant of which are included in Table 9.3. The maximum, minimum, average, median, 20th and 80th percentiles for key parameters are provided for the Lower Fitzroy River site in Table 9.3.

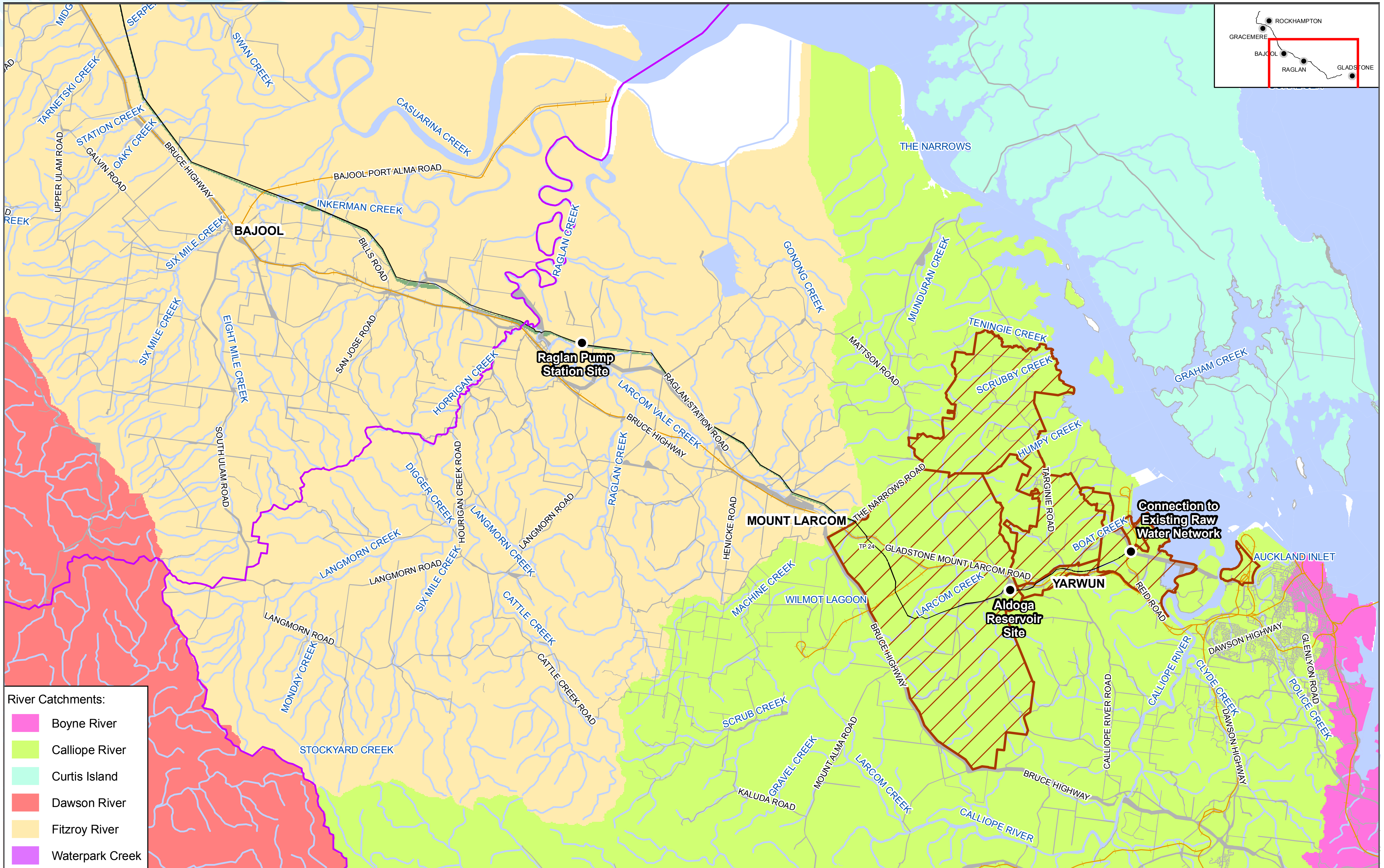


Gladstone - Fitzroy Pipeline Project

Figure 9.1 - River Catchments in the Project Area

Sheet 1 of 2

While every care is taken to ensure the accuracy of this data, the Gladstone Area Water Board (GAWB) makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which might be incurred as a result of the plan being inaccurate or incomplete in any way and for any reason. It should also be noted that final survey of the pipeline alignment and SGIC boundary are yet to occur and may result in changes to the alignments depicted here.



Gladstone - Fitzroy Pipeline Project

Figure 9.1 - River Catchments in the Project Area

Sheet 2 of 2

- The Right of Way
- Project Infrastructure
- Railway Line
- Road Reserve
- Waterways
- LGA Boundary
- SGIC
- GSDA

0 5 10 15 km

1:200,000 at A3

N

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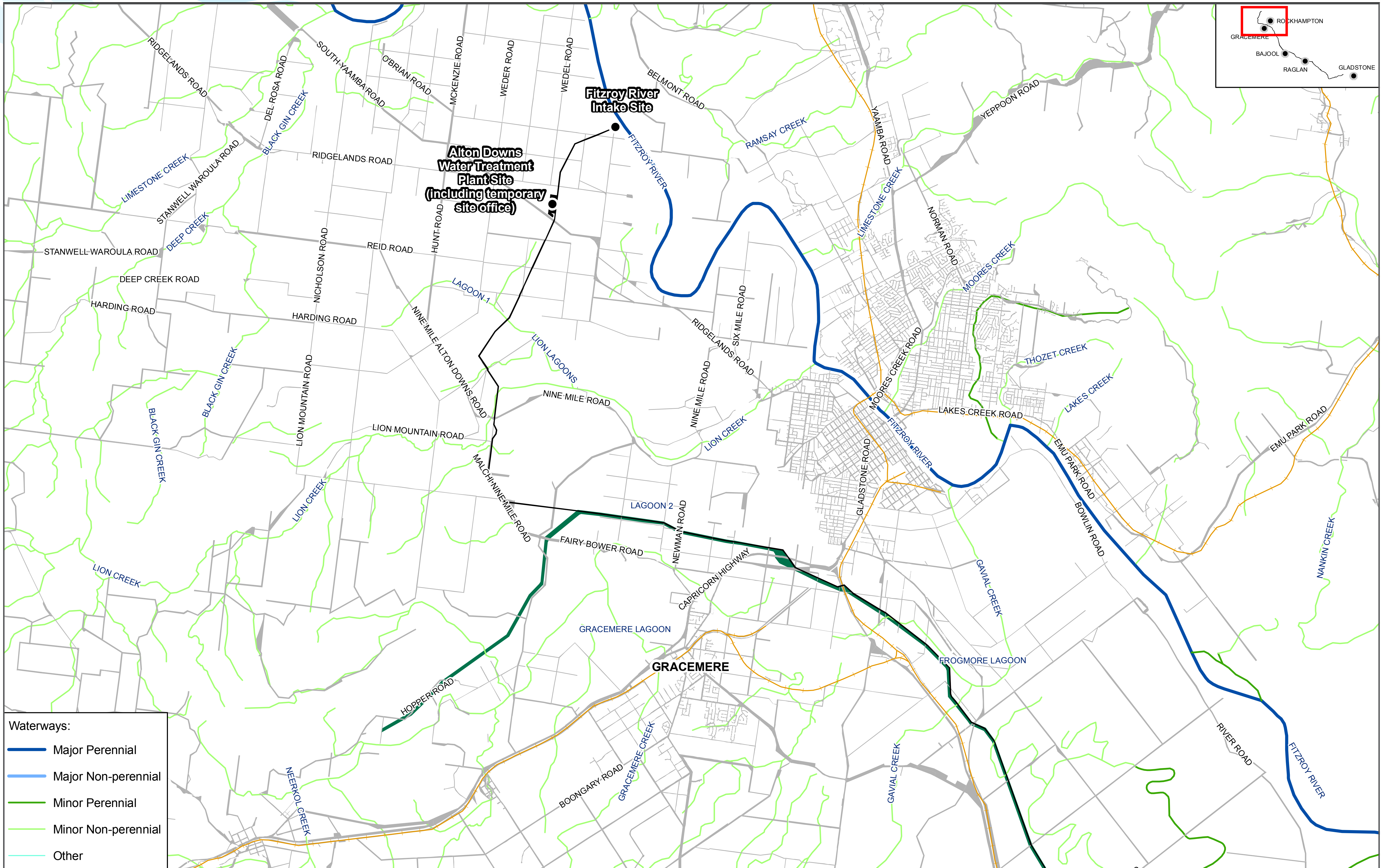

Gladstone - Fitzroy Pipeline Project

Figure 9.2 - Waterways - Fitzroy to Bajool

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- The Right of Way
- Project Infrastructure
- Railway Line
- Road Reserve
- LGA Boundary
- SGIC
- GSDA

0 2 4 6 8 km

1:100,000 at A3

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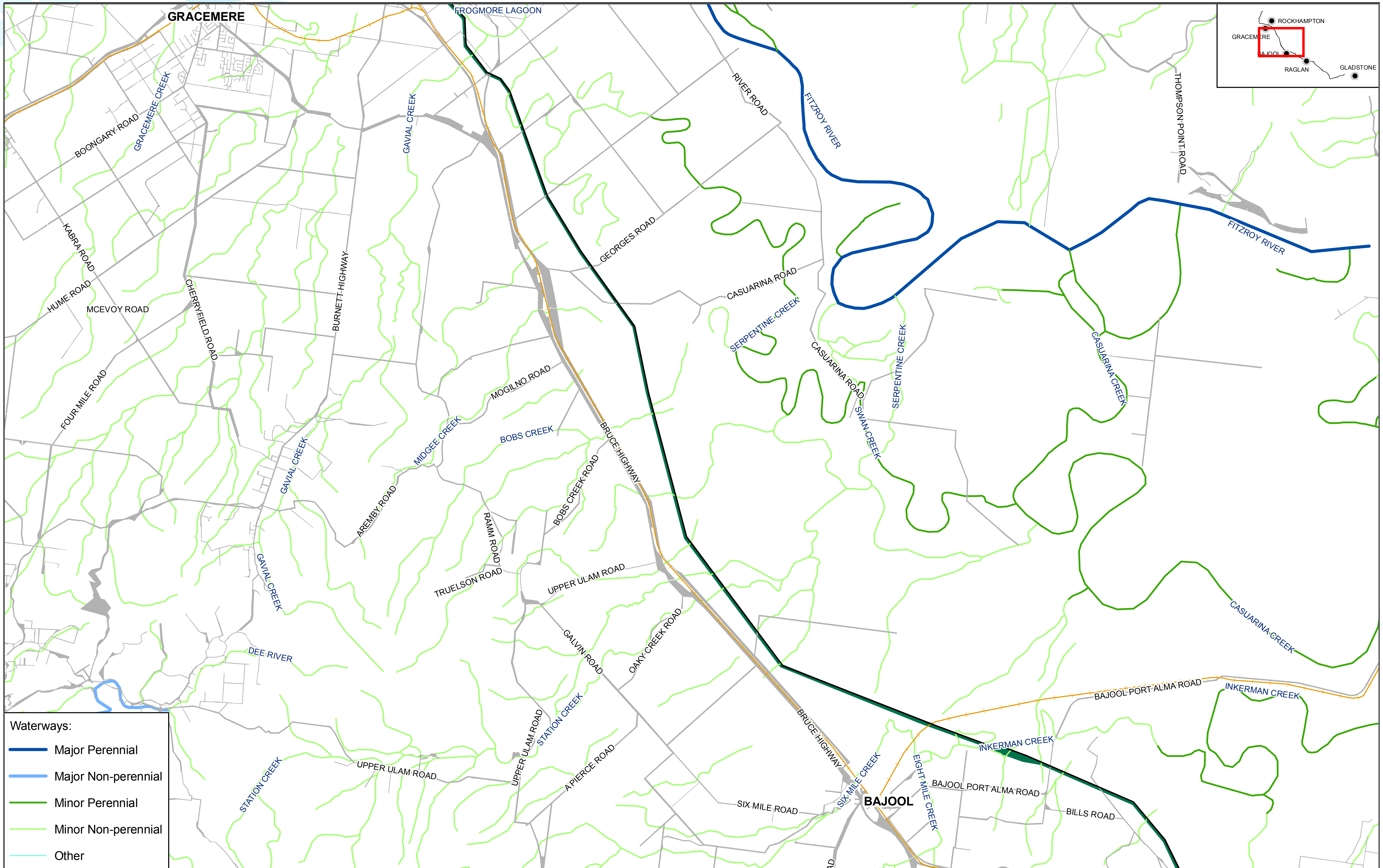

Gladstone - Fitzroy Pipeline Project

Figure 9.2 - Waterways - Fitzroy to Bajool

Sheet 2 of 2

The Right of Way
Project Infrastructure
Railway Line
Road Reserve
LGA Boundary
SGIC
GSDA

0 2 4 6 8 km

1:100,000 at A3

N

Gladstone Area Water Board

ARUP

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Table 9.3 Lower Fitzroy River at The Gap (1964 to 2008)

	DO mg/L	TOC mg/L	Turb. NTU	Cond. µS/cm	Temp °C	TSS mg/L	TDS mg/L	pH	NOx mg/L	TN mg/L	TP mg/L
Maximum	8.9	NT	2136	910	34.1	1730	762	9.1	NT	2.762	1.090
Minimum	4.0	NT	1	70	16.0	3	0	6.7	NT	0.300	0.038
Average	6.1	NT	365	251	25.2	291	146	7.6	NT	1.215	0.411
Median	6.2	NT	122	165	25.5	149	99	7.5	NT	1.076	0.319
20th %ile	5.1	NT	18	116	22.0	20	75	7.1	NT	0.591	0.116
80th %ile	7.0	NT	624	357	28.7	456	201	8.0	NT	1.701	0.725
KEY: NT = Not Tested											

The DNRW datasets are considered to be inconsistent but do provide an indication of the water quality upstream of the intake site. It can be seen that turbidity at the Lower Fitzroy site is twice the QWQG objective of 50 NTU. Total suspended solids and nitrates are also elevated.

Fitzroy River Water Data

FRW operates the Glenmore water treatment plant approximately 5 km upstream of the Fitzroy River Barrage and 6 km downstream of the proposed Fitzroy River intake for this project. While FRW holds a complete set of daily turbidity data dating back to 1975, analysis for this chapter has focussed on a recent turbidity dataset collected between February 2003 and January 2007.

The maximum, minimum, average, median, 20th and 80th percentiles for this dataset are given in Table 9.4.

Table 9.4 Turbidity Data from Fitzroy River Water (2003 to 2007)

	Turbidity (NTU)
Maximum	3097
Minimum	6
Average	246
Median	189
Percentile 20th	68.6
Percentile 80th	326.5

Data from FRW provides the best long-term dataset available. From the available data, a large range of turbidity levels have been recorded in the Lower Fitzroy River with a median value of 189 NTU (almost four times the WQO) and a maximum of 3,097 NTU (over 60 times the WQO) recorded.

During the four-year period used for analysis, totals of 131 and 19 days were recorded to have turbidity levels greater than 500 and 1,000 NTU respectively. From further analysis of this data, the average duration of excessive turbidity levels is relatively low with the average number of consecutive days that exceed 500 and 1,000 NTU being less than a fortnight and a week respectively. However, the maximum numbers of consecutive days experienced over these levels during the four-year period were 46 and 8 days respectively.

The water quality data gathered by both FRW and DNRW confirm that there are periods of high turbidity levels in the Fitzroy River.

Sampling Undertaken During Aquatic Flora and Fauna Surveys

As part of the investigations undertaken for the aquatic flora and fauna study (see Chapter 8, Aquatic Flora and Fauna) some water sampling was undertaken at selected creeks. The following observations were made with respect to characteristics of the proposed intake site that potentially may affect water quality.

At the time of sampling the Fitzroy River was approximately 331 m wide. The main channel within the vicinity of the intake was located approximately 50 m from the downstream right bank, and dropped sharply to a depth of approximately 11 m. From here the bed graduated uniformly towards the downstream left bank until reaching a depth of 4 m. Bed material was consistent across the channel, and was comprised mostly of very fine unconsolidated material with little to no coarse detritus.

The downstream right bank had a steep (approximately 50 to 60º) slope with an average bank height of 4 m. The bank was stable and showed no obvious signs of erosion. At the position of the proposed intake, the bank had been excavated to form an artificial pool, which had a dense cover of the noxious Water Hyacinth. The upper canopy on the lower bank of the downstream bank had moderate cover of *Melaleuca* and *Casuarina*. The upper bank was sparsely vegetated by *Eucalyptus*. Understorey vegetation was sparse at this site. Table 9.5 presents profiling results for key physio-chemical parameters sampled during the aquatic flora and fauna surveys.

The above results indicate that temperatures were slightly lower in deeper waters than in surface water. Deeper waters also had lower dissolved oxygen concentration compared to shallower waters. Turbidity was high (more than 118 NTU) at all depths.

GAWB Baseline Monitoring Data

CCI Australia Pty Ltd (formerly Carbon Consolidated International Pty Ltd) undertook a baseline water-quality monitoring program for the project. Monitoring occurred on a weekly basis at four locations: mid-depth at the existing Glenmore water treatment plant and at three depths at the proposed Fitzroy River intake site at Laurel Bank.

Monitoring included an extensive range of parameters including nutrient, metals, coliforms and pesticides. Table 9.6 presents a summary of data collected for key indicators from the proposed Fitzroy River intake site for the entire 13 month monitoring program from April 2007 to April 2008.

Table 9.5 Key Physio-chemical Parameters Sampled During the Aquatic Flora and Fauna Surveys

Site	Date	Depth (m)	Turbidity (NTU)	Conductivity (μS/cm)	Salinity (ppt)	DO (% sat)	pH
Fitzroy River	25/08/2007	surface	118	257	0.07	75	7.06
Fitzroy River	25/08/2007	1	127	221	0.05	73.4	7.12
Fitzroy River	25/08/2007	2	123	222	0.05	72.4	7.15
Fitzroy River	25/08/2007	3	121	222	0.04	71.1	7.16
Fitzroy River	25/08/2007	4	124	218	0.04	70.1	7.14
Fitzroy River	25/08/2007	5	124	219	0.04	68.4	7.13
Fitzroy River	25/08/2007	6	131	217	0.04	61.6	7.06
Fitzroy River	25/08/2007	7	158	219	0.04	48.5	6.97
Fitzroy River	25/08/2007	8	166	220	0.04	36.9	6.92
Fitzroy River	25/08/2007	9		220	0.04	33	6.89
Fitzroy River	25/08/2007	10		220	0.04	31.6	6.87
Fitzroy River	25/08/2007	11		223	0.04	24.7	6.86

Table 9.6 Water Quality Data at the Proposed Fitzroy River Intake Site (Mid Depth, April 2007 to April 2008)

	DO %	TOC mg/L	Turb. NTU	Cond. µS/cm	Temp °C	TSS mg/L	TDS mg/L	pH	NOx mg/L	TN mg/L	TP mg/L
Maximum	89.3	17.0	1000	360	28.0	211	230	7.8	0.45	3.00	0.260
Minimum	27.9	4.6	20	76	15.5	3	94	5.9	0.00	0.22	0.040
Average	63.4	9.8	151	204	23.1	30	158	6.8	0.12	0.87	0.094
Median	62.7	10.0	70	200	24.4	12	158	6.8	0.09	0.72	0.080
20th %ile	54.4	8.0	49	152	19.5	4	124	6.3	0.04	0.51	0.051
80th %ile	73.9	12.0	118	240	26.0	25	194	7.3	0.18	1.20	0.118

From the data above, the following observations can be drawn:

- Turbidity is consistently above the Queensland WQO of 50 NTU with a peak value of 1000 NTU
- Dissolved oxygen values consistently fall below the recommended range set in the QWQG
- Total suspended solids (TSS) levels are relatively low when correlated with turbidity and median values comply with the WQO
- Median ambient levels of nitrogen are above the WQOs for both TN and nitrates
- Median ambient levels of total phosphorus are above the QWQG WQO.

In addition to the data reported in Table 9.6, other data from the program shows non-compliances for a number of metals against ANZECC trigger values. The data has been compared against 95 percent and 80 percent protection levels which represent "slightly to moderately disturbed" systems and "highly disturbed" systems respectively. Non-compliances against these protection levels have been observed for metals including aluminium, copper, nickel, lead and zinc.

9.5.2.2 Traversed Waterways

The following sections provide descriptions of the key waterways traversed by the proposed pipeline corridor as observed during aquatic flora and fauna surveys. The descriptions principally describe aspects of the waterbodies that may potentially affect water quality such as hydrology, condition of riparian vegetation and characteristics of bed and bank material.

Where possible, these surveys also included some "snap shot" sampling of water quality. Locations of the surveys are shown on Figure 8.1 in Chapter 8, Aquatic Flora and Fauna.

Further data and analysis with regard to aquatic flora and fauna is provided in Chapter 8, Aquatic Flora and Fauna.

Unnamed Lagoons 1 and 2

Lagoons 1 and Lagoon 2 are situated on the low-lying Yeppen floodplain of the Fitzroy River. Their hydrology is not well understood, but probably receives waters from localised runoff and overflow from the Fitzroy River during flooding periods. Lagoon 1 consisted of a shallow (approximately less than 0.5 m) lake that was 560 m long by 63 m wide at the time of sampling. Lagoon 2 had an approximate size of 100 m by 25 m and a mean depth of approximately 0.4 m. The sub-stratum of both lagoons was predominantly moderately compacted fine silts and clays.

Table 9.7 presents results for key physio-chemical parameters taken at both lagoons.

Table 9.7 Water Quality Data for Lagoons 1 and 2

Site	Date	Depth (m)	Turbidity (NTU)	Conductivity (µS/cm)	Salinity (ppt)	DO (%)	pH
Lagoon 1	24/08/2007	surface	589.5	148	0.03	44.1	6.81
Lagoon 1	24/08/2007	surface	589.5	143	0.01	47.3	6.89
Lagoon 1	24/08/2007	surface	589.5	143	0.01	48.2	6.81
Lagoon 2	24/08/2007	surface	6.2	8000		77.2	7.05
Lagoon 2	24/08/2007	surface	19.6	3434	1.68	76.6	7.16
Lagoon 2	24/08/2007	surface	17.8	3426	1.63	75	7.18

Water quality varied between sites. Lagoon 1 was highly turbid at the time of sampling (approximately 589 NTU), most likely a result of disturbance of bed sediments by cattle. By contrast Lagoon 2 was relatively clear (turbidity approximately 14.5 NTU), although salinity at this site was slightly higher than other freshwater systems sampled within the project area. Levels of dissolved oxygen in both lagoons were consistently low and non-compliant with QWQG recommended ranges.

At both locations the banks and surrounds had been cleared for agriculture and there was no riparian vegetation present. Sparse stands of eucalypts were present at both sites, approximately 30 m from the edge of the bank.

Lion Creek

Within the project area, Lion Creek consisted of an ephemeral drainage with no water present at the time of the survey, and based on the occurrence of various grass species and juvenile *Eucalyptus* species within the creek, it would appear that the stream had been dry for some time.

No aquatic macrophyte or riparian vegetation was present, with surrounding lands cleared for grazing. Weed species formed a dense cover on both banks. The beds were gently sloping (approximately 20°) to a height of approximately 2 m. Both bed and bank material consisted of highly compacted clays and silts. Immediately upstream of the sampling site, an ephemeral pool approximately 50 m long was observed adjacent to a road culvert.

Gavial Creek

Gavial Creek is intersected by the pipeline corridor approximately 513 m downstream from the Bruce Highway (Figure 9.2). Habitat conditions varied markedly in Gavial Creek near the proposed pipeline crossing, reflecting different levels of habitat disturbance. Due to restricted access, two representative observation surveys were conducted downstream of the pipeline corridor.

At the time of the survey, the creek was dry, with a thick cover of grass growing within the stream bed, suggesting no substantial flows in recent times. Riparian vegetation was highly disturbed with surrounding land cleared for agriculture and grazing lands. The banks were highly eroded with evidence of slumping. The creek bed was comprised of consolidated silts and clays with occurrences of grass mat and juvenile eucalypt.

Station Creek

Due to access constraints, the survey on Station Creek was located outside the project area. Station Creek is an ephemeral stream characterised by a narrow, deep, undulating channel. No water was present at the time of sampling. Full channel width was approximately 3.8 m, and bank height was approximately 2 to 3 m. Riparian vegetation was semi-continuous and narrow, and was dominated by *Eucalyptus* species and Weeping Bottle Brush. High trees (approximately 10 m) afforded a high degree of in-channel shading. Both banks were thickly vegetated with grass species. There was evidence of cattle usage, and in places there was localised bank slumping. Bed substrates were comprised of compacted clays with approximately 5 percent rounded cobbles/large gravel.

Oakey Creek

Due to access constraints, the survey on Oakey Creek was also located outside the project area. Oakey Creek was also dry at the time of survey. Banks were approximately 4 m in height and full channel width was approximately 10 m. A narrow, semi-continuous riparian zone extended along both creek banks, and was dominated by Weeping Bottle Brush. Stream banks were severely eroded in places. The substrate was comprised of a compacted sand (approximately 80 percent) and cobble/pebble (approximately 20 percent) matrix.

9.5.3 Bajool to Gladstone

The waterways in this section of the project area include tidal creeks such as Eight Mile Creek and Raglan Creek, perennial freshwater streams including Larcom Creek and Twelve Mile Creek, upper estuarine creeks such as Horrigan Creek and ephemeral drainages of which there are approximately 15 within this section of the project area. The largest of the ephemeral drainages are Marble Creek, Sandy Creek and various drainages of Larcom Vale Creek. Refer to Figure 9.3.

9.5.3.1 Traversed Waterways

This section provides descriptions of the key waterways traversed by the proposed pipeline corridor as observed during aquatic flora and fauna surveys undertaken for the project in the Bajool to Gladstone section (see Chapter 8, Aquatic Flora and Fauna). The descriptions principally describe aspects of the waterbodies that may potentially affect water quality such as hydrology, condition of riparian vegetation and characteristics of bed and bank material. The crossing methods for each waterway and reason for method selection are described in Chapter 2, Project Description.

Where possible, these surveys also included some "snap shot" sampling of water quality. Table 9.8 presents results for key physio-chemical parameters of the sampled waterways.

Locations of the surveys are shown on Figure 8.1 in Chapter 8, Aquatic Flora and Fauna. Further data and analysis with respect to aquatic flora and fauna is provided in Chapter 8, Aquatic Flora and Fauna.

Eight Mile/Inkerman Creek

Eight Mile/Inkerman Creek is a mangrove-lined creek surrounded by extensive saltmarsh flats. The substrate of the creek bed and banks consisted of consolidated estuarine clays. The creek banks were stepped; the upper step had a steeper gradient (approximately 80° to 90°) than the lower step (approximately 30° to 60°). At low tide the creek had a wetted width of approximately less than 0.5 m and a depth of approximately less than 0.2 m. The bank full height was approximately 4 m and was approximately 3 m wide. Stream banks had a narrow (approximately 5 m), semi-continuous mangrove fringe. Canopy height was approximately 1 m to 3 m, and canopy cover varied with some cleared grazing lands. Weed species were present throughout this area.

The monitoring data showed very high turbidity values non-compliant with the QWQG objectives.

Twelve Mile Creek

Twelve Mile Creek drains into the coastal salt flats and the lower section of Raglan Creek. The creek and immediate surrounds have been modified by vegetation clearing, ongoing grazing pressures and road and rail infrastructure development. The creek channel was U-shaped, with the upper bank having a steeper gradient (approximately 70° to 90°) than the lower bank (20° to 30°). The bank full width and wetted stream width were both approximately 14 m, with low lying surrounding areas likely to become flooded during periods of high rainfall.

Table 9.8 Water Quality Data for Sampled Waterways – Bajool to Gladstone

Site	Date	Depth (m)	Turbidity (NTU)	Conductivity (μS/cm)	Salinity (ppt)	DO (%)	pH
Twelve Mile Creek	23/08/2007	surface	14.2	3799	1.81	75.4	7.66
Twelve Mile Creek	23/08/2007	surface	19.7	3739	1.78	74.2	7.78
Twelve Mile Creek	23/08/2007	1	27.4	3722	1.77	69.5	7.72
Twelve Mile Creek	23/08/2007	2	21.1	3749	1.78	29.7	7.44
Horrigan Creek	23/08/2007	surface	70.7	8000	36.04	22.2	5.84
Horrigan Creek	23/08/2007	surface	54.8	8000	35.9	16.1	5.84
Horrigan Creek	23/08/2007	surface		8000	32.49	26.1	5.9
Eight Mile Creek	25/08/2007	surface	375	8000	60	81.1	7.45
Larcom Creek	27/08/2007	surface	4.3	645	0.24	140	9.51
Larcom Creek	27/08/2007	surface	5.6	541	0.19	111.9	9.14
Larcom Creek	27/08/2007	surface	5.9	539	0.19	120.1	9.18

A continuous in-stream pool was present at the time of sampling. Creek bed and bank sediments consisted of silt and mud. The riparian vegetation was sparse and highly fragmented. Both banks were slightly eroding due to the lack of riparian vegetation and ongoing bank erosion due to stock usage of the creek.

The turbidity and DO monitoring data showed the potential occurrence of stratification in the water column.

Marble Creek

Marble Creek is a tributary of Twelve Mile Creek. The waterway is a low order ephemeral drainage that was dry at the time of sampling. A narrow semi-continuous riparian fringe extended along both banks. Cleared grazing lands surrounded the creek, although sparse (approximately 10 m) stands of *Eucalyptus* species occurred in places.

Pelican Creek

The upper reach of Pelican Creek is situated within the project area. This site had sparse to no riparian (tree) vegetation on either bank, and the surrounding area consisted of cleared grazing lands. The channel was broad (bank full width of approximately 12 m) and shallow (bank full height of approximately 0.5 m), with gently sloping creek banks (approximately 10° to 30°).

A small, freshwater pool was present at this site. Large amounts of filamentous algae were present, and formed a dense cover over the water surface. The creek bed and banks were highly disturbed, with high levels of erosion and aggradations, most likely resulting from cattle usage, observed throughout the waterway.

An artificial weir was present approximately 1 km to 2 km downstream of the site, which has resulted in the creation of a large weir pond. This structure separates the freshwater and estuarine reaches of Pelican Creek.

Raglan Creek

The section of Raglan Creek within the project area is a mangrove-lined tidal creek. Channel width was approximately 10 m and channel depth (at full bank height) was approximately 3 m. The channel was deeply incised (bank slope approximately 30° to 40°) and had a substrate comprised of compacted mangrove mud. A broad, continuous mangrove fringe occurred on both banks. Mangrove vegetation was 3 m to 8 m wide, and canopy height was less than 10 m. There was some isolated bank erosion where vegetation had been cleared to allow creek access, but overall, the creek bed and banks were in good condition.

Horrigan Creek

Horrigan Creek is a small tributary of Raglan Creek. Several isolated, shallow (less than 0.1 m depth) in-stream pools were present at the time of sampling. These pools had salinities close to seawater. However the dominance of eucalypts and scarcity of marine vegetation at this site suggests that tidal water intrusion occurs on an irregular basis (i.e. some spring tides). The creek had a bank full width of approximately 23 m and a wetted width of approximately 1.5 m. Bed sediments were predominantly compacted silts.

The upper reaches of the creek were intersected by the highway and railway. Riparian vegetation varied from narrow (less than 5 m depth) and highly fragmented, with the surrounding land use comprised of cleared grazing lands to dense (approximately 75 percent) *Eucalyptus* forest (canopy height approximately 10 m to 20 m) that was approximately 10 m wide and relatively continuous. Weed species were present throughout the site.

The monitoring data showed very low levels of dissolved oxygen and turbidity values above the QWQG objectives.

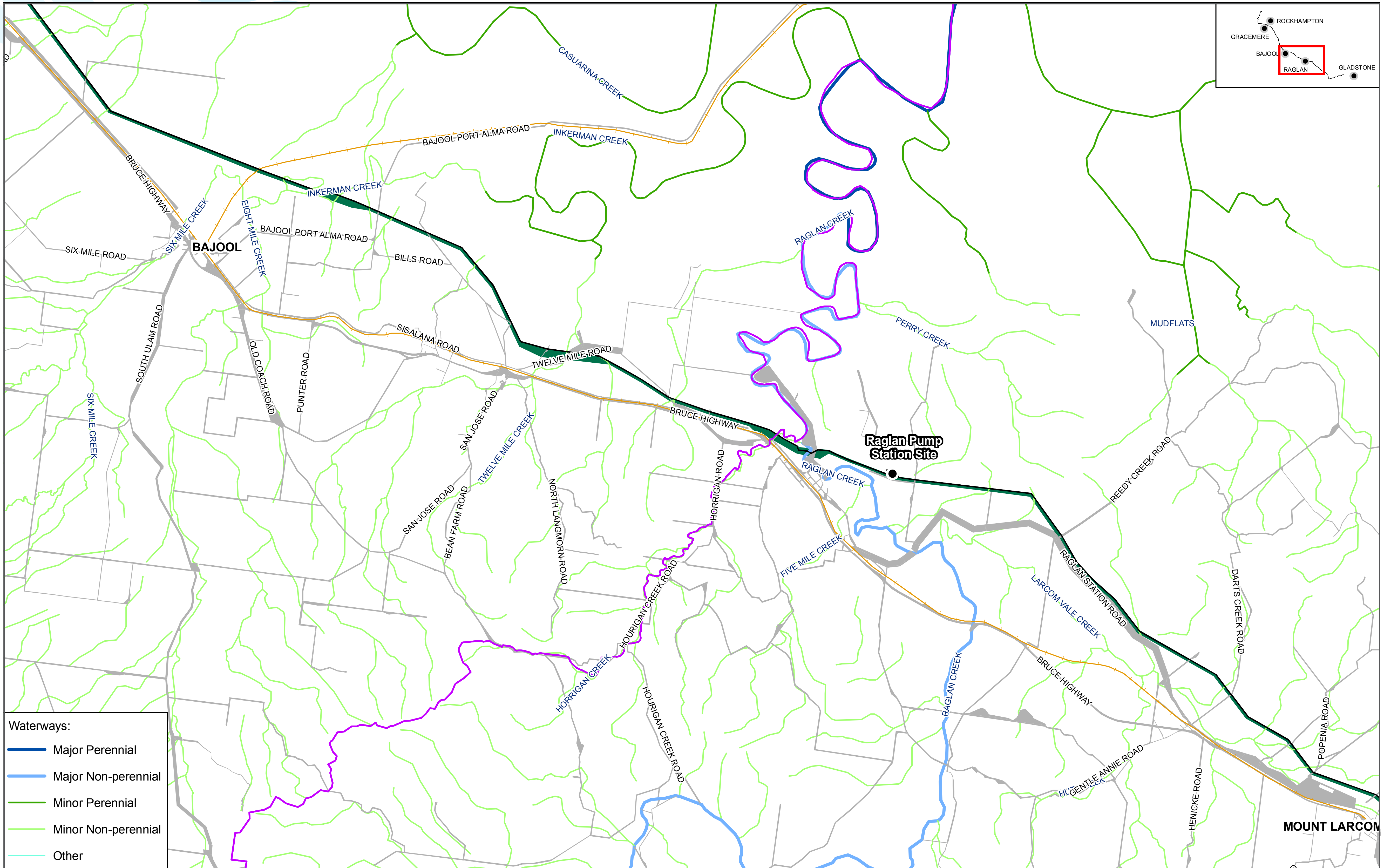
Unnamed Tributary of Larcom Vale Creek

The unnamed tributary on Larcom Vale Creek was dry at the time of sampling. This site is a low order ephemeral drainage with a substrate comprised of coarse sands (approximately 80 percent), cobbles and gravel. The channel had a flat U-shape, resulting from bank slumping and channel aggradations. Both banks supported semi-continuous riparian vegetation providing moderate in-stream shading.

The riparian vegetation canopy was dominated by *Eucalyptus*, *Melaleuca* and *Callistemon* species. Weed species were present in the riparian understorey. Surrounding areas ranged from semi-natural uncleared vegetation to cleared land for grazing.

Larcom Creek

Larcom Creek had a flat U-shape channel, consisting of steep to moderately sloped banks. The downstream right bank had a bank full height of approximately 20 m whereas the left bank was only approximately 4 m high. Riparian vegetation ranged from narrow and semi-continuous to patchy and very sparse. Canopy cover on both banks was less than 5 percent. Banks were highly unstable, a consequence of the lack of vegetation and ongoing stock and human usage. The site was surrounded by cleared pasture.



Gladstone - Fitzroy Pipeline Project

Figure 9.3 - Waterways - Bajool to Gladstone

Sheet 1 of 2

The Right of Way
Project Infrastructure
Railway Line
Road Reserve
LGA Boundary
SGIC
GSDA

0 2 4 6 8 km

1:100,000 at A3

N

Gladstone Area Water Board

ARUP

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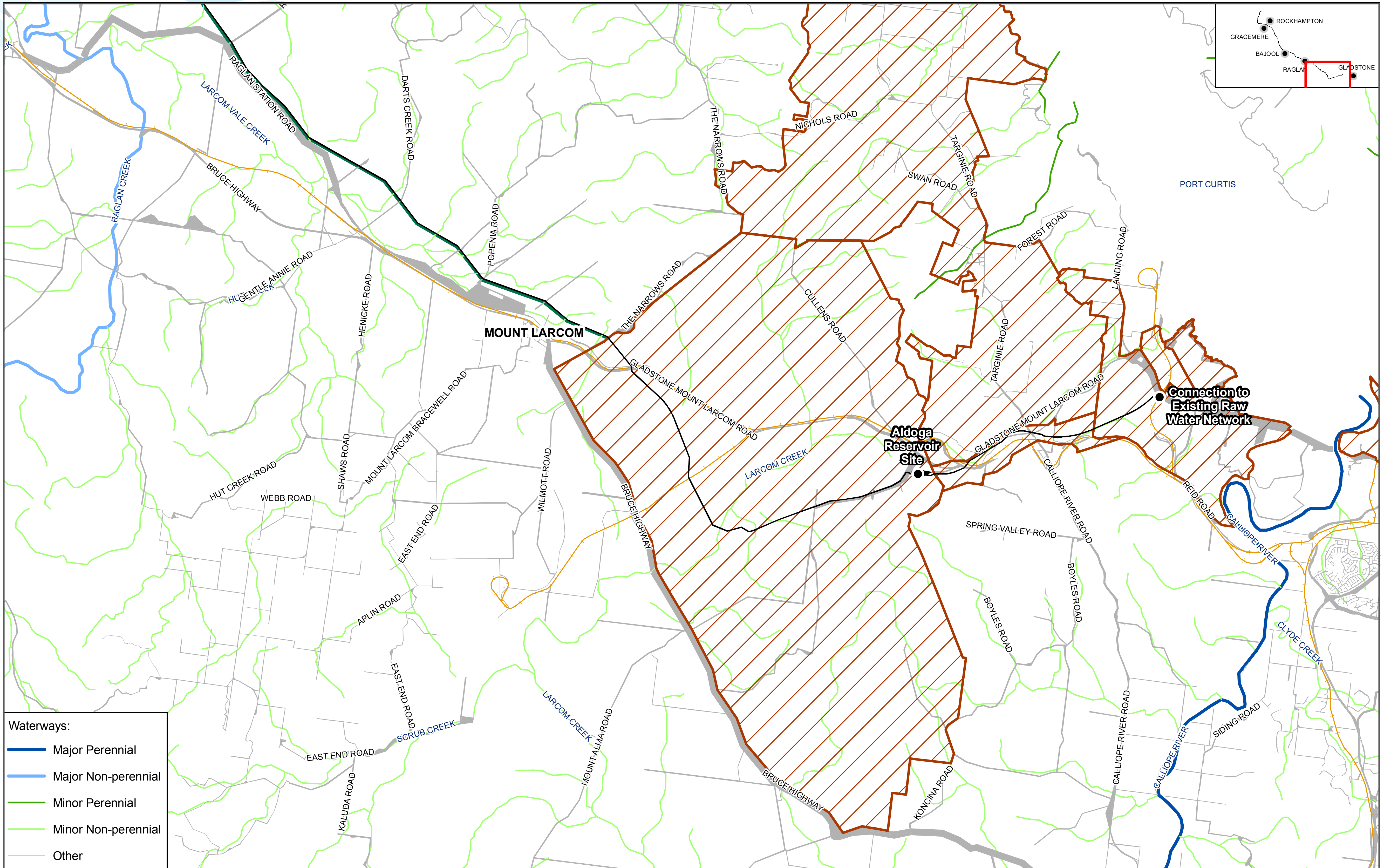

Gladstone - Fitzroy Pipeline Project

Figure 9.3 - Waterways - Bajool to Gladstone

Sheet 2 of 2

The Right of Way | **Project Infrastructure** | **Railway Line** | **Road Reserve** | **LGA Boundary** | **SGIC** | **GSDA**

0 2 4 6 8 km

1:100,000 at A3

N

Gladstone Area Water Board

ARUP

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Sandy Creek

Sandy Creek is an ephemeral drainage with a sand and mud substrate. Both banks were steep with a channel width of approximately 27 m at bank full height, and approximately 10 m at base of the channel. The surrounding lands consisted of cleared grazing lands, which had recently been burnt. A narrow riparian vegetation fringe, comprised of remnant eucalypt forest, was present on both sides of the creek. The channel was aggrading and had highly eroded banks. No water was present at the time of sampling.

9.6 Impact Assessment – Surface Water

The potential effects on surface water quality resulting from both the construction and subsequent operation of the project have been assessed. Principally, they are:

- Potential water contamination through the release of polluting substances (e.g. oil, litter and acid sulfate soils) resulting from spillages at the project site or, through the disturbance of contaminated material
- The impact of surface and stormwater discharge from the project site during construction or maintenance works on the water quality and bank stability of receiving watercourses
- The extraction of water from existing water sources for construction purposes
- Impacts associated with the maintenance and operation of both the pipeline and the Alton Downs WTP.

The impact assessment of the project has involved the following approach:

- The sensitivity of the receiving environment has been established on the basis of their use and environmental values
- An evaluation of the possible impacts on a waterway has been made taking into account the identified environmental values, proximity to the project site, length and extent of disturbance
- The consequences of the likely impact on water quality have been evaluated, assuming that mitigation measures are applied, in accordance with the significance criteria presented in Table 9.1.

9.6.1 Fitzroy to Bajool

9.6.1.1 Potential Construction Impacts

Impact of General Construction Activities on Surface Water

General construction activities may give rise to a variety of potential impacts on the surface water regime within proximity of the works. Impacts on water quality due to the discharge of site runoff are of a generic nature generally, and are likely to have a short-term and localised effect. Impacts can be readily minimised or eliminated through good practice in construction site management. Key sources of potential impact are described as follows:

- The presence at the construction site of fuels, chemicals and construction materials (e.g. cement) leading to the release of pollutants to surface water.
- Construction storage areas are likely to contain fuels, chemicals and other potentially harmful materials. Without adequate control and management these materials may have a number of potential impacts on surface water quality if substances are released, including dissolved oxygen depression, pH changes (particularly with cement) and alteration of light penetration or deleterious effect on aquatic fauna or flora.
- For the Fitzroy to Bajool section of the pipeline those waterways with permanent water present would be most sensitive to spills (Lagoons 1 and 2 and the Fitzroy River). Lagoons 1 and 2 are not known to have significant fauna or flora species, and any spills that reach the waterway would have only a localised impact. The Fitzroy River at the intake point is likely to contain significant aquatic fauna species (see Chapter 8, Aquatic Flora and Fauna) and the potential impact from a spill occurrence would be greater at this location.
- Generation of litter from construction sites and release to surface water.
- General construction waste is produced on construction sites in significant quantities and would have both a visual and environmental impact on waterways, if released. There are not expected to be large volumes of waste generated during construction of the project and this will be managed through the Construction Environmental Management Plan (EMP). Any impacts to surface water are expected to be localised.

- Surface water runoff with high loads of suspended solids from surface earthworks comprising soils, cement particles etc. entering adjacent waterways.
  - Impact on the Water Quality of Adjacent Waterways

    The highly disturbed Fitzroy River catchment has a low level of vegetation cover and is susceptible to large-scale erosion (CRC for Catchment Hydrology 2004).

    General earthworks will disturb soils and if entrained in surface runoff, can discharge to adjacent waterways impacting on the safe use of water for drinking, agricultural or recreational purposes. Direct impacts on surface water quality can include increased turbidity and levels of suspended solids leading to visual pollution, decreased light penetration and stress for aquatic fauna and flora through blocking gills, smothering sedentary aquatic plants, animals and their eggs. High sediment levels can also accumulate over time in channels and wetlands changing the substrate and, in the long-term, the vegetation type and habitat characteristics of a waterway. This can also impact the hydraulic capacity of the waterway, causing an obstruction during periods of flooding.

    As well as the direct impacts of sedimentation, other pollutants attached to soil particles such as nutrients and faecal coliforms from livestock can become entrained and released to surface water. Impacts from these pollutants can include a reduction in dissolved oxygen levels, increased aquatic macrophyte and algal growth leading to increased stress on aquatic life, and deterioration of suitability for drinking, recreation or agricultural purposes.

    If the volume and velocity of runoff leaving the site is not controlled, it can also cause destabilisation of waterway banks contributing to long-term erosion and sedimentation.

    Within this section of the project area, the majority of waterways that could be impacted by sedimentation are ephemeral. The Lion, Gavial, Station and Oakey Creeks are mainly dry and would only flow during periods of flood or high rainfall when suspended solid levels would already be excessive. Unless works are carried out within this period, the likelihood of suspended solids generated from general construction works becoming entrained in surface runoff and entering a filled or flowing waterway will be low. Lagoon 1 and the Fitzroy River contain permanent water and currently display significant loads of sediment above recommended levels as well as low levels of dissolved oxygen. The surrounding area is largely agricultural in use, so it is likely that nutrients and faecal coliform levels from livestock are also elevated within the permanent waterbodies. It is therefore important to ensure that sedimentation and associated levels of pollutants do not increase further. Given the current loads of TSS already present however (refer to Section 9.5.2), the sensitivity of the receiving environment to the impacts of sedimentation would be low, reducing the risk that sedimentation from the project would cause significant additional impact on the water quality of these two waterbodies.
  - Impact on Water Quality of Downstream Waterways

    As described in Chapter 8, Aquatic Flora and Fauna, a number of significant wetlands of both national and international importance, as well as the internationally protected Great Barrier Reef Marine Park (GBRMP), are located downstream of the project site. Although the amount of sediment likely to enter the Fitzroy River directly from the project is low, the sensitivity of these downstream protected areas to sedimentation would be high. For this reason it is particularly important that further sediment is not contributed to these areas.

    Impacts from general construction described above will reduce quickly downstream especially in low or no flow conditions. In a high flow environment, there is a greater likelihood that sediment will be mobilised but it will then be mixed with the catchment runoff which under these circumstances would be highly turbid.

    It should also be recognised that any sediment release will be of a short-term nature and limited to the period of construction only. Measures to reduce erosion and subsequent elevated suspended sediment concentrations will be implemented during construction works, as outlined in Section 9.7.

    It is considered there is a low risk of sedimentation created by the project having a significant additional impact on these sensitive environments.

- Release of contaminated water from dewatering of excavated areas.

  Requirements for the disposal of contaminated water from dewatering activities (i.e. excavation trenches or water detention basins) could lead to short-term impacts on surface water quality. The groundwater level along this section of the pipeline varies from 5 m to 20 m in depth. Excavations required for pipeline trenching generally range from 1 m to 3 m below surface, therefore it is unlikely that significant volumes of groundwater will be encountered or require dewatering.

  As works will be staged, the area of excavation where water could collect and require dewatering is expected to be minimal, therefore the volume of water disposed to surface waters is not expected to have significant impacts. Where dewatering is required, all water will be treated (through a settling tank or sediment trap) prior to discharge to surface waters.

- Water use for construction purposes.
  - Construction Activities

    Construction of the project will require a large volume of water for dust suppression, landscaping, surface stabilisation or compaction purposes. Due to the lack of town water supply along the pipeline route and a preference for the efficient use of potable water, supply for construction purposes is likely to be sought from non-potable sources such as existing waterways, private dams or quarry/extraction sites. Water from non-potable sources may have poor water quality, and if runoff from the construction site occurs at a high velocity, may contribute to soil erosion. The extraction of water from smaller watercourses may also draw down the existing water level and impact on fauna and flora reliant on this source.

    Where the use of extracted water occurs in close proximity to waterways and there is increased risk of runoff entering surface water, additional drainage and erosion and sediment controls will be applied. Water levels at the point of extraction will also be closely monitored to ensure no harm to fauna and flora occurs.

  - Site Facilities

    Site compounds will require water for kitchens, washrooms and toilets. This water will be supplied from domestic potable sources. It will be stored on site and appropriately disposed of following use. Site compounds will be located away from waterways and storage tanks contained in a bunded area to avoid any impacts in the event of a spill.

  - Disturbance of vegetation during construction

    As well as the direct impact of species and habitat loss (see Chapter 8, Aquatic Flora and Fauna), the removal of vegetation for construction purposes may destabilise surface soils or waterway banks, making them more susceptible to erosion and subsequent sedimentation over both the short and long-term period. This may include the removal of banks considered too steep for access. The soils of the catchment are noted as being susceptible to erosion due to a high level of disturbance from surrounding land uses (including grazing) and loss of vegetation cover.

    Impacts would be similar to those described above relating to sedimentation, however could be of longer duration and include greater volumes of material if serious destabilisation occurs. The removal of riparian vegetation can also potentially reduce shading of a waterway, which controls in-stream productivity, water temperature and aquatic weed growth.

    Given the erosive nature of the soils in the project area (see Chapter 5, Soils and Contaminated Land), vegetation removal or disturbance will be limited wherever possible. Where disturbance does occur, temporary stabilisation of soils will be provided until exposed surfaces can be permanently rehabilitated (see Chapter 20, Planning Environmental Management Plan).

- Spread of noxious/declared weeds.

  Aquatic and terrestrial weeds can become attached to machinery and spread to other locations if controls are not put in place. Aquatic weeds in particular can decrease water quality, making it unsuitable for use. Their spread can also cause changes to water flow and subsequently impact on bank stability. Regular visual inspection for the spread or establishment of weed species will occur and machinery will be washed down prior to their removal from the site. Furthermore, truck and other vehicle movement during construction will be planned to minimise the spread of weeds.

  All water-crossing points along this section of the pipeline contain exotic weeds, however particular care will be taken at Lagoon 1 and Lion Creek where the declared Fireweed is present and also at Fitzroy River, where the declared weed Water Hyacinth occurs.

Impact of In-stream Construction on Surface Water

- Intake construction.

  The construction of the intake structure will require the construction of a temporary coffer dam in the Fitzroy River. Water within the structure will be pumped back into the river allowing construction to occur in a dry environment. Potential impacts arising from the coffer dam may include:

  – Disturbance to in-stream sediments while the dam is being constructed, which may temporarily increase local turbidity

  – Disturbance to aquatic flora or fauna in the vicinity of the coffer dam.

    The water quality impacts from the intake construction are expected to be localised and short-term.

- Trenching works.

  In-stream works in waterways with water present will likely require the erection of a temporary barrier across the water whilst trenching occurs, usually constructed from an earth or rock bund. It is also likely that temporary construction roads will be built across waterways for access purposes. Chapter 8, Aquatic Flora and Fauna, contains a summary of the potential impacts of barrier construction on aquatic fauna. In-stream works involve a high level of temporary disturbance to the waterway and potential impacts include:

  – Release of sediment into the waterway during construction and from the removal of the barrier and the storage of fill material directly adjacent to waterways. Sediment release during installation and removal can be very high, however is usually of short duration and is localised in impact

  – Pipeline construction can involve concreting, which when released into surface water can have an impact on the pH and dissolved oxygen levels of a waterway, particularly where flow is limited (e.g. Lagoons 1 and 2). The construction of a coffer dam should reduce the risk of concrete coming in contact with water

  – Machines working within a waterway can leak or spill fuels, oils, greases and hydraulic fuels directly to surface water. The use of in-stream machinery will be avoided wherever possible with the utilisation of long-armed machinery operating from the bank

  – Alteration to channel morphology and the creation of in-stream barriers in waterways has the potential to increase upstream flood risk. However given that construction is temporary and generally short-term and the creeks to be trenched are generally ephemeral, the risk of flood impacts as a result of trenching is considered to be low.

    Where sensitive receiving environments have been identified, trenching will be avoided wherever possible, with trenchless methods the preferred construction method due to its avoidance of in-stream works. However all creeks in the Fitzroy to Bajool section of the project area will be trenched as they are ephemeral and no significant riparian vegetation has been identified. The waterways to be trenched include Lion, Gavial, Station and Oakey Creeks. Works will be timed to coincide with dry periods where possible, where large flow volumes are unlikely to occur.

- Trenchless creek crossings.

  As mentioned above, all waterways in this section of the project area are to be trenched. Trenchless crossings are discussed in Section 9.6.2 for the Bajool to Gladstone section of the project area.

Risk to surface water quality from disturbance of acid sulfate soils and generation of runoff

Along this section of the pipeline, acid sulfate soils (ASS) are most likely to occur in proximity to Scrubby and Gavial Creeks which are below 5 m AHD and were shown to have actionable levels (i.e. requiring treatment) of acidity during preliminary testing.

Impacts on water quality from the disturbance of ASS may include:

- Damage or death of aquatic fauna and flora
- A long-term change in aquatic plant communities and their composition
- The release of iron, aluminium and heavy metals into surface water, which reduces water quality
- Health impacts for humans caused by drinking or bathing in water
- Damage to infrastructure which is subject to corrosion from acidic water
- Slumping of structures built on material containing ASS, as this soil type generally has a low-bearing capacity.

Although neither of these waterways contains aquatic fauna or flora that would be sensitive to the release of acidic runoff, as a precautionary measure an ASS Management Plan will be developed for construction following the completion of a detailed ASS investigation (see Chapter 5, Soils and Contaminated Land, for further discussion of ASS).

Contamination of Surface Water from Disturbance of Potentially Leachable Contamination Present In Surface Material

Excavation undertaken as part of construction works can open up new pathways by which contaminants could migrate and affect resources elsewhere. Surface waters are potentially sensitive targets to contamination from both diffuse and point source pollutants released directly or indirectly from the land. Present water quality testing does not reveal evidence of existing surface water contamination relating to soil contamination, however this is due to a lack of parameter sampling, which may reveal contamination rather than the actual absence of contamination.

No known contaminated sites occur in this section of the project area although it is possible that land contamination exists as a result of previous agricultural land uses. This may include pesticide residues, cattle dips or waste dumps. If these areas are identified prior to or during construction, a contamination investigation will be undertaken and appropriate remediation will be carried out prior to the commencement or continuation of works in that area.

Impact of the Alton Downs Water Treatment Plant Construction

It is not anticipated that any specific impact on surface waters will be caused by construction for the Alton Downs WTP other than those general impacts discussed above (i.e. sedimentation, contaminated spills etc.). However, the scale of potential impact will be greater than construction work related to the pipeline installation, due to the increased size of disturbance.

9.6.1.2 Potential Operational Impacts

Flooding and drainage

The intake structure will be located in the river however the structure would not present a significant barrier to in-stream flow so is not expected to increase the risk of upstream flooding.

The WTP site is located outside flood prone areas and drainage design at the site will include the principles of water-sensitive urban design to reduce the impact to natural drainage. This includes the incorporation of a sediment basin and maximising stormwater infiltration by using swales, bioretention channels and kerbless roads where appropriate. The pipeline will be underground during operation so is not considered likely to increase the risk of upstream flooding.

Pipeline Maintenance

The maintenance of the pipeline involving excavation for the purposes of pipe replacement will have similar impacts as those of construction (refer to Section 9.6.1.1).

In-stream and bank erosion

In-stream erosion or low water levels can cause pipelines to become exposed, leading to changes in channel morphology such as further sediment deposition, scouring or bed and bank destabilisation. Planning and design of the pipeline will take this issue into account to avoid this problem occurring, particularly in areas identified as being prone to erosion. This should reduce the need for, and frequency of, maintenance and the generation of associated water quality impacts. Additional maintenance protection measures (such as placement of rock or concrete) may need to be installed within the waterway. For potential impacts of in-stream works, refer to Section 9.6.1.1.

Use of herbicides to control weed growth along pipeline corridor

It is not currently proposed to use herbicides along the ROW during construction or operation, however in the event they are required, potential impacts that may arise are described here. Under certain conditions, herbicides used to control weed growth can be transported via surface runoff to contaminate downstream surface waters. There are concerns that herbicides may have health impacts on both fauna and humans, and their use around surface water should be controlled. However, the risk to health from the volume of herbicides used along the pipeline will be minimal, although substantial amounts of herbicides would be used in the surrounding agricultural catchment, and may have a cumulative impact. As previously noted, the Fitzroy River discharges to internationally protected wetlands and the Great Barrier Reef. The use of herbicides will be limited around surface waters, with alternative weed removal measures utilised (including hand or machine removal) to minimise this cumulative impact.

Pipeline flushing or rupture

During the WTP and pipeline testing and commissioning period, surplus water is likely to be disposed of to the environment as required. The potential impacts of this disposal are described in Chapter 11, Waste.

In the unlikely event of a pipeline rupture during operation, water may be discharged at pressure, depending on the location of the rupture, for a short period of time. The pipeline control system is designed to detect any abnormal operating condition, such as pipe rupture, and upon detection would immediately commence to shut down the entire scheme.

The levels of residual chlorine (combined chlorine plus free chlorine) and organic chlorinated compounds that will occur within the pipeline water are dependent on the amount of chlorine required to be dosed, however testing performed to date indicates that levels up to 5mg/L may be required on a continuous basis. If released into the aquatic environment during a pipeline rupture, the residual chlorine levels may exceed regulatory requirements and further combine with organic compounds in the waterway to form persistent organic chlorine compounds.

Dilution processes in the initial mixing zones of the waterways, and exposure to sunlight and heat, may further reduce the concentrations of residual chlorine to levels within regulatory requirements. This will depend on numerous factors such as the available reducing organic compounds within the environment, volume of water in the waterway, the weather conditions, the size of the initial mixing zone and other environmental factors.

Despite the reductions in residual chlorine which may occur, some chlorinated organic compounds may remain persistent in the environment for long periods.

Spread of Pest Species (Aquatic Weeds and Fauna) Through the Intake Pipe to Recipient Catchments

Water Hyacinth (a declared pest species under the *Land Protection (Pest and Stock Route Management) Act 2002)* has been recorded in large numbers at the proposed Fitzroy River intake point. Three exotic fish species are also found in the vicinity. In the absence of appropriate management, it is a risk that the project would facilitate the transfer of these species to the recipient waterway. It should be noted that these species are also found in the receiving location, so the impact of this relocation would be reduced. Further detail on these risks can be found in Chapter 8, Aquatic Flora and Fauna. It is acknowledged that weed seeds may not be removed in the water treatment process and that the release of this water to the environment during commissioning and operation has a risk of spreading weed seeds to the receiving catchment. See Chapter 11, Waste, for mitigation measures.

Bed and Bank Disturbance at the Intake Location

The continuous intake of water from the Fitzroy River has the potential to cause long-term scouring of the riverbed if not controlled. If this occurs at the toe of a riverbank, this will eventually cause under-scouring and destabilisation of the bank. This will be taken into consideration during the design of the intake point, and hard protection (e.g. concrete apron) will be applied as necessary, to prevent this occurring.

Stormwater Discharge from the WTP

Stormwater discharges from the WTP catchment will have increased volume and velocity due to additional impervious sources and a concentration of flow. Areas containing hazardous substances will be bunded and any runoff collected and treated prior to discharge, making it unlikely that these substances would enter the waterway.

9.6.2 Bajool to Gladstone

Impacts of pipeline construction from Bajool to Gladstone are of a similar nature to those described in Section 9.6.1, however, waterways in this section are more likely to contain more sensitive fauna and flora. Only those impacts specific to this section are detailed as follows.

9.6.2.1 Potential Construction Impacts

Impact of General Construction Activities on Surface Water

- The presence at the construction site of fuels, chemicals and construction materials (e.g. cement) leading to the release of pollutants to ground and surface water.

  For the Bajool to Gladstone section of the pipeline those waterways with permanent water would be most sensitive to spills (Eight Mile, Twelve Mile, Horrigan, Raglan and Larcom Creeks). Twelve Mile Creek and Horrigan Creek are considered highly disturbed and are unlikely to provide habitat for significant aquatic fauna species due to their small size, the absence of optimal habitat, historical clearing and ongoing pressures from adjacent land uses (e.g. grazing). Any spills to these waterways, although not ideal, will have a limited impact if appropriate site management measures are in place. Eight Mile and Larcom Creeks provide potential habitat for significant aquatic fauna species and any spill to these waters could have a moderate adverse impact. Raglan Creek contains well-developed mangrove stands that are likely to represent locally important habitat for species of direct economic significance e.g. mud crabs, prawns etc. as well as the Saltwater Crocodile. It is also used for recreational fishing. No water quality data is available for this location, so it is difficult to ascertain the current state of this waterway and its sensitivity to spills. However, given the environmental and recreational values of Raglan Creek, any spill is likely to have an adverse impact.

- Generation of litter from construction sites.

  As long as good site practices are established and maintained onsite (including provision of waste receptacles and regular inspections for waste materials) any impacts on water quality along this section of the pipeline will be minimal. Given the recreational use of Raglan and Eight Mile Creeks, litter would have a high visual impact and additional care should be taken to control this.
- Surface water runoff with high loads of suspended solids from surface earthworks or dewatering of excavated areas, comprising soils, cement particles etc. entering adjacent waterways.
  - Impact on Water Quality of Adjacent Waterways

    Similar to the impacts of potential spills outlined above, Eight Mile, Twelve Mile, Horrigan, Raglan and Larcom Creeks have permanent water and would be most susceptible to the impacts of sedimentation. Eight Mile and Horrigan Creeks already display high loads of TSS, and the sensitivity of the environment to the impacts of sedimentation are expected to be low. These creeks are to be crossed by trenchless methods so there is not expected to be a large increase in sedimentation as a result of construction. Twelve Mile and Larcom Creeks currently have low TSS loads and are likely to be more sensitive to small changes. Additional attention to erosion and sediment controls is required at these locations, particularly as these creeks are to be trenched.
  - Indirect Impact on Water Quality of Downstream Waterways

    As described in Chapter, 8 Aquatic Flora and Fauna, a number of significant wetlands of both national and international importance, as well as the GBRMP, are located downstream of the pipeline works in this section of the project area. Potential impacts described in Section 9.6.1.1 are considered to be identical to those for the Bajool to Gladstone section.
- Release of contaminated water from dewatering of excavated areas.

  The groundwater level along this section of the pipeline varies from 10 m to 20 m in depth. Excavations required for pipeline trenching generally range from 1 m to 3 m below surface, therefore it is unlikely that significant volumes of groundwater will be encountered or require dewatering.

  As works will be staged, exposed excavation areas where water could collect and require dewatering are expected to be minimal, therefore the volume of water disposed to surface waters would have a minimal impact. Where dewatering is required, all water will be treated (through a settling tank or sediment trap) prior to discharge to surface waters.
- Disturbance of vegetation during construction, which may cause long-term destabilisation of waterway banks, and subsequent erosion and sedimentation.

  Impacts would be similar to those described above relating to sedimentation, however could be of longer duration and include greater volumes of material if serious destabilisation occurs. Waterways along this section of the pipeline already exhibit evidence of heavy erosion, so it will be important to avoid further unnecessary disturbance to banks or stabilising vegetation (e.g. mangroves along Raglan Creek). The design of the pipeline may have to provide additional scour protection in those areas which are subject to erosion. Where site practices are unable to prevent erosion or loss of vegetation, restoration of disturbances caused by construction will be undertaken as appropriate.
- Spread of noxious/declared weeds

  All water-crossing points along this section of the pipeline contain exotic terrestrial weeds, although no aquatic weed species were noted during the site inspection. Precautions that limit the spread of weeds will be undertaken during construction as described in Chapter 20, Planning Environmental Management Plan.

Impact of In-stream Construction on Surface Water

- Trenching works.

  Where sensitive receiving environments have been identified, trenching will be avoided wherever possible, with trenchless methods the preferred construction methods due to its avoidance of in-stream works. Table 2.2 in Chapter 2, Project Description, provides a summary of the crossing methods for the main waterways in the project area and reasons for method selection. For this section of the project area, the creeks that are planned to be trenched include the ephemeral waterways where significant vegetation has not been identified, but also include Twelve Mile and Larcom Creeks, which have a permanent pool. Works will be timed to coincide with dry periods where possible, when flow is reduced and significant flow is unlikely to occur in the ephemeral waterways.
- Trenchless creek crossings.

  In this section of the project area, trenchless methods are proposed for Eight Mile/Inkerman, Horrigan and Raglan Creeks due to the presence of significant riparian vegetation and in-stream habitat. Raglan Creek in particular contains protected vegetation (mangroves) and trenchless methods will minimise disturbance to this habitat, and minimise water quality impacts.

In general, trenchless creek crossings have a lesser environmental and visual impact as there are only small entry and exit points created that result in less ground disturbance and works within a waterway are avoided. There are however potential process-related impacts (i.e. drill muds) used during trenchless crossings that usually contain lubricants (including water and a clay substance called bentonite) that can seep through fractures in the soil profile and potentially into a waterway. This may present implications from a water quality perspective, as bentonite can be mildly toxic to fish and invertebrates.

It is considered that the risk of this material reaching surface waters is low, however management procedures will be put in place to reduce this risk further. Measures would include locating the point of entry/exit in less sensitive areas, ceasing drill operations immediately upon detection of a possible occurrence, having spill equipment available if seepage occurs, and having a monitor on site to oversee clean up and assess possible impacts.

All drilling fluid will be collected at the entry and exit points, with appropriate containment devices installed e.g. bunding, silt fences etc. It will be stored onsite and disposed of appropriately.

As trenchless crossings do not require the creation of in-stream barriers, this crossing method is not considered likely to have an impact on upstream flooding.

Risk to Surface Water Quality from Disturbance of Acid Sulfate Soils and Generation of Runoff

In this section of the project area, ASS are most likely to occur in proximity to Eight Mile/Inkerman and Raglan Creeks.

Both creeks may contain aquatic fauna that would be sensitive to the release of acidic runoff and an ASS Management Plan will be required for works within this area.

Contamination of Surface Water from Disturbance of Potential Leachable Contamination Present In Surface Material That Is Disturbed During Excavation

None of the potentially contaminated sites identified on the Environmental Management Register (EMR) within this section of the project area (see Chapter 5, Soils and Contaminated Land) are located in proximity to watercourses, and it is therefore not likely that contamination of surface waters will occur as a result of these sites. However there is the potential for unknown contaminated sites to exist within the project area as a result of current or previous land uses. Areas identified as containing significant or specific contamination will be remediated prior to the commencement of works in that area.

9.6.2.2 Potential Operational Impacts

Flooding and Drainage

In this section of the project area, the Raglan pump station and reservoir and Aldoga Reservoir sites have been selected on the basis that they are above flood prone areas. The pipeline itself will be underground and as such would not create a barrier to waterway flow or increase the risk of upstream flooding.

Drainage design at all permanent infrastructure sites will be undertaken to minimise the disruption to natural drainage patterns and measures will be taken to restore natural drainage profiles in areas of temporary construction disturbance.

Pipeline Maintenance

Pipeline Scouring and Bank Erosion.

The waterways along this section of the pipeline are heavily eroded, and regular maintenance and inspections will be required to prevent significant erosion occurring.

Use of Herbicides to Control Weed Growth Along Pipeline Corridor

Refer to Section 9.6.1.2.

Pipeline Flushing or Rupture

In addition to the impacts described in Section 9.6.1.2, pipeline rupture in this section of the project area has the potential to have more serious impacts due to the tidal nature of some of the waterways. The tidal waterways would have different characteristics to the fresh water in the pipe in relation to salinity and temperature.

A pipeline rupture located somewhere along a tidal crossing point will release the pipeline water into the waterway, causing a mixing zone within which the two water types equilibrate. A small rupture would likely go unnoticed, and continue to release small volumes of pipeline water indefinitely. A catastrophic rupture would be readily identified and due to the presence of isolation valves in the pipeline, the amount of water lost due to a rupture can be minimised.

It is unlikely that aquatic fauna within this mixing zone would be significantly affected by the differences in water quality, regardless of the rate of release. Fauna in tidal waters are generally well adapted to reductions in oxygen levels, and salinity and temperature fluctuations are normal occurrences due to tidal change.

The most significant impacts arising from pipeline rupture are more likely to be the disturbance of overlying substrate from high-pressure water, producing a sediment plume. Refer to Section 9.6.1.1 for the impact of sedimentation on waterways.

9.7 Mitigation and Residual Impacts – Surface Water

Table 9.9 describes the mitigation and residual impacts relevant to surface water quality in the project area. Chapter 20, Planning Environmental Management Plan, includes further detail on the proposed mitigation measures for impacts to water resources and water quality.

Table 9.9 Mitigation and Residual Impact Significance

Activity	Potential impact	Mitigation measures	Residual impact
Construction Phase			
Release of construction fuels, chemicals or other construction materials to surface water.	Deterioration in physical water quality parameters (pH, DO, light penetration) Visual impact. Damage to fauna and flora.	Implementation of a Construction EMP Storage of all harmful substances in a bunded area. Spill kits available at all times. Regular inspections of storage areas and water quality. Staff training in emergency response procedures.	**Minor adverse** (Lion, Gavial, Station and Oakey Creeks due to ephemeral nature of waterway). **Moderate adverse** (Lagoons 1 and 2, Fitzroy River due to presence of permanent water). **Minor adverse** (Eight Mile/Inkerman, Raglan, Horrigan, Marble, Pelican, Sandy Creeks and unnamed tributary of Larcom Creek – due to ephemeral nature of waterway or trenchless crossing method). **Moderate adverse** (Larcom Creek and Twelve Mile Creek due to trenched crossing and presence of permanent water).
Generation of litter.	Harm to fauna. Visual amenity.	Implementation of a Construction EMP. Provision of waste bins. Regular site inspections. Staff training in waste disposal procedures.	**Negligible.**
Release of sediment-laden water to adjacent surface water.	Deterioration of physical water quality parameters (particularly turbidity levels), making water unsafe for drinking, agricultural or recreational uses. Increase in aquatic macrophyte or algal growth from increased nutrients and faecal coliforms from livestock Visual amenity. Harm to common significant fauna and flora sensitive to sediment and associated pollutants.	Implementation of a Construction EMP. Selection of trenchless crossings for some creeks. Implementation of drainage, erosion and sediment control measures. Stabilisation of exposed/disturbed soils i.e. temporary geofabric/revegetation. Scheduling works for the dry season. Minimisation of cut and fill construction near waterbodies. Regular water quality monitoring.	**Minor adverse** (Lion, Gavial, Station and Oakey Creeks due to ephemeral nature of waterway). **Moderate adverse** (Lagoons 1 and 2, Fitzroy River due to presence of permanent water and likely level of disturbance). **Minor adverse** (Eight Mile/Inkerman, Raglan, Horrigan, Marble, Pelican, Sandy Creeks and unnamed tributary of Larcom Creek – due to ephemeral nature of waterway or trenchless crossing method). **Moderate adverse** (Larcom Creek and Twelve Mile Creek due to trenched crossing and presence of permanent water).

Activity	Potential impact	Mitigation measures	Residual impact
Release of sediment-laden water to downstream protected waters (Ramsar wetlands and GBRMP).	Deterioration of physical water quality parameters. Smothering of protected aquatic habitats e.g. mangroves/seagrass beds/reef that support protected aquatic fauna species. Visual amenity.	Refer to above measures.	**Negligible.**
Extraction of water for construction activities.	Soil erosion from release of construction water and subsequent sedimentation. Changes in water levels at the extraction source, impacting reliant fauna/flora.	Implementation of a Construction EMP. Regular inspection of levels, water quality parameters and presence of fauna/flora. Implementation of drainage, erosion and sediment controls. Ceasing of extraction where issues are identified. Off-site disposal of compound wastewater.	**Minor adverse** (water quality) **Beneficial** (reduced use of potable water)
Release of contaminated water from dewatering of excavated areas	Sedimentation of receiving waters.	Onsite containment and treatment of water to a suitable level prior to release.	**Minor adverse.**
Disturbance of vegetation	Exposure of soil to erosion and subsequent sedimentation of waterways. Long-term destabilisation of waterways banks and changes to creek morphology.	Implementation of a Construction EMP. Minimisation of construction footprint. Installation of vegetation protection measures. Trenchless crossing for areas subject to erosion or containing protected fauna or flora. Rehabilitation of disturbed areas.	**Minor to moderate adverse.**
Spread of noxious/declared weeds.	Displacement of native fauna and flora species. Changes to in-stream morphology and subsequent bank erosion. Deterioration in physical water quality.	Implementation of a construction and operation weed management plan. Regular vehicle inspections. Washdown of vehicles prior to entering/exiting construction site.	**Minor adverse.**
Release of lubricants from trenchless crossing methods.	Mild toxicity for fish and invertebrates.	Location of entry/exit point away from sensitive locations. Cessation of drill operations immediately upon detection of an occurrence. Spill kits available. Visual monitoring of surface waters during drilling.	**Minor adverse.**
Disturbance of acid sulfate soils.	Damage or death of aquatic fauna or flora. Release of iron, aluminium or heavy metals into surface water. Health impacts for humans. Damage to infrastructure.	Preparation and implementation of an ASS Management Plan. Avoidance of disturbance to areas where ASS are likely to occur (i.e. trenchless crossing methods).	**Minor adverse** (Scrubby and Gavial Creeks). **Moderate adverse** (Eight Mile/ Inkerman and Raglan Creeks).
Disturbance of contaminated soils.	Deterioration in physical water quality. Damage or death of aquatic fauna or flora.	Preliminary site investigation at potential contaminated sites. Remediation of contaminated soils prior to pipeline construction.	**Negligible.**

Activity	Potential impact	Mitigation measures	Residual impact
Operational Phase			
Project location and design.	Increased risk of upstream flooding and impacts to local drainage.	Siting of infrastructure outside of flood risk areas. Location of pipeline underground. Use of water sensitive urban design principles at infrastructure sites. Restoration of local drainage profiles following construction.	**Negligible.**
Intake operation.	Hydraulic obstruction, causing changes in flow in subsequent destabilisation of waterway banks. Exposure of in-stream infrastructure. Re-suspension of suspended solids within waterway.	Include pipeline protection measures in design. Regular inspections and maintenance of waterway crossing points.	**Minor adverse.**
Herbicide use for weed suppression.	Adverse health impacts for both humans and fauna.	Limitation of herbicide use near waterways. Preparation of weed management plan.	**Negligible.**
Pipeline rupture.	Release of chlorine to waterways Release of fresh waters into tidal waters. Changes to oxygen, salinity and temperature. Disturbance to substrate. Release of weed seeds to waterways.	Regular maintenance and inspections. Control system to shut down the pipeline in event of a rupture. Isolation valves along the pipeline to minimise amount of water discharged. Implementation of weed management plan.	**Minor to moderate adverse.**
Intake of pest species through pipeline infrastructure.	Spread of pest species to downstream waters.	Screening of pipe intake. Water treatment process.	**Negligible.**
Bed and bank disturbance at the intake location.	Undermining and destabilisation of waterway bank.	Design modification and installation of protection structures. Regular inspections.	**Minor adverse.**
Stormwater discharge from WTP.	Contaminated substances enter waterway.	Storage of hazardous substances in bunded areas. Treatment of water prior to discharge. Regular water quality monitoring at discharge point.	**Minor adverse.**
Release of treated wastewater from WTP.	Local turbidity. Erosion of banks. Changed water quality.	Water will be discharged at a rate that will not cause erosion or excessive turbidity. Erosion and sediment control measures will be implemented at the discharge point. Water discharged will be the same or better water quality as the Fitzroy River water and chlorine levels will be below guideline levels.	**Negligible.**

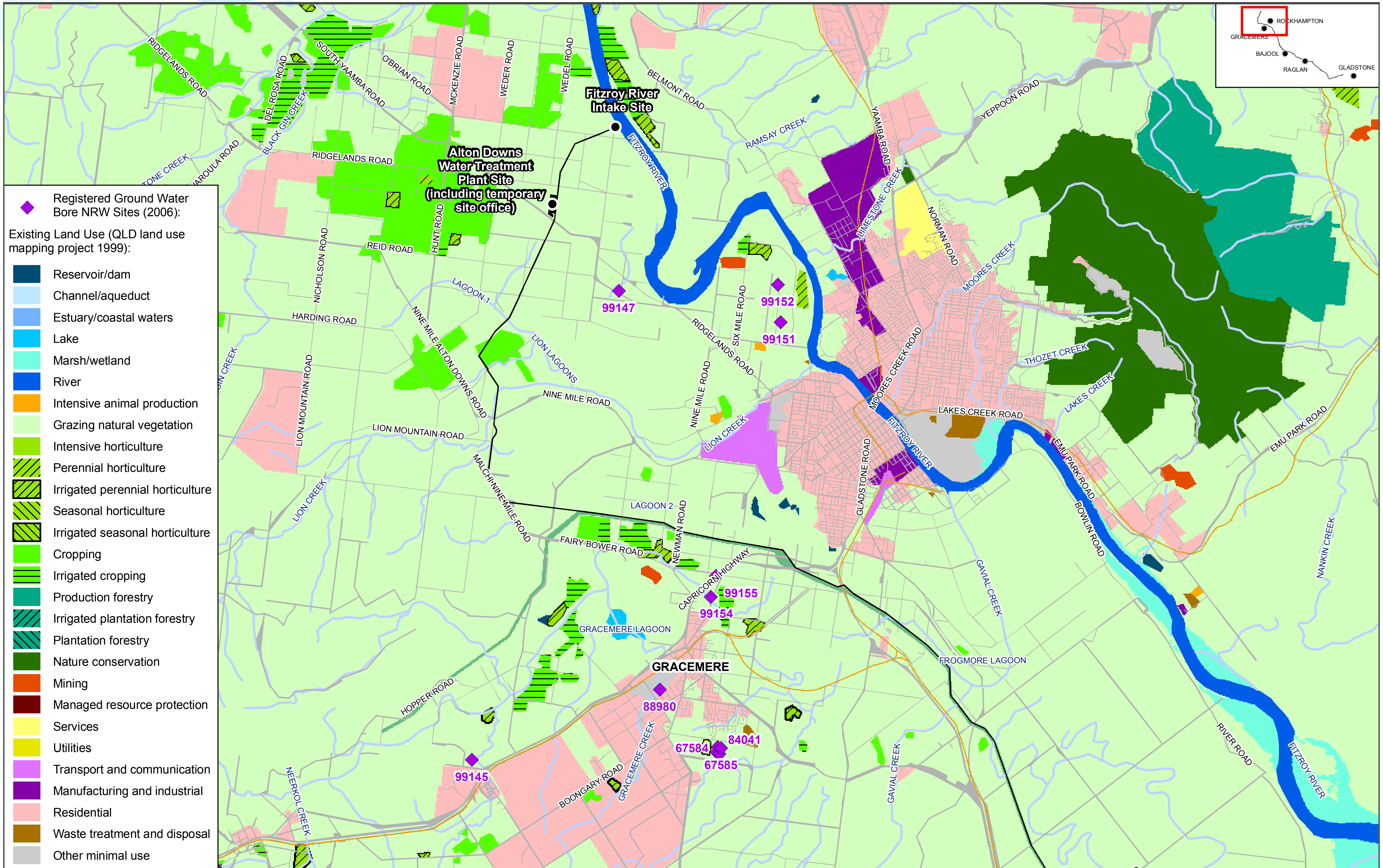
9.8 Baseline Environment – Groundwater

9.8.1 General

Existing groundwater conditions and usage along the pipeline alignment are broadly described here based on data from existing registered bores, geological and land use data and observations during the geotechnical test pit program. For consistency with other chapters the information has been split into two sections; Fitzroy to Bajool and Bajool to Gladstone, however there is some overlap in conditions as can be seen in Figure 9.4 and Figure 9.5 (i.e. Rockhampton to Gracemere and Raglan to Mt Larcom).

An overview of the locations of registered bores is shown in Figure 9.4 and Figure 9.5, superimposed over regional land use and geological data respectively.

A summary of basic water quality parameters recorded from the registered bores is shown in Table 9.10. These water quality data are not quality controlled, and represent a small selected data set of average values that are spatially and temporally inconsistent and should be seen as indicative only.



Gladstone - Fitzroy Pipeline Project

Figure 9.4 - Location of Registered Bores and Regional Land Use

Sheet 1 of 4

The Right of Way
Project Infrastructure
Railway Line
Road Reserve
Waterways
LGA Boundary
SGIC
GSDA

0 2 4 6 8 km

1:100,000 at A3

N

Gladstone Area Water Board

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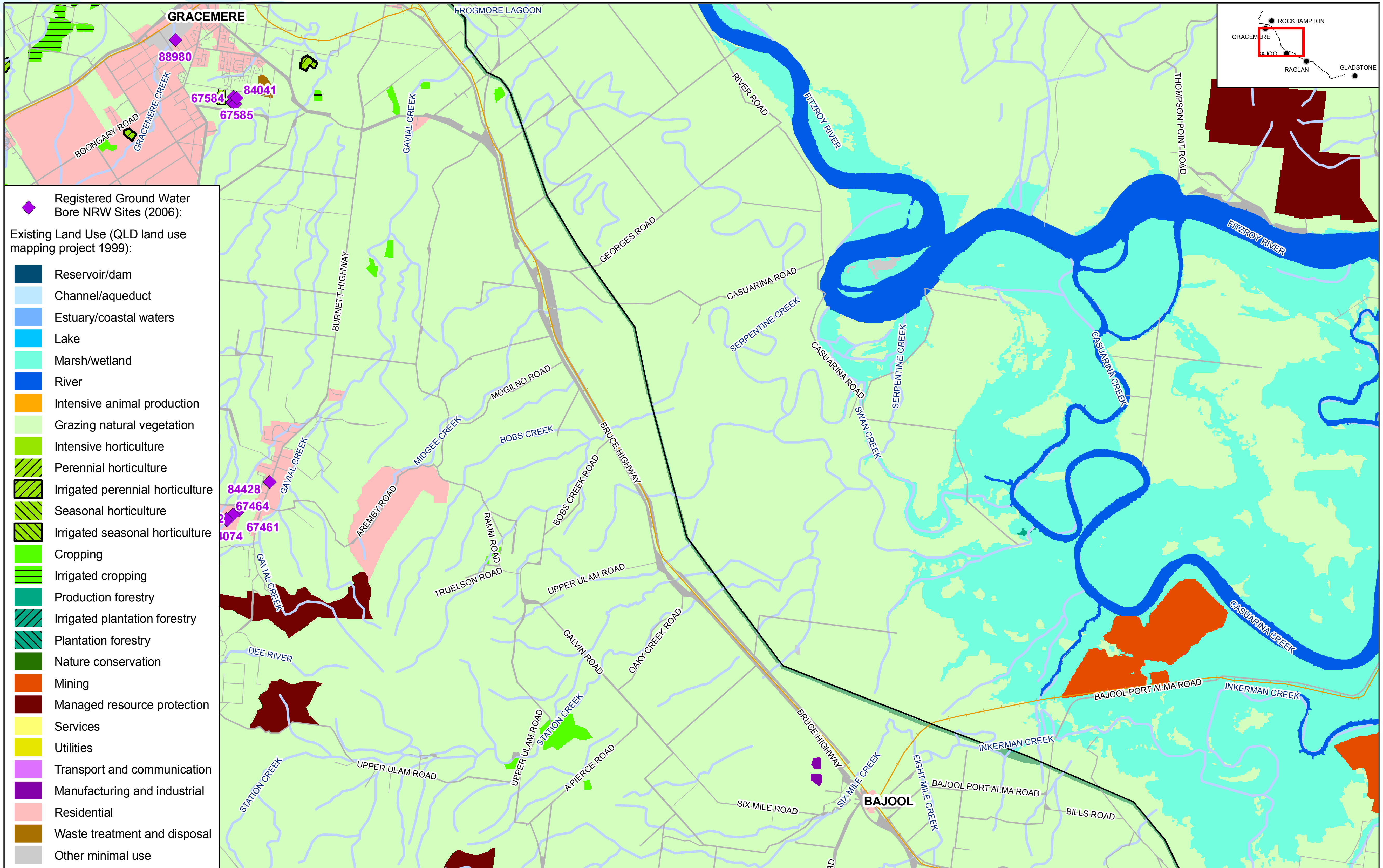

Gladstone - Fitzroy Pipeline Project

Figure 9.4 - Location of Registered Bores and Regional Land Use

Sheet 2 of 4

- The Right of Way
- Project Infrastructure
- Railway Line
- Road Reserve
- Waterways
- LGA Boundary
- SGIC
- GSDA

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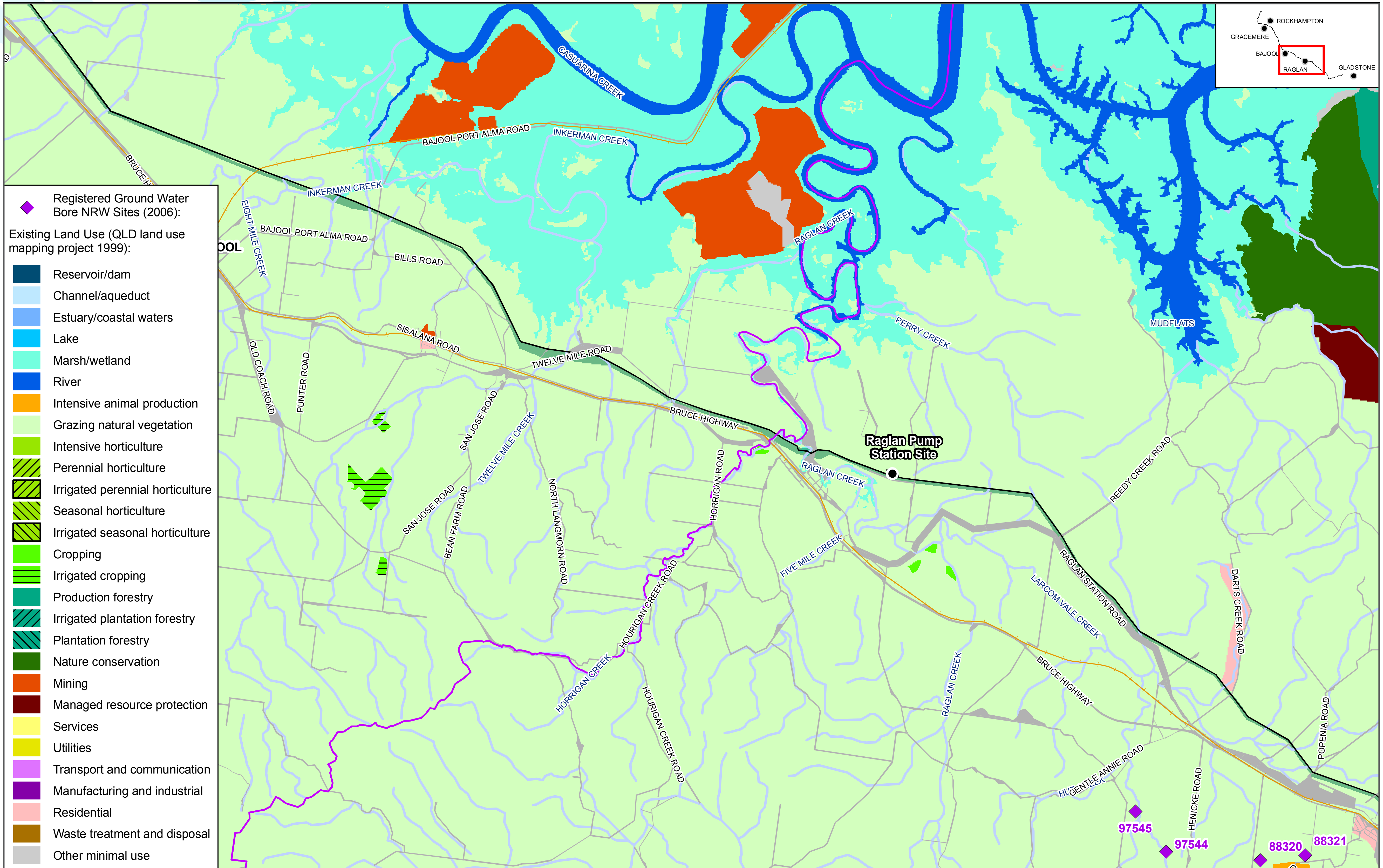

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Figure 9.4 - Location of Registered Bores and Regional Land Use

Sheet 3 of 4

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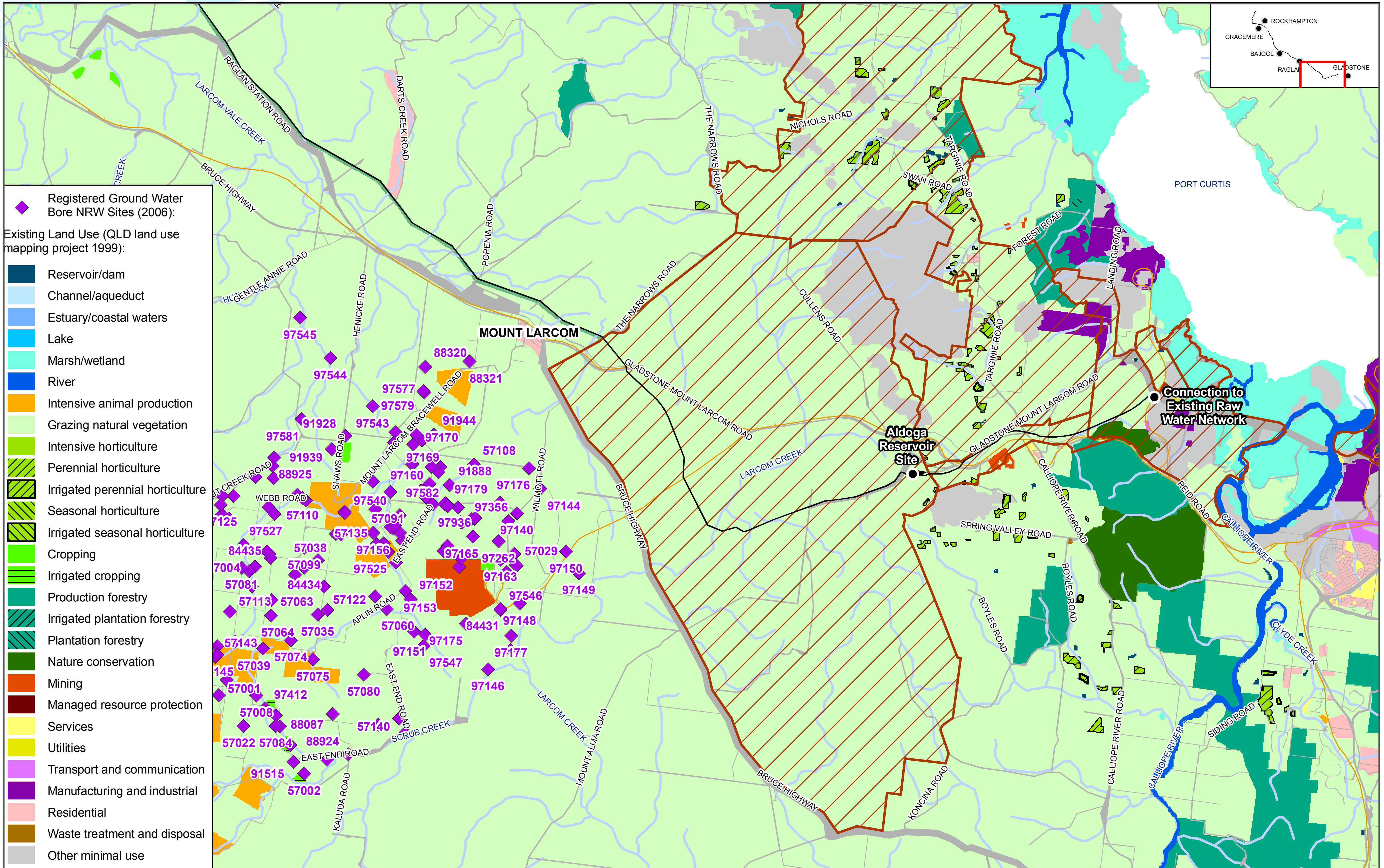

Gladstone - Fitzroy Pipeline Project

Figure 9.4 - Location of Registered Bores and Regional Land Use

Sheet 4 of 4

- The Right of Way
- Project Infrastructure
- Railway Line
- Road Reserve
- Waterways
- LGA Boundary
- SGIC
- GSDA

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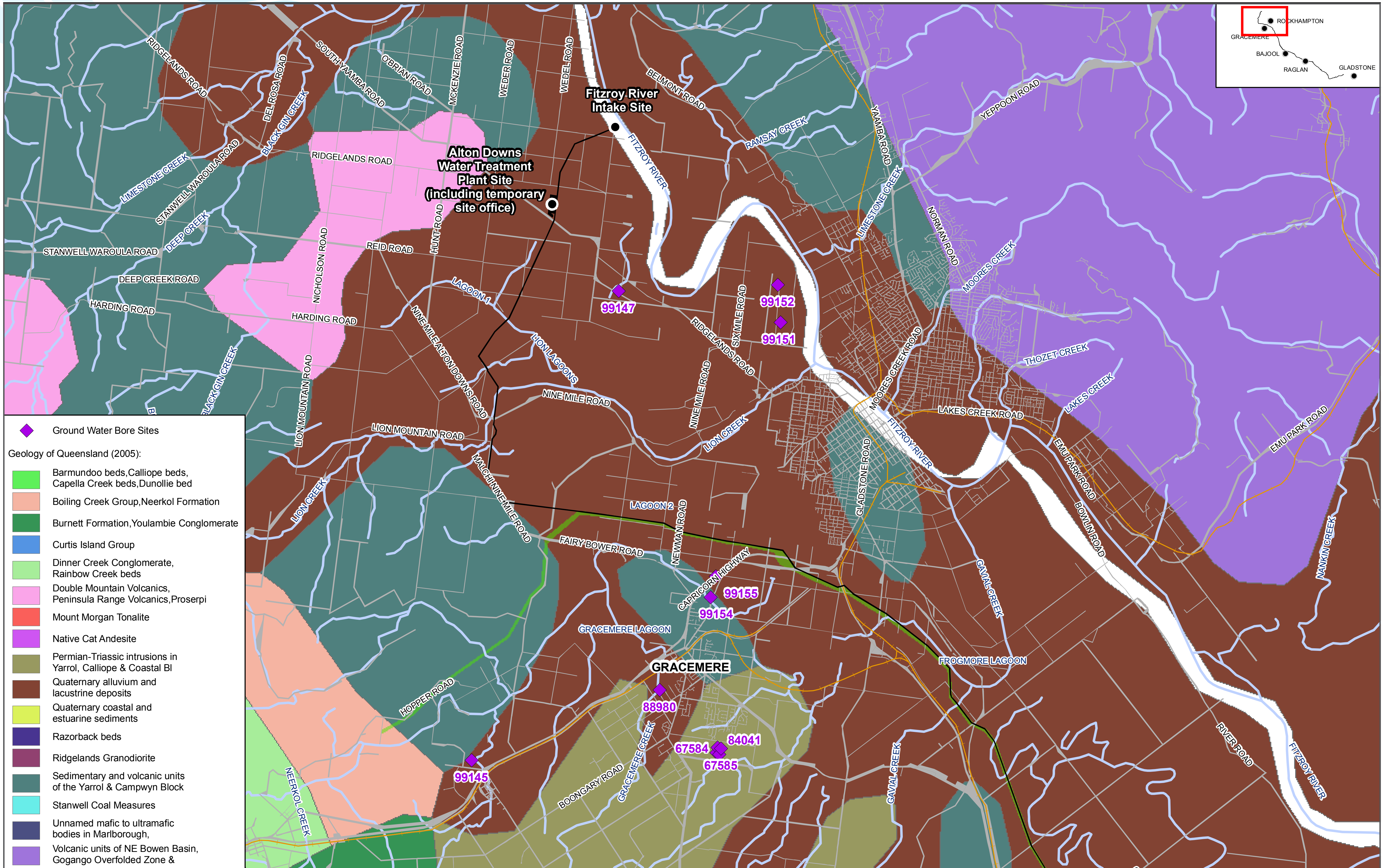
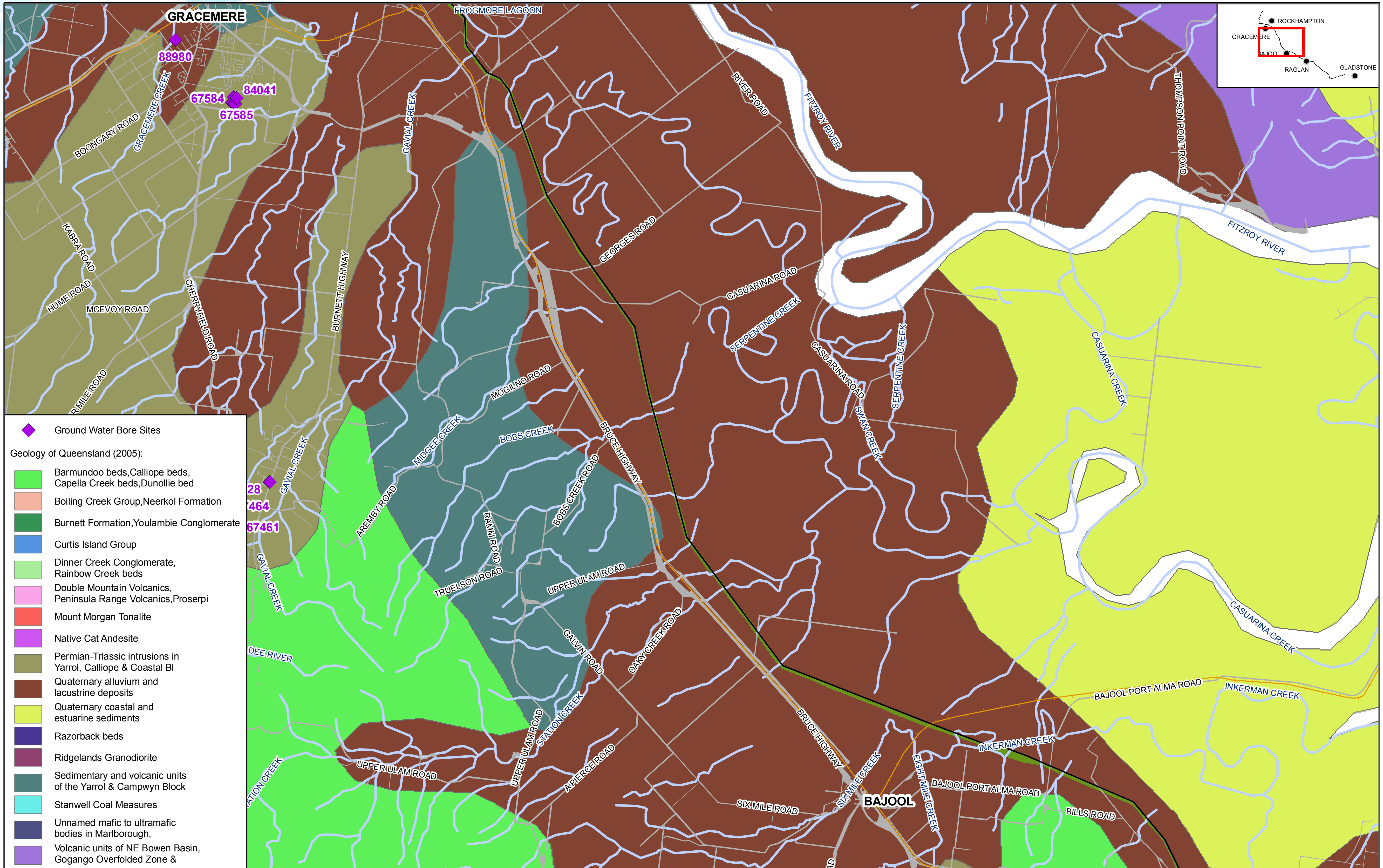


Gladstone - Fitzroy Pipeline Project

Figure 9.5 - Location of Registered Bores and Geological Data

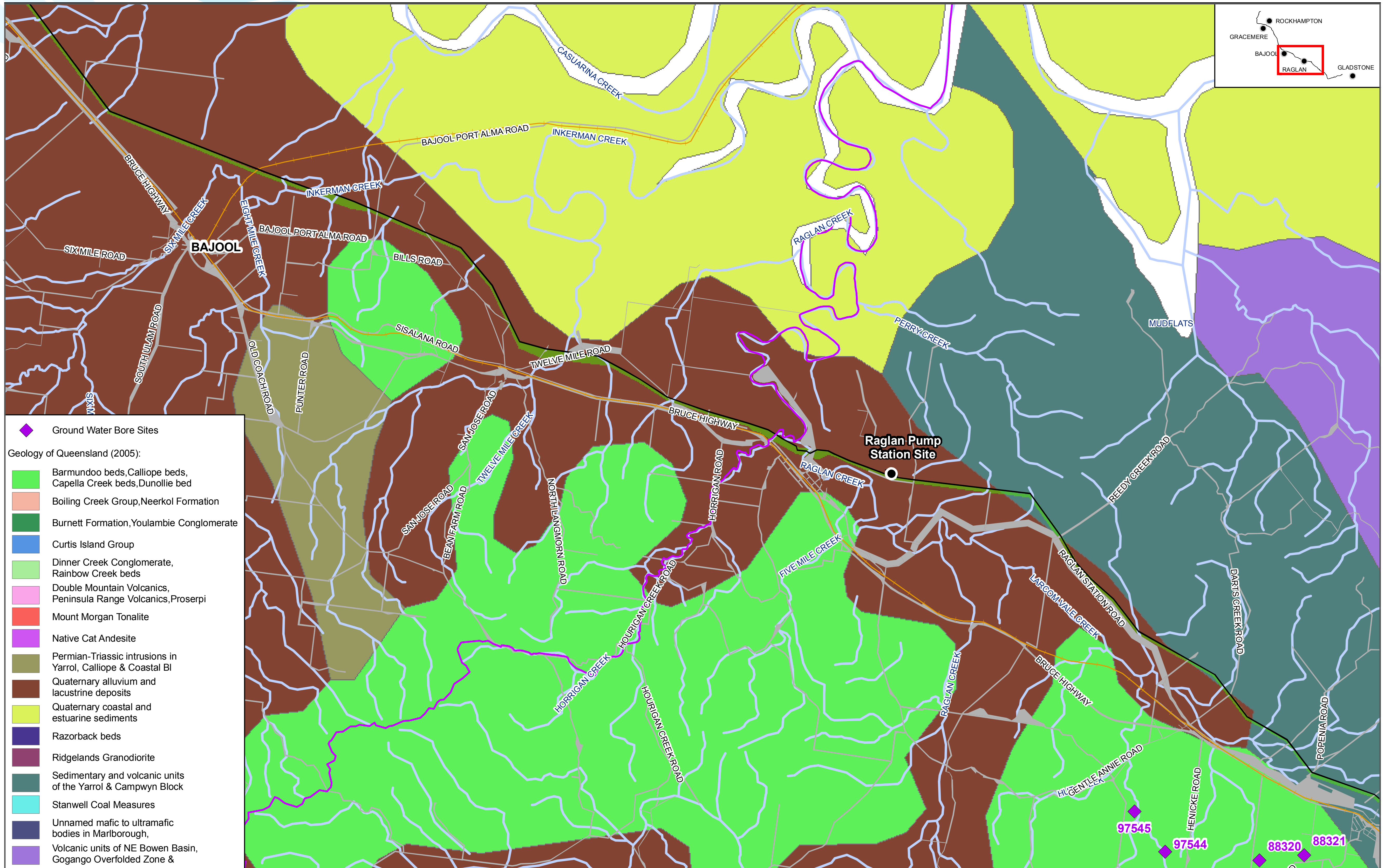
Sheet 1 of 4



Gladstone - Fitzroy Pipeline Project

Figure 9.5 - Location of Registered Bores and Geological Data

Sheet 2 of 4



Ground Water Bore Sites

Geology of Queensland (2005):

- Barmundoo beds, Calliope beds, Capella Creek beds, Dunollie bed
- Boiling Creek Group, Neerkol Formation
- Burnett Formation, Youlambie Conglomerate
- Curtis Island Group
- Dinner Creek Conglomerate, Rainbow Creek beds
- Double Mountain Volcanics, Peninsula Range Volcanics, Proserpi
- Mount Morgan Tonalite
- Native Cat Andesite
- Permian-Triassic intrusions in Yarrol, Calliope & Coastal Bl
- Quaternary alluvium and lacustrine deposits
- Quaternary coastal and estuarine sediments
- Razorback beds
- Ridgelands Granodiorite
- Sedimentary and volcanic units of the Yarrol & Campwyn Block
- Stanwell Coal Measures
- Unnamed mafic to ultramafic bodies in Marlborough,
- Volcanic units of NE Bowen Basin, Gogango Overfolded Zone &

Gladstone - Fitzroy Pipeline Project

Figure 9.5 - Location of Registered Bores and Geological Data

Sheet 3 of 4

The Right of Way · Project Infrastructure · Railway Line · Road Reserve · Waterways · LGA Boundary · SGIC · GSDA

0 2 4 6 8 km

1:100,000 at A3

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Gladstone Area Water Board

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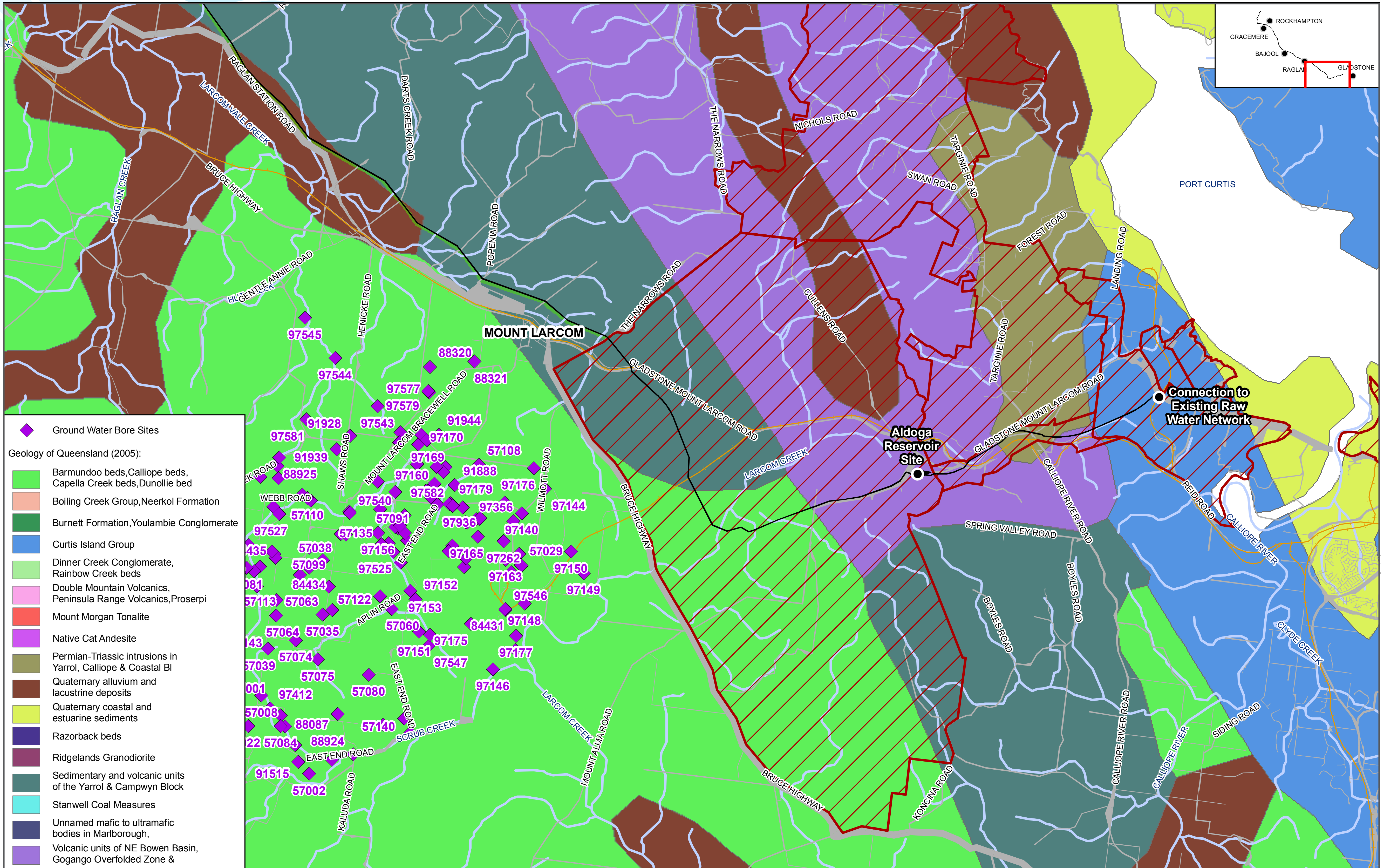

Gladstone - Fitzroy Pipeline Project

Figure 9.5 - Location of Registered Bores and Geological Data

Sheet 4 of 4

The Right of Way	Road Reserve	SGIC
Project Infrastructure	Waterways	GSDA
Railway Line	LGA Boundary	

0 2 4 6 8 km

1:100,000 at A3

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Gladstone Area Water Board

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Table 9.10 Indicative Water Quality Data from Existing Registered Bores Adjacent to the Project Area

Constituent		Location	Indicative Measured Values		Guidelines (where applicable)				
					Irrigation		Stock watering		Drinking Water
					Short	Long	Lower	Higher	
Physical Properties	Avg COND		Average	Max	<9500	<12200	<6000	<7500	<750
		Intake-Gracemere	3374	10900	~	✓	~	~	✗
		Gracemere-Raglan	5516	28225	~	~	~	~	✗
		Mt Larcom	7950	21950	~	~	✗	~	✗
		Yarwun	2804	4900	✓	✓	✓	✓	✗
	Avg pH		Max	Min	6 - 8.5	6 - 8.5			<8.5
		Intake-Gracemere	8.5	6.6	✓	✓			✓
		Gracemere-Raglan	8.6	6.65	✓	✓			✓
		Mt Larcom	8.7	7	~	~			~
		Yarwun	8.1	6.4	✓	✓			✓
Major Ions	NA		Average	Max	<115	<460			
		Intake-Gracemere	404	1466.4	✗	~			
		Gracemere-Raglan	939	5765	✗	✗			
		Mt Larcom	934	2750	✗	✗			
		Yarwun	138	288.8	~	✓			
	CA		Average	Max			<1000	<1000	
		Intake-Gracemere	123	394			✓	✓	
		Gracemere-Raglan	157	1134.5			~	~	
		Mt Larcom	133	372			✓	✓	
		Yarwun	217	436			✓	✓	
	FE		Average	Max			not toxic	not toxic	<0.3
		Intake-Gracemere	0.309	3.72			✓	✓	~
		Gracemere-Raglan	3.251	45			✓	✓	✗
		Mt Larcom	0.012	0.04			✓	✓	✓
		Yarwun	1.003	4			✓	✓	✗

Constituent		Location	Indicative Measured Values		Guidelines (where applicable)				
					Irrigation		Stock watering		Drinking Water
					Short	Long	Lower	Higher	
Major Ions	CL		Average	Max	<175	<700			
		Intake-Gracemere	810	3267	✘	✘			
		Gracemere-Raglan	1769	9540	✘	✘			
		Mt Larcom	1492	4750	✘	✘			
		Yarwun	697	1490	✘	~			
	SO4		Average	Max			<1000	<1000	<500
		Intake-Gracemere	65	183			✔	✔	✔
		Gracemere-Raglan	197	1120			~	~	~
		Mt Larcom	185	420			✔	✔	✔
		Yarwun	62	131.1			✔	✔	✔
Metals	MN		Average	Max	<0.2	<10			<0.5
		Intake-Gracemere	0.447	1.59	✘	✔			~
		Gracemere-Raglan	0.688	4.74	✘	✔			✘
		Mt Larcom	0.180	0.4	~	✔			✔
		Yarwun	0.000	0	✔	✔			✔
	ZN		Average	Max	<2	<5			
		Intake-Gracemere	0.026	0.1	✔	✔			
		Gracemere-Raglan	0.108	0.24	✔	✔			
		Mt Larcom	0.120	0.21	✔	✔			
		Yarwun	0.080	0.13	✔	✔			
	AL		Average	Max	<5	<20	<5	<5	none
		Intake-Gracemere	0.084	0.9	✔	✔	✔	✔	✔
		Gracemere-Raglan	0.010	0.05	✔	✔	✔	✔	✔
		Mt Larcom	0.010	0.01	✔	✔	✔	✔	✔
		Yarwun	0.020	0.04	✔	✔	✔	✔	✔

Constituent		Location	Indicative Measured Values		Guidelines (where applicable)				
					Irrigation		Stock watering		Drinking Water
					Short	Long	Lower	Higher	
Metals	B		Average	Max			<5	<5	<4
		Intake-Gracemere	0.196	0.6			✔	✔	✔
		Gracemere-Raglan	0.176	0.5			✔	✔	✔
		Mt Larcom	0.050	0.1			✔	✔	✔
		Yarwun	0.500	0.6			✔	✔	✔
	CU		Average	Max	<0.2	<5	<0.4	<5	<2
		Intake-Gracemere	0.032	0.26	~	✔	✔	✔	✔
		Gracemere-Raglan	0.106	0.75	✗	✔	~	✔	✔
		Mt Larcom	0.020	0.03	✔	✔	✔	✔	✔
		Yarwun	0.045	0.08	✔	✔	✔	✔	✔
Nutrients	NO3		Average	Max	<5	<125	<400	<1500	<50
		Intake-Gracemere	5.950	35.95	✗	✔	✔	✔	✔
		Gracemere-Raglan	1.067	5.1	~	✔	✔	✔	✔
		Mt Larcom	8.186	20	✗	✔	✔	✔	✔
		Yarwun	5.120	9.7	✗	✔	✔	✔	✔

The summary of water quality values shown in Table 9.10 comprises average values from selected key constituents, for four regions. Guideline values, where available, are also shown for reference. Based on these indicative water quality data, water quality is considered to be generally good, typically meeting drinking water requirements for all constituents shown except for the electrical conductivity (an indirect measure of salinity or total dissolved solids). The water is typically too saline to meet drinking water requirements, and is even marginal for usages in stock watering and irrigation. Higher iron levels in some regions would affect the aesthetic quality of drinking water. Higher concentrations of some major ions may limit the suitability for some irrigation practices.

The population of registered bores reflect land use and the location of suitable aquifers, with high-density clusters observed at Agnes Downs (west of Rockhampton), Gracemere, Bajool, Mt Larcom and Yarwun.

The proposed pipeline alignment does not transect these dense regions. Along the entire pipeline alignment, the existing land use is described as "production from relatively natural environments" (DNRW 1999). It is therefore likely that the groundwater resources in close proximity to the pipeline alignment may have been historically exposed to pollutants typical for agricultural practices, such as dispersed application of pesticides or fertilizers. The possibility of point source contamination cannot be discounted, such as unlicensed private rural disposal sites or spills. Pollutants typically associated with urban or industrial developments, such as hydrocarbons or heavy metals are not generally expected.

9.8.2 Fitzroy to Bajool

The Fitzroy River basin is formed on mixed volcanic and sedimentary rocks. A wide alluvial fan extends to the south of the current Fitzroy River, creating flat plains through infilling of lower lying basin formations. Above the level of the alluvial plains, rock outcrops of the volcanic and sedimentary basin formations are found. The alluvial sediments are described in geological sheets as comprising clays, silts, gravels and sand, although soils mapping sheets indicate cracking clays at the surface. Test pits undertaken in regions of alluvial sediment confirmed stiff plastic clays extending through to at least the depth of the test pit (3 m depth).

The proposed pipeline alignment seeks to avoid rock as much as possible, hence it follows the lower lying alluvial sediments for much of the distance; from the intake at Rockhampton through to Raglan.

Bores constructed in the region of the Fitzroy River Alluvium are typically in the order of 20 m depth, accessing good yields (typically 1 to 5 L/s, but some cases up to 20 to 30 L/s) of slightly saline to saline water (typically 1,000 to 5,000 us/cm, sometimes larger). Test pits undertaken in this region showed the presence of medium to high-plasticity clays at the surface, which would be effective aquicludes, significantly limiting recharge to any underlying aquifers.

Note: Aquicludes are hydrogeological layers with very low conductivity, which can be saturated with groundwater but are incapable of transmitting significant quantities of water. They act as impermeable boundaries to underlying aquifers. Thus the aquifers beneath aquicludes are called "confined aquifers".

Examination of registered bore data suggests these clays typically extend to 8 m to 10 m depth, with the possibility of horizons of higher water bearing alluvial sand aquifers (the Fitzroy River Alluvium) being located underneath. These aquifers are underlain by basalt or granitic formations.

There is some spatial variability in yields obtained which suggests that the sandy or higher yielding aquifer portions are inconsistently distributed, perhaps reflecting locations of previous alignments of the Fitzroy River. The proximity to the Fitzroy River suggests a degree of connectivity of these aquifers with the river base-flows is possible. The standing water level in these bores is typically slightly above the base of the clays, showing the clay to be an effective confining layer. The standing water level is typically 5 m to 9 m below ground.

9.8.3 Bajool to Gladstone

South from Raglan and through to Mt Larcom, the pipeline alignment increases in elevation and passes through mixed volcanic and sedimentary rocks. Test pits undertaken in this region showed the presence of fractured rocks and silty gravels. There are relatively few registered bores in this region, and where bores do exist, they are constructed to depths typically 25 m to 35 m, obtaining small yields (less than 0.4 L/s) of brackish to highly saline water. Depth to water is in the order of 10 m to 20 m.

In the Yarwun region, mixed volcanic and sedimentary rocks of Permian origin are encountered. Yields in the order of 5 L/s of fresh water are typically gained from bores of 20 m to 30 m depth. The higher yielding bores tend to access fractured or weathered rock (basalt/andesite) aquifers at approximately 15 m to 20 m depth.

9.8.4 Groundwater Summary

The water quality data is insufficient to accurately characterise the existing beneficial usage of existing groundwater systems. However, following consideration of current usages and yields, available water quality, geological data and land use, it is expected that these bores are effectively used for agricultural usages and secondary residential usages. It is considered that this existing usage is the best indication of the baseline highest beneficial usage, and higher usages are limited due to the following:

- The salinity values would require significant treatment for development of drinking water supplies
- The spatial distribution and quantity of yields from aquifers that are potentially affected by the pipeline indicate limited potential for development of centralised urban groundwater supplies.

Hence, it will be a requirement of the pipeline project to ensure that the capacity of existing aquifer systems to meet general agricultural usages and secondary residential usages is not compromised.

9.9 Impact Assessment – Groundwater

9.9.1 Construction Impacts – Fitzroy to Bajool

This section describes the potential impacts to groundwater associated with construction of the project in the Fitzroy to Bajool section of the project area.

The hydrogeology in the Fitzroy to Bajool region is characterised by the presence of medium- to high-plasticity clays which extend to around 8 m to 10 m depth below the surface. Beneath the clay horizon there are water-bearing alluvial sand aquifers in areas. These aquifers are underlain by basalt and granitic formations. Refer to Section 9.18 for further details on the groundwater environment for the Fitzroy to Bajool region.

9.9.1.1 Intake Pump Station

A concrete well will be required to be installed on the river bank to receive water via the intake structure. This will be a wet well structure up to 14 m deep.

It is expected that the construction of a well will intersect groundwater and some dewatering may be required to ensure dry working conditions. A dewatering system may need to be installed to control groundwater inflow into the well pit.

Groundwater abstraction associated with dewatering could cause drawdown in groundwater supply bores in close proximity to the pumping well. However, drawdown may not be significant due to the proximity to the recharge boundary (the Fitzroy River). Further, mapping does not indicate the presence of bores within the vicinity of the well point. Following cessation of dewatering, groundwater levels are expected to return to pre-construction levels. Hence, if any drawdown occurs in supply bores, it would be temporary.

Groundwater lowering associated with dewatering can also impact groundwater dependant ecosystems (GDE) that are supported by groundwater and the position of the water table. These ecosystems include wetland and riparian vegetation communities. However, dewatering is only a temporary measure and groundwater levels should return to normal after completion of pump station works.

Groundwater lowering can pose a risk to adjacent in-situ ASS which may oxidise if drained. This would result in the release of iron, aluminium and heavy metals into the groundwater. The risk of this occurring from shallow trenching will be minimal as works will be staged and of short duration at any one location. Nevertheless, an ASS Management Plan will be prepared that outlines measures to prevent oxidisation occurring from drawdown.

9.9.1.2 Trench Construction

The pipeline trench will generally be between 2 m deep, and up to 5 m deep depending on pipeline design. The top of the excavation trench will generally be 12 m wide, but could be up to 16 m wide in some locations, depending on trench wall soil stability and pipeline design. For a significant majority of the easement, the trench will run in the clay layer and is not likely to intersect any of the underlying sandy aquifers. The depth to the water table (technically known as the static water level (SWL) due to the presence of a confining clay layer) in the Fitzroy to Bajool region is typically 5 m to 9 m below ground level. If trenching does intersect groundwater, possible impacts may include localised disturbance to groundwater flow through pumping of water from the trench. If the trench does intersect the aquifer, the impacts to groundwater are considered manageable with appropriate mitigation.

The likelihood of impact associated with spill or leaching of contaminants resulting from servicing of equipment, spills of fuel or liquid chemicals, is low. The clay layer will act as an impermeable barrier, capturing any contaminants and preventing leakage into groundwater. If a spill occurs where there is interaction with the sandy aquifer, groundwater quality may be reduced. The impact to groundwater quality is likely to be localised and temporary if management strategies are adopted. However, the likelihood of disturbance with groundwater is considered unlikely due to the depth to the water table (5 m to 9 m below ground level) and expected trench depth.

Following laying of the pipeline, backfilling will be required. It is expected that sand will be used as backfilling material immediately around the pipeline and covered with clay uncovered during excavation. If the pipeline trench does happen to intersect groundwater, backfilling with sand may result in the creation of an artificial paleochannel connecting the sandy aquifer with the sand. This could result in groundwater inflow into the pipe bedding material with consequent localised saturation. However, the creation of a paleochannel is not considered likely due to the depth to the water table (5 m to 9 m below ground level) and expected trench depth.

9.9.1.3 Dewatering

If the trench intersects groundwater during construction, dewatering may be required to ensure dry working conditions and slope stability. Dewatering associated with trench construction may result in drawdown or lowering of the water table in the aquifer. Lowering of the groundwater table may adversely affect groundwater dependant vegetation unable to access the altered groundwater elevation. However, as the trench will be shallow (generally be between two metres deep, and up to five metres deep depending on pipeline design), the extent of lowering of groundwater is limited.

However it is considered unlikely that dewatering of groundwater inflow will be required by the pipeline. The following reasons have been considered:

- The hydraulic conductivity of the clays is low
- The trench is unlikely to intersect the water table (5 m to 9 m deep).

If groundwater inflow occurs, for the duration at which the trench will be open, it is expected that only a small and manageable amount of groundwater inflow will result. In addition, the construction process may well be able to tolerate having some water in the trench. It is also understood that trenchless methods under major river crossings will require some level of dewatering (e.g. the entry and exit points).

9.9.1.4 Extraction of Bore Water for Construction

Water for construction purposes may be drawn from bore water in the vicinity of the pipeline. This may result in impacts on local users and their water supply bores and environmental water requirements of GDEs. Groundwater abstraction could result in lowering of the water table in supply bores impacting on water supply requirements of local users. GDEs depend on groundwater availability for maintaining key ecosystem features and processes. A decline in the water table attributed to groundwater extraction could impact on the continued health of these ecosystems.

In order to abstract groundwater for construction purposes a water permit would need to be obtained from DNRW. In addition, each point of take or bore will require a development permit. However, if the point of take is not located within a Declared Subartesian Area, a water permit and development permits will not be required. The Fitzroy Declared Subartesian Area is present in the Fitzroy to Bajool section of the project area. Groundwater extraction for construction activities would require necessary permits in this area.

9.9.2 Construction Impacts – Bajool to Gladstone

The hydrogeological region from Bajool to Gladstone displays similar characteristics to the Fitzroy to Bajool region up to about Raglan. From Raglan to Gladstone, groundwater systems in this region are based predominantly within volcanic geological units and to a lesser extent sedimentary and alluvial deposits. The clay layer is inconsistently distributed throughout the region with groundwater systems more commonly topped by a more permeable, silty-gravel material. See Section 9.8.3 for further details on the Bajool to Gladstone region.

9.9.2.1 Trench Construction

The environmental impacts associated with spills of fuel or chemicals are more manageable in regions where the clay acts as an impermeable layer, confining and protecting the aquifer. South of Raglan, the layer of clay is inconsistently distributed and spills may risk percolating into the groundwater systems. Impacts to groundwater from spills should be avoided through implementation of mitigation measures to prevent and contain spills.

Similarly to the Fitzroy to Bajool region, the trench depth is unlikely to interact with groundwater systems. The depth to the water table is generally in the order of 10 m to 20 m and the trench will generally be between two metres deep, and up to five metres deep depending on pipeline design. The trench is expected to traverse the clay and/or silty- gravel layer that sit above the aquifer systems.

Groundwater lowering can pose a risk to adjacent in-situ ASS which may oxidise if drained. Similar to the Fitzroy to Bajool section, an ASS Management Plan will be prepared that outlines measures to prevent oxidisation occurring from drawdown.

9.9.2.2 Dewatering

Groundwater inflow resulting from the trench depth intercepting the water table is considered unlikely, although the absence of clay in this region may increase the risk of inflow in some areas. This is due to the increased hydraulic conductivity of silty-gravel material more prevalent in this region. Despite this risk, it is considered unlikely that construction activity (i.e. trenching) will disturb the water table and require dewatering. Section 9.9.1 on dewatering for the Fitzroy to Bajool region should be referenced for potential impacts should dewatering be required and why disturbance to the water table is unlikely.

9.9.2.3 Extraction of Bore Water for Construction

As discussed above, groundwater extraction for construction purposes may result in lowering of the water table and impact on local supply bores and GDE. There are no Declared Subartesian Areas in the Bajool to Gladstone region and a water permit and development permits for individual points of take will not required.

9.9.3 Operational Impacts

The following section addresses the impacts to groundwater during the operation of the pipeline. The operational impacts are discussed for the entire pipeline, the region from Fitzroy to Gladstone, to avoid duplication.

9.9.3.1 Pipeline Rupture

In regions where the pipeline is set in clays, any leaks from the pipeline are likely to be confined to the trench. The more permeable, silty-gravel layer will be less effective in preventing migration of pipe waters into groundwater. The quality of water in the pipeline, from a beneficial use perspective, is likely to exceed the groundwater quality. Hence, any leakage of water from the pipeline is not likely to degrade the groundwater quality. However, should any large or long-term leaks occur, the groundwater table could rise with consequent saturation of the land.

Degradation of the pipeline structure such as corrosion may occur over the life of the pipeline. In this instance, corrosive substances may contaminate the soil with leaching through to groundwaters contaminating the water quality.

Vegetation Clearance

While vegetation clearance will occur during the construction period possible impacts have been assessed as occurring after the construction period. Maintenance activity associated with the pipeline may require vegetation removal for ease of access to the pipeline. A lack of vegetation along the entire easement may act as a groundwater recharge corridor. Extensive vegetation clearance has been known to facilitate increased recharge to groundwaters whereby the volume of rainfall infiltrating the soil is increased.

When extensive vegetation is removed, the ability of vegetation to use the available rainwater is reduced and the excess seeps past the root zone to enter the groundwater system and may result in rising groundwater levels. The likelihood of rising groundwater levels in extreme cases may lead to development of dryland salinity. If deep rooted vegetation is removed, excess recharge can occur increasing the height of the water table. Where saline water rises to within 2 m of the surface, water can be taken up by plants or can evaporate through the soil. Evaporation results in the dissolved salts being left behind and concentrated as deposits at the soil surface.

Increased recharge and dryland salinity associated with vegetation removal is unlikely because:

- The pipeline ROW is a long and narrow area. Any reduced and subsequent mounding in the region along the pipeline alignment would quickly dissipate to adjacent regions
- Where the clay layer is prevalent it would act as an effective aquiclude, significantly limiting recharge to any underlying aquifers
- The project area as it exists currently is sparsely vegetated. Therefore it is expected that deep rooted native vegetation currently plays a minimal role in maintaining the water table
- It is expected that a Construction EMP would address the need to minimise vegetation removal and to undertake revegetation as required.

9.9.4 End of Life Impacts

9.9.4.1 Degradation of Pipeline Structure

Decommissioning of the Gladstone-Fitzroy Pipeline will either involve dismantling and removing the pipeline or it may be left underground. The decommissioning strategy is yet to be determined. If the pipeline is left below ground, there may be possible impacts to groundwater from degradation of the structure. The risk of groundwater contamination is reduced by the presence of clays acting as confining barriers. It is important to note that clay soil is heavy and not very dispersive and over time, the level of contaminants can build up and may become harmful.

9.10 Mitigation and Residual Impacts – Groundwater

The following table 9.11 provides a summary of construction, operation and end of life impacts associated with the project and appropriate mitigation strategies. A description of the residual impacts after the mitigation measures have been implemented is also included.

Table 9.11 Summary of Construction, Operation and End of Life Impacts Associated with the Pipeline, Mitigation Measures and Resultant Residual Impact

	Potential Impact	Mitigation measures	Residual impact
Construction			
Dewatering during intake construction.	Dewatering during intake pump station works resulting in drawdown lowering the water table and impacts to GDE.	Groundwater Management Plan (GWMP) to be included as part of Construction EMP to manage any dewatering during construction including: • Water level monitoring of groundwater bodies within a defined proximity to the pipeline • Appropriate disposal of discharge waters.	Impact temporary and minimal with groundwater levels eventually returning to normal. Residual impact assessed as **minor adverse.**
Disturbance to ASS during intake construction.	Disturbance to ASS during construction of the intake pump station resulting in soil acidification with through leaching to groundwater and subsequent groundwater acidification.	Development of an ASS Management Plan for construction.	Residual impact assessed as **negligible** with mitigation measures in place.
Spill or leaching of contaminants.	Spill or leaching of contaminants resulting from servicing of equipment, spills of fuel or liquid chemicals.	Construction EMP to include measures for managing fuel and chemical handling, storage, distribution and spill response during construction.	Mitigation measures likely to fully alleviate adverse impacts. Residual impact assessed as **negligible.**
Trench intersection with the water table.	Formation of a paleochannel resulting from pipeline works under river crossings or where the pipeline trench intersects the water table.	GWMP to be developed as part of the Construction EMP. Adherence to Construction EMP during construction.	Residual impact assessed as **negligible** following implementation of mitigation measures.
Disturbance to ASS during trenching.	Disturbance to ASS during trench construction resulting in soil acidification with through leaching to groundwater and subsequent groundwater acidification.	ASS Management Plan to be developed for construction works.	Residual impact assessed as **negligible** following implementation of mitigation measures.
Trench dewatering.	Dewatering during trench construction resulting in drawdown lowering the water table and impacts to GDE.	GWMP to be developed as part of the Construction EMP to manage dewatering during construction including water level monitoring of groundwater bodies within a defined proximity to the pipeline.	Impact considered unlikely and mitigation measures will fully alleviate adverse impacts. Residual impact assessed as **negligible.**

	Potential Impact	Mitigation measures	Residual impact
Operation			
Pipeline rupture.	Pipeline rupture resulting in groundwater impacts.	Develop and implement an Operations EMP to manage leakages from the pipeline.	Mitigation measures are likely to fully alleviate adverse impacts. Residual impact assessed as **negligible.**
Degradation of pipeline structure.	Degradation of the pipeline structure (e.g. corrosion) resulting in contaminants leaching into groundwater.	Develop and implement an Operations EMP to manage pipeline degradation and monitoring of groundwaters to detect possible contamination.	Mitigation measures are likely to fully alleviate adverse impacts. Residual impact assessed as **negligible.**
Vegetation clearance.	Vegetation clearance resulting in increased groundwater recharge.	Develop a Operations EMP which addresses impacts to flora and defines procedures to: • Minimise the extent of vegetation removal • Undertake revegetation .	The residual impact after mitigation measures have been implemented is assessed as **negligible.**
Pesticide use.	Pesticide use to maintain the pipeline easement resulting in leaching of contaminants to groundwater.	Develop and implement an Operations EMP to manage possible groundwater contamination resulting from pesticide use.	The significance of the residual impact is considered **negligible.**
End of life			
Degradation of pipeline structure in the long term.	Contamination of groundwater resulting from long-term degradation of pipeline structure.	Develop a decommissioning and rehabilitation plan in accordance with statutory requirements.	Residual impact assessed as **negligible** following implementation of mitigation measures.

9.11 Cumulative and Interactive Impacts

9.11.1 Cumulative Impacts

Cumulative impacts associated with possible future pipeline projects to be implemented within the Stanwell-Gladstone Infrastructure Corridor (SGIC) may occur. It is considered that cumulative impacts will be similar to those impacts highlighted for this project. It is important to note that impacts to groundwater are largely a function of the regional geology and soil profile. Comprehensive assessments should be undertaken specific to each proposal.

9.11.1.1 Surface Water

The cumulative impacts related to surface water may include:

- Release of sediment-laden water to surface waters
- Extraction of water for construction purposes
- Bed and bank disturbance and erosion.

9.11.1.2 Groundwater

The cumulative impacts related to groundwater may include:

- Disturbance to groundwater flow during trench construction where the trench intersects the groundwater table
- Dewatering requirements lowering the water table with impacts to groundwater dependant vegetation and supply bores
- Disturbance of ASS during trench construction etc resulting in acid generation with through leaching and subsequent acidification of groundwater
- Chemical spills or leakage resulting in leaching of contaminants into groundwater with subsequent localised decreases in groundwater quality
- The formation of a paleochannel such as where backfill material used in trench construction connects adjacent groundwater aquifers comprised of like materials. Groundwater inflow may result in localised saturation along the pipeline
- Vegetation clearance resulting in increased groundwater recharge and possible dryland salinity
- Leakage of pipe waters with infiltration into groundwater resulting in changes to groundwater quality and increases to water table height
- Degradation of pipe structures such as corrosive substances resulting in soil contamination and through leaching to groundwater
- End of life impacts associated with long-term degradation of the pipeline structure if the pipeline remains below ground. Leaching of contaminants into groundwater from structural degradation of the pipeline may result in possible impacts to groundwater quality.

9.11.2 Interactive Impacts

ASS may be encountered resulting in acid leaching into groundwater or surface water with subsequent decrease in water quality. Field and laboratory investigation has revealed a low mapped incidence of ASS along the pipeline route and a moderate risk to receiving environments associated with disturbance of ASS. Direct excavation into potential acid sulfate soils (PASS) material would trigger acid sulfate generation which would require appropriate management and disposal. Exposure and oxidation of PASS may lead to acidification of soils after construction works are complete and through leaching may acidify local groundwater. Appropriate management and disposal strategies will be included in the detailed ASS Management Plan to be developed prior to construction.

9.12 Summary and Conclusions

9.12.1 Surface water

Potential impacts associated with the project are mostly related to construction impacts and disturbance of the ground surface, which can be readily mitigated through good site practice and adherence to the EMP. Proposed mitigation measures for water resources are included in Chapter 20, Planning Environmental Management Plan.

Key potential construction impacts include:

- The release of construction fuels, chemicals or other construction materials to surface water
- The generation of litter from construction sites
- The release of sediment-laden water to adjacent surface waters or downstream protected areas
- The extraction of water for construction activities and associated disturbance to the hydrological regime and reliant vegetation
- The disturbance of vegetation and subsequent destabilisation of surfaces and waterway banks
- The spread of noxious/declared weeds into previously undisturbed areas
- The release of contaminated soils/water associated with trenchless crossing methods
- The disturbance of acid sulfate soils or contaminated soils and subsequent release of contaminants to waterways.

The development and implementation of a Construction EMP will alleviate adverse impacts associated with the above construction impacts as will the selection of the crossing method to avoid significant vegetation or waterways with aquatic habitat value. As a result only **minor adverse** to **moderate adverse** residual impacts are anticipated from construction activity.

Key potential operational impacts include:

- Scouring of bed and bank around the pipeline structure or inlet point, leading to hydraulic obstruction, exposure of in-stream infrastructure or re-suspension of suspended solids within the waterway
- Chlorination of water and harm to aquatic ecosystems from pipeline rupture
- The release of fresh water into tidal waters from pipeline rupture
- The spread of pest species to undisturbed areas through the pipeline intake point
- The release of contaminated stormwater or wastewater from the WTP.

Many of these potential impacts are readily mitigated through design and construction measures which have been identified in this chapter. The residual impacts are considered to be **negligible** to **minor adverse.**

Table 9.12 provides an impact summary for water resources and water quality.

9.12.2 Groundwater

Impacts to groundwater associated with the project are strongly related to the local geology and soil profile. For example, the presence of the clay layer acting as a protective barrier to impacts from the surface.

Key construction impacts include:

- Dewatering during intake works and trench construction
- The formation of a paleochannel where pipeline works run below river crossings or where the pipeline trench intersects the water table
- ASS
- Spills or leaching of contaminants resulting from servicing of equipment, spills or fuel or liquid chemicals.

The nature of the local soils and geology greatly influence the occurrence of such impacts. For example, the presence of the clay layer acts as a protective barrier to impacts from the surface. Also the expected trench depth is not likely to intersect groundwater.

The development and implementation of a GWMP for construction as part of the Construction EMP will fully alleviate adverse impacts associated with the above construction impacts with negligible residual impact. Impacts associated with dewatering during intake works are unavoidable despite implementation of mitigation measures however impacts are temporary and minimal. Mapping information does not indicate any bores within close proximity to the location of intake work. This suggests that any changes in groundwater level will not result in changes to bore water pressure affecting pressure in existing nearby bores.

Key potential impacts relating to operation of the pipeline include:

- Leakage of water as a result of pipeline rupture resulting in water quality impacts to groundwater
- Degradation of the pipeline structure such as corrosion resulting in contaminants leaching into groundwater
- Vegetation clearance resulting in increased groundwater recharge
- Groundwater contamination resulting from pesticide use to maintain the pipeline easement.

Proposed mitigation measures for water resources are included in Chapter 20, Planning Environmental Management Plan. Residual impacts have been assessed as **negligible**.

The decommissioning strategy for the pipeline, while as yet undetermined, may involve the pipeline being left below ground. This may result in degradation of the pipeline structure in the long-term with possible leaching of contaminants into groundwater. If this is the strategy adopted, a decommissioning and rehabilitation plan should be developed and implemented to ensure proper management of end of life impacts. The residual impact following implementation of mitigation measures has been assessed as **negligible**.

Table 9.12 provides an impact summary for water resources and water quality.

Table 9.12 Water Resources and Water Quality Impact Summary Matrix

EIS Area: Surface Water Feature/description	Current Value + Substitutable Y:N	Description of impact		
		Description in words	Mitigation inherent in design/standard practice amelioration	Significance criteria
Surface Water	Ecological function. Water Quality. Water Resource.	Potential temporary impacts to ephemeral and permanent surface waterbodies as a result of construction and operation activity.	Selection of creek crossing methods to reduce impact to sensitive areas. Construction and Operation EMP including: • Erosion and sediment control • Spill management • Vegetation clearing management • Rehabilitation • Water Quality monitoring.	Negligible to Moderate Adverse T, -ve, D
Groundwater	Ecological function. Water Quality. Water resource.	Potential temporary impact to groundwater level or quality as a result of construction, operation or decommissioning.	Construction and Operation EMP, including groundwater management plan.	Negligible

KEY:	Relative duration of environmental effects
Significance Criteria: Major, High, Moderate, Minor, Negligible	Temporary: Up to one year
+ve = positive; –ve = negative impacts	Short-term: From one to seven years
D = direct; I = indirect	Medium-term: From seven to 20 years
C = cumulative; P = permanent; T = temporary	Long-term: From 20 to 50 years
ST = short-term; MT = medium-term; LT = long-term	Permanent: Period in excess of 50 years

9.13 References

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