Surface water 13

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13.1 Introduction

This section describes the surface water values within the GFD Project area and associated surrounding catchment areas.

The GFD Project is located across three catchment areas: the Dawson River catchment (located within the Fitzroy Basin), the Comet River catchment (located within the Fitzroy Basin) and the Condamine-Balonne River catchment (located within the Condamine-Balonne Basin). The catchments include watercourses, wetlands, springs and ecosystems dependent on groundwater. Watercourses are mostly ephemeral (with the exception of major watercourses such as the eastern portion of the Dawson River and parts of the Condamine River).

The potential impacts arising from the GFD Project activities on surface water values are described and mitigation measures identified. Full details of the surface water assessment are provided in Appendix N: Surface water.

This section has been prepared in accordance with sections 4.5 and 4.6 of the *Terms of reference for an environmental impact statement* issued March 2013. The index to locate where each ToR requirement is met within this EIS is included in Appendix B: Terms of reference cross-reference.

13.2 Regulatory context

This EIS has been prepared in accordance with the State and Commonwealth regulatory context described within Appendix C: Regulatory framework. The legislation, policies and guidelines that apply to surface water values and potential impacts of the GFD Project are outlined within Table 13-1.

Table 13-1 Regulatory context of the GFD Project – surface water

Legislation, policy or guideline	Relevance to the GFD Project
Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) This Act is the central piece of environmental legislation at the Commonwealth level. It provides for the protection of environmental values, including matters of national environmental significance (MNES). *Environment Protection and Biodiversity Conservation Amendment Act 2013 (Cth)* This amendment to the EPBC Act recognised water resources as a matter of national environmental significance and introduced additional requirements for assessment of coal seam gas and large coal mining projects.	Actions that are likely to have a significant impact on MNES are subject to the assessment and approval process under the EPBC Act. Recent amendments to the EPBC Act have made water resources a MNES in relation to resource development projects. This means that projects such as the GFD Project that have potential for significant impacts on water resources must be referred to the Department of the Environment for assessment under the EPBC Act. Projects that have potential for significant impact on nationally threatened plants and animals must also be referred for assessment.
Environmental Protection Act 1994 (Queensland) (Qld) (EP Act) The EP Act is the principal legislation for the protection and management of environmental values within Queensland. The Act aims to protect the natural environment and associated ecological systems and processes, while allowing for sustainable development.	The EP Act sets forth regulatory instruments such as the *Environmental Protection (Water) Policy 2009* (Qld) (EPP (Water)). It includes provisions for the management and disposal of water produced from gas operations. Santos GLNG has developed a WRMP which outlines its commitment to avoid, minimise and mitigate potential impacts to surface water resources within the GFD Project area.

Legislation, policy or guideline	Relevance to the GFD Project
Environmental Protection (Water) Policy 2009 (Qld) (EPP Water) EPP Water aims to protect Queensland's waters while allowing for ecologically sustainable development. It provides a framework for identifying environmental values for aquatic ecosystems and human uses and determining water quality guidelines and objectives to enhance or protect the environmental values.	Schedule 1 of the EPP Water lists environmental values for specific catchments; within the GFD Project area these were available for the Comet and Upper Dawson River sub-catchments only. Santos GLNG has developed plans such as the Draft Environmental management plan (Draft EM Plan) and the Constraints protocol, which will provide commitments for avoidance, minimisation and mitigation of impacts for the protection of environmental values for the surface water receiving environment.
Coal Seam Gas Water Management Policy 2012 (EHP, 2012) This policy guides operators in managing coal seam water, including beneficial use in a way that protects the environment and maximises its productive use as a valuable resource.	Santos GLNG has developed a Draft EM Plan, which takes the requirements of this policy into consideration by seeking to maximise beneficial use of water where feasible.
Petroleum Act 1923 (Qld) Petroleum tenure was granted under the Petroleum Act prior to the development of the *Petroleum and Gas (Production and Safety) Act 2004* (Qld). Petroleum leases may still be granted under this Act for holders of existing tenure (authority to prospect) granted under this Act. However, prospecting tenure cannot be applied for under the Petroleum Act.	Provide rights to conduct petroleum activities within the GFD Project tenures, including provisions for extraction and management of groundwater associated with those petroleum activities.
Petroleum and Gas (Production and Safety) Act 2004 (Qld) (P&G Act) The P&G Act regulates petroleum activities with the aim of developing a safe, efficient and viable petroleum and fuel gas industry in Queensland. Petroleum tenure is granted under the Act.	
Water Act 2000 (Qld) The Act regulates the development of water resource plans (WRPs) and resource operations plans (ROPs) for major river catchments in Queensland. WRPs establish a framework for sharing water between human consumptive needs and environmental values. ROPs are developed in parallel with WRPs and provide a framework for implementing WRPs.	The *Fitzroy Basin Water Resource Plan 2011* and *Condamine-Balonne Basin Water Resource Plan 2004* outline requirements for the protection of environmental values associated with water resources throughout the portions of the GFD Project area located within each of these catchments. Environmental values and water quality objectives for the Fitzroy Basin are defined in the *Fitzroy Basin Water Resource Plan 2011* (in addition to Schedule 1 of EPP Water); however, they have not yet been developed in the Condamine-Balonne Basin *Water Resource Plan 2004*. Environmental values proposed by the Queensland Murray-Darling Committee (QMDC; 2012) and regional water quality objectives for toxicants in surface waters from ANZECC 2000 were applied to sub-catchments within the Condamine-Balonne Basin instead.
Fisheries Act 1994 (Qld) (Fisheries Act) This Act provides for the management, use, development and protection of fisheries resources and fish habitats in Queensland.	In the event that Santos GLNG needs to establish waterway barriers for watercourse crossings within the GFD Project area, approval will be sought under the Fisheries Act.
National Water Quality Management Strategy (NWQMS)	Guideline values (water quality objectives) used to assess the existing water quality within the surface water receiving environment of the GFD Project area were sourced from guidelines developed under the NWQMS (e.g. ANZECC 2000 and QWQG 2009).

Legislation, policy or guideline	Relevance to the GFD Project
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) The guidelines are the recognised standard for protecting ambient water quality in Australia and New Zealand.	Surface water values in the GFD Project area were assessed using the regional guideline values for Upper Dawson River (toxicants only) and Upper Balonne River Tributaries (both physico-chemical parameters and toxicants). This assessment was then used to determine potential impacts to the surface water receiving environment that could arise from GFD Project activities.
Queensland Water Quality Guidelines (QWQG) (EHP, 2013) The QWQG is a set of technical guidelines for the protection of Queensland's aquatic ecosystems including fresh, estuarine and marine waters.	The QWQG were reviewed to assess applicability to surface waters within the GFD Project area, however local values available for physico-chemical parameters in the Upper Dawson River (under Schedule 1 of the EPP (Water)) were identified as being more appropriate. There were no values available for the Upper Balonne River Tributaries or Dogwood Creek within the QWQG. As such, QWQG guideline values were deemed to be inapplicable for assessment of the existing condition of surface waters within the GFD Project area.

This EIS seeks to obtain primary approvals for the project including the Queensland Government Coordinator-Generals Report and Commonwealth Government EPBC Act approval.

Application for or amendments to existing environmental authorities will occur subsequent to this EIS process. Other subsequent approvals required after the EIS process has been completed, corresponding triggers and legislative frameworks applicable to the GFD Project are identified in Section 2: Project approvals.

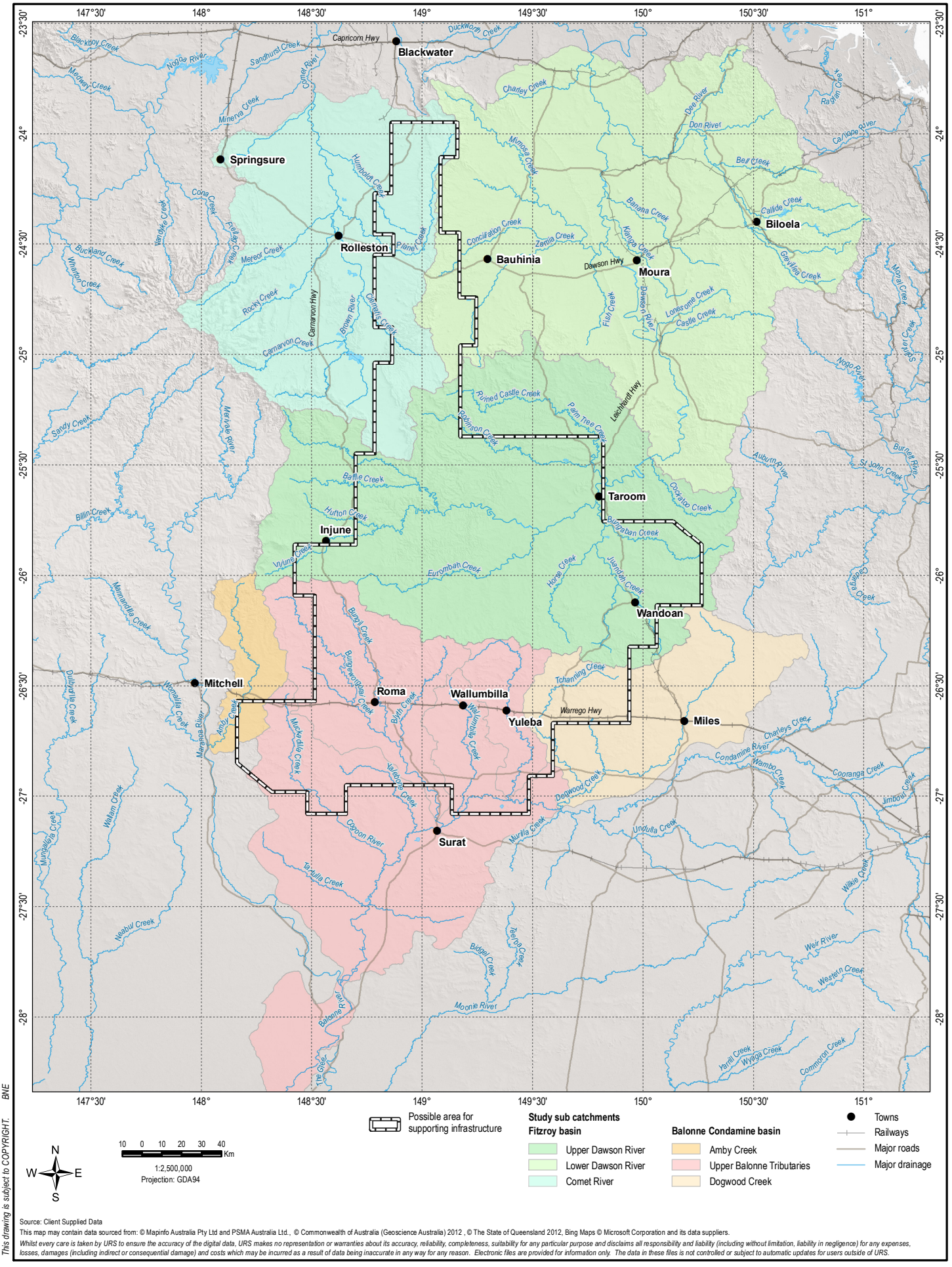
Approval of this EIS will trigger a number of subsequent approvals required for the GFD Project to proceed. Approvals will be required on tenure and off-tenure. Section 2: Project approvals summarises the key approvals necessary for the planning, construction, operations and decommissioning of the GFD Project. The triggers for each approval, the relevant administering authority and application details are provided. Consultation on the subsequent approvals will be ongoing with the administering authorities.

13.3 Assessment methodology

This assessment describes the surface water values and assesses the GFD Project's potential impacts on these values.

Impacts were assessed using the significance assessment methodology, which considers the sensitivity of the underlying environment and the magnitude of a potential impact to assess its level of significance. This methodology is used when it is known that some impact will occur and the significance of that impact is determined by considering its magnitude and the sensitivity to change of the environmental value that will be affected. The full description of the significance methodology is described in section 5.6.3 of Section 5: Assessment framework. A summary of the impact assessment is shown in section 13.7.

The GFD Project area and surface water study area sub-catchments (Dawson, Comet and Condamine-Balonne Rivers) used to assess the baseline surface water values and GFD Project impacts are shown in Figure 13-1.



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Santos GLNG Project

GFD PROJECT EIS

GFD PROJECT AREA AND STUDY SUB-CATCHMENTS

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SURFACE WATER

Figure: 13-1

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13.4 Environmental values

A description and discussion of the environmental values, water uses, water quality, hydrology and geomorphology of the GFD Project area is presented below. Further detail of these environmental values and the methods used to identify them, is included in Appendix N: Surface water.

Santos GLNG has completed a detailed assessment of the surface water receiving environment within the GFD Project area, in terms of the existing water resources (including surface water quality, hydrology and geomorphology) and associated environmental values and water resources. Existing water quality data collected by Santos GLNG were initially used to analyse water quality trends across the GFD Project area (encompassing portions of the Fitzroy and Condamine-Balonne River basins). This analysis was supplemented by a literature review of previous studies undertaken by Santos GLNG, publicly available EIS documents, technical reports produced by other resource projects within and directly downstream of the GFD Project area and other peer-reviewed sources. Data for the hydrology assessment were obtained from government sources, notably the Department of Natural Resources and Mines (DNRM) water monitoring network (stream gauges) and Bureau of Meteorology (BoM) climate stations.

13.4.1 Defined environmental values under the EPP Water

Table 13-2 and Table 13-3 provide a summary of environmental values identified for the surface water receiving environment relevant to the GFD Project area for the Fitzroy Basin and the Condamine-Balonne Basin respectively. The distribution of referable high ecological significance and general ecological significance wetlands (EHP, 2013) throughout the surface water study sub-catchments is illustrated in Figure 13-2, along with high ecological value areas scheduled under the EPP Water. A complete list of wetlands identified within the GFD Project area is contained within Appendix N: Surface water.

Table 13-2 Existing environmental values for surface waters within the GFD Project area (Condamine-Balonne Basin)

Environmental values	Condamine River			Balonne River		
	Dogwood Creek	Lower Condamine River	Yuleba Creek	Bungil and Murilla Creeks	Lower Maranoa	Balonne River
Aquatic ecosystems	High	High	High	High	High	High
Irrigating crops	High	High	High	High	High	High
Agriculture (farm use)	High	High	High	High	High	High
Stock watering	High	High	High	High	High	High
Aquaculture	Low	Low	Low	Low	Low	Low
Human consumption	High	High	High	High	High	High
Primary recreation	High	High	High	High	High	High
Secondary recreation	Low	High	High	High	High	High
Visual appreciation	High	High	High	High	High	High
Raw drinking water	High	High	High	High	High	High
Industrial use	Low	Low	Low	Low	Low	Low
Cultural and spiritual values	High	High	High	High	High	High

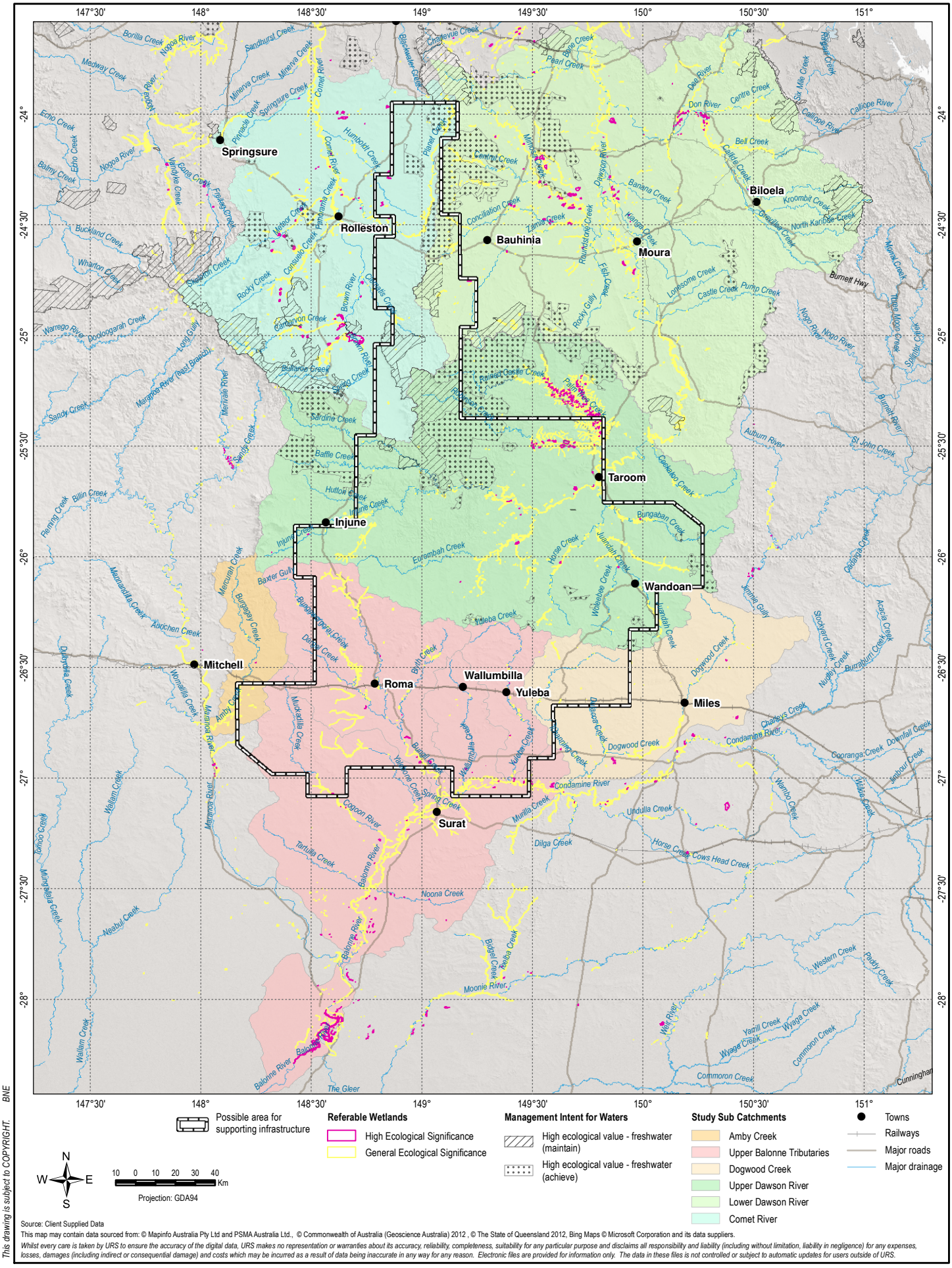
Note: Ecological values for the Condamine-Balonne Basin are listed in QMDC 2012 as either low or high priority. This distinction is not made for ecological values within the Fitzroy Basin (Table 13-3).

Table 13-3 Existing environmental values for surface waters within the GFD Project area (Fitzroy Basin)

Environmental value	Comet River			Upper Dawson River					Lower Dawson River					
	Main channel	Western tributaries	Eastern tributaries	Main channel (below Hutton Creek)	Western upland tributaries	Southern tributaries	Northern upland tributaries	Central tributaries	Northern upland tributaries	Main channel – unregulated reaches	Main channel – regulated reaches	Southern upland tributaries	Eastern Tributaries	Western tributaries
Aquatic ecosystems	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Irrigation	✓	✓	✓	✓	×	✓	✓	×	✓	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stock water	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aquaculture	×	×	×	×	×	×	×	×	×	×	✓	×	✓	×
Human consumer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Primary recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Secondary recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Visual recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drinking water	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓
Industrial use	✓	✓	✓	✓	×	✓	×	×	×	✓	✓	×	✓	×
Cultural and spiritual values	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓

1) ✓ = Environmental Value applicable to surface water resources within the GFD Project area.
2) × = Environmental Value not applicable to surface water resources within the GFD Project area.

Lake Murphy and part of the Palm Tree and Robinson Creek wetland complex located in the Lake Murphy Conservation Park (GFD Project Tenure ATP803) are listed as nationally important (Environment Australia, 2001). This area is mapped as having high ecological value (referrable) wetlands in the Great Barrier Reef catchments – Lake Murphy Conservation Area. These wetlands contain species and regional ecosystems (REs) of conservation significance under both the EPBC Act and the NC Act.



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HIGH ECOLOGICAL VALUE AREAS AND WETLANDS

URS

SURFACE WATER

Figure: **13-2**

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13.4.2 Existing users of surface water resources

An assessment of existing users of surface water resources throughout the surface water study area was undertaken to identify associated human environmental values; this included analysis of water entitlements data available from DNRM within a 50 kilometre (km) radius of the GFD Project area to capture downstream users.

The water uses identified in Appendix N: Surface water (Table 4-3, section 4.2.3) are considered to be sensitive to human impacts within the respective sub-catchments. In general, the following water uses are considered to be the most sensitive within the GFD Project area:

- Livestock water
- Impound water (e.g. agricultural dams, emergency fire-fighting water supply)
- Domestic supply
- Water harvesting
- Industrial use
- Town water supply.

13.4.3 Surface water quality

An analysis of existing data provided by Santos GLNG and sourced from other secondary sources (such as previous studies undertaken within the GFD Project area) enabled physico-chemical characterisation of water quality throughout the surface water study area. The results of the data analyses were compared with applicable local, sub-regional and regional guideline values to determine the water quality objectives for the GFD Project.

Local guideline values were derived from the Upper Dawson and Lower Dawson sub-basin water quality objectives (for the respective catchments within the GFD Project area), while sub-regional guidelines were applicable (for electrical conductivity only) within the Upper Balonne River sub-catchments and Dogwood Creek. ANZECC regional guidelines for southeast Australia were utilised to provide WQOs for toxicants in all sub-catchments (and also for physicochemical parameters within the Upper Balonne River tributaries). These values were able to be applied consistently and were appropriate for the sub-catchments assessed. A number of key water quality trends were identified, both in regards to consistent exceedances of guideline values and also as an indication of parameters which would potentially be most sensitive to human impacts. These trends are detailed as follows:

- pH tended to be alkaline throughout the Comet and Upper Dawson River sub-catchments, neutral in the Upper Balonne River Tributaries and slightly acidic in Dogwood Creek.
- Dissolved oxygen was elevated in most sub-catchments and trends appeared to be more clearly defined in tributaries than in main channels of the Dawson and Balonne rivers; this is possibly influenced by the time and season in which sampling occurred and the ephemeral nature of the watercourses that were monitored.
- EC was highly variable but generally higher than the local guideline values within the Upper Dawson River sub-catchments, and elevated compared to sub-regional guidelines within the Upper Balonne River Tributaries. EC values reported by third party sources were lower than the applicable sub-regional guideline value within Dogwood Creek. A clear relationship between low flow conditions and elevated EC was established.
- Chromium, copper, lead and zinc were elevated above applicable guideline values for the majority of sub-catchments. Exceptions included the Upper Balonne River main channel where heavy metals were below their respective guideline values and Robinson Creek in the Upper Dawson River where only copper exceeded the regional guideline value.

- Ammonia was particularly elevated throughout the Upper Dawson River. While ammonia in the Upper Balonne tributaries did not exceed its guideline value, it should not be interpreted that these waters are of better quality than those of the Upper Dawson River, as the guideline value for ammonia for the Upper Balonne River (900 micrograms per litre (µg/L)) is much higher than that of for the Upper Dawson River (20 µg/L).
- Nutrient enrichment (indicated by elevated total nitrogen, oxidised nitrogen, reactive and total phosphorus) was evident across the majority of sub-catchments. The following were key trends in relation to nutrient concentrations across the GFD Project area:
  - Comet River was noted as having historically elevated levels of phosphorus.
  - Total nitrogen and total phosphorus were the highest in the Juandah and Bungaban Creek sub-catchment of the Upper Dawson River.
  - Phosphorus was significantly elevated in Wallumbilla Creek sub-catchment and with potentially greater short-term impacts than long-term trends.
  - Oxidised nitrogen was found in high concentrations in the Upper Balonne River main channel and Yuleba Creek, compared with other sub-catchments of the Condamine-Balonne River Basin.
- In most cases there appeared to be a strong relationship between elevated turbidity, total suspended solids and concentrations of nutrients and heavy metals known to bind easily to particulate matter, such as chromium and zinc.

13.4.4 Hydrology

Rainfall and resultant streamflow in the surface water study area sub-catchments is characterised by a distinct seasonal and highly variable nature. Analysis of the relevant stream gauge data has shown that most watercourses within the study area are typically ephemeral in nature, only flowing during or immediately after significant rainfall events and subjected to relatively rapid flow recessions. Further clarification regarding the definition of a 'watercourse' and characterisation of flow regimes predominant within the GFD Project area is included in Appendix N: Surface water.

Peak stream discharges usually occur during the wet season months of December to February when rainfall is highest, although the Dawson River downstream of its confluence with Hutton Creek shows a relatively consistent level of baseflow year round as a result of inflow from the Dawson River Springs. The high level of variability in both annual and monthly rainfall totals for the weather stations across the study area indicates a high likelihood of both floods and droughts.

13.4.5 Fluvial geomorphology

The surface water study area sub-catchments cover 30,000 km^2 across the Fitzroy and Condamine-Balonne basins. Watercourses within this area exhibit a wide range of fluvial geomorphologic characteristics and typically show a moderate to high level of impact from the effects of land clearance for grazing and cropping, stock access and removal of riparian vegetation.

Watercourses in the headwater catchments of the Comet River, Upper Balonne tributaries and Upper and Lower Dawson River sub-catchments are typically located in steep, confined to partially-confined valleys which at times become gorges (e.g. Dawson River). The stable, single channels are often highly sinuous, laterally confined and bedrock to coarse bedload dominated. The bedrock controlled, discontinuous floodplains become increasingly connected downstream. The function of these headwater catchments as a material source has been exacerbated through changes in land use such as land clearance and stock access, which has greatly increased the vulnerability of stream banks to erosion during high energy floods, which result in downstream movement of large volumes of sediment.

As watercourses in the surface water study area transition from the steep headwater catchments to the lower energy mid-catchments (e.g. Dawson River east of the Expedition Ranges and the upper tributaries of the Comet River as they enter the Arcadia Valley fan) they typically become located in partially confined to unconfined valleys. Channels also become suspended load dominated and show more lateral instability with anabranching, meander cut-offs and remnant channels as well as more frequent sediment deposits. An example of such an environment is illustrated in Plate 13-1. Watercourses also show a higher level of impact from land use activities such as vegetation clearance for grazing and cropping, which has led to significant bank and bed instability (e.g. Bungeworgorai Creek) particularly during flood events when rapid channel adjustments are common.

Plate 13-1 Example of geomorphic setting in Upper Dawson River at Dawson's Bend

The lower reaches of sub-catchment watercourses (e.g. lower Comet and Balonne rivers) are characterised by flat, low relief terrain. Watercourses are located on broad alluvial floodplains and show a high degree of lateral instability with multiple active channels, high sinuosity, frequent meander cut-offs, anabranching and remnant channels.

Based on the fluvial geomorphology assessment, watercourses in the study area have the following characteristics:

- Flow regime and dependent ecosystems; the typically ephemeral and episodic nature of the flow regime of watercourses in the study area has resulted in the development of a range of flora and fauna dependant on the seasonality of flows.
- Stream bank stability; the stability of stream banks along watercourses within the study area is strengthened by riparian vegetation (and associated habitat values for flora and fauna) and can influence and be influenced by streamflow hydraulics.
- Channel geomorphology; watercourses in the study area can be subject to periodic, high energy flood events that may cause rapid adjustments to channel morphology.

13.5 Potential impacts

Potential surface water impacts that may occur as a result of the GFD Project include:

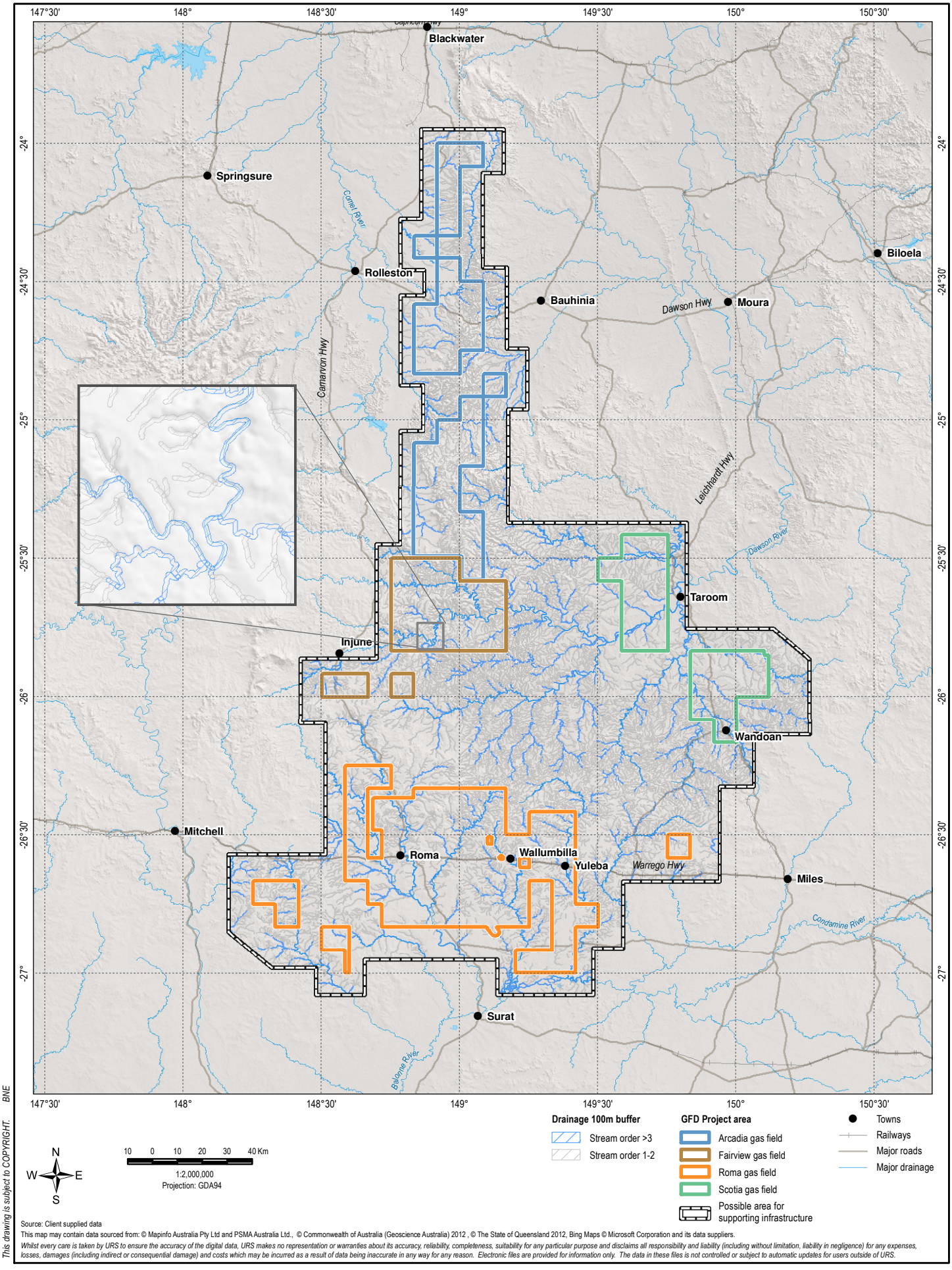
- Increased sedimentation within a watercourse
- Decreased water quality due to increased erosion and related increase in suspended sediment load
- Decreased surface water quality due to increased concentrations of contaminants (i.e. adverse impact on surface water quality, primary and secondary toxicity to aquatic ecosystems)
- Altered surface water flow regime (i.e. risk to overland flow paths, infrastructure, riparian vegetation, terrestrial ecosystems, baseflow from watercourse springs/aquifers and environmental flow regime)
- Altered geomorphic character (e.g. increased lateral instability, alteration of geomorphic units).

13.6 Mitigation measures

13.6.1 Constraints protocol

To assist in mitigating potential impacts from the development of the GFD Project, a Constraints protocol has been developed. In accordance with the Constraints protocol, wetlands of high ecological significance[1] and wetlands of national importance are classified as no-go areas, and no GFD Project activity will be undertaken within 200 m of these areas. Similarly, a buffer of 100 m from the 'high bank' of surface water bodies and watercourses within the GFD Project area has been set as a high constraint area. This buffer is illustrated in Figure 13-3. Low impact petroleum activities and linear infrastructure are permitted within this area.

[1] Also known as 'High conservation value wetlands'



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Santos GLNG Project

GFD PROJECT EIS

HIGH CONSTRAINT AREA FOR WATERCOURSES INCLUDING 100 METRE BUFFER

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SURFACE WATER

Figure: **13-3**

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13.6.2 Management plans

Santos GLNG is committed to the implementation of the mitigation measures in Table 13-4 to manage potential surface water-related impacts. These measures are incorporated into Santos GLNG's management framework as described in Appendix Y: Draft environmental management plan.

Table 13-4 Mitigation measures – surface water

Management plan	Mitigation measures
GFD Project Environmental protocol for constraints planning and field development (the Constraints protocol)	The Constraints protocol applies to all gas field related activities. The scope of the Constraints protocol is to: • Enable Santos GLNG to comply with all relevant State and Federal statutory approvals and legislation • Support Santos GLNG's environmental policies and the General Environmental Duty (GED) as outlined in the EP Act • Promote the avoidance, minimisation, mitigation and management of direct and indirect adverse environmental impacts associated with land disturbances • Minimise cumulative impacts on environmental values. The Constraints protocol provides a framework to guide placement of infrastructure and adopts the following management principles: • Avoidance — avoiding direct and indirect impacts • Minimisation — minimise potential impacts • Mitigation — implement mitigation and management measures • Remediation and rehabilitation — actively remediate and rehabilitate impacted areas • Offset — offset residual adverse impacts in accordance with regulatory requirements. The Constraints protocol enables the systematic identification and assessment of environmental values and the application of development constraints to effectively avoid and/or manage environmental impacts. The Constraints protocol includes mitigation measures such as: • Avoiding wetlands of high ecological significance and wetlands of national importance and placing a 200 m buffer around these areas • Permitting only low impact petroleum activities within Declared Catchment Areas and Ramsar sites • Permitting only low impact petroleum activities and linear infrastructure within a 100 m buffer of a watercourse. • Detailed internal approval process completed in alignment with pre-disturbance requirements • Flood assessments of the 1:50 Average Recurrence Interval will be undertaken prior to establishing camps or permanent infrastructure (that are not pipelines or roads).
Water resource management plan (WRMP)	The WRMP has been developed to proactively detail how Santos GLNG manages and monitors potential adverse impacts to water resources, recently defined as a matter of national environmental significance. The WRMP includes mitigation measures such as: • Ensuring that the quality of coal seam water generated via GFD Project activities is 'fit for purpose' and complies with relevant regulatory water quality requirements (such as from the applicable environmental approval or beneficial use agreement) (section 3.4.3 of the WRMP) • Management of brine and/or solid salts produced via desalination in accordance with the *Coal Seam Water Management Policy* (EHP, 2012) (section 3.4.3 of the WRMP). • Undertaking a Receiving Environment Monitoring Program for approved release schemes in accordance with relevant environmental authority conditions. • Surface water monitoring as required by relevant regulatory requirements; indicative types, scope and frequency of monitoring that may be undertaken during each phase of the GFD Project are summarised in Table 3-5 (section 3.4.5) of the WRMP. Monitoring will take place throughout construction, during operation and during decommissioning, as per legislative requirements.

Management plan	Mitigation measures
Draft environmental management plan (Draft EM plan)	The Draft EM plan identifies the environmental values potentially affected by the GFD Project and proposes measures to manage the risk of potential adverse impact to these environmental values. The Draft EM Plan comprises: • Environmental values potentially affected by the GFD Project • Environmental management objectives and associated management measures • Environmental monitoring and reporting • Coal seam water management • Proposed conditions. Surface water monitoring and reporting of results for the GFD Project will be undertaken in accordance with regulatory requirements. These include monitoring and reporting procedures such as: • Field procedures for water sampling, for example where sampling must comply with the *Monitoring and Sampling Manual* (EHP 2009) and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). • Details regarding the scientific design of surface water sampling programs and statistical techniques used for assessment of trends and hypotheses • Instructions for storage and management of electronic data associated with surface water monitoring programs.
Erosion and sediment control management plan (ESCMP)	The ESCMP identifies erosion and sedimentation risk and provides an erosion and sediment control strategy that incorporates understanding of the risk inherent to local land resource characteristics. The ESCMP is supported by the Erosion and Sediment Control Manual, which provides erosion, sediment and drainage controls in line with best practice guidelines. The relevant ESCMP requirements for drainage control (on a location-specific basis) are outlined in section 5.2 (Construction Phase) and section 5.3 (Operation Phase) of the ESCMP and include mitigation measures such as: • Diversion of up-slope stormwater runoff around disturbed areas including stockpiles and waste storage areas • Installation of lateral catch drains or flow diversion banks to minimise rill erosion along steep continuous slopes (e.g. >10%) especially associated with linear infrastructure construction (i.e. pipelines, roads and power lines) • Placement of velocity control structures such as rock check dams to reduce the flow velocity in channels • Lining of channel with scour resistant materials including erosion control matting or rock lining • Use of energy dissipation structures at the outlets of banks, drains and chutes • Spreading mulch or retained native vegetation over disturbed areas as soon as practicable after construction to reduce splash erosion and sheet erosion • Use of erosion blankets as an alternative to mulching in drainage channels or areas of strong winds or overland flow • Use of sediment traps and sediment basins • Use of 'ripping' or similar techniques on finished soil surfaces to encourage revegetation where required. • Scheduling major earthworks activities to avoid, where possible, the higher rainfall months of November to April. • Maintaining access to erosion and sediment controls especially during the higher rainfall months of November to April. • Making spill response materials available at fuel and chemical storage areas to clean up spills and minimise potential soil and surface water impact. Section 5.4.2 of the ESCMP details monitoring of sediment basin water quality to be undertaken prior to discharges and water quality monitoring that will be undertaken upstream and downstream from watercourse crossing work associated with construction of linear infrastructure. In the event that Santos GLNG needs to establish waterway barriers for watercourse crossings within the GFD Project area, approval will be sought under the Fisheries Act.

Management plan	Mitigation measures
Land release management plan (LRMP)	The LRMP addresses the management of releases of water to land in Santos GLNG's gas fields, including: • Coal seam water use for irrigation, construction and operations purposes • Treated sewage effluent releases to land • Use of treated sewage effluent for construction and operational purposes • Low point drain water releases to land • Hydrostatic test water releases to land. The LRMP includes the principles, methods and controls to effectively manage and minimise the risk environmental harm being caused by release of water to land. Section 4.1 of the LRMP outlines the circumstances under which coal seam water may be used for beneficial purposes. Mitigation measures for each use of coal seam water are listed in sections 6.1 (use of coal seam water for irrigation) and section 6.2 (use of coal seam water for dust suppression, construction and operational activities) respectively. Conditions under which treated sewage effluent may be released are outlined in section 4.2 of the LRMP and the associated mitigation measures are detailed in section 6.3. Conditions under which hydrostatic test water may be released are outlined in section 4.4 of the LRMP and the associated mitigation measures that will be implemented during site evaluation and application of hydrostatic test water as outlined in section 6.6 of the LRMP.
Chemical and fuel management plan (CFMP)	The CFMP details the appropriate storage and handling practices of chemicals and fuels. The objectives of the plan are to: • Facilitate compliance with relevant legislation, regulations and approvals • Provide a framework for Santos GLNG to store and handle bulk chemicals and fuels in a way that minimises risk to the environment and human health • Assess the potential risk of a chemical or fuel prior to its use • Identify and implement appropriate mitigation measures. A selection of relevant mitigation measures from the CFMP are as follows: • Chemicals and fuels shall be stored and transferred in appropriately engineered containment systems in accordance with relevant Australian Standards. As per EHS02, 'minor' storages (as defined in the relevant Australian Standard) and temporary storages (i.e. storage in one location for less than three weeks) do not require engineered bunds. However the following requirements will be met or exceeded: — Storage base is impermeable — Storage is located away from stormwater drains, pits and surface waters — Storage is undercover, wherever practicable — Equipment is in place to allow immediate recovery of spilt materials. • Bunds for storages other than minor or temporary are to be located and engineered, where applicable, in accordance with the following considerations: — Regulatory requirements (including site or activity specific requirements in the relevant environmental authorities) — Relevant international and Australian Standards — Volume and nature of the environmentally hazardous substance — Environmental values and risks posed by the location such as significant nearby environmental values, drainage, rainfall potential and infiltration capacities. • Bunds will be recorded in the Santos GLNG Bund Register and will be managed and operated in accordance with site procedures that may consider issues such as: — The collection/clean-up of releases, stormwater, or firefighting water within bunds — The inspection, testing and maintenance of bund integrity. • Internal approval of the risks associated with the use, storage and handling of chemicals and fuels will be completed prior to the commencement of proposed activities associated with the GFD Project.

Management plan	Mitigation measures
Decommissioning and abandonment management plan (DAMP)	The DAMP describes the management framework in place for when petroleum activities cease. The objectives of the plan are to: • Undertake decommissioning of assets in a manner that complies with regulatory requirements and minimises the risk of environmental harm • Undertake decommissioning activities in a manner that meets stakeholder expectations • Leave a landform that is stable and compatible with intended post-closure land use • Provide for the beneficial reuse of Santos GLNG infrastructure constructed to third parties (e.g. landholders or local authorities) where an appropriate agreement has been signed by both parties and regulatory authorities are satisfied. Management of wastewater during the decommissioning phase and demolition activities is detailed in section 7.3 of the DAMP, while management measures for stormwater and sediment are outlined in section 7.7.

13.6.3 Monitoring and review

High level strategies for implementing a monitoring program throughout the GFD Project duration have been identified. The monitoring programs outlined below will assess the effectiveness of management strategies outlined in Table 13-4. These programs will be revised to target specific areas of the GFD Project once infrastructure plans and operational processes have been finalised.

In general, monitoring will involve the following:

- In situ water sampling associated with operational activities aligned with relevant environmental authority conditions (and associated Receiving Environment Monitoring Program where applicable)
- Surface water receiving environment monitoring for beneficial use of treated coal seam water (as per general beneficial use approval, EHP 2014). This includes the monitoring program for the release scheme currently approved within the GFD Project area; the Dawson River Release Scheme (subject to the requirements of the existing EA; EPPG00928713, effective from 14 April 2014).

Details regarding the surface water monitoring programs to be implemented for the GFD Project (including indicative monitoring parameters, locations and frequencies) are outlined in section 3.4.4 of the Appendix AE: Water resource management plan.

13.7 Significance assessment

As discussed in section 13.3, impacts were assessed using the significance assessment methodology. As the GFD Project area covers a large geographical area, the general nature of potential impacts to environmental values associated with GFD Project activities are identified and assessed within this section.

Table 13-5 summarises the assessment undertaken for the potential impacts of the GFD Project on surface water values. For each identified potential impact, the assessment considered:

- The potential pre-mitigated significance, where only the Constraints protocol has been applied and the potential impacts are uncontrolled
- The mitigation measures that will be used to manage the potential impacts on surface water values. These measures will reduce the magnitude of the potential impacts
- The residual significance of the potential impact after the implementation of mitigation measures.

The residual significance takes into account the potential for impact that remains after the mitigation measures are applied.

Table 13-5 Project activities and potential impacts on surface water environmental values

Potential impact	Phase	Pre-mitigated significance			Mitigation	Residual significance	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Increased sedimentation (adverse impacts on water quality and geomorphology)	Construction	Moderate	Moderate	Moderate	• Water resource management plan • Draft environmental management plan • Erosion and sediment control management plan • Land release management plan • Decommissioning and abandonment plan • Chemical and fuel management plan	Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Moderate	Moderate		Low	Low
Erosion of stream banks	Construction	Moderate	Moderate	Moderate		Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low
Surface water impact (adverse impact on surface water quality)	Construction	Moderate	Moderate	Moderate		Moderate	Moderate
	Operations		Moderate	Moderate		Moderate	Moderate
	Decommissioning		Low	Low		Low	Low
Altered surface water flow regime (risk to infrastructure, riparian vegetation, terrestrial ecosystems, and environmental flow regime)	Construction	Moderate	Moderate	Moderate		Moderate	Moderate
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low
Altered geomorphic character (e.g. increased lateral instability; significant alteration of geomorphic units)	Construction	Moderate	Moderate	Moderate		Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low

13.8 Conclusions

Impacts were assessed using the significance assessment methodology and the residual impacts are summarised in Table 13-6. The significance assessment for the identified potential impacts on surface water values shows that the residual impacts over the life of the GFD Project are considered to range from low to moderate and that the GFD Project's management framework (outlined in Table 13-4) would appropriately manage the majority of impacts to surface water values. Impacts with a low level of significance are generally localised and temporary. Impacts with moderate significance may result in further impact to surface water environmental values; however, as the environmental values are generally already abundant throughout the region, the impacts are likely to be localised in nature and unlikely to result in irreversible change.

Table 13-6 Residual significance – surface water

Potential impacts	Residual significance		
	Construction	Operations	Decommissioning
Increased sedimentation (adverse impacts on water quality and geomorphology)	Low	Low	Low
Decreased water quality due to erosion of stream banks	Low	Low	Low
Surface water impact (adverse impact on surface water quality)	Moderate	Moderate	Low
Altered surface water flow regime (risk to infrastructure, riparian vegetation, terrestrial ecosystems and environmental flow regime)	Moderate	Low	Low
Altered geomorphic character (e.g. increased lateral instability; significant alteration of geomorphic units)	Low	Low	Low