Australia Pacific LNG Project

Volume 3: Gas Pipeline

Chapter 11: Water Resources

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11. Water resources

11.1 Introduction

11.1.1 Purpose

This chapter provides the assessment of groundwater and surface water resources along the proposed gas pipeline for the Australia Pacific LNG Project (the Project). This assessment was conducted in accordance with the environmental impact statement (EIS) terms of reference for the Project. Its purpose was to determine those construction and operational activities that may result in significant impacts on the environment, and identify suitable management and mitigation measures to reduce the risk of any such impacts to an acceptable level.

The water resources technical report in Volume 5 Attachment 25 examines the gas pipeline crossings at creeks and rivers along the adopted gas pipeline route. The report presents preliminary assessments of peak flows, levels and velocities of floodwaters in the 100 years average recurrence interval (ARI) design flood events. It also examines potential scour risks at the proposed gas pipeline crossings. The assessments were undertaken at 27 locations where the proposed gas pipeline route will cross watercourses that have a stream order classification of '3' or greater. These locations represent the major watercourses including the Calliope River.

It is possible the construction of the gas pipeline and its associated activities, if not properly managed, could have an affect on the shallow groundwater systems. Some of these impacts could include disturbing surface water connectivity mechanisms, gas pipeline leakage, or disruption to groundwater dependent ecosystems. Receptors that may be affected by these potential impacts include people who use the shallow groundwater resources for stock watering and agriculture, or as a complementary source of water for domestic use.

The construction of the proposed gas pipeline is described in Volume 3 Chapter 3. The gas pipeline is to be constructed of welded steel pipe with epoxy internal lining and polypropylene external coating. Various methods may be used to construct the gas pipeline across watercourses, including:

- Open cut
- Open cut with flow diversion
- Boring
- Horizontal directional drilling (HDD).

The type of construction method for each crossing will be determined during further design and field inspections. All necessary regulatory approvals will be obtained prior to construction.

Australia Pacific LNG's sustainability principles will be applied to the planning, design, construction and operation of the gas pipeline to encourage management and mitigation of any adverse impacts to people and the environment. These principles are described further in Volume 3 Chapter 3.

Of Australia Pacific LNG's 12 sustainability principles, key principles in relation to the gas pipeline include:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas

- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

Under these principles, surface water resources are reflected in a number of ways. Surface water is a key resource for the people and ecology of Australia. Within the operational area of the Project, surface water is utilised by numerous stakeholders including heavy and light industry, cities and townships, both indigenous and non-indigenous cultures and Queensland's diverse terrestrial and aquatic wild life. To meet the demands of these stakeholders and the needs of the Project, a water management plan will be developed.

Through a number of strategies, the Project will endeavour to use water efficiently and be as self sufficient as practicable for all construction and operational water requirements. The innovative design of surface water ponds, which comply with Queensland's regulatory authorities, assists the Project in using the associated and treated water it generates. In addition, the planned and controlled discharge of treated water back into the project area provides all stakeholders and ecosystems with an opportunity for enhancement.

Through a surface water management plan the Project will have a clear vision for the future and sustainable use of water acquired and generated, for the life of the Project.

11.1.2 Scope of work

The following scope of work was undertaken when assessing potential impacts on water resources along the proposed gas pipeline route:

- Site inspection and sample collection at selected crossing locations
- Desktop review of groundwater resources
- Identification of potential groundwater dependent ecosystems
- Identification of significant watercourse crossing locations
- Estimation of peak flows, peak flood levels and velocities for 100 years Average Recurrence Interval (ARI) design flood events
- Assessment of scour and erosion risk at crossing sites
- Assessment of environmental values
- Identification of potential impacts on groundwater and surface water resources
- Identification of appropriate mitigation, management and monitoring strategies
- Assessment of residual risks.

11.1.3 Legislative framework

Certain legislation needs to be considered when assessing the potential impacts of gas pipeline construction and operation activities on groundwater and surface waters in the study area, which principally includes:

- *The Water Act 2000*
- Water Resource (Fitzroy Basin) Plan 1999

- Water Resource (Boyne River Basin) Plan 2000
- Water Resource (Condamine and Balonne) Plan 2004
- *The Environmental Protection Act 1994* (EP Act), Environmental Protection Regulation 2008 and Policies
- Environmental Protection (Water) Policy 1997 (EPP Water)
- *Sustainability Planning Act 2009* replacing the *Integrated Planning Act 1997*
- *Petroleum and Gas (Production and Safety) Act 2004*

Volume 3 Chapter 2 provides an overview of the relevant Queensland legislation (referred to above) and its purpose. Those statutory plans, environmental protection policies, legislation and regulations directly relevant to activities undertaken for the Project that may impact on water resources are outlined in Table 11.1.

Table 11.1 Relevant policy and legislation

Policy or legislation	Description	Relevance
Water Act 2000	*The Water Act 2000* provides for the sustainable management of water and other resources. The Act regulates the use and allocation of water through water resource plans.	Under this Act, a water licence is required for all operations that are not directly related to activities authorised under the *Petroleum and Gas (Production and Safety) Act 2004* that will interfere with surface water or watercourses. The Act requires that permits be obtained for the removal of riverine vegetation and for the excavation or placing of fill in a watercourse. Riverine protection permit (permit to destroy vegetation, excavate or place fill in a watercourse) will not be required if carried out under a licence, petroleum lease or Authority to prospect (ATP) under the *Petroleum and Gas (Production and Safety) Act 2004*.
Water Act 2000 - state water resource and resource operations plans	Under the *Water Act 2000*, water resource plans (WRPs) have been developed to define the availability and allocation of water and to ensure the sustainable management of water in Queensland. The objectives of the WRPs are to balance the needs of humans and the environment in a sustainable manner.	The proposed gas pipeline route falls within the bounds of three water resource planning catchments and may be influenced by the following WRPs: • Water Resource (Condamine and Balonne) Plan 2004 • Water Resource (Fitzroy Basin) Plan 1999 • Water Resource (Border Rivers) Plan 2003 • Water Resource (Great Artesian Basin) Plan 2006

Policy or legislation	Description	Relevance
		The Fitzroy Basin feeds into the Great Barrier Reef, which is a protected water environment. The Fitzroy Basin water resource plan regulates overland flow water only and does not manage groundwater in the Surat Basin. Groundwater resources in the area are managed in accordance with the Great Artesian Basin water resource plan. The Condamine and Balonne water resources plan regulates the taking of water from all surface bodies.
Environmental Protection Act 1994 (EP Act)	The objective of the EP Act *1994* is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.	The aims are achieved through the implementation of an integrated management program that is administered by the Department of Environment and Resource Management (DERM), formerly the Environmental Protection Agency (EPA). The program incorporates policies and guidelines that have been refined over the last 15 years. This approach ensures that proposed future developments are ecologically sustainable. The disposal of hydrotest water is to be undertaken in accordance with the conditions set out in a permit issued by DERM under an Environmental Activity (Petroleum Activities) under the provisions of the Act.
Environmental Protection (Water) Policy, 2009 (EPP Water)	The purpose of the EPP Water is to achieve the object of the EP Act *1994* in relation to Queensland waters. The object of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.	Under the EPP Water, the addition of pollutants including sand, silt or mud into a stormwater drain or waterway is prohibited. In addition, under Section 319 of the EP Act, all persons must not 'carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimize the harm (the 'general environmental duty')'. Section 319, the general environmental duty, requires the implementation of pro-active measures to prevent environmental degradation and act in accordance with the precautionary principle.

Policy or legislation	Description	Relevance
		The precautionary principle is defined under Principle 15 of the Rio Declaration (1992) as follows: 'Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.'
Sustainability Planning Act 2009	The *Sustainability Planning Act 2009* provides the framework for Queensland's planning and development assessment system.	The Act requires that a development permit is obtained for operational work that is the removal, destruction or damage of a marine plant (with limited exceptions) or operational work that is the constructing or raising of waterway barrier works.
Petroleum and Gas (Production and Safety) Act 2004	The purpose of this Act is to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry. The distillation, production, processing, refining, storage and transport of fuel gas are included in 'petroleum activities' covered by the Act.	According to the Act, the petroleum tenure holder may take or interfere with groundwater (with no volumetric limit) taken during the course of an activity authorised under the petroleum tenure such as drilling petroleum wells. The Act imposes obligations on each petroleum tenure holder to take restorative measures in relation to particular water bores or compensate the owners of particular water bores. Importantly, the 'make good obligation' stipulated in the Act (Part 9 Sections 244 to 280) indicates that if the petroleum activity unduly affects an existing water bore, the tenure holder must implement restorative measures to ensure a suitable supply of water to the owner of the bore, or compensate the owner for being unduly affected.

In addition to the above legislation, the proposed gas pipeline is subject to local planning controls. These are discussed in Volume 3 Chapter 3, and a summary of the local planning controls is provided here.

The Great Barrier Reef Coast Marine Park includes The Narrows located between Friend Point and Laird Point and encompasses the wetlands associated with these points, and includes the waters around Kangaroo Island and Graham Creek. Activities within the park are managed by the provisions of the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004.

The gas pipeline corridor crosses the harbour in the vicinity of Friend and Laird Points and hence is subject to the provisions of the Curtis Coast Regional Coastal Management Plan.

The gas pipeline corridor intersects the Graham Creek and Kangaroo Island strategy areas as defined by the Gladstone Harbour Protection and Enhancement Strategy.

The Gladstone State Development Area (GSDA) incorporates lands situated to the north-west of Gladstone and on the southern part of Curtis Island, and includes the gas pipeline corridor. The GSDA was established to provide land for large-scale industrial development. The development scheme, which is supported by a number of policies, is a land use planning instrument administered by the Queensland Coordinator-General for the purpose of guiding future development in the GSDA.

The Callide Infrastructure Corridor State Development Area is an infrastructure corridor to provide for the co-location of underground pipelines to transport coal seam gas from Callide to the GSDA.

Under the *Sustainability Planning Act 2009*, development for an activity authorised by the *Petroleum and Gas (Production and Safety) Act 2004* or development for a petroleum activity defined under section 309A in the EP Act, is exempt from assessment against a planning scheme.

11.2 Methodology

11.2.1 Groundwater

The assessment of potential impacts of the gas pipeline on groundwater consisted of:

- Reviewing existing groundwater resources along the gas pipeline route
- Identifying potential impacts on groundwater levels, flows and quality, and on groundwater dependent ecosystems
- Devising monitoring, management and mitigation actions necessary to address the identified impacts.

11.2.2 Surface water

The assessment of potential hydraulic impacts on waterways was limited to locations where the adopted gas pipeline route crosses major watercourses. These watercourses were identified from topographical and cartography maps as having a stream order classification of '3' or greater. These represent all watercourses other than minor creeks. The methodology adopted for these assessments comprised the following activities:

- Estimating 100 years ARI peak flows at crossing sites
- Estimating peak flood levels and velocities at crossing sites
- Estimating potential scour risks at crossing sites
- Identifying mitigation strategies relating to the potential impacts.

The gas pipeline hydrology technical report in Volume 5 Attachment 25 describes how streams are classified.

The potential impacts associated with managing the water required for gas pipeline hydrotesting during construction were identified and assessed.

11.2.3 Water quality

Assessments on the potential impacts on water quality and mitigation measures are discussed in Volume 3 Chapter 9. The review of existing water quality was undertaken for selected watercourses and on a regional basis, as described in Volume 5 Attachment 18.

11.3 Existing environment

The proposed route of the gas pipeline is shown in Figure 11.1. The route comprises the following three branches:

- The Woleebee lateral, which extends approximately 38km from the Combabula-Ramyard, Woleebee and Carinya tenements south-west of Wandoan, to the main transmission pipeline
- The Condabri lateral, which extends approximately 44km from the Condabri tenement south of Miles, to the main transmission pipeline
- The main transmission pipeline, which extends 362km from the junction of the Woleebee and Condabri laterals to the proposed LNG plant site on Curtis Island.

The proposed gas pipeline corridor is 10km wide with a 40m wide right of way for the gas pipeline.

The gas pipeline route traverses parts of the Condamine-Balonne, Fitzroy and Boyne River basins, with the northern end located on Curtis Island. The predominant land use over the corridor is cattle grazing. Various forms of cropping are found in areas of more fertile soil and where the use of machinery is not constrained. Other land uses include forestry, nature conservation, resource extraction and urban activities.

The bulk of watercourses to be crossed are ephemeral, with flow generally only during the summer 'wet' season between November and March. The only 'permanent' watercourses are the Calliope River and Cockatoo Creek, which are also fed from groundwater resources.

The gas pipeline will need to cross The Narrows in order to reach Curtis Island. The preferred method for this crossing is horizontal directional drilling (HDD), as described in Volume 3 Chapter 3.

The northern section of the main gas pipeline is located within the Callide Common Infrastructure Corridor and the GSDA. The Callide Infrastructure Corridor State Development Area is an infrastructure corridor to provide for the co-location of underground gas pipelines to transport coal seam gas from Callide to the GSDA. The corridor is approximately 44km long and is generally 200m wide. In specific areas where environmental, geographic and construction issues exist, the corridor is wider for pipe separation and construction purposes. Preferred land uses for the corridor are animal husbandry, gas transportation infrastructure, and to a lesser degree services infrastructure.

The proposed gas pipeline route crosses numerous watercourses, including the Calliope River and 27 watercourses identified as larger than minor according to their stream classification order '3' or higher. These crossings are shown on Figure 11.1. The catchment areas upstream of the crossing locations vary up to 2,351km^2. The major watercourses are generally ephemeral therefore they do not flow continuously throughout the year. The bed material at the crossing sites was generally identified as fine to medium sands, with some sites containing medium to coarse gravels and silt bed material.

A number of waterway crossings were observed during the fieldwork component of the soils, geology and topography assessment (refer to Volume 5 Attachment 6). Most of the waterway crossings had clearly evident erosion, in the form of gully and bank incisions.

For a distance of approximately 145km along the south western section of the proposed gas pipeline route, the gas pipeline (including the laterals) is within the Surat Basin. The Surat Basin is one of the component basins of the Great Artesian Basin. It comprises a sequence of alternating sandstone-dominated units and mudstone- and siltstone-dominated units which constitute aquifers and aquitards respectively and reach a maximum total thickness of approximately 2500m. These aquifers and aquitards are broadly flat-lying, but they are titled slightly to the south-west and are exposed on the surface along the northern margin of the basin, which the gas pipeline intersects. The areas where the aquifers are exposed constitute the recharge zone for the basin. The regional groundwater flow direction is to the south-west.

There are few licensed groundwater users in the vicinity of the gas pipeline corridor, but there are a large number of users of groundwater for stock and domestic purposes within the 5km radius. Springs and areas of seepage are abundant in the marginal regions of the basin. However, the only spring complex in the vicinity of the gas pipeline route is near the Cockatoo Creek crossing.

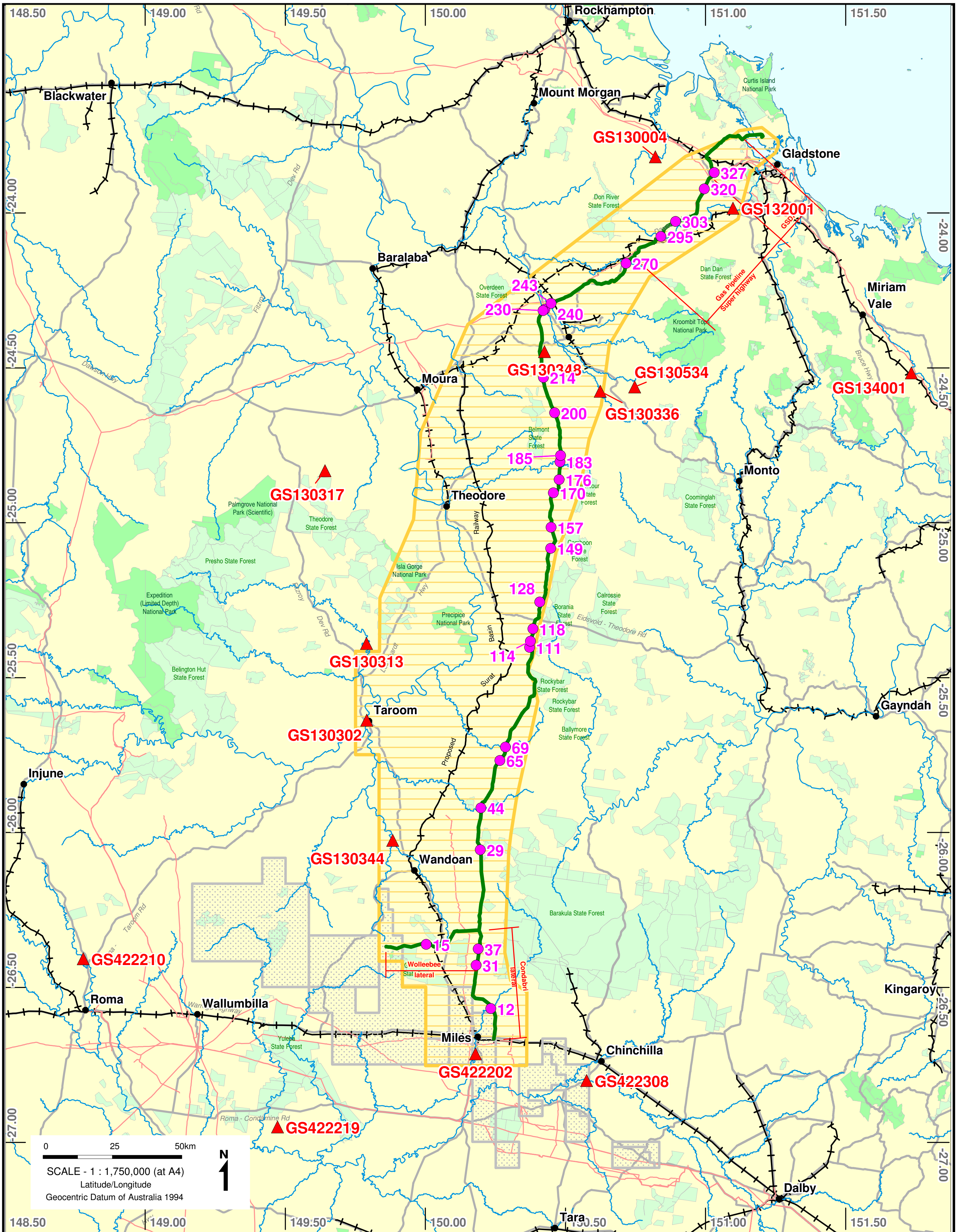
In the central parts of the gas pipeline route, once it crosses the Great Dividing Range, the route traverses level to gently undulating plains and low hills. It will intersect igneous rocks like the Camboon Volcanics, Glandore Granodiorite, and Galloway Plains Tonalite which pre-date the sediments of the Surat Basin (and underlying Bowen Basin). In igneous rocks like these, the groundwater flow will likely be fracture-dominated, meaning any groundwater effects may be localised or otherwise limited to regional fracture sets. In the creek and river valleys (that it, low lying areas), groundwater is known to be utilised from high yielding alluvial deposits, such as the Callide Creek, Calliope River and Kroombit Creek Alluvia, where a large number of registered bores are noted to exist.

There are mud flats near the coast close to Gladstone in the northern reach of the gas pipeline route. The shallow groundwater associated with these is likely to be influenced by the marine environment.

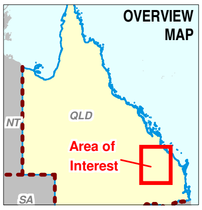
Specific groundwater level and quality data pertaining to the gas pipeline route is provided in Section 11.3.2 and 11.3.3. A detailed description of the geology of the gas pipeline route is presented in Volume 5 Attachment 6, while the hydrogeology of the Surat Basin is discussed in Volume 5 Attachment 21.

11.3.1 Environmental values

Environmental values are the qualities of groundwater and surface water resources that need to be protected from the effects of pollution, waste discharges and deposits. These qualities need to be protected to ensure the maintenance of healthy aquatic ecosystems and waterways that are safe and suitable for community use. The environmental values include maintenance and protection of healthy aquatic ecosystems, health and safety, and commercial and cultural heritage values.



OVERVIEW MAP



SOURCE INFORMATION

Protected Areas, DERM Streamflow gauge stations
Department of Environment and Resource Management 2009

Pipeline creek crossing locations
Determined by WorleyParsons November 2009

Pipelines
Commonwealth of Australia (Geoscience Australia) 2009
Department of Mines and Energy, MERLIN Mining Tenures system and Database (MTDB) 200

LEGEND

- DERM Streamflow gauge station
- 12 Pipeline creek crossing locations (km points)
- Railway
- Road
- Gas pipeline route
- Existing pipeline
- River
- National park
- State forest
- Gas pipeline study area
- Walloons gas fields development areas

AUSTRALIA PACIFIC LNG PROJECT

Volume 3 Chapter 11
Figure 11.1 - Proposed pipeline route and creek crossing locations

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EPP Water was established to achieve the objectives of the EP Act in relation to Queensland waters. It also provides the framework for establishing environmental values and Water Quality Objectives for Queensland waters. The protection assists with retention of healthy aquatic ecosystems and waterways that are safe and suitable for community use. The environmental values vary depending on the classification of the relevant waters – high ecological waters, slightly disturbed waters, moderately disturbed waters, highly disturbed waters, waters used in primary industry, waters used for recreation purposes, waters used for drinking water, and waters used for industrial purposes. The environmental values identified in the policy are summarised below:

- Biological integrity of aquatic ecosystems
- Suitability of the water for agricultural use
- Suitability of the water for aquaculture use
- Suitability of the water for producing aquatic foods for human consumption
- Suitability of the water for primary recreation
- Suitability of the water for secondary recreation
- Suitability of the water for drinking water
- Suitability of the water for industrial purposes
- Suitability of the water for raw drinking water
- Suitability of the water for industrial use
- Cultural and spiritual values.

The policy includes indicators and water quality guidelines in relation to the abovementioned environmental values. An indicator for an environmental value is a physical, chemical, biological or some other property, which can be measured or decided in a quantitative way. For example, the concentrations of nutrients or pH values are types of chemical indicators. Water quality guidelines are quantitative measures or statements for indicators, including contaminant concentration or sustainable load measures of water, which protect a stated environmental value.

The policy is met, and the environmental values for particular waters are protected, when the measures for relevant indicators do not exceed the stated water quality guidelines.

Indicators and water quality guidelines for an environmental value are decided using the following documents, listed in order of precedence of application:

- Site specific documents for the watercourse
- Queensland Water Quality Guidelines – DERM 2009
- Australian Water Quality Guidelines – Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ 2000).

As there are no specific documents relating to the waters potentially affected by the Project, the Queensland Water Quality Guidelines and Australian Water Quality Guidelines apply where relevant.

The Queensland Water Quality Guidelines 2009 include regional guideline values for physio-chemical indicators for slightly to moderately disturbed waters, biological guidelines and habitat guidelines for the central coast region that includes the Fitzroy and Boyne River basins and Curtis Island. No guidelines have been prepared for the Murray-Darling Basin that includes the Condamine-Balonne basin and suggest ANZECC 2000 guidelines may be adopted.

The environmental values for surface waters that may be exposed to potential impacts primarily relate to habitat (riverine vegetation) preservation, suitability of water for existing uses and cultural and spiritual values.

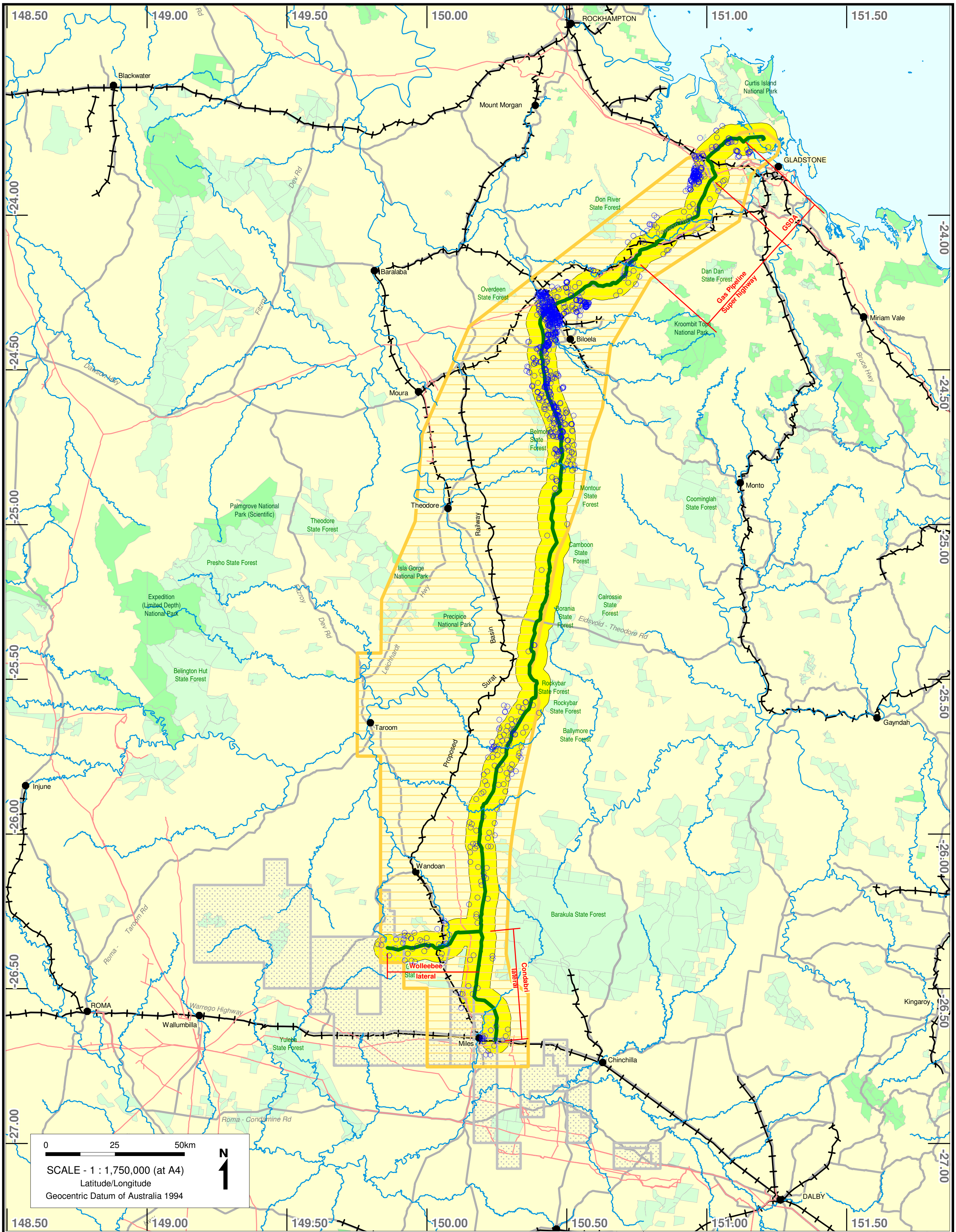
The environmental values of groundwater which may be exposed to potential impacts include the use of shallow groundwater resources for stock watering and agriculture, or as a complementary source of water for domestic use.

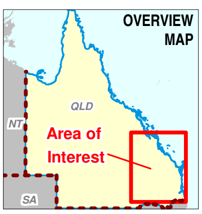
11.3.2 Groundwater

A search of the DERM groundwater bore database was conducted along the 10km wide gas pipeline corridor. The locations of all registered bores within the gas pipeline corridor are shown on Figure 11.2. The search revealed that the water level in these areas is generally greater than five metres below ground surface (mbgs) and mostly in the range of 10mbgs to 20mbgs. In these areas the water levels may be higher than 10mbgs. Water level records for selected bores in the vicinity of these creeks near the crossing indicate that water levels have been declining since the late 1970s. These bore water levels have generally receded below 10mbgs and even with significant recharge events such as in 2002, the water level did not rise above 5mbgs, as illustrated on Figure 11.3.

The limited groundwater bore information available from the DERM database for Curtis Island indicated that the watertable is approximately 10mbgs, as reported in Volume 4 Chapter 11.

Springs and areas of seepage are abundant in the marginal regions of the Great Artesian Basin, particularly in the southern, south-western and northern areas. Groundwater-dependent ecosystems are common in spring areas and are classified as ecosystems which have their species composition and their natural ecological processes determined by groundwater (ANZECC/ARMCANZ 2000). The only spring complexes within the 5km radius of the gas pipeline route are located in the vicinity of where the gas pipeline crosses Cockatoo Creek as shown on Figure 11.4.





SOURCE INFORMATION

Protected Areas, Groundwater Bore Locations
Department of Environment and Resource Management 2009
Pipelines
Commonwealth of Australia (Geoscience Australia) 2009
Department of Mines and Energy, MERLIN Mining Tenures system and Database (MTDB) 2009

LEGEND

- Registered groundwater bore
- Railway
- Road
- Gas pipeline route
- Existing pipeline
- River
- Gas pipeline corridor
- National park
- State forest
- Gas pipeline study area
- Walloons gas fields development areas

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Volume 3 Chapter 11
Figure 11.2 Registered groundwater bores within pipeline corridor (DERM groundwater bore database)

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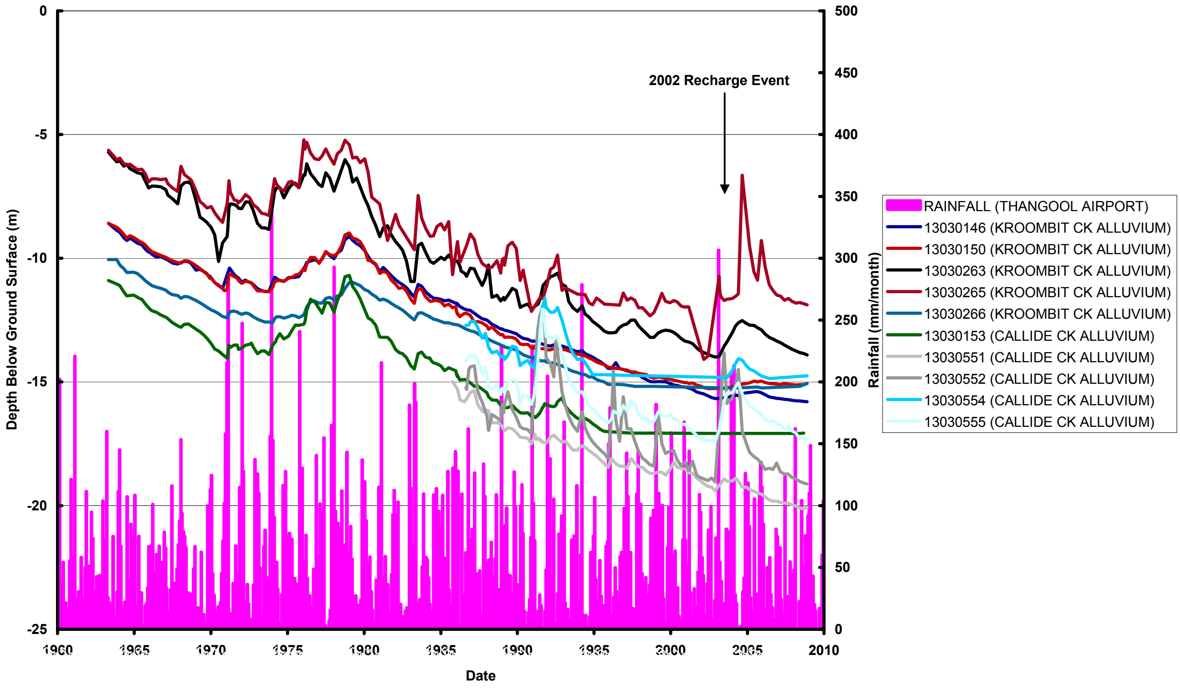


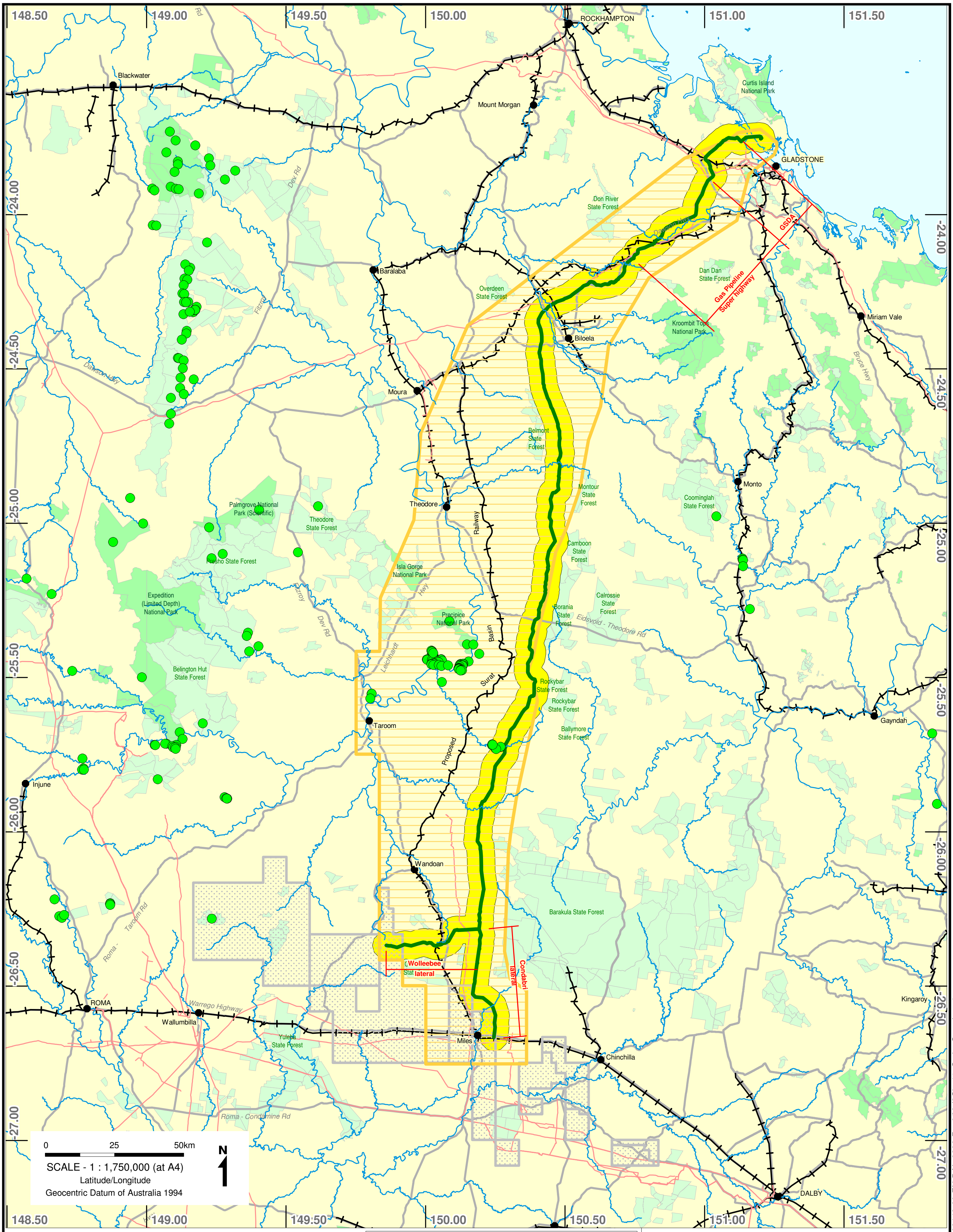
Figure 11.3 Selected water level hydrographs from vicinity of Kroombit Creek and Callide Creek gas pipeline crossings

11.3.3 Groundwater quality

Groundwater quality along the gas pipeline route, expressed in terms of electrical conductivity, is predominantly in the range of 1000 microsiemens per centimetre (µS/cm) to 2500µS/cm. The measurement of electrical conductivity is a commonly accepted methodology for ascertaining the salinity of water. In terms of salinity, the quality appears to be best in the vicinity of Bell Creek at the Dawson Highway crossing. It is anticipated to be most saline as the gas pipeline corridor approaches The Narrows and is influenced by the marine environment. The available groundwater bore data obtained from the DERM groundwater database is summarised in Table 11.2.

It should be noted that no groundwater bore data was available in the search radius in the vicinity of:

- Calliope River at the Dawson Highway crossing
- Cockatoo Creek
- Bungaban Creek
- Dogwood Creek
- Juandah Creek.



SOURCE INFORMATION

Protected Areas
- Department of Environment and Resource Management 2009

Queensland Wetland Data Version 1.2 - Springs
- The State of Queensland (Environmental Protection Agency) 2008

Pipelines
- Commonwealth of Australia (Geoscience Australia) 2009
- Department of Mines and Energy, MERLIN Mining Tenures system and Database (MTDB) 2009

LEGEND

- Spring complexes
- Railway
- Road
- Gas pipeline route
- Existing pipeline
- River
- Gas pipeline corridor
- National park
- State forest
- Gas pipeline study area
- Walloons gas fields development areas

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Volume 3 Chapter 11
Figure 11.4 Spring complexes in proximity to the study area (DERM Wetland Mapping database)

Table 11.2 Hydrogeological information at major creek crossings along the gas pipeline

Crossing location	No of bores	Water level (mbgl)			Electrical conductivity (µS/cm)			Yield (L/s)	
		Min[1]	Max[2]	Median	Min	Max	Median	Min	Max
Bell Creek at the Dawson Highway	9	15.45	6	9.6	650	1,260	815	0.38	2
Kroombit and Callide Creeks at the Burnett Highway	170	18.5	0.71	11.3	500	7,300	1925	0.01	46.6
Pump Creek	8	20.9	12	20.7	1,200	5,600	4,250	0.03	1.7
Cockatoo Creek	6	33	33	33	1,500	1,500	1,500	3.78	3.78

[1] Min refers to the lowest elevation in metres below ground level (mbgl)
[2] Max water level refers to highest groundwater elevation

11.3.4 Surface watercourses

A detailed geomorphic investigation was conducted throughout the study area, and is reported within Volume 5 Attachment 17 and Volume 3 Chapter 9.

Seven crossing sites in the Dawson and Don catchments were inspected and were found to exhibit variable geomorphic characteristics. This variability was largely a reflection of their relative positions within the catchments and their respective local and upstream processes which include water abstractions and agricultural land uses. Most sites have experienced considerable disturbance, mostly in the form of vegetation clearance. Bed aggradation was a common feature, although three sites had stable beds with good geomorphic features. Banks were generally stable and riparian and floodplain vegetation and channel diversity was variable across the sites.

A single site was assessed on the Calliope River. This site exhibited stable bed and banks with limited evidence of aggradation and reasonable bed variability. C & R Consulting (2005) suggest groundwater percolation has extended the periods of baseflow in the Calliope which has in turn maintained waterholes and riffle habitats. Riparian vegetation was well developed along both banks although vegetation clearance was considered the dominant form of disturbance.

11.3.5 Surface water quality

The existing water quality occurring within the areas potentially affected by the gas pipeline is described in terms of the values identified in EPP Water and the Queensland Water Quality Guidelines in Volume 3 Chapter 9.

Most waterways along the gas pipeline route in the Dawson and Don catchments were intermittent and a number of sites were dry during sampling. Where water was present, sampling was generally confined to small (non-flowing) pools. A notable exception was Cockatoo Creek, which is a spring fed stream. The Calliope catchment has a sustained base flow due to its connection to shallow underlying aquifers

Water quality in the Fitzroy catchment is characterised by low to moderate conductivity levels, high turbidity and suspended solids and high nutrients. Monitoring by DERM has also found elevated metals at various sites within the Fitzroy Basin. The catchment has been heavily impacted by stock, loss of riparian vegetation and diffuse pollution and numerous weirs and dams have modified flow regimes and contributed to reduced water quality.

Water quality in the Calliope River catchment is highly seasonal, but is generally characterised by moderate to high conductivity levels, low to moderate turbidity and low to moderate levels of nutrients.

The existing water quality for The Narrows is included in the marine ecology assessment outlined in Volume 3 Chapter 10 and presented in Volume 5 Attachment 19.

11.4 Potential impacts

The potential impacts on the waterway physical environment, ecology and riparian consumers of the water are summarised in Table 11.3. The potential impacts on the riverine environment and ecology and surface water quality are discussed in Volume 3 Chapter 9 – Aquatic ecology. The impacts assessed included:

- Sediment transport and nutrient loads
- Impacts on aquatic flora and fauna
- Impacts on groundwater dependent ecosystems
- Blockage and diversion of streamflow
- Accidental spills
- Drainage, erosion and sediment control of construction works sites
- Biting insects.

Table 11.3 Potential impacts

Construction phase	Operation phase
Removal of riparian vegetation and marine plants	Induced bed scour and/or bank erosion
Re-profiling of creek banks	Changes to recharge along the trench
Diversion of streamflow	Impacts resulting from rupture of gas pipeline
Induced bed scour and/or bank erosion	
Exposure of acid sulfate soils (ASS)	
Trench inflows/dewatering impacts	
Alteration of local groundwater flow patterns	
Contamination of shallow groundwater due to spills	

When comparing the construction phase to the operational phase of the gas pipeline, the greatest disturbance and interaction with the watercourse occurs during construction.

There is a potential, although it is unlikely, that the pipeline trench would intersect the watertable during construction and cause significant impact. Therefore it is necessary to identify these potential impacts.

It would be possible for surface water bodies, groundwater dependent ecosystems or groundwater users to be impacted if significant volumes of groundwater were to enter the open trench. These impacts would include inflows to surface water from activities associated with dewatering of the pipeline trench. In extreme events, it is possible that alteration of local groundwater flow patterns and changes in rainfall recharge along the trench may be observed. These impacts are highly unlikely, due to construction methods outlined in Volume 3 Chapter 3.

Where the gas pipeline crosses the mudflats at Friend Point on the approach to the crossing of The Narrows to Curtis Island, the pipeline trench may encounter subsurface water which is under tidal influence (refer to Volume 3 Chapter 10). Significant variations to users or ecology due to the nature of these soils and their interaction with tidal influences should be negligible as the system is highly dynamic.

An assessment of potential impacts of the gas pipeline on hydrologic and stream morphologic characteristics of surface watercourses was undertaken at the 27 locations shown on Figure 11.1. The assessments were undertaken at these locations, as the proposed gas pipeline route will cross watercourses having a stream order classification of 3 or greater at these locations. As stated above, these represent all watercourses other than minor creeks.

11.4.1 Groundwater impacts

The potential impacts on shallow groundwater associated with the construction and operation of the gas pipeline may include:

- Trench inflows/dewatering impacting on groundwater dependent ecosystems or groundwater users
- Alteration of local groundwater flow patterns
- Changes to rainfall recharge along the trench
- Groundwater dependent ecosystems
- Drawdown effects to landholder bores due to taking water for construction and testing activities
- Contamination of shallow groundwater resources
- Environmental values' impacts.

For the first three of these potential impacts to occur, it is necessary for the trench and/or gas pipeline to intersect the watertable. It is anticipated that that the watertable will generally be deeper than the base of the pipeline trench, but the watertable may be intersected in the vicinity of 'permanent' streams (Cockatoo Creek and Calliope River), and approaching The Narrows.

The pipeline trench will typically be excavated to a depth of approximately 2 to 3m with a minimum width of approximately 1.4m. As stated above, groundwater is typically encountered at depths greater than 5m below the surface. Once the pipeline is laid in the trench, it is covered and compacted to prevent erosion and subsidence. As the disturbance is only less than 3m wide, the effect of variations of recharge on the catchment should be negligible. Rehabilitation practices of the gas pipeline right of way should further reduce any variations in recharge potential.

A limited duration will be required to install the pipeline in a section of the trench spanning a crossing site and the approaches. Therefore it is anticipated that any depression of the watertable due to trench inflow/dewatering activities would be limited to the immediate vicinity of the trench and would be of a temporary nature only – that is, the water level would recover once dewatering ceased. The use of horizontal directional drilling (HDD) to install the pipeline beneath a river or creek should not require dewatering to be carried out, even if it is below the watertable.

The backfilling of pipe trenches may increase the hydraulic conductivity of the trench relative to the surrounding ground. This would be particularly evident if the backfill is not compacted or a bedding layer is used, which would create a conduit for preferential flow. Conversely, reduced permeability due to over-compaction of the backfill material may result in potentially elevated groundwater levels.

For flows to artesian springs and hence their associated groundwater-dependent ecosystems to be impacted, the spring would need to be in the immediate vicinity of the pipeline trench, and the trench would have to intersect the watertable and be dewatered. Short term reductions in spring flows to groundwater-dependent ecosystems are unlikely to impact on the integrity of the ecosystem as similar reductions in flow may occur through natural climatic variability. The only springs located within the gas pipeline corridor are adjacent to Cockatoo Creek.

Groundwater extraction from bores for the purpose of construction, dust suppression or hydrostatic testing may result in localised drawdown effects. Groundwater is not the preferred source of water for these activities and the volume of water used for hydrostatic testing will be minimised through other sources of water and recycling of the test water.

Potential sources of contamination relating to construction are predominantly related to diesel and hydrocarbon-based lubricants associated with the machinery. A secondary potential source of contamination is human effluent associated with temporary accommodation facilities. Hydrostatic test water can include chemical additives such as corrosion inhibitors and biocides. Uncontrolled releases and spills of this water have the potential to degrade the local groundwater quality.

Environmental values of groundwater resources that may be exposed to potential impacts include using shallow groundwater resources for stock watering and agriculture, or as a complementary source of water for domestic use. It is not anticipated that the gas pipeline will cause any significant impact on groundwater resources, so these environmental values should not be affected.

11.4.2 Surface water impacts

The potential impacts on surface waterways associated with the construction and operation of the gas pipeline are essentially related to hydraulic behaviour, riverine ecology and, to a lesser degree, surface water resource management. These may result in changes in flood levels, depths and velocities of floodwaters and temporary or long-term changes in flow paths and sediment transport regime and are discussed below.

The creek channels at most of the crossing locations are relatively confined. They are part of much wider floodplains that would normally convey a significant proportion of the flow during flood events. Therefore, it is expected that there will be no changes in flood behaviour in moderate and major flood events. Some temporary ponding within the channel may occur following minor rainfall events when the water level does not rise above the level of the stockpiled material.

The potential impacts on the riverine environment relate to removal of vegetation and changes in bank formation for access to the waterway during the construction period. These impacts are discussed in Volume 3 Chapter 9.

The water requirements for construction of the gas pipeline are described in Volume 3 Chapter 3.

Each section of the gas pipeline will be hydrostatically pressure-tested (hydrotested) in accordance with Australian Standard AS2885.5 Pipeline – Gas and liquid petroleum Part 5 – Field testing. This is carried out to establish the leak tightness of the section, and to confirm the gas pipeline's capability to operate at the maximum allowable operating pressure. It is expected that a maximum of 100ML of water will be required for hydrotesting.

The water required for testing will be obtained from the sources listed below, in order of preference:

- Treated water from the Project's gas fields' water treatment facilities
- Re-used water from other test sections, pumped down the gas pipeline for the next section to be tested
- Commercial suppliers
- Water from local watercourses/rivers.

In all situations, permits will be obtained from the relevant regulatory authority, where required.

A few temporary ponds of approximately 20ML capacity are likely to be required along the gas pipeline route to hold test water. The holding ponds will provide sufficient freeboard (space above normal level) to allow for storage of direct rainfall. The ponds will be restored and rehabilitated after testing is complete.

Depending on the source and quality of water used for hydrotesting, additives may be required. These could include biocides, oxygen scavengers and corrosion inhibitors that remove biological organisms and reduce corrosion potential during testing.

The use of additives in hydrotest water will be minimised. Where possible, it will be re-used to reduce the amount required to be managed.

The potential impacts resulting from the disposal of hydrotest water are contamination of surface waterways and/or groundwater, as well as soil erosion, scour and sedimentation of surface watercourses.

Research undertaken on the disposal of water used for hydrostatic testing of pipelines (CSIRO Manufacturing & Infrastructure Technology (CMIT) 2005) has revealed the following:

- The hydrotest water contains contaminants that may require treatment prior to disposal
- The contaminants for new pipelines are mainly due to mill scale breakdown and unreacted additives and their reaction products
- The contaminant levels are generally not toxic
- Appropriate treatment of the hydrotest water is required prior to disposal
- The characteristics of the disposal site play age role in determining the treatment required
- Special planning is required when biocides are used and when the source water itself presents a disposal problem
- The discharge of hydrotest water is a one-off event and this should be considered when evaluating the potential environmental impact.

The disposal of hydrotest water is to be undertaken in accordance with the conditions set out in a permit issued by DERM under an environmentally relevant activity for petroleum activities under the provisions of the EP Act. The release of water to land is to be carried out in a manner that ensures:

- Vegetation is not damaged
- Soil erosion and soil structure damage is avoided

- No surface ponding of released water occurs
- The quality of groundwater is not adversely affected
- No release of water to any surface waters occurs.

It is anticipated that the permit will require a hydrotest water management plan to be submitted. It will be required to specify that hydrotest water is to be released to land for disposal and that the land disposal area will be located more than 100m from the nearest watercourse. The disposal of hydrotest water is outlined in the environmental management plan (Volume 3 Chapter 24).

Given the preference to obtain water from other sources than surface waterways, it is anticipated that the gas pipeline element of the Project will have a negligible impact on the supply of water to existing consumers either locally or regionally. The necessary permits required by the relevant water resource plan will be obtained in the event that water is required to be sourced from a surface watercourse.

The potential impacts of emergency events, such as a rupture of the gas pipeline, may include personal safety hazards in addition to the abovementioned impacts on the physical environment that may be more extensive and more rapid than 'normal' operational impacts. The preparation of emergency response plans is discussed in Volume 3 Chapter 24.

The assessments of potential impacts on flood behaviour, and of scour and erosion risk, were based on the estimated peak flows in the 100 years ARI flood event. This event is commonly adopted for floodplain management purposes and was considered to be appropriate for adoption as a design criterion for the gas pipeline, which will be exposed to possible flood related damage for the full lifetime of the gas pipeline, not just during construction.

Flood frequency analyses were undertaken for DERM gauging stations that are located near to the adopted gas pipeline route. This was done so that the adopted 100 years ARI peak flows would be derived from historical flow data. This avoids uncertainties associated with hydrologic modelling using design rainfall data. The 100 years ARI peak flows determined by the flood frequency analyses are summarised in Table 11.4.

Table 11.4 Flood frequency results

River basin	Station	Name	Catchment area (km^2)	100 years ARI Flow (m^3/s)
Condamine	GS422202	Dogwood Ck	3,010	880
	GS422210	Bungil Ck	710	810
	GS422219	Yuleba Ck	490	355
	GS422308	Chinchilla Weir	19,190	2,635
	GS422201	St George	75,370	2,833
	GS422321	Spring Ck	35	89
	GS422334	Kings Ck	516	631
Dawson	GS130302	Taroom	15,846	2,881
	GS130313	Palm Tree Ck	2,660	180
	GS130317	Woodleigh	28,503	1,835

River basin	Station	Name	Catchment area (km^2)	100 years ARI Flow (m^3/s)
	GS130319	Bell Ck	300	971
	GS130334	South Kariboe Ck	284	675
	GS130336	Grevillea Ck	233	427
	GS130344	Juandah Ck	1,678	1,080
	GS130348	Prospect Ck	369	607
Coastal	GS130004	Raglan Ck	389	1,599
	GS132001	Calliope R	1,288	4,070
	GS134001	Baffle Ck	1,402	2,895

The regional relationships derived from the flood frequency analyses exhibit significant variability between inland and coastal basins, particularly in the exponent. The correlation coefficients for the separate regional relationships varied between 0.81 and 0.87, indicating a 'reasonably good fit' to the data as illustrated on Figure 11.5.

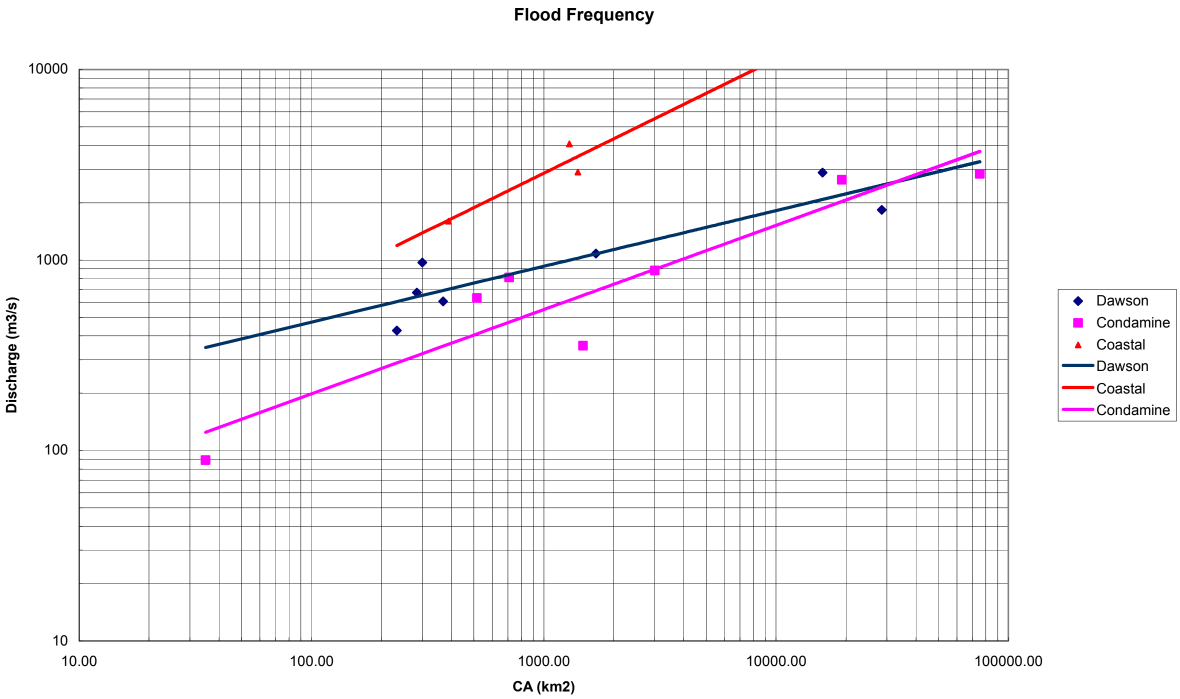

Figure 11.5 100 year ARI peak flow regional relationships

The flood levels and the maximum depth and velocity of floodwaters at the 27 crossing sites in the 100 years ARI design flood event were determined. This was done using cross-section conveyance and slope data derived from the available digital elevation data. The estimated 100 years ARI peak flows were estimated using the regional flood frequency peak flow relationships and catchment area at each site.

The estimated 100 years ARI peak flows, flood levels, depths and velocities, at the identified crossing sites, are presented in Table 11.5.

Table 11.5 100 years ARI flood data at crossings

Pipeline branch	Stream	Crossing (KP km)[1]	Catchment area (km^2)	Q100 (m^3/s)	Level (mAHD)[2]	Depth (m)	Velocity (m/s)
Condabri	Dogwood Creek	12	2172.1	773.9	302.97	4.21	0.77
	L Tree Creek	31	130.1	222.7	335.75	2.23	1.31
	Bottle Tree Creek	37	53.9	150.8	337.15	1.34	0.89
Main	Roche Creek	29	129.4	509.6	291.3	2.12	1.65
	Bungaban Creek	44	326.0	667.7	263.95	2.73	1.53
	Kennedy Creek	65	51.2	388.4	252.1	1.46	1.59
	Cockatoo Creek	69	235.9	607.4	235.6	3.12	2.66
	Ross Creek	111	65.8	418.1	332	2.47	1.94
	Ross Creek	114	52.3	390.9	342.3	1.82	1.72
	Ross Creek	118	28.3	326.7	363.9	1.95	2.02
	Cracow Creek	128	51.8	389.7	353.1	1.80	2.00
	Delusion Creek	149	131.7	512.1	334.6	2.34	2.09
	Oxtrack Creek	157	83.3	447.9	347.8	2.51	1.42
	South Creek	170	35.0	347.4	341.68	1.84	2.03
	Keen Creek	176	63.9	414.4	323.5	1.86	2.07
	Pump Creek	183	107.1	482.1	297.65	3.05	2.68
	Twenty Mile Creek	185	63.8	414.3	302	1.77	1.76
	Prospect Creek tributary	200	35.7	349.5	260.96	0.97	1.35
	Prairie Creek	214	63.2	413.1	219	3.02	2.12
	Kroombit Creek effluent	239	102.0	1190.4	151.12	2.73	0.98
	Kroombit Creek	240	2351.3				
	Callide Creek	243	806.2	870.3	150.1	1.98	2.05
	Bell Creek	278	37.8	400.2	314.25	2.95	2.84
	Calliope River	295	195.8	1073.4	62.35	2.94	1.46
	Harper Creek	303	61.8	537.1	51.16	1.97	1.85
	Larcom Creek (crossing #1)	320	281.5	1334.5	29.2	4.83	1.47

Pipeline branch	Stream	Crossing (KP km)[1]	Catchment area (km^2)	Q100 (m^3/s)	Level (mAHD)[2]	Depth (m)	Velocity (m/s)
	Larcom Creek (crossing #2)	327	90.3	674.4	47.5	2.33	1.47
Woleebee	Juandah Creek	15	45.1	374.4	336.2	1.49	1.97

[1] KP km - kilometre point measured along gas pipeline route from start of branch
[2] mAHD – metres above Australian Height Datum.

Scour is the removal of sediment (soil and rocks) from stream beds and stream banks caused by moving water. The depth of scour in alluvial channels is dependent on both the depth and velocity of flows, and the particle size distribution of the bed material. Creek channels are susceptible to scour and erosion when the average particle size D_{50} of the bed material is smaller than the critical grain size D_c; that is, smaller than the particle size capable of being transported by hydraulic forces present under given flow conditions.

Armouring occurs when the hydraulic forces are sufficient enough to remove the smaller particles but not the larger particles. The smaller particles are removed from the bed leaving the coarser material to form an armour layer, thus limiting the depth of scouring. Armouring can occur when at least 5% of the bed material is larger than the critical grain size, that is, D_{95} is greater than D'_c. The thickness of the armour layer is typically two to three times the critical grain size.

The bed material at the crossing sites is generally comprised of fine to medium sands. The exception to this is at Prairie Creek, where the bed was comprised of medium to coarse gravels, and Roche and Bungaban Creeks, where the bed material was predominantly silty. Grain size distribution curves for the 16 sites sampled are plotted on Figure 11.6.

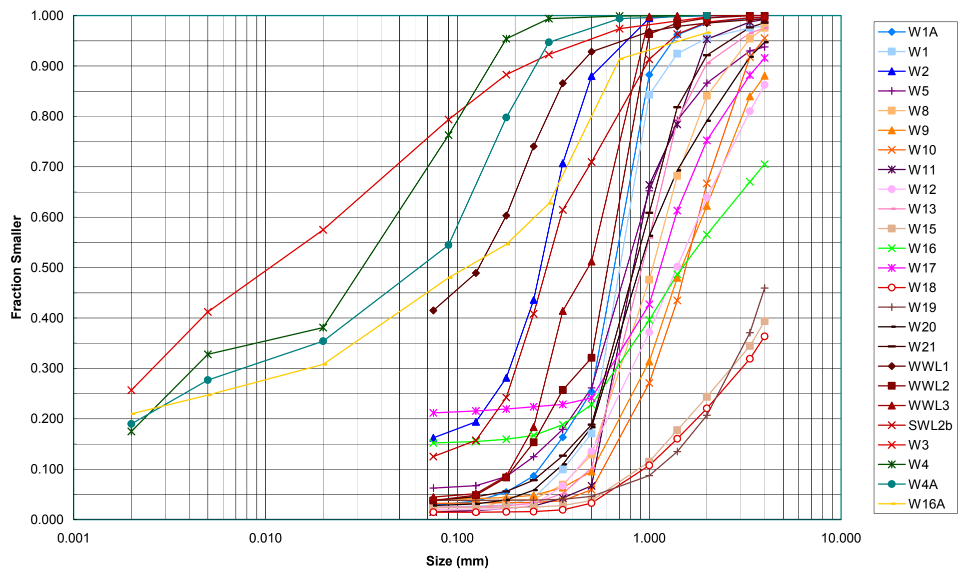

Figure 11.6 Bed material gradings

The potential risk of scour occurring at the proposed gas pipeline crossings was estimated. This was done using procedures for stream degradation analysis outlined in Stream Stability at Highway Structures (US Federal Highway Administration 2001).

Sediment particles that are of a critical size can be moved by hydraulic forces. These sizes, in relation to the required forces, are calculated using the Shields formula.

The particle grading summary and critical sediment sizes at the crossing sites are listed in Table 11.6.

Table 11.6 Particle gradings and critical grain sizes

Pipeline branch	Stream	Crossing (KP km)	Sample no	Soil grading D_{50} (mm)	Soil grading D_{84} (mm)	Soil grading D_{95} (mm)	Scour D_c (mm)	Armour D'_c (mm)
Condabri	Dogwood Creek	12	W1A	0.70	0.98	1.45	0.95	1.39
	L Tree Creek	31	W1	0.75	1.00	1.90	6.35	4.58
	Bottle Tree Creek	37	W2	0.28	0.45	0.75	2.59	1.99
Main	Roche Creek	29	W3	0.01	0.15	0.45	13.11	5.03
	Bungaban Creek	44	W4	0.03	0.13	0.18	9.10	3.97
	Kennedy Creek	65					14.09	8.34
	Cockatoo Creek	69	W5	0.80	1.80	5.00	45.11	20.04
	Ross Creek	111					19.72	10.45
	Ross Creek	114					15.95	9.07
	Ross Creek	118					24.76	12.16
	Cracow Creek	128	W8	1.05	1.95	3.30	25.09	13.07
	Delusion Creek	149	W10	1.58	2.90	3.90	25.20	14.80
	Oxtrack Creek	157	W11	0.87	1.60	2.00	7.65	5.84
	South Creek	170	W12	1.40	3.70	6.00	26.08	15.82
	Keen Creek	176					27.54	13.05
	Pump Creek	183	W13	0.93	1.60	3.00	46.38	19.82
	Twenty Mile Creek	185					17.16	9.52
	Prospect Creek tributary	200					10.63	6.90
	Prairie Creek	214	W15	6.00	8.00	10.00	23.05	18.54
	Kroombit Creek effluent	239	W16	1.50	10.00	20.00	2.38	14.80
	Kroombit Creek	240						
	Callide Creek	243	W17	1.15	2.90	5.00	25.72	22.11
	Bell Creek	278	W21	0.85	1.50	2.70	56.13	5.57
	Calliope River	295					7.67	10.21

Pipeline branch	Stream	Crossing (KP km)	Sample no	Soil grading			Scour D_c (mm)	Armour D'_c (mm)
				D_{50} (mm)	D_{84} (mm)	D_{95} (mm)		
	Harper Creek	303					19.06	4.77
	Larcom Creek	320					6.05	6.12
	Larcom Creek	327					8.83	11.07
Woleebee	Juandah Creek	15	WWL2	0.65	0.90	1.00	26.46	4.32

Scour D_c – creek channels are susceptible to scour and erosion when the average particle size D_{50} of the bed material is smaller than the critical grain size Scour D_c; that is, smaller than the particle size capable of being transported by hydraulic forces present under given flow conditions.

Armour D'_c – armouring can occur when at least 5% of the bed material is larger than the critical grain size, i.e. D_{95} is greater than Armour D_c. The thickness of the armour layer is typically two to three times the critical grain size.

The critical grain sizes for scour and armouring are generally much larger than the D_{50} sizes obtained from the particle grading information for most of the crossing sites. This would indicate that most creek crossing sites are prone to scouring of the creek beds, during flood events.

The Dogwood Creek crossing site was the only investigated site that was found to have a low risk of scour during flood events. The critical grain size for scour is slightly greater than the average grain size, but the D_{95} grain size is greater than the critical armour grain size.

Therefore, detailed scour assessments will be required to be undertaken during detailed design phases of the Project, to determine the appropriate depth of cover or scour protection measures for each crossing.

11.5 Mitigation and management

11.5.1 Groundwater

The proposed mitigation and management measures to prevent or minimise potential impacts on groundwater are summarised below.

Backfilling, including compaction, of the trench will be undertaken to minimise any potential changes to the permeability, compared to the undisturbed area around the trench. Trench breakers will be installed in sloping areas to minimise the potential for the trench to act as a preferential pathway for groundwater movement. The breakers will be designed to ensure that the water does not discharge at the surface.

Drilling fluids used during HDD will be bentonite, a water based drilling fluid, and will be managed onsite using tanks and sumps to avoid concentrated discharge to a surface watercourse or surface water body. HDD activities are discussed in Volume 3 Chapter 3.

It is anticipated that hydrostatic test water will be re-used where practicable, thereby minimising the volumes required. The disposal method for this water will depend on the nature of any additives included. Specific management measures will be implemented which take into account its chemical nature and that of the receiving waters, as well as other environmental considerations. The management of hydrotest water is addressed in Volume 3 Chapter 3.

Where practicable, water required for construction purposes is to be obtained from sources other than surface waterways or groundwater, thereby minimising impacts on local water resources.

Should potential acid sulfate soils be encountered, these will be managed to minimise the potential for acid generation. This will include minimising the disturbance of the soils and neutralisation of the spoil as required. The management of acid sulfate soils is addressed in Volume 3 Chapter 24.

In the event that fuel or chemicals are released to surface water or groundwater, reducing water quality, the source should be identified and stopped. Environmental sampling will then be conducted to determine the extent of the impact. To prevent the impact, spills may be mitigated by secondary containment and controlled transfer and refuelling stations.

The gas pipeline will have a pipeline integrity management system in accordance with AS 2885, as well as isolation plans and operations and maintenance plans.

11.5.2 Surface water

The proposed mitigation and management measures to prevent or minimise potential impacts on surface waterways are summarised in this section. The design of the waterway crossings will incorporate appropriate measures to prevent or minimise residual, long-term impacts caused by the presence of the gas pipeline. Construction methods proposed for the gas pipeline crossings of watercourses are described in Volume 3 Chapter 3.

Most watercourse crossings are expected to be constructed using standard open cut (trenching) construction. This technique is most suited to dry or low flow conditions which are expected during most of the construction period. If water is present, flow diversion techniques will be employed where necessary and in accordance with regulatory requirements being sourced.

Construction will involve excavating a trench across the creek beds and then backfilling the excavation and covering the pipeline with the originally excavated bed material. Construction methods proposed for the gas pipeline crossings of watercourses are described further in Volume 3 Chapter 3.

During the construction period, it may be necessary to divert the flow at some crossings to protect pipe laying equipment and exposed works. This may be more likely if any crossings need to be constructed during wet periods. These temporary diversions will be removed once the construction of the creek crossing has been completed. By following these proposed construction methods, it is unlikely that there will be a need to obtain waterway barrier permits, as there will be no long lasting changes to the watercourse. However, this aspect of the Project will need to be considered on a case-by-case basis.

The creek beds will be reinstated as far as practicable to their original form in order to prevent any significant impact on post-construction flood behaviour.

Detailed scour assessments will be required to determine the appropriate depth of cover or scour protection measures that may be needed at each crossing. The detail design of the creek crossings will incorporate works and measures to minimise, as far as practicable:

- The risk of damage to the creek banks during construction
- Change in the sediment transport regime at the crossing
- The risk of creek bank collapse or erosion during flood events
- The risk of damage to the gas pipeline during flood events.

The construction of the gas pipeline crossings will be done in a way that results in minimal damage to the creek banks and riparian vegetation. The backfill placed over the pipeline will be compacted in order to minimise the potential for scour along the trench line which may result in erosion of the creek banks. Erosion and sediment control plans will be prepared in accordance with relevant guidelines, such as Soil Erosion and Sediment Control – Engineering Guidelines for Queensland Construction Sites (The Institution of Engineers, Australia 1996). These plans are designed to manage and mitigate potential erosion, scour and sediment control impacts at waterway crossings and along the gas pipeline corridor.

Given the preference to obtain water from other sources than surface waterways, it is anticipated that the gas pipeline will have a negligible impact on the supply of water to existing consumers, either locally or regionally. The necessary permits required by the relevant water resource plan will be obtained in the event that water is required to be sourced from a surface watercourse. The disposal of hydrotest water will be undertaken in accordance with an approved hydrotest water management plan prepared in accordance with the provisions of a permit issued by DERM under an environmentally relevant activity (petroleum activities) under the provisions of the EP Act.

Hydrotesting activities have the potential to contaminate surface and groundwater resources and to cause erosion on discharge. This risk of contamination will be minimised through:

- Designing with an appropriate freeboard above storage capacity at all temporary hydrotest dams
- Selecting biocide and oxygen scavenger (if necessary) which can be neutralised, are biodegradable, or do not bio-accumulate in the soil
- Monitoring of hydrotest water and receiving water quality
- Discharging hydrotest and trench water in compliance with all regulatory and landholder requirements
- Selecting chemical additives that are least harmful to the environment.

The risk of erosion caused by hydrotesting activities will be minimised through:

- Constructing erosion control measures at discharge locations
- Locating suction pumps to avoid significant vegetation and minimise disturbance to vegetation
- Locating suction pumps above the watercourse bed to minimise erosion
- Including fish screens on intakes.

The mitigation and management of potential impacts on water quality is discussed in Volume 3 Chapter 9.

11.6 Conclusions

11.6.1 Assessment outcomes

The construction and operation of the gas pipeline is expected to cause minimal impacts to groundwater, due to the limited areas where the gas pipeline is could intersect the watertable.

The construction and operation of the gas pipeline is not expected to change flood behaviour in the watercourses crossed along the route.

Most creek crossing sites were found to be prone to scouring of the creek beds, during flood events. The design of the waterway crossings will incorporate appropriate measures to prevent or minimise residual, long-term impacts caused by the presence of the gas pipeline.

Where practicable, water required for construction purposes is to be obtained from sources other than surface waterways or groundwater, and this will minimise impacts on local water resources.

A summary of the environmental values, sustainability principles, potential impacts and mitigation measures is shown in Table 11.7. The risk level following application of mitigation measures is also given. For the purposes of this EIS, the risk assessment has focussed on potential risks to third parties, property and the environment. The risk assessment process is discussed in detail in Volume 1 Chapter 4.

The surface water risks to third parties, property and the environment for the proposed gas pipeline relate primarily to potential changes in streamflow, groundwater flows, level and quality and waterway geomorphology and riparian vegetation. The residual risk levels following the implementation of mitigation measures is detailed in Table 11.7

Table 11.7 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Life, health and wellbeing of people. Diversity of ecological processes and associated ecosystems. Land use capability, having regard to economic considerations.	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.	Drawdown effects associated with trench inflow/dewatering during gas pipeline construction. Changes in groundwater flow regimes.	Pipeline trench intersects shallow groundwater.	The gas pipeline alignment has been selected to minimise the number of crossings of watercourses, limiting the risk of encountering groundwater.	Low
		Changes in groundwater recharge characteristics.	Inappropriate trench restoration following pipe laying.	Backfilling of the trench will be undertaken to minimise any potential changes to the permeability of the backfill as compared to the undisturbed area around the trench. Trench breakers will be installed in sloping areas to minimise the potential for the trench to act as a preferential pathway for groundwater movement. The breakers will be designed to ensure that the water does not discharge at the surface.	Low
		Disturbance of groundwater-dependent ecosystems during gas pipeline installation.	Pipeline alignment intersects Groundwater Dependent Ecosystems, disturbing habitat conditions and ecosystem structure.	The gas pipeline alignment has been selected to minimise the impact on springs.	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
		Drawdown effects associated with water extraction for construction or testing	Groundwater extraction for construction uses.	If required, bores will be located with appropriate separation distances from potential receptors. Bores will be constructed and operated in accordance with license conditions.	Low
		Groundwater contamination during gas pipeline construction and operation	Poor practices in waste management and fuel transfer	The storage of hazardous materials, fuel and industrial or process chemicals will be in accordance with applicable federal, state and regional council requirements to prevent spills or unintentional releases to surface waters or groundwater. Spills will be cleaned up and remediated if necessary.	Low
		Degradation of local groundwater quality during gas pipeline construction	Acid sulfate soils exposed during trenching	Undertake work in accordance with acid sulfate soils management plans (Volume 3 Chapter 6). Minimise to disturbance to potentially acid generating soils.	Low
		Contamination of groundwater and/or surface watercourses by hydrotest water	Uncontrolled release Leakage from holding ponds	Appropriate freeboard to be provided above storage capacity of all temporary hydrotest dams. The use of additives in hydrotest water will be minimised.	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
				Where possible, hydrotest water will be reused to reduce the amount required to be managed. Disposal of hydrotest water will be undertaken in accordance with an approved hydrotest water management plan.	
		Reduced supply to existing riparian consumers.	Extraction of water from watercourses for construction uses.	The necessary permits required by the relevant water resource plan will be obtained in the event that water is required to be sourced from a surface watercourse.	Low
		Flood afflux due to gas pipeline construction activities. Changes in flood flow distributions, possible increased flow onto adjoining properties and damage to buildings, personal injury.	Obstruction to flowpaths due to construction machinery, temporary stockpiles and diversion works.	Creek crossings will be constructed in dry periods where practicable.	Low
		Sediment and erosion during construction of gas pipeline causing siltation of natural drainage lines.	Clearing for access and trench excavation.	Erosion and sediment control plans will be implemented (see Volume 3 Chapter 5) and removal of riparian vegetation will minimised, as far as practicable.	Medium

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
		Sediment and erosion post construction. Siltation of natural drainage lines.	Overland flow along trenchlines not adequately reinstated Induced erosion or scour as a result of gas pipeline protection measures.	Crossings will be designed to minimise changes in erosion, scour and sedimentation regimes. The restoration of pipeline trenches and watercourse crossings will utilise construction techniques and erosion and sediment control methods to minimise erosion risk. Backfill placed over the gas pipeline will be compacted in order to minimise the potential for scour along the trench line and resultant erosion of the creek banks.	Low
		Contamination to waterways, crater formation resulting in collapse of banks, damage to nearby infrastructure. Public safety issues.	Seismic activity, corrosion or fatigue of pipe, third party activities (drilling/excavation) within right of way potentially causing a rupture of the gas pipeline.	The gas pipeline design and construction will be undertaken in accordance with AS 2885. Implementation of emergency response plans (Volume 3 Chapter 24).	Low

11.6.2 Commitments

Australia Pacific LNG will:

- Undertake works, where practicable, in watercourses when the channels is dry
- Undertake, where practicable, any post-construction remedial works of waterway crossings prior to the onset of the wet season
- Undertake annual post-construction monitoring of waterway crossing sites at the end of the wet season, until it has been established that the construction works were successfully completed
- Implement water efficiency measures for construction activities which require the use of surface or groundwater
- Be as self-sufficient as practicable for all construction and operational water requirements
- Require all major contractors to submit water conservation plans.

To manage potential impacts of hydrotest water, Australia Pacific LNG will:

- Test the quality of the hydrotest water prior to release
- Discharge hydrotest water in compliance with all regulatory requirements and consult landholders about opportunities for reuse.

References

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