9 SURFACE WATER RESOURCES

9.1 INTRODUCTION

Chapter 9 describes the environmental values associated with surface water resources and the potential impacts on those values during construction and operation of the Gas Field Component of the Queensland Curtis LNG (QCLNG) Project.

Issues relating to Associated Water are briefly described in this chapter but are detailed in *Chapter 11* of this volume.

9.2 PROJECT ENVIRONMENTAL OBJECTIVE

The Project environmental objective for surface water resources is to protect as much as practicable surface waters from contamination, diversion of natural flows, and sedimentation so as to preserve the ecological health, public amenity and safety of surface waters.

9.3 METHODOLOGY

Available data was obtained, prepared and interpreted for the purposes of a surface water impact assessment for this Environmental Impact Statement (EIS). The methods used included data collation and review, spatial analysis and catchment definition, hydrological analyses and field assessment.

The northern-most tenements shown as ATP 768 and PL 171 in *Figure 3.9.1* were included as part of the Gas Field after the surface water study provided in *Appendix 3.3* was completed. These additional areas contain the same and similar watercourses to those which occur in the northern-most tenements included in that study.

9.3.1 Data collation and Review

Legislation guiding the management and development of surface water for the Gas Field Component was reviewed, namely:

- Queensland Coal Seam Gas Water Management Policy 2008
- *Water Act 2000*
- *Environmental Protection Act 1994*
- *Environmental Protection (Water) Policy 1997*
- *Water Resource (Condamine and Balonne) Plan 2004.*

Stream-flow data and water quality data within the Gas Field area was obtained from the Department of Environment and Resource Management (DERM). The sites selected were:

- 422333A – Condamine River near Dalby (sporadically from 1963–2006)
- 422336A – Condamine River at Brigalow (sporadically from 1973–1999)
- 422308C – Condamine River at Chinchilla Weir (sporadically from 1962–2008)
- 422325A – Condamine River at Cotswold (sporadically 1971–2002)

Quality codes were provided with the data and were generally good.

9.3.1.1 Stream-flow data

Stream-flow data was obtained from DERM and converted into usable data using Hydstra (database management software used by most state and territory governments) was used to create Intensity Frequency Duration (IFD) curves for each of the sites. Refer to *Appendix 3.3* for further details.

9.3.1.2 Water quality data

Water quality data was obtained from DERM and from field investigations.

Duplicate samples were also taken for quality control and quality assurance (QC/QA). *Table 3.9.1* describes the parameters sampled as part of the field assessment. The full analyses are located in *Appendix 3.3*.

Table 3.9.1 Surface Water Quality Parameters

Group	Surface Water Quality Parameters
Major Anions (dissolved)	Chloride, Sulfate
Major Cations (dissolved and total)	Magnesium, Calcium, Sodium, Potassium
Nutrients	Ammonia, Total Kjeldahl Nitrogen, Total Phosphorus, Total Nitrogen, NOx (nitrate + nitrite), Dissolved organic carbon (DOC), Total organic carbon (TOC)
Physicochemical	Dissolved oxygen (DO), pH, Turbidity, Conductivity/salinity, Temperature, Total suspended solids (TSS), Total alkalinity, Bicarbonate alkalinity, Hydroxide alkalinity, Carbonate alkalinity, Total acidity

9.3.2 Spatial Analysis and Catchment Definition

Catchment boundaries were derived from the Shuttle Radar Topography Mission (SRTM) raster. Hydrological analysis of the data was then conducted using ArcMap to identify and delineate the catchment boundaries in the region. This was done in three main steps:

- the direction of flow from every cell in the raster was determined
- the flow accumulation for each cell in the raster was calculated
- the location of streams and discharge points was estimated using the ArcMap watershed function.

9.3.3 Hydrological Analyses

Hydrological analysis was undertaken from available data to assess the impact of floods and base flows in the Gas Field area.

9.3.3.1 Flood Impact Assessment

Data for the flood impact assessment was obtained from the Bureau of Meteorology (BoM), DERM, and Land Resource Assessment and Management Pty. Ltd. (LRAM). The history of flooding in the Condamine River, Moonie River, Dogwood Creek, Charley's Creek and adjacent tributaries was obtained from the BoM website.

Stream-flow data was obtained from DERM and converted into usable data using Hydstra to create Intensity Frequency Duration (IFD) curves for each of the sites (see *Section 9.3.1.1* for details).

The Condamine floodplain elements and flow paths were obtained from LRAM who developed the Condamine Flow Coordination NRM Report for the former Department of Local Government and Planning (LRAM, 2002). This report details the landscape elements, flow characteristics and implications for land use within the Condamine catchment.

Data from the BoM website was also used to develop the flood inundation map for the Condamine River.

9.3.3.2 Baseflow Assessment

In lieu of recorded data; relevant literature, anecdotal evidence identified during the field visits and regional parameters for the Gas Field area were used to assess the contribution of base flow to stream flow.

9.3.4 Field Assessment

Fifteen sites were identified as potential water quality sampling sites, although the majority of those sites were dry or only had isolated pools of water during the period of the field survey. Therefore only five sites could be sampled. The details of the sample locations are provided in *Appendix 3.3.*

9.4 EXISTING ENVIRONMENT

9.4.1 Catchments

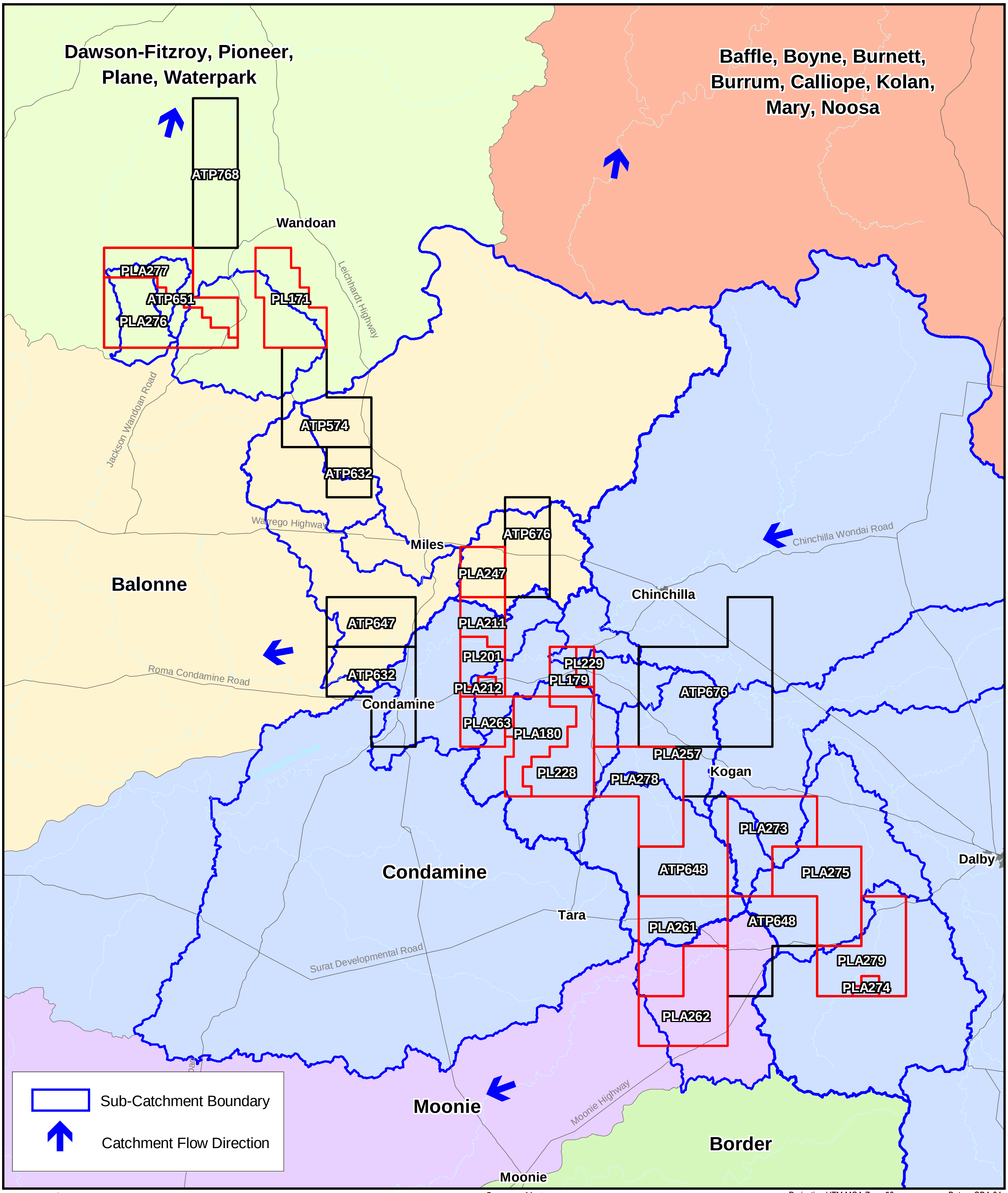
The Gas Field is situated within four surface water catchments (refer *Figure 3.9.1*):

- Condamine River catchment
- Balonne River catchment
- Moonie River catchment
- upper reaches of the Dawson River catchment.

The Gas Field is predominantly located within the Condamine and Balonne River catchments. The Condamine catchment has a diversity of landforms ranging from steep, mountainous terrain along the Great Dividing Range to the extensive floodplains of the Condamine River. Sandstone hills and slopes are the dominant geomorphic unit in the catchment.

The Gas Field areas that occur within the Moonie River catchment are essentially flat with low relief hills scattered throughout the floodplains of the Moonie River.

As a result of grazing and cropping practices the majority of the floodplain and lowland areas have been cleared of native vegetation.



Legend:

Gas Fields - Petroleum Lease/Petroleum Lease Application

Gas Fields - Authority to Prospect

Source Note:
1:250,000 Topographic vector copyright Geoscience Australia
Catchment data copyright State of Queensland (2008)

Projection UTM MGA Zone 56 Datum GDA 94

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QUEENSLAND CURTIS LNG
A BG Group business

ERM
Environmental Resources Management Australia Pty Ltd

Project	Queensland Curtis LNG Project	Title	**Surface Water Catchment Boundaries**
Client	QGC - A BG Group business		
Drawn Mipela	**Volume** 3 **Figure** 3.9.1	Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.	
Approved CDP	File No: QC02-T-MA-00065		
Date 06.07.09	Revision A		

9.4.2 *Major Watercourses within the Gas Fields*

The two major river systems that occur within the Gas Fields are the Condamine and Moonie Rivers. Both of these rivers form part of the Queensland section of the Murray-Darling Basin.

The Condamine River flows in a north-westerly direction from Dalby to Chinchilla where it takes a south-westerly turn and becomes the Balonne River at the Dogwood Creek junction, south-west of Miles (downstream of the Project area). This river system traverses tenements ATP 676, PL 179, PL 201, PLA 211 and ATP 632. The principal flow characteristics of the Condamine River are illustrated in *Figure 3.9.2* and *Figure 3.9.3*.

The Moonie River flows in a south-westerly direction from its headwaters near Dalby. The upper Moonie River and tributaries traverse tenements PLA 261 and PLA 262.

Although no major river systems traverse the northern tenements of the Gas Fields (e.g. ATP 651 and PL 171), a number of tributaries traverse the Project area. These include Horse Creek, Wandoan Creek and Woleebee Creek, which all flow into the Dawson River catchment (refer *Figure 3.9.1*).

Figure 3.9.2 Condamine River (Dalby) – Daily Flow

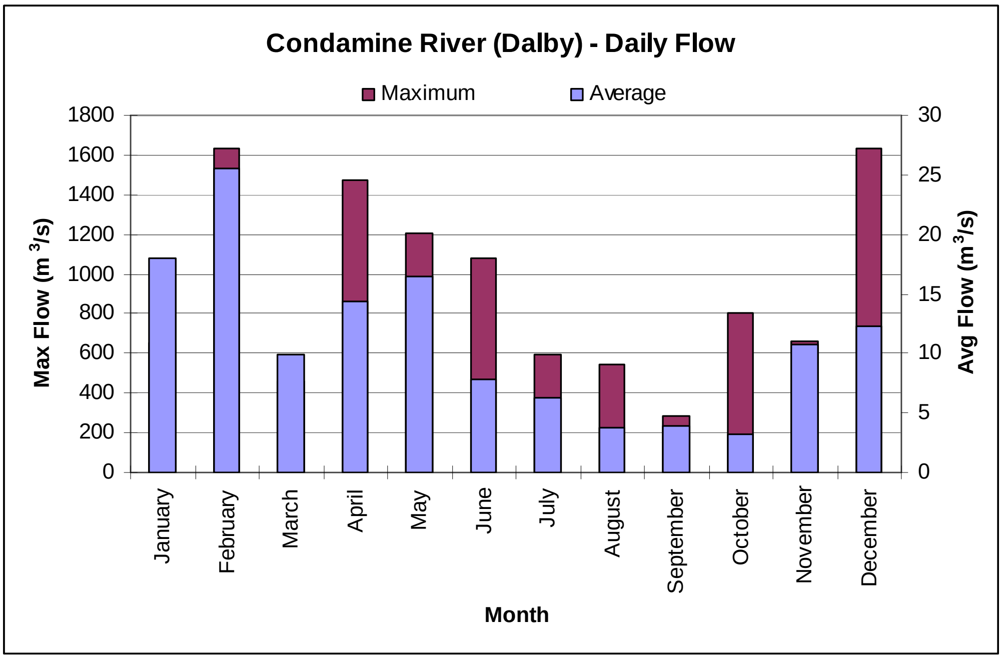
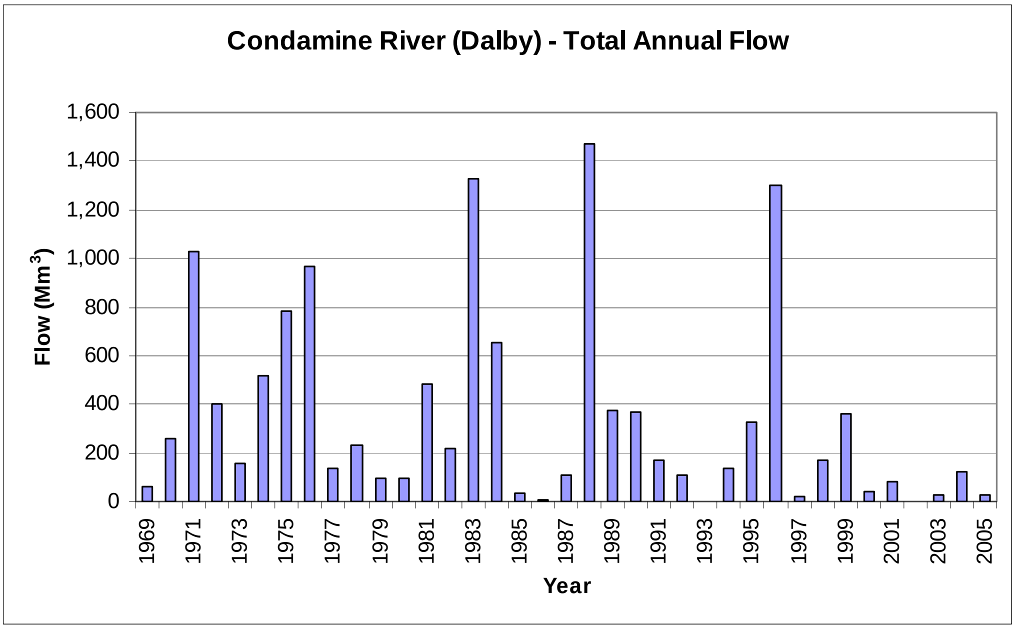


Figure 3.9.3 Condamine River (Dalby) – Total Annual Flow



Stream Classification

All streams in the Project area have been classified as ‘type C’ in accordance with the Rosgen stream classification system (Rosgen, 1942). These streams are typically well defined, meandering channels, with a low gradient and riffle/pool bed morphology. They are characterised by alluvial soils and broad, well defined floodplains.

9.4.3 *Wetlands*

There are no significant wetlands present in the Gas Field. Two nationally significant wetlands within the vicinity of the Gas Field area are Lake Broadwater, located within Lake Broadwater Conservation Park south-west of Dalby and directly east of the southern tenements; and The Gums Lagoon near Tara (refer *Volume 3, Chapter 8*).

There are seven other nationally listed wetlands in the Condamine catchment, downstream of the site; one of which, the Narran Lakes, is also an internationally listed Ramsar site (approximately 450 km downstream of the Gas Field).

9.4.4 Base Flow Runoff

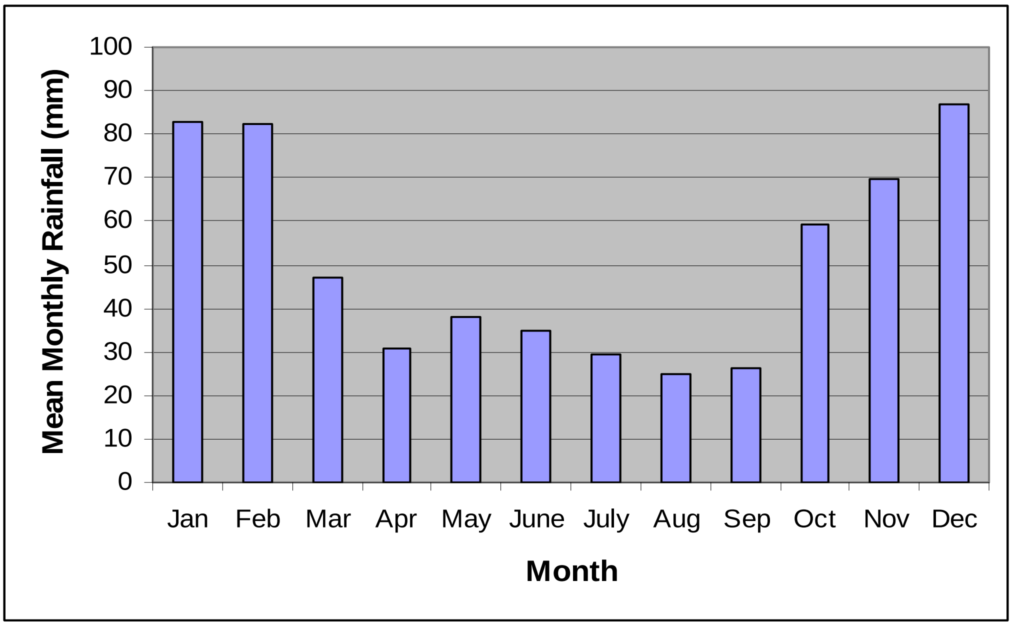
A surface-groundwater connectivity assessment of Condamine-Balonne undertaken by the Commonwealth Scientific and Research Organisation (CSIRO, 2008) indicated that the Condamine River is largely "losing" to the groundwater system rather than "gaining" from the groundwater system. A scoping study states that "some discharge of groundwater to the local streams within the Upper Condamine is suspected, especially when groundwater levels are high but no detailed investigations have been undertaken" Resource and Environmental Management (REM, 2007).

A losing stream is a stream or river that loses water as it flows downstream. The water infiltrates into the ground recharging the local groundwater, because the water table is below the base of the stream channel. This is the opposite of a more normal gaining stream which increases in water volume farther down stream as it gains water from the local aquifer.

9.4.5 Flooding Characteristics

Rainfall is received throughout the year; however more rainfall is generally expected in the summer months from November to February. The mean monthly rainfall data for the Roma Airport, Miles Post Office and Dalby Airport weather stations is set out in *Figure 3.9.4*. The average annual rainfall is approximately 610 mm.

Figure 3.9.4 Mean Monthly Rainfall within the Gas Fields



Rainfall events within the Gas Fields tend to be irregular and intense, resulting in rapid rises and falls in stream flood height. According to the BoM, average catchment rainfalls in excess of 25 mm, with isolated 50 mm falls in 24 hours, may result in stream rises and minor flooding in the Condamine River potentially causing localised traffic interruption. Average catchment rainfalls in excess of 50 mm, with isolated 75 mm to 100 mm falls in 24 hours, may result in significant stream rises with the possibility of moderate to heavy flooding within the catchment (BoM website).

9.4.6 Catchment Conditions

The surface water study (*Appendix 3.3*) found that existing and historical anthropogenic activities (e.g. vegetation clearing, grazing, cropping and agriculture) have adversely impacted the surface water environment and resources.

The overall condition of the stream sites surveyed was moderate. The stability of the banks at the sites surveyed was found, on average, to be moderate.

Key conclusions identified with respect to the existing surface water environment include:

- depletion of stream and river flows in the Condamine and Balonne systems occurs to the extent that these are losing stream systems (normal river systems gain water downstream)
- little or no base flow contributing to the river systems due, at least in part, to existing and historical exploitation of the river alluvial aquifers
- reduction in riparian zone diversity and size
- increased erosion and sedimentation due to land clearing and agricultural activities impacting stream flow and quality
- aquatic habitats and vegetation affected and of poor quality
- suspended solid loads and concentrations of nitrogen and phosphorous in nearly all streams and rivers sampled being greater than Australian and New Zealand Environment and Conservation Council (ANZECC) guideline values.

9.5 POTENTIAL IMPACTS

9.5.1 Potential Impact of flooding on CSG Activities

Flooding within the Gas Field could potentially have a number of impacts on infrastructure including:

- damage to infrastructure from high velocity flows and debris
- potential loss of production due to power shut-offs
- access issues due to flooded roads and tracks
- if not appropriately mitigated, overtopping of water storage ponds causing environmental harm.

9.5.2 Potential Impact of Gas Field Activities on Surface Water

9.5.2.1 Vegetation Clearing

Any clearing of vegetation to enable infrastructure development such as roads, ponds and other facilities increases the area of impervious surfaces throughout a catchment. This, in turn, increases the risk of erosion and hence stream sedimentation rates, runoff, stream-flow volumes and velocity, and flood levels. As the estimated footprint of proposed infrastructure (excluding consideration of progressive rehabilitation) represents approximately 3 per cent of the Gas Field area, such impacts are likely to be proportional.

As described in *Chapters 7 and 8* of this volume, clearing of riparian vegetation is expected to be minimal. In particular, all watercourses and wetlands are within proposed very high ecological constraints areas for development.

9.5.2.2 Sedimentation, Eutrophication and Contamination

There is potential for sediments, nutrients and pollutants to be transferred to waterways by overland flows and inappropriate placement of materials. Erosion creating sediment transport is the primary mechanism for transferring nutrients into streams and increasing nutrient concentrations in stream waters. Increased nutrient concentrations can result in eutrophication that reduces water oxygen levels which affects aquatic organisms and vegetation. Excessive sediments, nutrients and accidental release of pollutants would have the potential to degrade watercourses and aquatic ecosystems, and affect potential water uses including irrigation, farming, domestic water supply, town water supply, infrastructure supply, fishing and other recreational activities.

9.5.2.3 Accidental Release of Associated Water

Accidental release of Associated Water stored in water storage ponds through overtopping, wall failure or seepage would increase the potential for rising levels of salinity in watercourses within the Gas Field area. This would affect biodiversity associated with surface water habitats and potential water uses as listed in *Section 9.5.2.2*.

9.5.2.4 Groundwater Extraction

A groundwater impact study assessed whether dewatering of the Walloon Coal Measures had the potential to lower the water table in surface aquifers, in particular the Condamine River Alluvium, which is a potential source of base flow to the Condamine River. The groundwater modelling indicated that the dewatering would have minimal impact on the Condamine Alluvium water levels, and therefore on the base flow of the Condamine (Refer *Volume 3, Chapter 10*). A reduction in base flow could potentially have affected environmental values such as aquatic and riparian biodiversity.

Also, water levels in the Alluvium have been declining for decades. The decline is considered to be due to extraction of groundwater from the Alluvium mainly for irrigation purposes.

Mitigation strategies to address these potential impacts are discussed below.

9.6 MITIGATION MEASURES

Increased flows will be mitigated by the installation of drains to intercept overland flow, upslope of construction sites where required. Drains will be designed to move the water around infrastructure where appropriate. Drains, downslope from infrastructure will also be installed where necessary. Drains will direct water to siltation dams and sediment traps where required to remove excessive sediments.

Water interception (diversion drains) and storage facilities will be designed to hold a minimum of a 1:100 year, 72 hour storm event, plus an average three-month wet season volume, to reduce the chance of overtopping. New designs will consider increased rainfall and runoff from climate change factors. Any new storage ponds will have an overflow capacity designed for a 1 in 10,000 year flood event. Furthermore, monitoring of water storage ponds includes level monitoring and integrated pond management to allow transfer of water between ponds.

To minimise the erosion and sedimentation impacts from land clearing, Sediment and Erosion Control Plans will be developed for Gas Field activities. Techniques for erosion and sediment control could include the following as applicable:

- overland flow interception drains to move runoff away from disturbed areas
- sediment fences and bunding of disturbed areas
- installation of stream flow retardation structures in drains to limit flow velocities
- slope and drain stabilisation using mulching, rip-rap or similar devices
- installation of sediment dams
- early revegetation using defined maximum landform stability criteria
- the application of defined buffer zones and clearing limits
- regular clean-out of sediment traps, ponds and drains until erosion stability has been achieved
- visual monitoring to identify active erosion rills and gullies and implementation of remediation measures.

Erosion and sedimentation controls and creek bank stabilisation and rehabilitation activities will be implemented in all locations where watercourse crossings are unavoidable.

To minimise the risk of flood related impacts, Gas Field infrastructure will as far as practicable be located above flood levels. This approach will also reduce the impact of any flood on Gas Field operations. Gas Field infrastructure such as roads, ponds and pipelines will be planned to minimise the need to locate such infrastructure within flood areas.

The potential for accidental hydrocarbon loss from vehicles will be addressed by strict environmental controls over all vehicle maintenance and refuelling activities.

The existing water monitoring data will be included into a program to monitor potential impacts of the Gas Field activities in the various river catchments and potential impacts from water storage ponds and other infrastructure.

For natural rivers and streams the flow and quality of water upstream and downstream of the development areas will be monitored. This approach will also apply to infrastructure, but in some instances, downstream monitoring alone will be sufficient and appropriate.

Evidence of increasing pollutant discharge to the watercourses will result in immediate investigation to determine the direct cause wherever possible. If Gas Field activities are the likely cause, water quality improvement devices would be installed at the locations of concentrated flow discharging off the Gas Field sites.

Any infrastructure for the management of Associated Water will consider designs to accommodate a 30 per cent increase in rainfall intensity during peak tropical cyclone precipitation and a 10 per cent increase in runoff. These factors will be incorporated in the Gas Field design parameters and sizing selection for all infrastructure, including stormwater structures and water storage ponds. Consideration will also be given to the development of a more sophisticated surface water model, which can incorporate climate change factors.

All aspects of water management are best quantified with the use of a water balance model. As such, a life-of-operation water balance will be developed.

9.7 CONCLUSIONS

Existing and historical anthropogenic activities have adversely impacted the surface water characteristics and environment of the Gas Field Component of the Queensland Curtis LNG (QCLNG) Project.

There are two main factors that can pose risks to the surface water environment from the development of the Gas Field Component. First, the volume and the quality of the Associated Water that has to be handled, once brought to the surface. Second, the development of infrastructure can affect surface water flow and water quality.

With the implementation of appropriate mitigation measures, the potential impacts to surface water resources can be managed to ensure that direct impact is unlikely. A summary of the impacts outlined in this chapter is provided in *Table 3.9.2* below.

Table 3.9.2 Summary of Impacts for Surface Water

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short term
Impact extent	Local
Impact likelihood	Medium

Overall assessment of impact significance: minor.