9 SURFACE WATER

9.1 INTRODUCTION

The Pipeline Component of the Queensland Curtis LNG (QCLNG) Project, comprising Export Pipeline, Lateral Pipeline and Collection Header, will traverse a significant number of waterways of varying size and flow regimes. This chapter, *Chapter 9*, identifies issues associated with the crossing of these waterways, specifically potential impacts on channel stability and water quality.

As the majority of the watercourses intersected are ephemeral and likely to be dry at the time of the crossing the main potential impacts on surface water quality will essentially be related to the potential for erosion along pipeline routes, leading to sediment run-off into watercourses. This has been addressed in *Volume 4, Chapter 4*.

9.2 PROJECT ENVIRONMENTAL OBJECTIVE

The Project's 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.

The Queensland *Environmental Protection Act 1994* (Qld) (*EP Act*) and *Environmental Protection (Water) Policy 1997* (EPP Water) are the principal state legislative controls for managing and protecting waterways as a result of development works. The EPP Water sets out the environmental values that need to be enhanced or protected. These include:

- biological integrity
- suitability for recreational use
- suitability for minimal treatment before supply as drinking water
- suitability for agricultural use
- suitability for industrial use.

The EPP Water also provides that when:

> *"an activity involves exposing or disturbing soil it may be necessary to implement waste prevention measures or to install control or treatment measures".*
>
> Furthermore, *"a person must not deposit or release prescribed material (e.g. oil, pesticide, degreaser) into a gutter, drain or water, or into a place where that material may be reasonably expected to enter a gutter, drain or water. A person must not release stormwater into a gutter, drain or water that results in a build-up of sand, silt or mud, or deposit sand, silt or mud where it might be reasonably expected to move or be washed into a drain, gutter or water".*

The EPP Water states, that the measures to be undertaken to protect waters such as erosion and sediment control and contamination prevention should be addressed in the draft Environmental Management Plan (Draft EMP). A Draft EMP for the Pipeline Component is provided in *Volume 10* of this Environmental Impact Statement (EIS).

Schedule 1 of the EPP Water sets out specific environmental values that may be set for a given catchment. The EPP Water does not list any relevant documents for the catchments potentially affected by the proposed pipelines so specified environmental values for these areas do not exist.

Water quality objectives have therefore been determined using the *Queensland Water Quality Guidelines 2007* (QWQG) and the following water resource plans depending, on which catchment the particular pipeline section is traversing:

- Water Resource (Fitzroy Basin) Plan 1999
- Condamine-Balonne Water Resource Plan (2004)
- Water Resource (Callide River Basin) Plan 2006.

The key issue with the development of the pipelines and associated effects on water quality will be the potential for increased turbidity levels immediately following the construction phase. However, these can be mitigated effectively with good construction management practices.

9.3 METHODOLOGY

The assessment of potential surface water impacts associated with the three pipelines (Export, Lateral and Collection Header) comprised a detailed desktop review of available data and field inspections of the watercourses within the proposed pipeline corridors.

The desktop review involved obtaining existing water quality data for the major watercourses and determining the water quality objectives that could apply to the areas affected by the proposed pipelines.

The field review identified the existing characteristics of the various watercourses to be traversed by the proposed pipelines and determined the existing level of erosion and stream bank stability.

Where it was not possible to access the actual crossing point, a nearby and readily accessible point was selected and assessed to gain an overall impression of the stream character and the stream bank stability.

Of the 41 identified watercourses that have a designation of stream order three or higher (refer to *Section 9.4.2*), 30 sites were inspected. While an additional six watercourses of stream order two (also refer to *Section 9.4.2*), were inspected.

A full report on the surface water assessment is provided in *Appendix 4.1*. Once the surface water assessment was completed, the EIS risk assessment methodology as described in *Volume 1, Chapter 4* was applied.

9.4 EXISTING ENVIRONMENT

9.4.1 Catchments

The main catchments traversed by the pipeline routes are identified in *Figure 4.9.1* as the:

- Condamine–Balonne
- Dawson–Fitzroy
- Burnett.

Approximately the first 60 km of the preferred Export Pipeline route (i.e. Option 2) lies within the Condamine River catchment, 240 km lies within the Burnett River catchment, and 70 km lies within the Dawson River catchment. The last 10 km of the Export Pipeline lies within the Calliope River catchment. The original Option 1 route avoids the Burnett Catchment and results in the majority of the Export Pipeline, approximately 260 km, falling within the Dawson–Fitzroy catchment.

The initial sections of the Collection Header lie mainly within the Condamine River catchment, with shorter sections located within the Moonie and Balonne River catchments. The northern limits lie within the Dawson River catchment.

The Lateral Pipeline lies entirely within the Dawson River catchment.

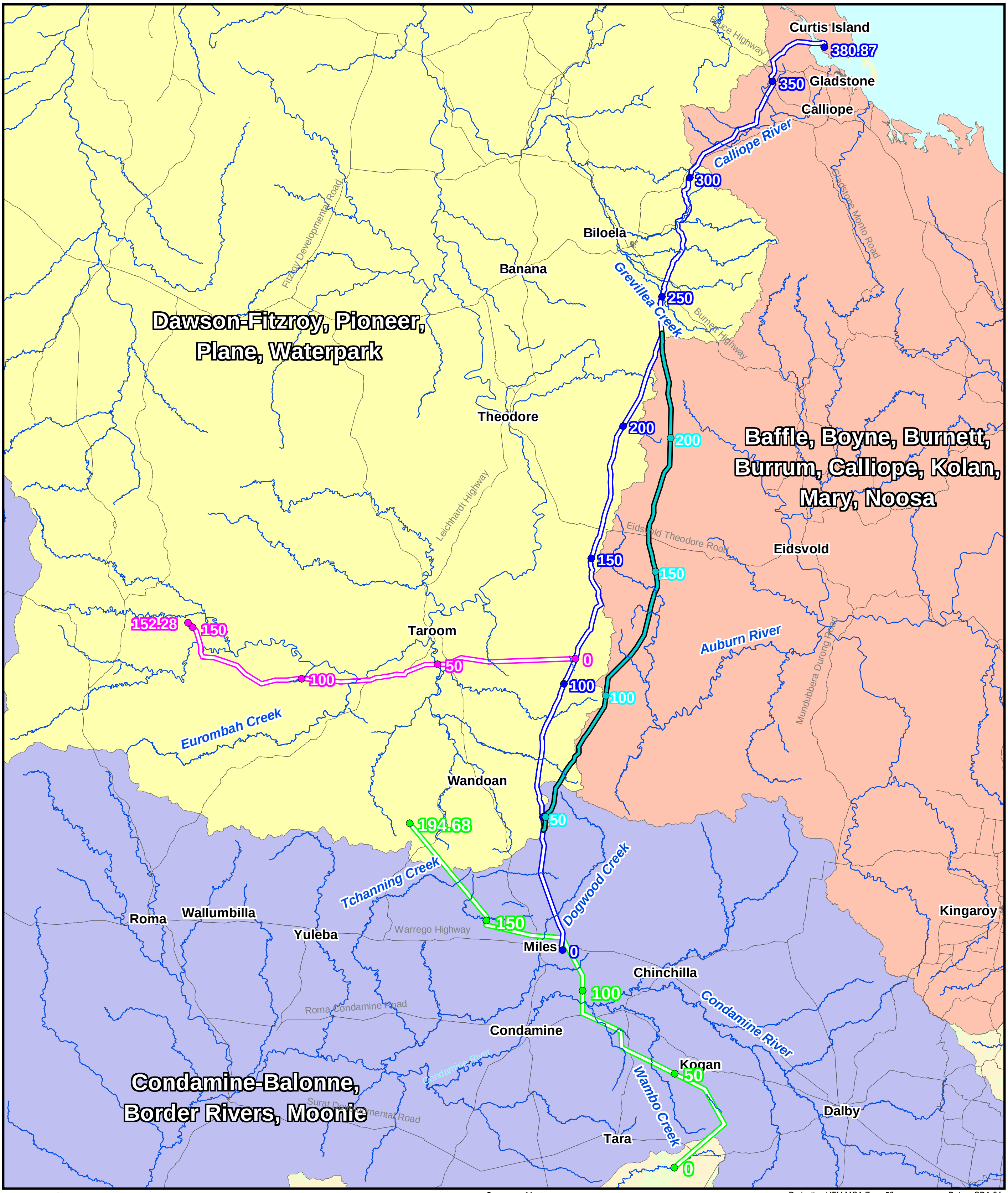
9.4.2 Stream Classification

Streams were assessed by Strahler's (1952) method for stream classification, which is based on the stream branching within the basin. Stream order provides an indication of the size of the stream and is used in natural resource management. For example, it is used to determine the extent of riparian vegetation required to be maintained as a buffer in the Regional Vegetation Management Codes.

The Strahler system ranks watercourses based on stream branching within a drainage basin such that first order streams have no tributaries; second order streams form from the intersection of two first order streams; and third order streams form from the intersection of two second order streams and so on as shown in *Figure 4.9.2*.

Waterways were assessed for Stream Order 3 or above with the largest stream crossed being the Condamine River which has a Stream Order 5 watercourse designation applied to it at the proposed crossing point. Some Stream Order 2 watercourses were also assessed where readily accessible.

A summary of the classification of stream morphology for the major streams crossed by the Pipeline is provided in *Table 4.9.1* A full listing of the watercourses crossed by the various Pipeline routes is provided in *Appendix 4.1, Section 3.3.1.*



Legend:

- Export Pipeline & Kilometre Point
- Export Pipeline Option 2 & Kilometre Point
- Lateral Pipeline & Kilometre Point
- Upstream Infrastructure Corridor & Kilometre Point
- Waterways

Source Note:
1:250,000 Topographic copyright Geoscience Australia
Drainage Divisions copyright State of Queensland and NRW

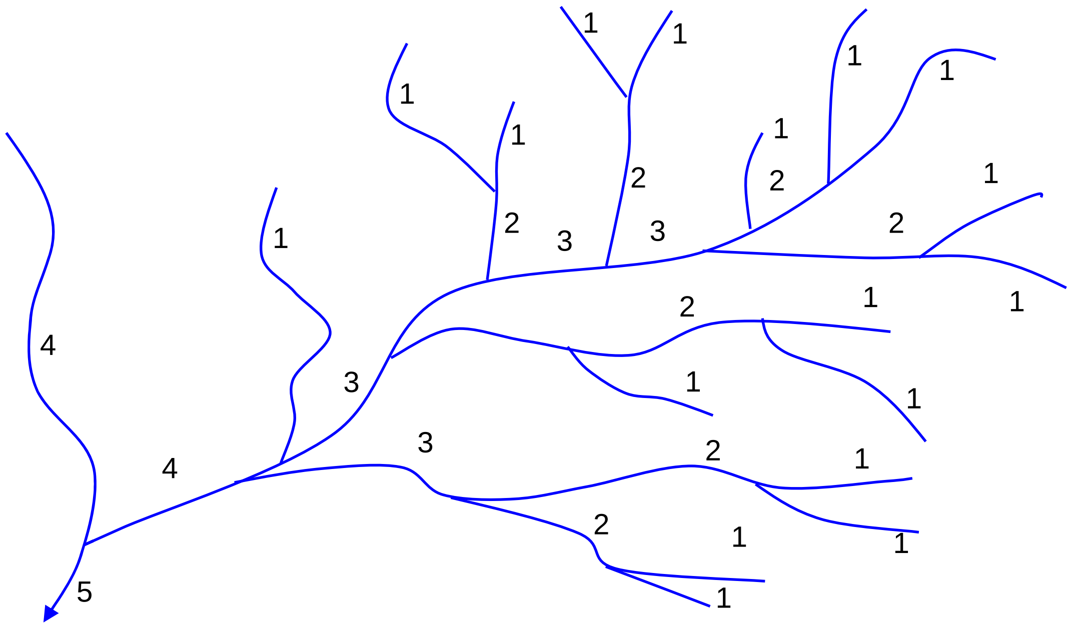
Projection UTM MGA Zone 56 Datum GDA 94

0 20 40 60 80
Kilometres

N

QUEENSLAND CURTIS LNG A BG Group business	Project: Queensland Curtis LNG Project Client: QGC - A BG Group business		Title: Catchment Boundaries
ERM Environmental Resources Management Australia Pty Ltd	Drawn: Mipela Approved: CDP Date: 18.06.09	Volume: 4 Figure: 4.9.1 File No: EO5-P-MA-96163 Revision: A	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.

Figure 4.9.2 Strahler Classification



9.4.3 Water Quality

A desktop analysis of historical data and published material e.g. from technical reports associated with the various Water Resource Plans for the potentially affected catchments including those by van Manen (1999), Shields (2005) and Esselmont et al (2006) was undertaken to characterise the water quality of the areas that the pipeline works may affect. Based on this data it was determined that the:

- Condamine–Balonne waters exhibited high levels of turbidity, exceeding Australian and New Zealand Environment and Conservation Council (ANZECC) (1992) and National Health and Medical Research Council (NHMRC) (1996) targets. It is thought that the nature of the local soils may be the main cause for these turbid conditions as the highest turbidities recorded occur in the less intensively cultivated lower reaches of the catchment (Department of Natural Resources and the Environmental Protection Agency, 1998). However, trend analysis indicates that turbidity levels are increasing in the middle catchment suggesting that the removal of native vegetation, cropping and cattle grazing may be impacting on the basin.
- Dawson–Fitzroy waters exhibited high turbidity values common in most rivers and creeks assessed in the catchment. In most sites, measured turbidity levels exceeded both ANZECC (1992) and NHMRC (1996) targets, rendering the water unsuitable for drinking and for the protection of aquatic ecosystems.
- This is most likely related to a combination of factors, including the region's soil type, agricultural land use and mining activities. Trend analysis indicates that there has not been a significant increase in turbidity levels in

the last 10 years. This suggests that the observed elevated turbidity levels may be strongly dependent on the basin's soil type and topography rather than activities that have been occurring in the catchment area in recent times.

- Burnett catchment is highly vulnerable to soil erosion with a consequent flow-on effect to elevated turbidity levels in the major streams. Such erosion levels have been identified as an important contributor to elevated levels of particulate-bound nutrients with downstream effects on the coastal and marine environment. Grazing pressures have been identified as the main cause of significant to severe erosion in upper catchment areas. Studies also found that the Boyne and Lower Burnett River subcatchments were the most severely eroded areas within the broader Burnett River Basin and presented the highest salinity risk areas. The Auburn and Nogo River subcatchments, through which a section of the proposed pipeline will pass, have the lowest erosion and salinity risk.

Field surveys provided a qualitative assessment of water quality in the various watercourses (refer to *Table 4.9.1)*. The findings from the field review suggested that many of the watercourse crossing points are likely to be dry in the winter months and that where water is present the quality is expected to be highly turbid.

9.4.4 Flooding

The Dawson–Fitzroy catchment is capable of producing severe flooding following heavy rain events, which occur on average once every 10 years. The highest recorded flood occurred in January 1918 (10.11 m on the Rockhampton gauge). The most recent major flood occurred in January 1991 (9.30 m on the Rockhampton gauge, Cooperative Research Centre (CRC) for Coastal Zone Estuary Waterway Management, 2003).

These flood events result in plumes carrying sediments, nutrients and contaminants, which extend out to sea from the Fitzroy River mouth. These flood plumes tend to move northward carried by ocean currents and remain within 20 km of the coast from the mouth of the Fitzroy River (Productivity Commission, 2003).

The Condamine–Balonne River system forms the headwaters for the Murray–Darling River system. Flooding can result from heavy rainfall in any of the large tributaries to the system. The Bureau of Meteorology (BoM) states that as a result of this, “forecast lead times (for flood warnings) may be short”.

Flood records for the Balonne River date back to 1890 and show that major floods occur on average every two years usually in the first half of the year with the most recent worst flood events occurring between January and April (BoM website). The floods have widespread impacts on agriculture in the region inundating crops and swamping machinery.

According to the BoM, major flooding in the Burnett River is relatively infrequent. However, significant rises and floods can occur if a tropical low pressure system and heavy rainfalls occur. This can lead to flooding of rural properties along the rivers and in some of the smaller towns in the area.

Flood records for the Burnett River date back to the middle of the 19th century. The highest level recorded was at Mundubbera in 1942 when the river peaked at 23.62 m. Floods since then have been well below this level.

9.4.5 Downstream Environments

There are several nationally significant wetlands located on the lower Balonne River system including the Ramsar-listed Narran Lake Nature Reserve (which includes Back and Clear Lakes) which is part of large terminal wetlands of the Narran River at the end of the Condamine River system flowing out of Queensland. The Narran Lake Nature Reserve is approximately 450 km south-west of the Gas Field Component, in New South Wales and therefore quite remote from the proposed Pipeline alignments.

In addition to the Narran Lake Nature Reserve there are two major wetlands within the Condamine catchment. These are the Lake Broadwater Conservation Park and Resources Reserve 25 km south-west of Kogan and approximately 10 km west of KP 24 of the Collection Header and The Gums Lagoon 26 km south-west of Tara and approximately 45 km south of the Collection Header (refer to *Figure 4.7.10*).

Lake Broadwater is classified as a palustrine[1] system with lacustrine[2] wetlands on the outskirts and supports four wetland communities: open water, lake edge, marsh and riparian communities.

The Gums Lagoon is classified as a palustrine system with a relatively undisturbed wooded swamp in a small reserve of similarly undisturbed woodlands and open forest (Australian Wetlands Database). The Gums Lagoon supports 79 identified species of birds, some of which come under the Japan-Australia Migratory Bird Agreement China-Australia Migratory Bird Agreement and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

The Dawson–Fitzroy River system flows towards the coast entering the Pacific Ocean in the Gladstone–Rockhampton region. The Ramsar wetland site at Shoalwater and Corio Bays is approximately 50 km north of the proposed Export Pipeline alignment at its closest point.

The Export Pipeline alignment does not transect any of the catchments which feed directly into this or any other Ramsar site. The catchments which are transected by the alignment feed water into the ocean at least 60 km to the south of this Ramsar wetland site.

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1 Palustrine wetlands are primarily vegetated non-channel environments of less than eight hectares. They include billabongs, swamps, bogs, springs, soaks etc, and have more than 30 per cent emergent vegetation.

2 **Lacustrine wetlands** are large, open, water-dominated systems (for example, lakes) larger than eight hectares. This definition also applies to modified systems (for example, dams), which possess characteristics similar to lacustrine systems (for example, deep, standing or slow-moving waters).

Table 4.9.1 Watercourse Summary

KP (approx)	Waterway	Catchment/ Stream Order*	Main Channel Width (m)**	Depth to Top of Banks (m)	Existing Condition and Key Management Issues
Export Pipeline (Option 2)					
13	Dogwood Creek	Condamine/4	45	9	Dry. Currently relatively stable although some undercutting of low-flow channel; soils unstable; steep right bank; significant rock on left bank may pose construction issues. Route can avoid major trees; care required to avoid significant erosion of right bank; soils dispersive
29	LTree Creek	Condamine/3	30	6	Low flow; significant turbidity (recent runoff event in catchment) Minor streambank erosion; significant weeds (mother of millions) Route will need to avoid rock scarps in proximity; stony matrix will mitigate erosion; weed control required
37	Tributary of Bottle Tree Creek	Condamine/2	25	3	Stream banks generally stable. No significant stability issues. No significant constraints; route will need to avoid significant trees
68.5	Roche Creek	Dawson/2	11	3	Dry. Stable grassed stream. Minor evidence of erosion. No significant constraints
121	Fishy Creek	Burnett/3	Not inspected		
138.2	Dogherty Creek	Burnett/3	Not inspected		
148	Auburn River	Burnett/4	25	5	Dry. Stream channel stable. No evidence of significant erosion. Deep excavation may require disturbance of granitic rocks. No major stability constraints however possible difficult excavation conditions due to rock
203.1	Montour Creek	Burnett/2	18	1.5	Dry. Incised but stable stream protected by vegetation and woody debris. No significant constraints
249.5	Grevillea Creek	Dawson/4	45	8	Dry. Deep channel with very steep right bank; moderate streambank erosion in low-flow channel Steepness of banks will require long and deep trench sections; stringent controls required for effective stabilisation
255	Kariboe Creek	Dawson/4	43	7	Dry. Deep channel with very steep right bank; minor streambank erosion in low flow channel Steepness of banks will require long and deep trench sections; stringent controls required for effective stabilisation; important groundwater recharge so gravel/cobble base needs to be reinstated
268	Kroombit Creek	Dawson/3	40	5	Dry. Creek generally stable due to absence of stocking pressure; heavy weed infestation; steep left bank Steepness of left bank will require long and deep trench section; stringent controls

KP (approx)	Waterway	Catchment/ Stream Order*	Main Channel Width (m)**	Depth to Top of Banks (m)	Existing Condition and Key Management Issues
					required for stabilisation and weed control
280	Callide Creek	Dawson/3	42	1.5	Dry. Multi-channelled bed; minor streambank erosion; extensive weed infestation notably Parthenium which will require stringent weed management
283	Rainbow Creek	Dawson/3	22	1	Dry. Open grassed low channel near powerline crossing; very stable with no significant issues
316	Calliope River	Calliope/4	45	5	No flow; pools over 70 per cent of channel; low turbidity Lower channel in relatively good condition with dense stabilising vegetation; second terrace banks have significant streambank erosion and unstable; significant rock outcrops; dispersive soils Will require extreme care with streambank protection; possible difficult extraction conditions due to rock
324	Harper Creek	Calliope/ 3	15	1.5	Dry. Low banks with minor erosion; generally stable with no significant constraints
342	Larcom Creek	Calliope/3	10	2.5	No flow; pool 50% of crossing; highly turbid Incised but stable stream protected by vegetation and woody debris with no significant constraints
Lateral					
31	Bentley Creek	Dawson/2	15	1.5	Dry. Stable grassed stream with minor erosion only and no significant constraints
80	Eurombah Creek	Dawson/4	25	3	Low flow with elevated stream level due to recent event in catchment; highly turbid. Significant stands of river gum on both banks and in channel; channel has moderate streambank erosion Care with route selection required to avoid significant trees; no special constraints to stabilisation
99	Tiggrigie Creek	Dawson/3	20	1	No flow; pools over 50 per cent of site; minor turbidity Very stable channel with minor streambank erosion and no significant constraints
Collection Header					
42.5	Bloodwood Creek	Condamine/2	12	1.5	Dry. Generally stable with minor streambank erosion but no significant constraints
73	Wambo Creek	Condamine/4	45	3	Dry. Extensive sheet and gully erosion in proximity to crossing; narrow vegetation fringe adjacent to low-flow channel; extensive laterite layer on left bank provides some protection Creek very unstable with soils highly prone to gully and tunnel erosion; intensive stabilisation measures required; lateritic layer provides some protection
83 & 86	Nine Mile Creek	Condamine/3	12	2.5	Dry. Incised channel with significant streambank erosion; extensive exposed roots; erosion active; adjacent gully and tunnel erosion. Unstable crossing will require

KP (approx)	Waterway	Catchment/ Stream Order*	Main Channel Width (m)**	Depth to Top of Banks (m)	Existing Condition and Key Management Issues
					intensive stabilisation measures on stream banks and adjacent soil areas which are prone to tunnel erosion
95.5	Wieambilla Creek	Condamine/3	43	3	No flow; isolated pools ~10 per cent of site; moderate turbidity Very stable stream banks with extensive woody vegetation and *Lomandra* in channel floor; significant riverine species Minimal stability issues; route required to avoid significant disturbance of riverine species
108	Condamine River	Condamine/5	120	11	Minor isolated pools – turbid Open grass with sporadic trees, generally stable with minor streambank erosion
119	Columboola Creek	Condamine/3	20	2	No flow; water quality highly eutrified; opaque Stream highly sinuous; much degraded with significant streambank erosion; unstable banks on outside of arc; dispersive soils Bank instability will require intensive stabilisation measures; no significant construction constraints due to low channel depth
139.5	Dogwood Creek	Condamine/4	45	7	No flow; pools 80 per cent of site; significant turbidity Upper banks generally stable but slumping of low faces adjacent to low-flow channel; some rock Steep banks will require large set backs. Constraints with stabilisation of low-flow channel; intensive stabilisation measures required; rock may present some construction constraint
160.5 & 170.5	Wallan Creek	Condamine/3	16	4	Dry. Generally stable; dispersive soils but no significant constraints
177	Tchanning Creek	Condamine/3	20	4	Dry. Some streambank erosion and undercutting of low-flow channel, dispersive soils. No major constraints but stringent controls required for effective stabilisation

Source: DERM (formerly Department of Natural Resources and Water) database

** Stream Order as per Strahler (1952)*

*** As measured from point of high bank*

Other nationally listed wetlands within proximity to the Pipeline Component study area (refer to *Figure 4.7.10*) are:

- Lake Nuga Nuga, 93 km north-east of Injune, 68 km north-west of the nearest point on the proposed Lateral route and 190 km west of the nearest point on the proposed Export Pipeline route
- Boggomoss Springs, freshwater springs 20 km north-east of Taroom and approximately 40 km west of the nearest point on the proposed Export Pipeline route
- Palmtree and Robinson Creeks 28 km north of Taroom, approximately 30 km north of the proposed Lateral route and 73 km west of the proposed Export Pipeline route at the nearest points.

Current disturbances and threats, as described for the above wetlands (Directory of Nationally Important Wetlands), are sewage, stormwater, industrial effluents and large-scale clearing which have increased turbidity, siltation and nutrient loads.

The most readily identifiable downstream environment of significance is the Great Barrier Reef Marine Park. The potential impacts to this area are addressed in *Volume 5, Section 8.*

9.5 IMPACT ASSESSMENT

This section specifically addresses the potential impacts that may occur as a result of the installation of pipelines across watercourses. As previously mentioned the key issues relate to soils and erosion leading to sedimentation of watercourses. *Volume 2, Chapter 12* describes pipeline watercourse crossing methodologies.

The key impacts to watercourses that can arise from the installation of pipelines are:

- sedimentation as a result of soil erosion
- scouring of the streambed due to destabilisation of ground
- changes to stream flow due to construction
- pollution of waters
- spread of weed species.

9.5.1 Sedimentation

Construction and operational activities have the potential to lead to sedimentation of watercourses due to erosion as a result of land clearing, soil disturbance and vehicle movements. The cumulative effect of numerous point sources (e.g. disturbed crossings and unstable banks) in an already turbid river system has the potential to impact on sensitive downstream environments and in-stream habitats.

Gully erosion associated with trenches is the greatest risk during construction and before revegetation. This is a particular concern for stream approaches and the risk is compounded where there are dispersive subsoils.

After rain, water may infiltrate and collect in unconsolidated trench backfill and trace the trench downslope resulting in gullying of trenches and possible bank failure. Similarly, sheet flows could collect in shallow depressions over the backfill trenches and channels causing rilling and gullying.

9.5.2 Scouring

Scouring can lead to the destabilisation of the watercourse. The greatest risk with respect to scouring of creek beds and banks will be the initial wet-season flows prior to successful rehabilitation. Risks will be associated with trench and backfill construction techniques which may result in variations in compaction of soils adjacent to watercourses and inconsistencies in the bed and bank surface, such as bare areas of banks or protruding rocks and logs in the bed of the stream.

There is also a risk that the high discharge velocities that can occur in many of the stream types, and variations in the velocity flow path could lead to the reinstatement stabilisation techniques failing and causing exposure of the pipeline.

9.5.3 Streamflow

During construction there will be temporary interruptions to existing drainage patterns resulting from clearing, grading and trenching activities, diversion bunding and temporary detention ponds/dams. All barriers and/or dams installed during the construction of the pipelines will be removed after construction leaving no permanent flow inhibition.

Variations to the compaction of the beds and banks of the watercourses as a result of construction may, under high velocity flows, result in changes to the stream-flow regime.

A number of flood mitigation methods will be employed to protect downstream water quality. These are described under *Section 9.6*.

9.5.4 Water Pollution

Waste management from construction camps is addressed in *Chapter 15* of this volume. Construction of the Pipeline Component has the potential to cause water pollution through the mobilisation of sediments, nutrients and pathogens, accidental releases of hydrocarbons and/or chemicals and release of sewage and wastewater. Elevated sediment and nutrient levels are identified water quality issues in the Dawson–Fitzroy catchment (Fitzroy Basin Water Resource Plan (WRP) 1999). Release of sediments will be controlled by the mitigation methods described in *Section 9.6*.

Another source of water pollution is reduced pH levels as a result of the excavation of acid sulfate soils (ASS) and sulfidic rock material. Coastal plains around Gladstone have the potential for ASS. Management procedures to minimise exposure of these materials are described in *Volume 5, Chapter 4*.

Hydro-testing of the three pipelines as described in *Volume 2, Section 12.3.6* requires moving large volumes of water along the pipeline and disposal on completion of the testing. The pipeline test sections may be up to 30 km in length, and between 5 per cent and 100 per cent of the water may be discharged at the end of a segment. The discharge water may contain mill scale and construction debris such as welding rod stubs. Localised pollution may occur if this water directly enters a watercourse. The potential to transfer pest species from one catchment to another happens if the hydro-test water is sourced from surface water resources.

A number of mitigation measures have been proposed to prevent pollution of surface waters. These are described under *Section 9.6*.

9.5.5 Weed Management

Weed Management is addressed in *Volume 4, Chapter 7* and in the Draft EMP in *Volume 10* of this EIS.

9.5.6 Ramsar and Nationally Important Wetlands

Due to the separation of catchments transected by the proposed routes and the closest Ramsar wetlands being more than 50 km from the nearest pipeline, it is very unlikely that the proposal could have any potential impact on any Ramsar wetland.

It is considered that, subject to the mitigation measures set out in *Section 9.6* and the Draft EMP in *Volume 10* of this EIS, Ramsar and Nationally Important Wetlands will not be affected by the Project activities.

9.6 MANAGEMENT AND MITIGATION METHODS

A key mitigation measure for watercourse crossings has been the selection of crossing points. Selection criteria has included avoidance of:

- unstable banks or sites where effective stabilisation is likely to be unachievable following reinstatement works
- bends in the channel
- deep pools
- rock basements or rock outcrops in the channel
- confluences with other channels.

Construction methodologies for each crossing will vary depending upon the stream classification; soils; logistics; engineering considerations; geotechnical information; environmental factors such as habitat value of riparian vegetation; in-stream vegetation and sites of active bank erosion; and weather conditions.

The various techniques for constructing watercourse crossings have been described in *Volume 2, Chapter 12*. Due to the ephemeral nature of most of the watercourses intersected, open-cut techniques, as described in *Volume 2, Chapter 12* are expected to be the chief method of construction.

Trenchless techniques will be considered if alternatives potentially cause detrimental effects to the environment or the cultural significance of the watercourse, or where works may result in bank and ground instability.

Management measures to prevent sedimentation and pollution of watercourses and the spread of pest species will include:

- targeting construction of the watercourse crossings primarily during the dry periods where possible, particularly crossings of larger watercourses
- monitoring regional weather conditions and river flow levels during construction to pre-empt changes in weather patterns and flow regimes to minimise impacts that would be associated with wet weather
- crossing streams perpendicular to flow to minimise the area of impact
- using sediment fences between the watercourse and the construction area to minimise sediment releases
- avoiding, where practicable, the destruction of mature riparian trees
- returning banks to a slope no steeper than existing site conditions and to a grade compatible with the strength of the site's soil type
- using existing access roads where available
- pre-stripping and stockpiling topsoil, and clearing and trenching of the watercourse to minimise the potential for soil erosion
- storing topsoil and bed material separately and in areas above the top of the bank where it will not be buried or damaged (i.e. free from traffic)
- directing any trench water away from the bed or bank of the watercourse in cases where water is being pumped near a crossing
- investigating gypsum to stabilise subsoils on slopes approaching stream crossings
- installing trench plugs on approaches to stream crossings to reduce subsurface flow potential in the backfilled trench
- using diversion banks at the crest of, and on the slopes of, approaches to stream crossings to divert sheet flow away from backfilled trenches
- ensuring that each diversion bank has a stabilised outlet to disperse channelled flows on the downstream side of the easement
- ensuring that storage and loading/decanting areas for fuels and chemicals are bunded and located outside the floodplain of the stream channels (i.e. at least 10 m away from the top bank)
- ensuring that vehicle crossings do not impede flow, or potential flow, in the watercourses (e.g. use of culverts)

- ensuring any existing layer of cobbles and/or coarse gravel in the bed of the watercourses is reinstated post construction
- ensuring all construction and maintenance crew inductions cover:
- environmental values associated with stream channels (e.g. habitat, water quality, areas of downstream significance)
- erosion risk and management
- fuel and chemical (including fertilisers) handling, storage and use procedures
- weed hygiene and control protocols
- monitoring of water quality upstream and downstream of the construction area on wet crossings including:
- observation of sediment plumes and surface sheen
- measurement of turbidity, suspended solids, pH and dissolved oxygen
- respreading of cleared vegetation to assist in bank stabilisation
- weeding control works within and adjacent to the corridor
- filters to prevent transporting pest species if hydro-test water is sourced from a watercourse
- prohibiting the release of hydro-test water directly to a watercourse
- collecting mill scale and construction debris by using a settling trap to collect the first flush waters from the hydro-test
- aerating discharging hydro-test water to eliminate residual oxygen scavenger chemicals (where used)
- discharging and construction or testing waters away from watercourse to stable ground to reduce the potential for soil erosion.

Regular monitoring of the watercourses post-construction will be carried out to ensure that rehabilitation works and stability of the watercourses is at least equal to the pre-construction condition.

9.7 CONCLUSION

The surface water characteristics of the pipelines that comprise the Pipeline Component of the QCLNG Project have been assessed. The key catchments potentially impacted by the pipelines are the Condamine–Balonne, Dawson–Fitzroy and Burnett. All watercourse crossing points have been characterised and the potential for the Project to impact on local watercourses and wetlands has been assessed as minor. Appropriate management strategies have been proposed (refer to the Draft EMP in *Volume 10*).

A summary of the impacts outlined in this chapter is provided in *Table 4.9.2*

Table 4.9.2 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	High

Overall assessment of impact significance: minor, providing that mitigation measures are implemented for the management of soils and the storage and handling of fuel, chemicals and acid sulphate soils.