

Aquatic ecology 19

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19 Aquatic ecology

19.1 Introduction

This section describes the aquatic ecology of the GFD Project area and surrounds.

The GFD Project is located across three catchment areas: the Dawson River catchment, the Comet River catchment, and the Condamine-Balonne River catchment. Aquatic habitats in the GFD Project area include watercourses, wetlands, springs and groundwater ecosystems. Watercourses in the GFD Project area 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 aquatic ecology are described, and mitigation measures are identified. Full details of the aquatic ecology assessment are provided in Appendix S: Aquatic ecology.

This section has been prepared in accordance with section 4.10 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.

19.2 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 the aquatic ecology values and potential impacts of the GFD Project are outlined within Table 19-1.

Table 19-1 Regulatory context of the GFD Project – aquatic ecology

Legislation, policy or guideline	Relevance to the GFD Project
<p><i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act)</p> <p>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).</p> <p><i>Environment Protection and Biodiversity Conservation Amendment Act 2013</i> (Cth)</p> <p>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.</p>	<p>The GFD Project is a controlled action requiring assessment and approval under the EPBC Act before it can proceed. The controlling provisions are:</p> <ul style="list-style-type: none"> • Wetlands of international importance (sections 16 and 17B) • Listed threatened species and communities (sections 18 and 18A) • Listed migratory species (sections 20 and 20A) • Water resources (sections 24D and 24E). <p>GFD Project activities that have the potential to impact on MNES require appropriate management measures for impact mitigation. Santos GLNG has developed a Water resource management plan, which outlines its commitment to avoid, minimise and mitigate potential impacts to water-related MNES within the GFD Project area.</p>
<p><i>Environmental Protection Act 1994</i> (Qld) (EP Act)</p> <p>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.</p>	<p>The EP Act governs the management of surface water resources, and the management and disposal of water generated from gas production.</p>

Legislation, policy or guideline	Relevance to the GFD Project
<p><i>Environmental Protection (Water) Policy 2009 (Qld) (EPP Water)</i></p> <p>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.</p>	<p>EPP Water is the primary instrument by which the relevant objectives of the EP Act are achieved. The EPP Water deals with the discharge of wastewater to land, surface water and groundwater within Queensland.</p>
<p><i>Fisheries Act 1994 (Qld)</i></p> <p>This Act provides for the management, use, development and protection of fisheries resources and fish habitats in Queensland.</p>	<p>Section 76G of the <i>Fisheries Act 1994 (Qld)</i> provides the power to grant an approval for waterway barrier works. Under Part 5, Division 3A, Subdivision 3 (76G) of the Fisheries Act, a waterway barrier works approval is needed to build a structure across a freshwater waterway, whether it is temporary or permanent.</p> <p>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.</p>
<p><i>Land Protection (Pest and Stock Route Management) Act 2002 (Qld)</i></p> <p>The LP Act lists declared plants and animals that are targeted for control because they have, or could have, serious economic, environmental or social impacts. The Act mandates the control of declared species, including their supply, sale, keeping and transport.</p>	<p>Declared noxious weeds in Queensland are listed under the <i>Land Protection (Pest and Stock Route Management) Regulation 2003 (Qld)</i>. Class 1 declared pests under this regulation are uncommon in Queensland, and if introduced, are likely to have adverse economic, environmental or social impacts. Class 1 pests established in Queensland must be eradicated from the State. Class 2 and 3 declared pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact. Landowners must take reasonable steps to keep their land free from Class 2 pests. Landowners are not required to remove Class 3 pests, unless their land is next to an environmentally significant area (e.g. national park).</p> <p>The GFD Project will comply with the pest management requirements of this Act.</p>
<p><i>Nature Conservation Act 1992 (Qld) (NC Act)</i></p> <p>The NC Act provides for the conservation and protection of native flora and fauna species in Queensland and a framework for establishing, managing and the use of protected areas.</p>	<p>Native flora and fauna species are protected in Queensland under the NC Act. The subordinate <i>Nature Conservation (Wildlife) Regulation 2006 (Qld)</i> contains the following categories reflecting both abundance and levels of legislative protection: extinct in the wild, endangered, vulnerable, near threatened and least concern.</p> <p>Protected areas on State land such as national parks and conservation parks are listed in the <i>Nature Conservation (Protected Areas) Regulation 1994 (Qld)</i>.</p> <p>Additionally the NC Act also provides a framework for the establishment and management and use of protected areas. These also have a role in protecting aquatic species.</p>
<p><i>Water Act 2000 (Qld) (Water Act)</i></p> <p>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.</p>	<p>The GFD Project may require approvals under the Water Act for the construction, control and management of works with respect to water conservation and protection, drainage, supply, flood control and prevention. Under section 269 of the Water Act, a riverine protection permit is required to:</p> <ul style="list-style-type: none"> Excavate in a watercourse, lake or spring and/or Place fill in a watercourse, lake or spring. <p>However, on-tenure petroleum activities are exempt from the requirement for a riverine protection permit under section 814 of the Water Act and sections 49-51 of the <i>Water Regulation 2002 (Qld)</i>.</p> <p>Approval under the Water Act may be required for the construction of road and pipeline crossings within watercourses.</p>
<p><i>State Planning Policy</i></p> <p>The single SPP introduced in December 2013 defines Queensland Government policies about matters of State interest in land use planning and development.</p>	<p>The SPP provides for the protection of high ecological significance wetlands in catchments contributing to the Great Barrier reef. The GFD Project area contains some sub-catchments of the Fitzroy Basin which is within the catchment of the Great Barrier Reef.</p>

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

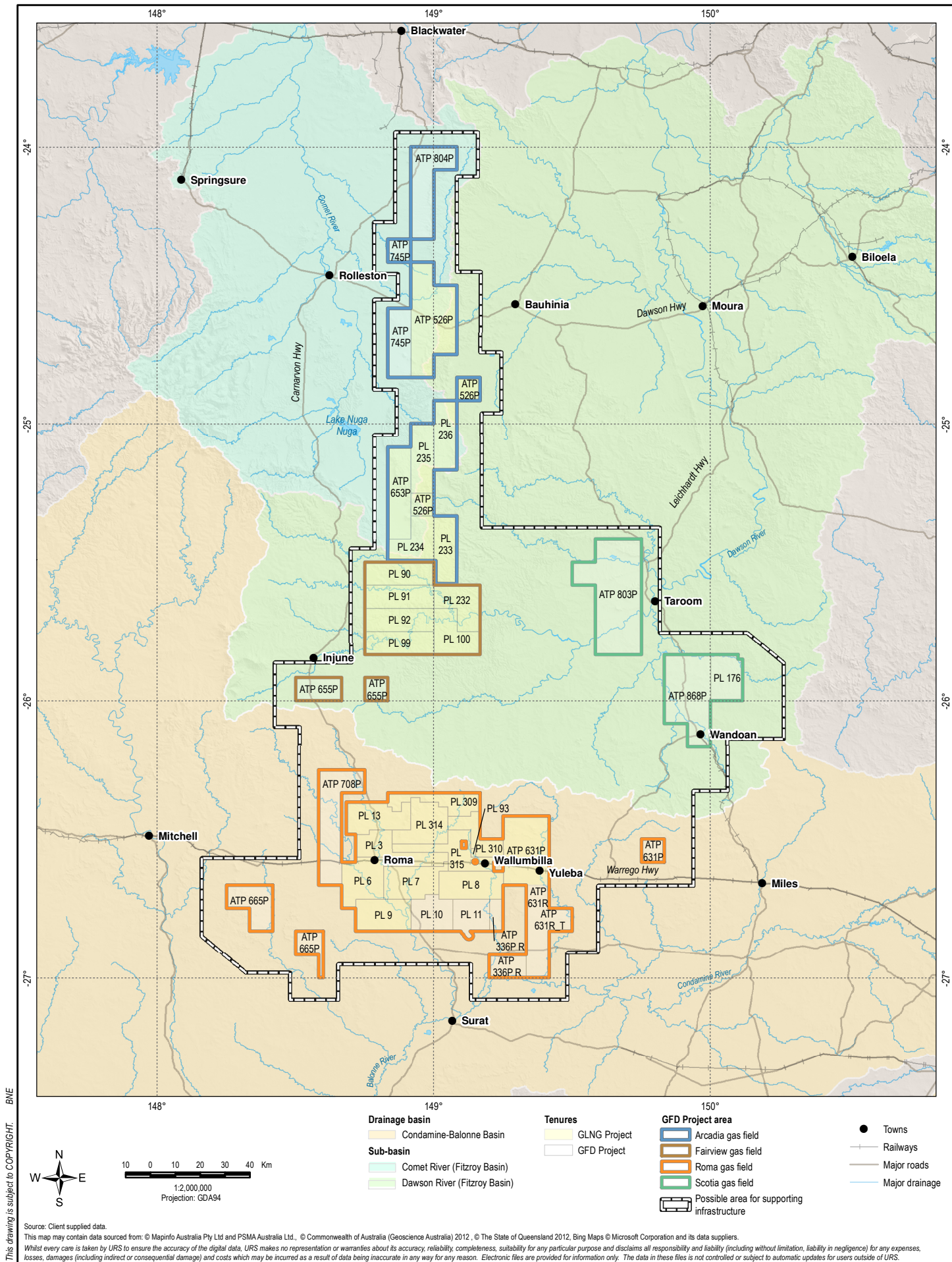
Application for or amendments to existing environmental authorities will occur subsequent to this EIS process. Other subsequent approvals required after the EIS process has been completed, corresponding triggers and legislative frameworks applicable to the GFD Project are identified in Section 2: Project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

19.3 Assessment methodology

The assessment describes the aquatic ecology 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. A summary of the impact assessment is included in section 19.7. The full description of the significance methodology is described in section 5.6.3 of Section 5: Assessment framework and in Appendix S: Aquatic ecology

The GFD Project area and relevant drainage catchments (Dawson, Comet and Condamine-Balonne rivers) used to assess the baseline aquatic ecology values and GFD Project impacts are shown in Figure 19-1.



19.4 Environmental values

Aquatic ecology values in the GFD Project area include watercourses, wetlands, springs and groundwater ecosystems. Watercourses in the GFD Project area are mostly ephemeral (with the exception of major watercourses such as the eastern portion of the Dawson River and parts of the Condamine River) and many are in a moderate to poor ecological condition. The decline of ecological conditions are a result of impacts associated with historic vegetation clearing, cattle grazing, river flow regulation and watercourse crossings for roads and other linear infrastructure.

Despite these impacts, watercourses in the GFD Project area continue to provide habitat for aquatic biota that is representative of the wider regional area, including aquatic plants, macroinvertebrates, fish, turtles and platypus. Wetlands, deep watercourse pools and springs in the GFD Project area provide permanent aquatic habitat. Many wetlands and springs have been impacted by clearing, modification of drainage patterns, and cattle access; although some of these sensitive ecosystems are in good ecological condition and provide habitat for conservation significant species. Details on macroinvertebrates, aquatic flora, fish and turtles as well as the Great Artesian Basin (GAB) springs are provided in Appendix S: Aquatic ecology.

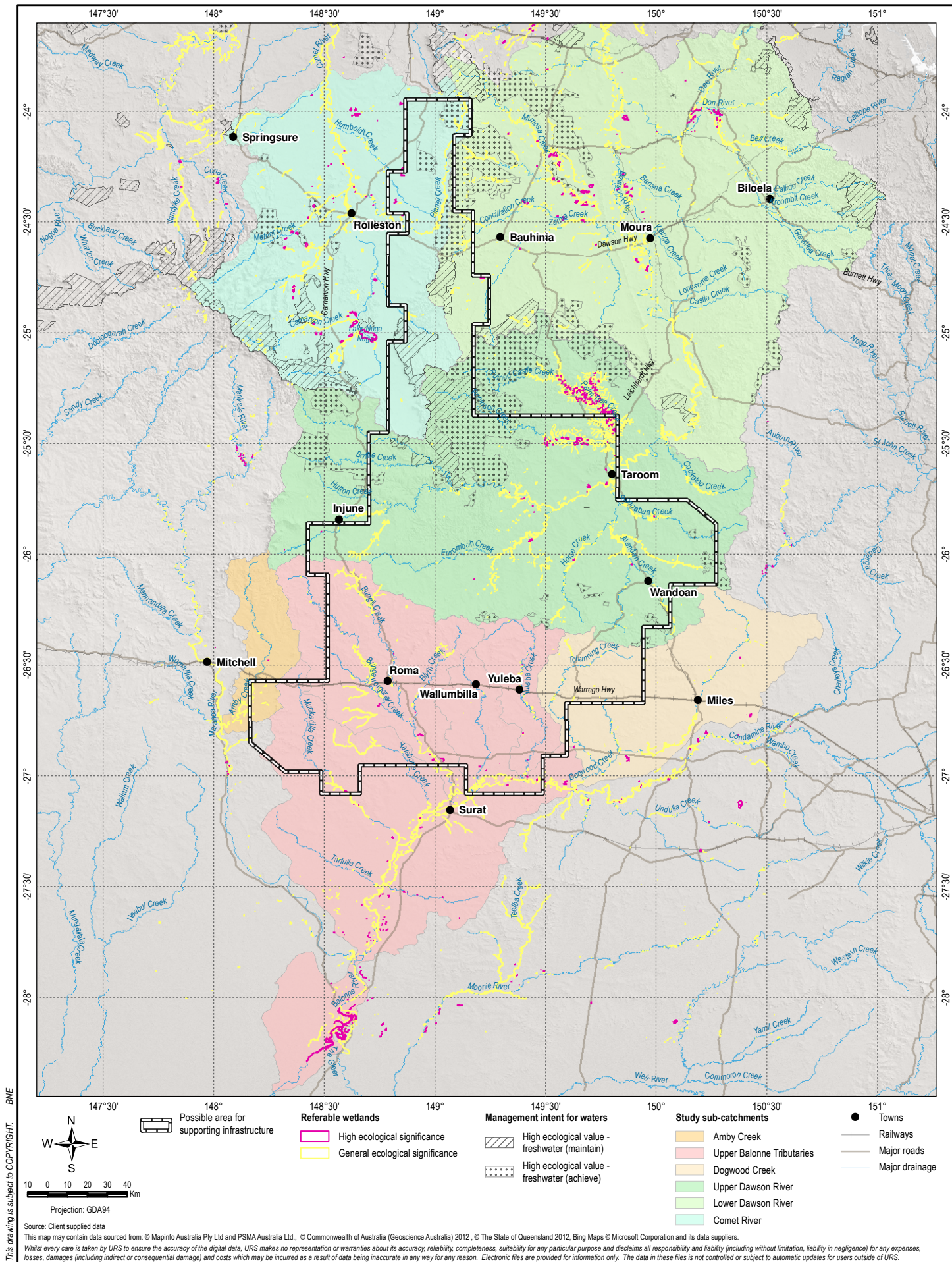
A summary of the findings of the aquatic ecology assessment and delineation of key environmental values for the GFD Project area is presented in Table 19-2.

Table 19-2 GFD Project environmental values

Environmental values	Dawson River	Comet River	Condamine – Balonne River	Description
Aquatic habitat				
Wetlands	✓	✓	✓	<p>Wetlands provide intermittent to perennial aquatic habitat and provide refugia for aquatic fauna.</p> <p>The Dawson River catchment is mapped as having high ecological value (referrable) wetlands in the Great Barrier Reef catchment – Lake Murphy Conservation Area. These wetlands contain species and regional ecosystems (REs) of conservation significance under both the EPBC Act and the NC Act.</p> <p>None of the wetlands in the Comet or Condamine-Balonne River catchments are mapped as high ecological value (referrable) wetlands in the Great Barrier Reef catchments. Wetlands within the Condamine-Balonne River catchment are classified as being of moderate conservation value using the AquaBAMM methodology, although several wetlands near Roma are of high conservation value (DERM, 2011). The conservation value of wetlands in the Comet River catchment ranges from very low to very high, though the majority are of moderate conservation value (DERM, 2009).</p> <p>The Palm Tree and Robinson Creek wetland complexes are regionally unique, have a diverse and abundant native wetland flora and fauna, support threatened species and provide recreation opportunities and visual amenity (Alluvium, 2014).</p> <p>The distribution of referable high ecological significance and general ecological significance wetlands throughout the aquatic ecology study area is illustrated in Figure 19-2, along with high ecological value areas scheduled under the EPP Water.</p>

Environmental values	Dawson River	Comet River	Condamine – Balonne River	Description
Springs	✓	✓	✓	<p>Springs provide intermittent to perennial aquatic habitat. Eleven spring complexes feed 45 spring vents within GFD Project gas fields in the Dawson River catchment. Of these, only complex 230 (Lucky Last), with 12 vents, and complex 591 (Yebna2), with one vent are considered part of the EPBC Threatened Ecological Community (TEC) <i>The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin</i>. The EPBC Act-listed aquatic plant salt pipewort (<i>Eriocaulon carsonii</i>) has been recorded at the Lucky Last complex and the nearby Abyss complex (592) (Fensham <i>et al.</i>, 2011). The presence of an EPBC Act-listed plant species does not necessarily mean the spring is part of the EPBC TEC. Ratings of spring condition vary within the catchment from very good to very poor. Livestock impacts are the main factor affecting condition ratings (Fensham <i>et al.</i>, 2004).</p> <p>Two spring complexes comprising three vents are present within the GFD Project gas fields in the Comet River catchment; complex 78, vents 551 and 552 and complex 308, vent nv383. Neither complex corresponds to the EPBC Act listed TEC.</p> <p>A single spring complex (507) feeds four vents in the GFD Project gas fields in the Condamine-Balonne River catchment. This complex does not support the EPBC listed TEC. Fensham <i>et al.</i> (2011) note that these spring wetlands have been destroyed by impoundment or excavation and therefore have been given a very low conservation rank.</p> <p>Further details of springs and watercourse springs within the GFD Project area are provided in Appendix S: Aquatic ecology.</p>
Riverine regional ecosystems (RE)	✓	✗	✓	<p>REs within the Dawson River catchment portion of the GFD Project gas fields include:</p> <ul style="list-style-type: none"> ATP 803 contains one riverine RE ATP 868 contains two riverine REs ATP 655 contains one riverine RE. <p>REs within the Condamine-Balonne River catchment portion of the GFD Project area include:</p> <ul style="list-style-type: none"> ATP 665 contains one riverine RE PL 10 contains one riverine RE ATP 708 contains three riverine REs.
Waterholes	✗	✓	✓	Waterholes provide refugia for aquatic fauna.
Aquatic flora				
Listed threatened species	✓	✗	✓	<p>Several aquatic flora species recorded in the catchments are listed under the EPBC Act and <i>Nature Conservation (Wildlife) Regulation</i>. Emergent aquatic plants are the most common form, although submerged and floating species are also known from waterways near the GFD Project area.</p> <p>Note: no listed threatened species were recorded in the Comet River catchment; however, it is possible that salt pipewort (<i>Eriocaulon carsonii</i>) listed as endangered under the EPBC Act and <i>Nature Conservation (Wildlife) Regulation</i>, occurs within or in the vicinity of tenures in the Comet River catchment, as there are several springs in the area.</p>
Non-indigenous species	✓	✓	✓	Non-indigenous species are those living in an area where they are not naturally found. A non-indigenous species can be a native Australian species or a non-native species (i.e. exotic).
Aquatic fauna				
Macroinvertebrates	✓	✓	✓	<p>Macroinvertebrate richness was surveyed for the three river catchments and was generally found to be higher in edge habitat than bed habitat. Plectoptera, Ephemeroptera and Tricoptera (PET) richness ranged from 0 to 4 at most locations and was generally indicative of poor to moderate habitat and water quality at the locations surveyed.</p>

Environmental values	Dawson River	Comet River	Condamine – Balonne River	Description
				Non-biting and phantom midge larvae (sub-family Chironominae, Tanypodinae and Chaoboridae), diving beetles (family Dytiscidae) and water bugs (family Corixidae) dominated the macroinvertebrate communities in Dawson River catchment (FRC Environmental, 2009b). Macrocrustaceans such as freshwater shrimp (family Atyidae), the freshwater prawn (<i>Macrobrachium australiense</i>) and the freshwater yabby (<i>Cherax destructor</i>) are known from the three catchments (FRC Environmental, 2007, 2009a, 2009b; Hydrobiology, 2009; 2010; Simmonds and Bristow 2007, 2012).
Fish - Listed threatened species	✗	✗	✓	Murray cod (<i>Maccullochella peelii peelii</i>) is listed as vulnerable under the EPBC Act (Condamine-Balonne River catchment).
Fish - Non-indigenous species	✓	✓	✓	Common carp (<i>Cyprinus carpio</i>) (Condamine-Balonne River catchment) and Mosquito fish (<i>Gambusia</i> spp) (all catchments) are declared noxious species under the <i>Fisheries Regulation 2008</i> (Qld).
Turtles	✓	✓	✓	The Fitzroy River Basin has a high conservation value with respect to freshwater turtles as there are many species endemic to the region. Six species have been recorded in the Fitzroy River Basin including the Fitzroy River turtle (<i>Rheodytes leukops</i>) which is a conservation significant species listed under the EPBC Act. The Fitzroy River turtle is endemic to the natural permanent riverine habitats of the Fitzroy Basin where it has been recorded from the Fitzroy Barrage to the Theodore Weir on the Dawson River, the Connors River, and the Duck Ponds on the Lower Nogoa River, upstream of the Comet-Mackenzie Junction (FRC Environmental, 2011, Limpus et al., 2007). Fitzroy River turtles were not recorded in the 2009 EIS surveys or subsequent surveys of the gas transmission pipeline (FRC Environmental, 2009a, 2012b).
Platypus	✓	✗	✗	Platypus (<i>Ornithorhynchus anatinus</i>) are found in freshwater streams, rivers, lakes and water storages with a preference for steep, well vegetated banks for burrowing (Menkhorst & Knight, 2004). Platypus have been recorded in the region. However, no evidence of platypus was observed in the recent surveys undertaken in the region (Aquateco, 2011; BAAM, 2009; FRC Environmental, 2009a; 2009b) and it is unlikely that they would inhabit ephemeral streams in the area. Platypuses are known to be present in Hutton Creek, a tributary of the Dawson River.
Boggomoss snail	✗	✗	✗	The Boggomoss springs, which are located on the Dawson River downstream of the GFD Project area, support the EPBC Act critically endangered boggomoss snail (<i>Adclarkia dawsonensis</i>) (Stanisic, 1996). Extensive targeted surveys for the boggomoss snail were undertaken as a part of this EIS within tenures ATP803 and PL 176. Boggomoss snails were not found during these surveys.



19.5 Potential impacts

Recognising that firstly avoidance (i.e. through the constraints planning processes) where practicable would apply to siting decisions, potential impacts to the aquatic environmental values that may result from construction, operations and decommissioning activities of the GFD Project include:

- Sediment to water – may temporarily increase turbidity levels in the vicinity of the contamination source and downstream as the plume disperses.
- Chemicals to water – may temporarily increase toxicity (depending on the properties of the chemical and rate of processes such as biodegradation) in the vicinity of the source and downstream as the plume disperses; however some toxins may accumulate in the environment (e.g. substrate, vegetation, etc.) over time.
- Altered flow regime – increased or changed flow regime as a result of GFD Project activities (e.g. stream discharge) may disrupt seasonal patterns affecting dependent riparian vegetation and fauna, resulting in long-term changes to species diversity.
- Disturbance of stream channel and associated habitat (e.g. pools, riffles, etc.) – localised change associated with GFD Project infrastructure (e.g. waterway crossings) or activities (e.g. stream discharge) may apply for the life of the infrastructure/activity; however change can generally be reversed by natural flows over time.
- Loss of abundance and diversity of riparian vegetation and aquatic biota, including groundwater dependent ecosystems – generally localised impact associated with clearing and traffic movement, which may be long-term due to time required to restore pre-disturbance species composition/abundance before dependent fauna return.

19.6 Mitigation measures

19.6.1 Management plans

Santos GLNG is committed to implementing the mitigation measures in Table 19-3 to manage potential aquatic ecology related impacts. These measures will be incorporated into Santos GLNG's management framework, as outlined in Appendix Y: Draft environmental management plan. It is anticipated that the mitigation measures listed in Table 19-3 will be applied after the avoidance measures detailed in the Constraints protocol (and summarised in section 5.1 of Appendix S: Aquatic ecology).

Table 19-3 Mitigation measures – aquatic ecology

Management plan	Mitigation measures
GFD Project Environmental protocol for constraints planning and field development (the Constraints protocol)	<p>The Constraints protocol applies to all gas field related activities. The scope of the Constraints protocol is to:</p> <ul style="list-style-type: none"> • 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. <p>The Constraints protocol provides a framework to guide placement of infrastructure and adopts the following management principles:</p> <ul style="list-style-type: none"> • Avoidance — avoiding direct and indirect impacts • Minimisation — minimise potential impacts • Mitigation — implement mitigation and management measures • Remediation and rehabilitation — actively remediate and

Management plan	Mitigation measures
	<p>rehabilitate impacted areas</p> <ul style="list-style-type: none"> Offset — offset residual adverse impacts in accordance with regulatory requirements. <p>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 identifies the protection of surface water resources (wetlands, lakes, watercourses and flood prone areas) as a planning constraint for the placement and design of GFD Project infrastructure.</p> <p>The Constraints protocol applies as follows:</p> <ul style="list-style-type: none"> No-go area constraint applies to spring vents and/or spring complexes protected under the EPBC Act plus a 200 m buffer zone, wetlands of high ecological significance, and wetlands of national importance plus a 200 m buffer zone. Surface development exclusion areas apply to Ramsar sites. High constraint areas include watercourses (stream orders) plus a 100 m buffer, general ecologically significant wetlands and wetlands of other environmental value (Map of Referrable Wetlands dataset), and all other spring vents and spring complexes plus a 200 m primary buffer. Moderate constraint areas include a 100 m secondary buffer around spring vents and spring complexes protected under the EPBC Act and the 200 m primary buffers.
Draft Environmental management plan (Draft EM plan)	<p>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:</p> <ul style="list-style-type: none"> 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.
Rehabilitation management plan	<p>The Rehabilitation management plan outlines the rehabilitation objectives for Project-related disturbances within the GFD Project area. This includes the phasing of rehabilitation to first achieve stabilisation and subsequently final rehabilitation for disturbances to land (i.e. ground surface).</p> <p>The Rehabilitation management plan:</p> <ul style="list-style-type: none"> Describes Santos GLNG's approach to rehabilitation Identifies key rehabilitation objectives and criteria to deem rehabilitation success Outlines general rehabilitation actions to be undertaken by Santos GLNG when rehabilitation a disturbance Provides an overview of monitoring and maintenance actions to be conducted on rehabilitated areas.
Significant species management plan (SSMP)	<p>The plan provides an overview of the strategy, methods and controls implemented by Santos GLNG to manage adverse impacts to EPBC Act-listed significant species and their habitats, and threatened ecological communities. Specifically, the SSMP:</p> <ul style="list-style-type: none"> Identifies and profiles significant species and threatened ecological communities that are present, or may occur, within the gas fields Identifies key threats to significant species and threatened ecological communities caused by activities within the gas fields Outlines general mitigation measures to be implemented by Santos GLNG to minimise the potential adverse impact of key threats to significant species and threatened ecological communities caused by Santos GLNG activities.

Management plan	Mitigation measures
	<p>The SSMP will include mitigation measures such as:</p> <ul style="list-style-type: none"> Regular visual inspections by a spotter catcher during clearing to remove turtles from threat of harm where clearing occurs within or adjacent to permanent water pools. Ensuring that watercourse and wetland crossings conform to approval conditions issued under the Fisheries Act (i.e. raising of a waterway). Alternatively, works are to be undertaken in accordance with the Department of Agriculture, Fisheries and Forestry (DAFF) State development assessment provisions module 5.2 – constructing or raising waterway barrier works in fish habitat state code (version 1.1 21/11/13). Ensuring that for minor waterway crossings where horizontal directional drilling (HDD) is not the agreed construction method, the watercourse bed and bank material and trench spoil will be stockpiled separately outside the buffer zone to reduce potential impacts to turtle nest areas (where applicable). Weather permitting, rehabilitating impacted watercourses immediately after the pipeline has been lowered in and backfilled Taking reasonable and practical measures to minimise the area to be cleared and avoiding the clearing of mature trees within 200 m of a wetland and/or watercourse. Clearing within the riparian zones to comply with clearing approval conditions (e.g. NC Act approval). Clearing within the riparian zones to comply with the relevant clearing approval conditions Minimising fragmentation of riparian vegetation along watercourses Limiting the total clearing footprint within the riparian zones to that required for safe construction Revegetation to be consistent with the plant density, floristic composition and distribution of the adjacent riparian and creek bed communities Avoiding impacting on regenerating riparian zones and associated species habitat Restricting vehicle and pedestrian access within and adjacent watercourses and wetlands to the defined access tracks <p>In the event that aquatic fauna are injured or killed during works or where there is unauthorised clearing of vegetation or native flora, the mitigation strategies being used will be reviewed in conjunction with an aquatic fauna specialist and any recommended changes implemented.</p>
Fauna management plan (FMP)	<p>The FMP provides Santos GLNG's strategy to manage fauna during the construction and operations phases of the GFD Project. The plan:</p> <ul style="list-style-type: none"> Identifies fauna species present within the gas fields Prioritises management of both livestock and wildlife Provides mitigation measures to minimise impacts to fauna from Santos GLNG activities. <p>The FMP includes measures such as:</p> <ul style="list-style-type: none"> Scheduling watercourse crossings, where practicable, during low flow periods. Ensure mitigation measures for creek crossings are consistent with AS2885 'Pipelines', 'Gas, Liquid and Petroleum' and Australian Pipeline Industry Association Code of Environmental Practice' and the conditions of any specific approval (such as waterway barrier works). Fauna passage devices such as pipes that allow the movement of fish and other aquatic fauna should be considered for major watercourse crossings. Implement measures to reduce soil erosion and stream sedimentation.

Management plan	Mitigation measures
Pest and weed management plan (PWMP)	<p>The management of pest and weed species will be undertaken in accordance with the PWMP. The plan includes measures such as:</p> <ul style="list-style-type: none"> • Identification of pest and weed species and areas of infestation • Avoidance of traversing and placing infrastructure in areas of known infestation • Prevention of the spread of pest and weed species by implementing appropriate work practices and promotion of risk awareness • Control of identified pest and weeds through containment, reduction or eradication as required by legislation. <p>Santos GLNG will review local government's pest and weed management plans and apply measures from these to the PWMP where it is appropriate.</p>
Offset strategy	<p>Offsets are a mechanism to counterbalance any significant adverse residual impact, after the hierarchy of avoidance, minimisation, mitigation, remediation and rehabilitation measures have been implemented.</p> <p>The Offset strategy is part of the management framework and will be further developed and implemented to meet regulatory requirements. The purpose of the strategy is to:</p> <ul style="list-style-type: none"> • Summarise the Australian and Queensland Governments' offset requirements and policies • Identify the environmental values that exist within the GFD Project area that after avoidance, minimisation, mitigation and remediation and rehabilitation measures may require offsetting • Demonstrate offsets completed as part of the Santos GLNG Project • Identify where existing Santos GLNG offset areas may be used for future additional offset required for the GFD Project • Provide a description of Santos GLNG's staged offsets approach to provide potential offset delivery options and proposed method of delivery.
Water resource management plan (WRMP)	<p>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.</p>
Decommissioning and abandonment management plan (DAMP)	<p>The DAMP describes the management framework in place for when petroleum activities cease. The objectives of the plan are to:</p> <ul style="list-style-type: none"> • 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 plan	Mitigation measures
Erosion and sediment control management plan (ESCMP)	<p>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.</p> <p>The ESCMP is supported by the Erosion and sediment control manual, which provides erosion, sediment and drainage controls in line with best practice guidelines.</p> <p>The ESCMP includes measures such as:</p> <ul style="list-style-type: none"> • Drainage control (on a site-specific basis) may include: <ul style="list-style-type: none"> — 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 (i.e. >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. • Erosion and sediment control (on a site-specific basis) may include: <ul style="list-style-type: none"> — Prioritising drainage and erosion control measures, rather than allowing erosion to occur and trying to trap the resulting sediment. — 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 (i.e. jute and coir matting) as an alternative to mulching in drainage channels or areas of strong winds or overland flow. — Use of sediment traps (i.e. sheet flow, kerb inlet and field inlet sediment traps) and sediment basins. — Use of 'ripping' or similar techniques on finished soil surfaces to encourage revegetation where required. — Erosion and sediment controls will be routinely inspected and maintained for capacity and structural integrity, particularly following significant rainfall events. • Sediment basin water quality will be monitored prior to discharge to determine compliance with any relevant environmental authority (EA) water quality release limits. <p>Water quality monitoring will be undertaken within watercourses subject to significant disturbance from linear infrastructure construction. Turbidity levels will be monitored at upstream and downstream sites at a frequency appropriate to determine compliance with relevant EA conditions.</p>

19.6.2 Monitoring and review

Implementation of monitoring and reporting to support the protection of aquatic environmental values is an important component of the GFD Project to demonstrate the effectiveness of the mitigation and management plans and to demonstrate compliance with regulatory approvals. High level strategies for implementation of a monitoring program throughout the GFD Project duration have been identified. Monitoring programs will be consistent with Santos GLNG's management plans discussed in Table 19-3.

The Draft EM plan (Appendix Y) will inform the development of asset-specific monitoring programs once GFD Project infrastructure plans and operations processes have been finalised. Additional details on monitoring, including indicators, is provided in section 5.7 of Appendix S: Aquatic ecology.

In general, monitoring during construction will involve the following:

- Photo records of points established upstream, downstream and in the construction footprint will be maintained to provide a record of erosion, works and control measures
- Visual monitoring for sediment plumes and increases in turbidity will be undertaken during the construction of watercourse crossings. If plumes are observed during construction works erosion and sediment control measures will be inspected and repaired or revised as required.

Upon completion of rehabilitation at the end of the construction phase, each watercourse crossing location will be inspected by a suitably qualified person to ensure that the rehabilitation has been completed to a standard suitable for protecting the ecological values of the watercourse in the long-term.

Where coal seam water will be released to natural watercourses, a receiving environment monitoring program (REMP) will be developed to monitor the impacts of such releases. The REMPs will be submitted to the relevant authority for approval prior to implementation.

19.7 Significance assessment

As discussed in section 19.3, 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 19-4 summarises the assessment undertaken for the potential impacts of the GFD Project on aquatic ecology environmental 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 aquatic ecology environmental 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 19-4 Project activities and potential impacts on aquatic ecology environmental values

Potential impact	Phase	Pre-mitigated significance			Mitigation and management measures	Residual significance	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Sediment to water	Construction	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> Draft EM plan ESCMP LRMP DAMP Rehabilitation management plan 	Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Moderate	Moderate		Low	Low
Chemicals to water	Construction	High	Moderate	High	<ul style="list-style-type: none"> CFMP Draft EM plan LRMP Contingency plan for emergency environmental incidents DAMP 	Low	Moderate
	Operations		Moderate	High		Low	Moderate
	Decommissioning		Moderate	High		Low	Moderate
Altered flow regime	Construction	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> Draft EM Plan DAMP Rehabilitation management plan 	Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low
Disturbance of stream channel and associated habitat	Construction	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> Draft EM plan Rehabilitation management plan ESCMP 	Low	Low
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low
Loss of abundance and diversity of riparian vegetation and aquatic biota, including groundwater dependent ecosystems	Construction	High	Moderate	High	<ul style="list-style-type: none"> Draft EM plan Rehabilitation management plan ESCMP FMP PWMP CFMP 	Low	Moderate
	Operations		Low	Low		Low	Low
	Decommissioning		Low	Low		Low	Low

19.8 Conclusions

The aquatic ecology impacts that remain after the application of mitigation and management measures are detailed in Table 19-5. The significance assessment found that the residual impacts of the GFD Project are expected to be low to moderate.

The aquatic communities within the GFD Project area have generally adapted to seasonal fluctuations such as high flows, high turbidity and changes in salinity. These aquatic communities possess adaptations to withstand environmental variables and recolonisation of disturbed areas can be relatively rapid. This may lower the significance of the potential impact and improve the rehabilitation time frames.

Impacts with a low level of significance are generally localised and temporary. Impacts with moderate significance may result in further impact on aquatic ecology environmental values; however the environmental value is generally already abundant throughout the region and the impact is likely to be localised and unlikely to result in irreversible change.

Table 19-5 Residual significance – aquatic ecology

Potential impacts	Residual significance		
	Construction	Operations	Decommissioning
Sediment to water	Low	Low	Low
Chemicals to water	Moderate	Moderate	Moderate
Altered flow regime	Low	Low	Low
Disturbance of stream channel and associated habitat	Low	Low	Low
Loss of abundance and diversity of riparian vegetation and aquatic biota, including groundwater dependent ecosystems	Moderate	Low	Low