# 32. CUMULATIVE IMPACTS

This chapter describes the potential cumulative impacts on environmental values that may result when residual project impacts are combined with the impacts of other approved or proposed developments in the Gladstone region. The criteria used to select the components of the Arrow LNG Plant and developments for inclusion in the cumulative impact assessment are described and the methodology for determining cumulative impacts is provided for each technical study.

Project objectives for cumulative impacts are shown in Box 32.1 and are based on legislative policies described below.

**Box 32.1 Objectives: Cumulative impacts**

- To identify and assess the cumulative impacts of existing, approved and proposed developments.
- To determine how the development and operation of the Arrow LNG Plant may contribute to the overall impact on environmental values.
- To minimise Arrow LNG Plant contributions to cumulative impacts by designing mitigation strategies to address cumulative impacts.

## 32.1 Legislative Context and Standards

The *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) provides a framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (i.e., matters of national environmental significance). While no specific mention of cumulative impacts is made in the EPBC Act, the act does require consideration of reasonably foreseeable indirect impacts by third parties. Federal court rulings have interpreted the EPBC Act to include cumulative impacts (Franks et al., 2010).

Cumulative environmental impact must be considered as part of the environmental impact assessment process under *State Development and Public Works Organisation Act 1971* (Qld), via an environmental impact statement for a declared project of state significance. The act does not differentiate between cumulative or other impacts, but does require the environmental impact assessment (EIS) to comply with the project terms of reference.

## 32.2 Study Method

This section describes the study method used to determine potential cumulative impacts from the interaction of the Arrow LNG Plant with other developments in the Gladstone region.

### 32.2.1 Identification of Third Party Developments

The Arrow LNG Plant cumulative impact assessment has considered projects under construction and those that have taken a financial investment decision to proceed by January 2011. The cumulative impact assessment also includes projects that have been approved by Queensland's Coordinator-General or have sufficient information in the public domain e.g., an EIS, to enable the potential impacts associated with these projects to be included in the assessment.

The cumulative impact assessment has used information available in the public domain to characterise impacts associated with third party developments e.g., emissions of pollutants to the atmosphere, water and land, transportation of materials and goods. Arrow Energy is unable to

control impacts associated with third party projects and any changes to these impacts may alter cumulative impacts to the Gladstone region.

Developments that have been included in the cumulative impact assessment are those that meet any of the following criteria:

- The development is under construction.
- The development proponent has taken a financial investment decision to proceed.
- The development has been assessed or is being assessed in accordance with one of the following:
  - The *State Development and Public Works Organisation Act 1971* (Qld) and has been declared by the Queensland Coordinator-General as a 'project of state significance' for which the status of the EIS is either complete or, as a minimum, has an Initial Advice Statement published on the Department of Local Government and Planning website.
  - The *Environmental Protection Act 1994* (Qld) and has completed an EIS or has an Initial Advice Statement or similar listed on the Department of Environment and Resource Management website.
- The development is envisaged in statutory planning documentation.

Developments considered in this assessment are shown in Figure 9.2. A description of each project is provided in Chapter 9, Impact Assessment Method, Table 9.7.

Projects have been recognised but not assessed if insufficient information exists to assess the contribution of a nominated development to cumulative impacts. On this basis, the following developments in the Gladstone region were not included in the assessment:

- Stuart Oil Shale Project proposed by Queensland Energy Resources. Despite work commencing on a pilot plant and refurbishment of site facilities, an EIS has not been initiated for the revised project.
- Aldoga Aluminium Smelter Project proposed by Aldoga Aluminium Smelter Pty Ltd. Although approved in 2003, the project has not progressed to development.
- Queensland Coke and Power Plant Project proposed by Queensland Coke and Energy Pty Ltd. The proponent has not progressed its approved proposal to develop a coking plant adjacent to Stanwell Power Station near Rockhampton and an export terminal at Fishermans Landing near Gladstone.

### 32.2.2 Assessment Approach for Technical Studies

Cumulative impacts are described in terms of the effect they have on environmental values.

The potential for cumulative impacts to arise from interaction of Arrow LNG Plant activities with third party developments was assessed during the preparation of EIS technical studies, e.g., air quality, groundwater, coastal processes. For each technical study, only third party projects that could potentially impact on the environmental values relevant to that study, and for which sufficient third party information was available, were included in the cumulative impact assessment. In some cases, technical studies assessed impacts by including the effects of third party developments. Cumulative impacts were therefore incorporated from the outset.

The cumulative impact assessment showed that, following the application of avoidance, mitigation and management measures and implementation of management plans described in Chapter 11, Geology, Landform and Soils, to Chapter 31, Waste Management, not all Arrow LNG Plant components and activities will result in significant cumulative impacts.

Consequently, only Arrow LNG Plant activities that will result in significant cumulative impacts to environmental values, i.e., impacts that have been assessed as greater than negligible, and which have not already been discussed in earlier chapters, are detailed in this chapter.

Cumulative impact assessment was not considered relevant for the Climate and Climate Change Adaptation technical study (Appendix 1, Climate and Climate Change Adaptation) on the basis that this technical study considered how climate change, (i.e., changes to sea level and temperature, the magnitude and frequency of cyclones and associated storm surges) will affect the project, and how the project must incorporate actions to address climate change in project design and operation.

## 32.3 Cumulative Impacts

Study specific methods, assumptions and findings of the cumulative impact assessment are described below. Studies that included cumulative impacts from the outset, or which identified negligible cumulative impacts, are summarised below. Cumulative impacts discussed in detail in this chapter include:

- Socio-economic.
- Traffic and transport (LNG project cumulative impacts only).
- Marine ecology.
- Marine water quality and sediment.
- Landscape and visual.
- Terrestrial ecology.

### 32.3.1 Studies which Included Cumulative Impacts from the Outset

Three technical studies assessed potential project impacts within the context of existing industry, facilities under construction, and future developments. These studies incorporated cumulative impacts in the impact assessments presented in previous chapters of this EIS, and include:

- Coastal Processes (Chapter 15 and Appendix 8, Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment). Project impacts have been assessed within the context of wider developments in Port Curtis by comparing cumulative and Arrow LNG Plant impacts to cumulative impacts without Arrow LNG Plant impacts.

- Air Quality (Chapter 21 and Appendix 14, Air Quality Impact Assessment). Project impacts were assessed by including the effects of existing industry and all future developments, including those under construction. As such, the assessment addresses cumulative impacts and demonstrates that all air quality objectives will be met for routine and non routine operation of the Arrow LNG Plant (inclusive of background levels) at sensitive receptor areas, and no project specific or cumulative impacts are predicted to occur.

- Traffic and Transport (Chapter 28 and Appendix 23, Traffic and Transport Impact Assessment). Traffic growth rates for major roads for the life of the project were endorsed by the Department of Transport and Main Roads (DTMR). These growth rates were used to account for non LNG project traffic in the assessment presented in Chapter 28. This chapter

segregates and describes the cumulative effects of LNG projects on Gladstone region traffic and transport.

### 32.3.2 Studies with Negligible Cumulative Impacts

Cumulative impacts associated with a number of technical studies were assessed as being negligible. These include:

- **Geology, Landform and Soil**s (Appendix 2, Geology, Landform and Soils Impact Assessment). Construction activities associated with other projects in the study area will include major topographic alteration of parts of Curtis Island, and regional impacts along project pipeline alignments. These projects are expected to permanently modify landform through major earthworks. The nature and extent of long-term impacts will to some extent be dependent on the success of rehabilitation. Topographical impacts are not expected to be cumulative.
- **Land Contamination and Acid Sulfate Soils** (Appendix 3, Preliminary Site Investigation and Appendix 4, Acid Sulfate Soil Impact Assessment):
  - Land Contamination. Each of the significant development projects in the Gladstone region will require the storage and use of selective hazardous materials. Projects will be designed and constructed to relevant Australian standards with spill containment measures incorporated into the design. The ongoing environmental monitoring and implementation of appropriate measures contained in environmental management plans, and the required assessment and remediation of any contamination at the completion of the project, means the Arrow LNG Plant will have negligible contribution to land contamination that may potentially arise from current and future projects in the region.
  - Acid Sulfate Soils. The minimisation of ASS/PASS disturbance and application of crushed agricultural lime during construction has been identified as the treatment method for neutralising acid sulfate soils in the majority of the projects reviewed for the cumulative impact assessment. Overall, the successful adoption of the mitigation measures identified for the project and the acid sulfate management strategies, as presented in relevant EISs, mean negligible cumulative impacts will arise over the long term from the activities of the Arrow LNG Plant in conjunction with other projects in the Gladstone region.
- **Surface Water, Hydrology and Water Quality** (Appendix 5, Surface Water Impact Assessment). The timing of construction of the Arrow LNG Plant may occur concurrently with some projects. However, the cumulative assessment found that the construction, operation and decommissioning of the Arrow LNG Plant in combination with the three other LNG plants on Curtis Island (i.e., the Queensland Curtis LNG (QCLNG) Project, Gladstone LNG (GLNG) Project and Australia Pacific LNG (APLNG) Project) is expected to have a negligible cumulative impact on altered hydrology i.e., timing and volumes of runoff from facilities, and geomorphology.
- **Groundwater** (Appendix 7, Groundwater Impact Assessment). The deep groundwater systems beneath the Arrow LNG Plant site are associated with bedrock that dips from the north to the south and underlies the coastal mudflats. Inferred groundwater flow is southerly from the elevated hogback ridges, of which Ship Hill is prominent. There is no intention for the project to source groundwater, and the recharge areas in and adjacent to Ship Hill, including the associated surface water catchments relevant to the project site, are largely isolated from other catchments. Cumulative impacts on groundwater are therefore unlikely.

- **Freshwater Ecology** (Appendix 11, Freshwater Ecology and Water Quality Assessment). The freshwater ecology resource within the study area largely consists of ephemeral, low value waterways. The impact of individual projects on watercourses within the Gladstone region will be minimal and comparable to those assessed for the Arrow LNG Plant. Aquatic habitat is sparse, and impacts will be spread across a number of small watercourses of low conservation value. The construction of four LNG projects on Curtis Island will result in an increase in the area of hardstanding. All proponents have developed or will be required to develop plans to manage erosion and sedimentation including mitigations used to control stormwater runoff, erosion and sedimentation during rainfall events.
- **Non-Indigenous Cultural Heritage** (Appendix 19, Non Indigenous Cultural Heritage Impact Assessment). Cumulative impacts on non-Indigenous cultural heritage sites across the footprint of the four LNG developments on Curtis Island will be managed though mitigation measures similar to those in the Arrow LNG Plant EIS, most notably archival recording. Project specific management measures are detailed in the respective project EISs and environmental management plans and the cumulative impact of the four LNG projects on non-Indigenous cultural heritage is not significant.
- **Indigenous Cultural Heritage** (Appendix 18, Indigenous Cultural Heritage Impact Assessment). The cumulative impacts from the project were considered to be negligible as numerous examples of the archaeological sites identified in the Gladstone area, including the project area, are found elsewhere in the region. Other sites offer a better opportunity for detailed investigation and analysis and suitable recording of sites will offset the loss of sites in the event that avoidance is not possible.
- **Greenhouse Gas** (Appendix 13, Greenhouse gas Impact Assessment). The aggregate scope 1 (direct) and scope 2 (indirect) greenhouse gas emissions from the project associated with the worst-case, all electrical scenario were calculated. The predicted greenhouse gas $CO_2$-e emissions for the worst-case Arrow LNG Plant operational year, when compared to 2007 emissions, were equivalent to 4.25% of Queensland emissions, 2.08% of Australian energy sector emissions, and 0.028% of global emissions from fossil fuel consumption. On a global scale, the emissions from the Arrow LNG Plant and other projects in Gladstone are considered negligible.
- **Noise and Vibration** (Appendix 16, Noise and Vibration Impact Assessment). The proposed project noise criteria considered both project noise and allowance for other developments and assumed that all other projects exhibited similar noise characteristics as those adopted for the Arrow LNG Plant noise assessment. The proposed noise conditions at the closest sensitive receptor are 10 dB more stringent than the requirements of the EPP (Noise) to allow similar noise contributions from other projects. With the noise from the project achieving the proposed noise conditions, and other projects contributing similar levels, the cumulative noise from the Arrow LNG Plant, existing developments and other proposed projects (LNG and other) will achieve the requirements and intent of the EPP (Noise). No cumulative impacts are likely and vibration associated with construction and operation at all locations assessed is expected to be below the threshold of human detection.

### 32.3.3 Socio-economic

This section provides an assessment of the cumulative socio-economic impacts of the project when combined with other major industrial projects in the study area. The assessment considers impacts to the Gladstone region, Queensland and Australian economies, and the domestic gas market. The assessment is based on information provided in the Social Impact Assessment

prepared by SKM (Appendix 20), the Economic Impact Assessment prepared by AEC Group (Appendix 21) and the Implications for Domestic Gas Markets report prepared by ACIL Tasman (Appendix 22).

Cumulative impacts may arise in relation to workforce, accommodation, social infrastructure and recreation in the event that all financial investment decision projects proceed as scheduled. Information on the workforce, proposed schedule and accommodation arrangements of projects in the study area has been gathered from existing publicly available information. The indicative start dates detailed in public information may differ to actual start dates. Workforce projections may be subject to deferment, significantly changing the date of the peak workforce.

## Workforce

The cumulative construction workforce of projects that achieved financial investment decision by January 2011 is expected to peak in 2012, with a second peak occurring in 2016. The construction of Arrow LNG Plant trains 1 and 2 will not contribute to the initial cumulative construction peak in 2012 but would comprise approximately 58% of combined workforce in the 2016 peak if these projects proceed as scheduled (Figure 32.1). The operational workforce for the Arrow LNG Plant is expected to comprise around 14% of the combined operational workforces of major projects in the study area.

Should all planned projects, including the Arrow LNG Plant, proceed as scheduled, a cumulative workforce peak of approximately 14,000 persons would be reached in 2016 (Figure 32.2). This is considered unlikely to occur. Several planned projects have been delayed or may not proceed, which will reduce the cumulative workforce growth.

A large proportion of workers will need to be sourced outside the study area on a fly-in, fly-out basis during project construction phases. All four LNG projects on Curtis Island intend to locate their primary construction workforce accommodation facilities on the island.

## Housing and Accommodation

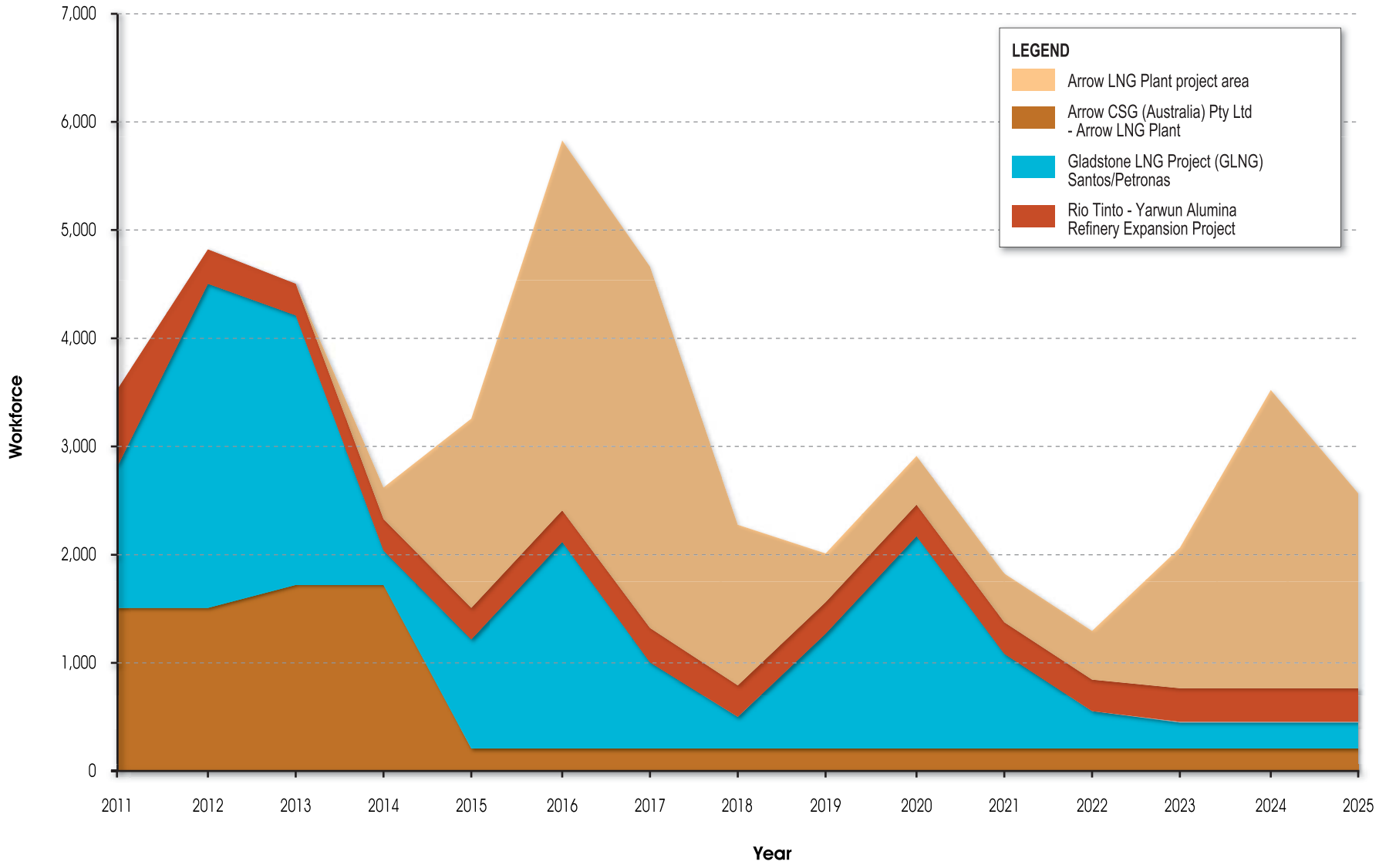
Without the supply of additional housing stock, projects that achieved financial investment decision would increase demand and exhaust current and proposed Gladstone housing stock. These impacts will occur prior to the construction of the Arrow LNG Plant.

When all planned projects are considered, demand for housing is likely to exhaust existing housing stock prior to the construction of the Arrow LNG Plant. The highest demand is likely to be experienced from 2011 to 2013. Demand for housing from other projects is expected to have eased slightly by the commencement of construction of the Arrow LNG Plant and will plateau for the duration of the construction phase. Following LNG project construction, demand for housing is likely to further decline.

The combination of these effects will result in property prices stabilising and potentially declining to a new equilibrium point.

## Employment and Training

A large increase in peak local employment will be generated from projects that have achieved financial investment decision. During peak construction of the Arrow LNG Plant, the combined workforce, including all projects that have received financial investment decision, would be 5,834 workers. Assuming 20% cumulative local employment, approximately 1,200 local workers will employed at the peak of the construction phase. During operation a total of 1,500 workers will be required, of which approximately 300 would be local workers, based on 20% local employment.




Source: Arrow Energy

coffey environments

Job No: 7033

File Name: 7033_07_F32.01_GL

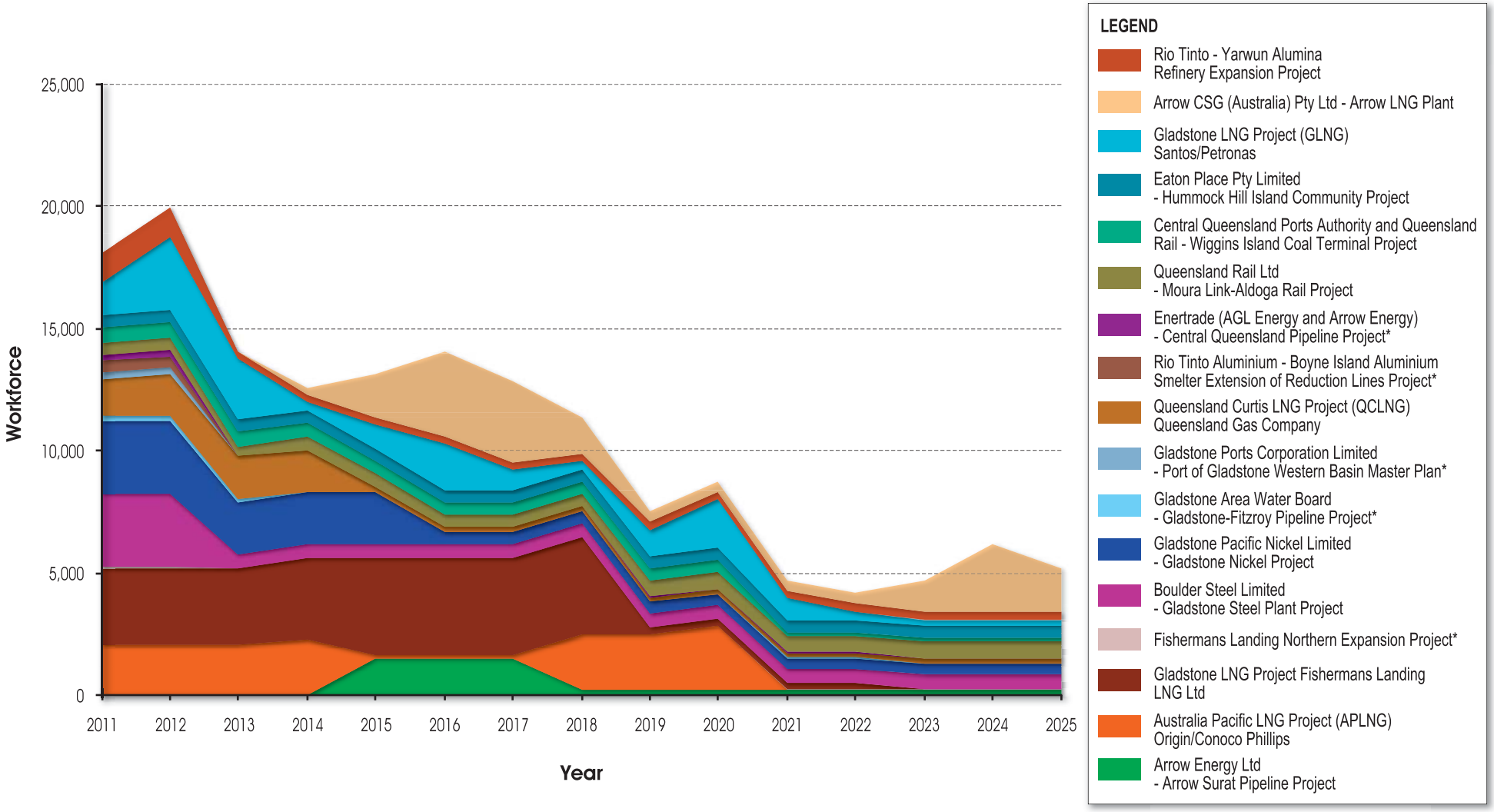
Arrow Energy

Arrow LNG Plant

arrow energy go further

Cumulative workforce baseline scenario

Figure No: 32.1




Source: Arrow Energy
Note:
*Workforce for these projects is too small to be visible on this scale

coffey environments

Job No: 7033
File Name: 7033_07_F32.02_HB

Arrow Energy

Arrow LNG Plant

arrow energy go further

**Cumulative workforce worst case scenario**

Figure No: 32.2

However, if all planned projects are considered, the cumulative workforce during the peak construction period of the Arrow LNG Plant will be approximately 14,000 people. Assuming local employment of 20%, this would employ a total of approximately 3,000 local workers, although it is unlikely, based on the size of the local labour force, that a pool of available labour would exist to meet this need. The combined construction period of all planned projects will also likely provide a construction related employment to at least 2025.

Cumulatively, during operation, 5,000 positions will be created. Allowing for 20% local employment, this will create 1,000 positions for local workers.

### Business

If all of the proposed projects included in the cumulative assessment proceed, they will generate increased opportunities for businesses to increase sales revenue and overall viability through the supply of goods and services. Existing businesses may expand and new businesses are likely to move to the region at least temporarily to provide services to projects under construction. Indirect benefits are also likely where services are needed to cater for population growth in Gladstone, rather than catering directly to the project e.g., building residential housing stock, undertaking road upgrade works, increased air services.

The potential loss of staff to projects may limit some businesses from taking up contract opportunities. Higher production costs due to increased wages, property rental and increased transportation costs may reduce profit margins for some businesses in the area.

Without implementation of appropriate management measures, the likelihood of adverse cumulative impacts on local business is almost certain. However, Arrow Energy will develop a Local Industry Participation Plan as part of the project Social Impact Management Plan (see Attachment 7), and liaise closely with industry, relevant government departments and local industry to minimise negative impacts and maximise opportunities and benefits to local businesses.

### Social and Community Infrastructure

The number of families in the study area will increase as a percentage of workers relocate to the study area with their spouses and children, leading to increased demand for a range of community services and facilities.

Some growth capacity exists in the school system and ongoing consultation with Education Queensland will be required to inform the planning process and align with expected future demand. Demand for health and medical services will also increase with increasing population, including for public hospital services and general practitioners. Difficulties accessing local general practitioner services is likely to result in increasing numbers of people presenting to the emergency department of Gladstone Hospital for minor health and medical issues.

Indirect effects on community services and facilities are also likely to occur with higher living costs making it increasingly difficult for some services to attract and retain staff, which may reduce the level of services available. This may extend cumulative impacts to residents of other regional centres such as Rockhampton, should people leave the study area to access services elsewhere. To reduce the potential impact on local health services during construction, Arrow Energy will establish limited health facilities on Curtis Island for construction personnel.

### Land Use and Planning

Potential cumulative impacts have been reduced through the establishment of the Gladstone State Development Area by the Queensland Government, and the siting and engineering design

of the Arrow LNG Plant. Further industrialisation of the Gladstone State Development Area is expected through the construction of project components in the Curtis Island Industry Precinct, Yarwun Precinct, Clinton Precinct and the Materials Transport and Services Precinct. Permanent loss of public access for recreational and commercial boating and fishing activities will occur along the foreshore of the Curtis Island Industry Precinct, through establishment of exclusion zones around the four LNG plants.

### Recreation

Water-based activities may be impacted cumulatively as construction works at Curtis Island require the enforcement of multiple exclusion zones. This may affect marine and recreational traffic access to these areas, including for boating and fishing users. Congestion and potential safety impacts may occur as a result of increases in vessel traffic from all LNG projects. However, given measures put in place to manage marine construction traffic and LNG shipping movements (i.e., the operation of the LNG Maritime Movement Scheduling Authority and the adherence of LNG proponents to the Port Procedures Manual (MSQ, 2010)) the impact on community use and enjoyment of the marine environment of Port Curtis is expected to be low. The project will collaborate with other proponents to coordinate communications and responses to safety concerns such as increased activity in Port Curtis and will continue to liaise with Marine Safety Queensland regarding safety education campaigns for boat users and anglers.

Increased population growth and subsequent demand for water-based recreation is likely to impact on the use and access to the harbour and waterways. Concerns were raised during social impact assessment consultation that increased use of boat ramp facilities is likely to cause congestion.

Increased population growth is also expected to increase demand for other formal and informal recreational facilities, such as pools, tennis courts, squash courts, gyms, indoor sports, parks and bikeways.

### Domestic Gas Market

The cumulative gas market assessment (Appendix 22, Impacts on Domestic Gas Markets) involved modelling the impact that a series of approved projects would have on the gas market in eastern Australia. ACIL Tasman has estimated a total recoverable resource base of 110,000 PJ for Queensland coal seam gas production capability over a period of 25 years to support a full cumulative scenario.

Modelling indicates that major effects on domestic gas availability and pricing will result under the cumulative scenario. This is an extreme scenario whereby all potential projects proceed to full development capacity, which is unlikely to occur.

Under the cumulative scenario the following effects are expected with respect to gas prices:

- An average increase of $3.78/GJ (approximately 76%) is expected in the wholesale gas price in Queensland over the period 2020 to 2030 compared to the baseline. This increase is exaggerated as the modelling assumed an unrealistically high international LNG price after 2025. A more realistic average increase is between $2.10/GJ (42%) and $2.50/GJ (51%) above the baseline.
- Impacts in the southern states are expected to be smaller, with an average price increase of 2.6% in Victoria, 3.2% in New South Wales and 3.8% in South Australia, from 2020 to 2030.

With respect to gas consumption, increased pressure on the available gas resource is expected to drive marginal production into the high-cost area of the production cost curve. As a result,

compared to the base case, consumption is expected to reduce up to 266 PJ/a (approximately 20%), with an average reduction of 147 PJ/a (11%) expected from 2020 to 2030.

Reductions in gas consumption will largely occur in Queensland and the electricity generation sector is expected to account for most of this, with the industrial sector being affected to a lesser extent. Gas consumption for electricity generation in Queensland is expected to decline 108 PJ/a (approximately 23%) on average over the period 2020 to 2030. Gas usage levels in electricity generation are anticipated to continue to surpass the Queensland Government's minimum gas generation target of 18%, even at the point of greatest market impact under the cumulative scenario.

While the magnitude of adverse cumulative effects on gas prices and consumption is high, the likelihood of such effects occurring is low due in part to normal market mechanisms. The very significant commercial commitment needed to develop an LNG project requires high levels of confidence in the size and deliverability of the gas resource. A decision to proceed with investment could only occur if the size of the resource was sufficiently large and subsequently it is very unlikely that the cumulative scenario would occur with respect to the assumed size of the resource (110,000 PJ).

The cumulative risk is further mitigated by current policies of the Queensland Government relating to gas supply security. The Queensland Government has announced that, while it estimates the state has 500 years of gas supply at current levels, the state will establish a capacity for future fields to be reserved for domestic gas supply, should it be determined domestic supply is constrained (MMA, 2010b).

### Beneficial Impacts

A number of beneficial cumulative economic impacts are expected from the development of multiple projects in the region and include:

- An estimated investment of A$15 billion and estimated annual operating costs of A$750 million from the Arrow LNG Plant alone. Local, regional and state economies will realise the direct benefits and flow-on effects of these investments.
- The Arrow LNG Project will directly create of approximately 3,500 jobs during stage one of project construction, a further 2,330 jobs during stage two of project construction and up to 600 long-term jobs created during the Arrow LNG Plant operational phase. This will include both general positions and those that require training for highly skilled roles. If all planned projects proceed, an estimated 14,800 positions may be generated during peak construction.
- Increased wages and household incomes as separate development projects compete to attract and retain skilled workers.
- Enhanced domestic and commercial economic confidence due to better certainty in demand for goods, services, local infrastructure and assets.
- Expansion of supply chain networks, resulting in additional infrastructure development that may be coordinated and enhanced to support construction activities.
- Cumulatively, the LNG projects will reinforce Australia's position as a global energy producer of less carbon intensive energy resources.

### Avoidance, Mitigation and Management Measures

Most of the cumulative impacts from third party projects will occur prior to the construction stage of the Arrow LNG Plant, with the project contributing only partially to these. Cumulative impacts will be difficult to address should all projects go ahead, although this is unlikely as the majority of these projects have not begun as scheduled and may not proceed. Rather than increase any peak effect, the Arrow LNG Plant may extend impacts associated with other developments.

Mitigation measures to address the identified cumulative impacts have been identified in the Social Impact Management Plan (Attachment 7). Although all measures in the plan will assist in reducing impacts of the project, specific measures to address cumulative impacts have been proposed as follows:

- Continue to participate in the Industry Leadership Group for Coal Seam Gas Resource Projects.
- Participate in the existing Regional Community Consultative Committee for Gladstone.
- Participate in Coal Seam Gas Industry Monitoring Group established by APLNG and QCLNG.
- Liaise with the relevant body that can coordinate investment efforts across all proponents.
- Continue to engage the Office of the Coordinator-General to manage housing and accommodation across the industry.
- Continue to work with existing training providers to coordinate assistance for relevant training programs.
- Collaborate with the job service established by other proponents for local businesses.

## 32.3.4 Traffic and Transport

This section provides an assessment of cumulative impacts the road network and shipping when the Arrow LNG Plant and the three other LNG development projects in the study area (APLNG, GLNG and QCLNG projects) are considered.

Cumulative impacts to air services will be managed through consultation with air service providers, to enable providers to take advantage of the requirements for additional passenger movements. The use of charter flights may be considered if required.

The assessment is based on information provided in the Traffic and Transport Impact Assessment prepared by GTA (Appendix 23).

The operation and construction of the four LNG projects is likely to increase demand on bus services, taxis and the use of pedestrian and cycling infrastructure by personnel and their families who relocate to Gladstone. A range of mitigation measures to address increasing demands on social infrastructure arising from movement of personnel and families to Gladstone are considered as part of the Social Impact Management Plan (Attachment 7).

### Road Network

Modelling of cumulative traffic effects on the road network was undertaken for Arrow LNG Plant design scenario years 2014, 2016, 2024 and 2026. Only traffic data relating to third-party LNG projects that coincided with Arrow Energy's site peak travel times for the design scenario years was considered in the cumulative impact assessment. Traffic generated from non LNG development projects was accounted for via traffic growth rates for major roads endorsed by DTMR (see Chapter 28, Traffic and Transport).

The cumulative traffic modelling for the LNG projects assessed intersections along the road network (see Figure 28.3) that may be affected by increased traffic, and the capacity of these intersections to accommodate the predicted increases. Of the intersections assessed (those intersections deemed likely to experience a greater than 5% increase in annual average daily traffic due to the LNG projects), modelling indicated the following intersections would accommodate cumulative LNG project traffic:

- Intersection D: Gladstone–Mount Larcom Road/Reid Road.
- Intersection Q: Gladstone Port Access Road/Glenlyon Road/Railway Street.
- Intersection T: Hanson Road/Lord Street.

Other intersections are less able to accommodate cumulative project traffic without being upgraded. Modelling shows several of these intersections will not operate at an acceptable level due to background traffic growth irrespective of the LNG projects. Table 32.1 summarises the outcomes of the modelling for these intersections and identifies the predicted impacts on these intersections of the cumulative traffic volumes of the four LNG projects. Intersections A, B, C and E were found to be least able to accommodate cumulative project traffic without upgrades being brought forward, with modified layouts in the case of intersections A and C.

The planned road works by DTMR and project related road and intersection upgrades are also identified in Table 32.1. Assuming these measures are implemented, cumulative impacts on the road network are not expected to be significant.

**Table 32.1 LNG proponents cumulative intersection assessment**

| Intersection | Design Year | Scenario | Issues and Potential Impacts | Mitigations (Upgrades and Modified Layout) |
|---|---|---|---|---|
| Intersection A: Hanson Road/ Blain Drive/Alf O'Rourke Drive | 2016 | All scenarios | Intersection exceeds capacity at 2016 for LNG projects. | Bring forward DTMR works with modified layout to accommodate traffic generated by the LNG proposals. |
| | 2024 | Scenarios 1,4,5 | Intersection not operating at acceptable level irrespective of LNG projects. | |
| Intersection B: Landing Road/ Gladstone–Mount Larcom Road | 2024 | Scenario 3 | Intersection is not able to accommodate cumulative LNG project traffic. | Bring forward DTMR works for planned period 2020-2030. |
| | 2026 | Launch site 1/4N | | |
| Intersection C: Gladstone–Mount Larcom/Red Rover Road | 2016 | Scenario 3/4 | The upgrade required for background traffic may not be sufficient to provide for cumulative LNG project traffic under scenarios 3 and 4. | Bring forward DTMR works with a modified layout. |
| | 2026 | Launch site 4N | | |
| Intersection E: Dawson Highway/Blain Drive/Herbertson Street | 2026 | Launch site 1/4N | Intersection is expected to accommodate cumulative LNG project traffic up until 2024. Following the peak construction period, cumulative impacts will impact the intersection. | Upgrade may be required. |
| Intersection R: Glenlyon Road/ Bramston Road intersection | 2016 | All scenarios | The addition of cumulative LNG project traffic does not impact beyond that expected during network peak periods. The impact by LNG projects is not considered significant, though may spread the congestion of traffic. | Intersection upgrades should be determined by DTMR for background traffic. |
| | 2024 | All scenarios | | |
| | 2026 | Launch site 1/4N | | |

**Table 32.1 LNG proponents cumulative intersection assessment (cont'd)**

| Intersection | Design Year | Scenario | Issues and Potential Impacts | Mitigations (Upgrades and Modified Layout) |
|---|---|---|---|---|
| Intersection L: Dawson Highway/ Aerodrome Road | 2026 | Launch site 1/4N | Intersection is expected to accommodate LNG project traffic up until 2024. Cumulative impacts will impact the intersection in the early site peak period. The intersection still operates to a better standard than is anticipated in the AM network peak period, without LNG project traffic. | Upgrades are not considered necessary due to cumulative LNG project impacts. |

Once the site selection for the TWAF and launch site is finalised, Arrow Energy will develop a traffic management plan in consultation with DTMR and Gladstone Regional Council. Arrow Energy will liaise with other LNG proponents on an ongoing basis to ensure that the traffic management plan is kept up to date and accommodates traffic movements associated with other projects. The traffic management plan will be developed in conjunction with a detailed logistics strategy to be developed for the project. Details of the traffic management plan and logistics strategy are provided in Chapter 28, Traffic and Transport.

## Shipping

Potential cumulative impacts of shipping in Port Curtis are associated with the increased volumes of shipping due to the construction and operations of the Arrow LNG Plant and other developments. Potential impacts include pollution and the potential for major spills through vessel grounding or collision.

### *Marine Construction Traffic*

During construction, fast passenger ferries, RoPax ferries, barges, heavy purpose cargo vessels, dredgers and support vessels will be operating in Port Curtis. The LNG Maritime Movement Scheduling Committee will manage and monitor marine construction traffic travelling from the mainland to Curtis Island to reduce cumulative impacts of this traffic in the harbour.

### *Marine Operations Traffic*

If all proposed projects are approved, an additional 1,344 one way LNG carrier trips and 560 one way coal export vessels from the Wiggins Island Coal Export Terminal totalling 1,904 vessels will be expected per year through Port Curtis and, depending upon the shipping route, may also pass through designated shipping lanes within the Great Barrier Reef Marine Park. Currently, over 3,500 ships exporting commodities make over 9,700 voyages through or near to the Great Barrier Reef Marine Park each year (GBRMPA, 2010). Of those, over 1,200 vessels enter Port Curtis (GPC, 2010c).

All vessels entering the Great Barrier Reef Marine Park and Port of Gladstone are expected to comply with applicable maritime law, Commonwealth and state legislation, and local port rules to keep the risks of an accident as low as possible. This includes rules for the prevention of pollution, ballast water management and waste management.

The modelling of port activities commissioned by Gladstone Ports Corporation (AECOM, 2010) takes into account the operation of all four LNG projects with shipping impacts assessed as low subject to the management of ship movements in accordance with port requirements. A collision between two LNG carriers was assessed in the Gladstone Marine Hazard Identification Study (ELP, 2010b) as a non-credible event due to strict passing rules and separation distances

between ships. The Port Procedures Manual (MSQ, 2010) includes specific LNG shipping protocols based on ship simulations for all LNG projects, with which all projects must comply.

Details of the actions that will be undertaken to minimise impacts associated with marine construction traffic and LNG shipping operations are provided in Chapter 28, Traffic and Transport.

### 32.3.5 Marine Environment

Cumulative impacts to the marine environment will occur to both physical (water quality) and biological values (marine and estuarine ecology).

Project dredging activities that could occur concurrently with other dredging activities in Port Curtis are limited to Stage 2 of the Western Basin Dredging and Disposal (WBDD) Project dredging at Laird Point. The dredge management plan for the Arrow LNG Plant will consider the locations and timing of all dredging activities in Port Curtis (project and non-project) and additional modelling work may be necessary to determine the likely extent of any dredge plume interaction and associated impacts.

#### Impact on Marine Fauna

Increases in vessel frequency and varying navigation routes used by each project could interfere with the feeding and movement of marine fauna species within Port Curtis. Dugongs, turtles and some species of cetaceans, e.g., dolphins, will be susceptible to boat strike and underwater noise. In addition, the increase in lighting has the potential to modify the behaviour of some species of marine fauna, in particular turtles.

##### *Boat Strike*

The cumulative impacts of boat strike on large marine organisms such as dugongs, marine turtles and cetaceans are related to increasing marine vessel movements from all port activities, to which the Arrow LNG Plant will likely be a relatively small contributor. The main shipping channels are away from the seagrass feeding areas and the zones of impact risk are not increased, although the level of risk to animals that cross shipping channels will increase relative to increased shipping activity.

The greatest potential for boat strike will occur where construction of all projects occurs concurrently, resulting in the greatest number of vessel movements occurring at the same time. Boat strike is mostly associated with faster vessels such as fast passenger ferries, RoPax ferries and some support vessels. The total vessel movements in Port Curtis during the construction and operation phases for all projects are indicative only. While third party LNG carrier movements are known, other vessel numbers and movements are not available. Vessel movements for all projects are likely to become available during the detailed design phase of the Arrow LNG Plant.

Reduced speed and vigilance are the most effective mitigation against boat strike. Additional measures such as propeller guards and hull design can reduce the severity of injury from accidental collision. These measures will only be effective if they are implemented as part of an overall management strategy for the Port of Gladstone. Consequently, cumulative impacts will be identified and managed as part of the development of a joint Port of Gladstone shipping activity strategy and management plan, which will include adherence to speed limits. Details are provided in Chapter 19, Marine and Estuarine Ecology.

##### *Underwater Noise*

The cumulative impact of underwater noise from vessel movements and pile-driving activities will depend on the construction schedule for the contributing projects and proximity of activities to

each other. For example, the Arrow LNG Plant proposed mainland launch site 1 is adjacent to the Wiggins Island Coal Terminal Project. If construction activities at these locations occur at the same time, cumulative impacts may occur. Note, however, that these construction schedules are not currently predicted to overlap. The distance between launch site 1 and Curtis Island is such that cumulative impacts will not arise from concurrent Arrow LNG Plant construction activities.

Prolonged impacts may arise if all activities happen sequentially, and an intensity effect may occur if activities all take place simultaneously. Zones of potential physiological harm are within tens of metres from sources; and cumulative effects will remain restricted to relatively small areas, with no overlap with other projects.

### *Lighting*

Light generated by all proposed projects could affect the behaviour of marine turtles. The closest turtle nesting beach to the Arrow LNG Plant site is 8 km away at Southend (see Figure 19.2). Of the proposed projects, the Arrow LNG Plant site has closest proximity to and a direct line of view to Southend. Light generated from the Arrow LNG Plant will be similar to existing and proposed industrial sources of light around Port Curtis.

The other LNG projects and port operations are expected to cause an indirect glow from light emissions during the construction, operation and decommissioning of each facility, which will be visible from Southend. Cumulative impacts will be low, given the distance from source and assuming the implementation by other LNG projects of similar mitigation measures to those proposed by the Arrow LNG Plant.

## Loss of Marine and Estuarine Habitat

If all proposed projects are approved and constructed, an unavoidable direct and indirect loss of marine habitat will occur in Port Curtis. This loss will add to any previous loss caused by existing marine infrastructure. A comparison of these cumulative losses is shown in Table 32.2, which outlines the predicted loss (both direct and indirect) of marine habitats related to each project.

The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Arrow Energy will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project (see Chapter 19, Marine and Estuarine Ecology). Other projects have been conditioned to provide offsets to reduce the residual impacts associated with loss of these habitats.

**Table 32.2 Estimated cumulative area of marine habitat to be directly or indirectly impacted**

| Project | Area of Environmental Habitat to be Directly or Indirectly Impacted (ha) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mangroves*** | | **Saltmarsh*** | | **Seagrass** | | **Reef and Rock Substrate** | | **Benthic Zone and Intertidal Mudflat** | | **Fish/Intertidal Habitat†** | | **Total** |
| | Direct | Indirect | Direct | Indirect | Direct | Indirect | Direct | Indirect | Direct | Indirect | Direct | Indirect | |
| Wiggins Island Coal | – | – | – | – | – | – | – | – | – | – | 398 | | **398** |
| WBDD Project | – | – | – | – | 258.8 | 1,406 | – | – | 643.2 | 4,010 | – | – | **6,318** |
| Fishermans Landing | 1.45 | – | 0.45 | – | 89.18 | – | – | – | 84.35 | 461.51 | 395 | 3,728 | **4,759.94** |
| APLNG Project | 2.4 | – | 31.7 | – | – | – | – | – | – | – | – | – | **34.1** |
| GLNG Project | 4.42 | 28.09 | 25.26 | 18.44 | – | 34 | – | – | – | – | – | – | **110.21** |
| QCLNG Project | – | 9.4 | – | – | 2.00 | – | – | – | – | – | – | – | **11.40** |
| Gladstone LNG (Fishermans Landing) | | | | – | – | – | – | – | – | – | – | – | 3.3 |
| Hummock Hill | 0.86 | – | 0.04 | – | – | – | – | – | – | – | – | – | 0.90 |
| *Subtotal* | *9.13* | *37.49* | *57.45* | *18.44* | *349.98* | *1,440* | *0* | *0* | *727.55* | *4,471.51* | *793* | *3728* | *11,635.85* |
| Arrow LNG Plant | 2.36 | 0 | 59 | 0 | 0 | 0 | 0.14 | <0.1 | 5.31 | 0 | – | – | 66.81 |
| **Cumulative Area (Total)** | **11.49** | **37.49** | **116.45** | **18.44** | **349.98** | **1,440** | **0.14** | **<0.1** | **732.86** | **4,471.51** | **793** | **3,728** | **11,702.66** |
| **Arrow LNG Plant (% of total area)** | **20.54** | **0.00** | **50.67** | **0.00** | **0.00** | **0.00** | **100.00** | **0.00** | **0.72** | **0.00** | **0.00** | **0.00** | **0.57** |

* Components of or regional ecosystems listed under the Vegetation Management Regulation. (Regional Ecosystems determined by DERM)

† Fish and intertidal habitats sourced from proponent documents are not separated into individual environmental values. Areas provided are assumed to be inclusive of mangroves, saltmarsh and seagrass.

### 32.3.6 Landscape and Visual

The cumulative impact assessment considered impacts on landscape and visual amenity and of lighting from the increased number of developments planned and under construction in the Gladstone region (see Appendix 17, Landscape and Visual Impact Assessment). The method described in Chapter 23 (Landscape and Visual Impact Assessment) was also used to assess cumulative impacts and adopted a qualitative approach consistent with established impact assessment guidelines. The impact assessment in Chapter 23 has already taken into account the QCLNG and GLNG projects on Curtis Island.

#### Landscape and Visual Cumulative Impacts

Large-scale industrial development is anticipated to expand in the Gladstone region over the next 30 years and is likely to be accompanied by large-scale supporting infrastructure. The Arrow LNG Plant will be situated within the Gladstone State Development Area, which is increasingly being characterised by industrial development.

Twelve other projects were considered in the assessment. It is possible, albeit unlikely, that construction of all projects will take place concurrently. During the construction phase, there will be major, albeit short term, cumulative impacts on landscape character, views and visual amenity. As some projects pass from the construction to the operational phase, their impacts will diminish, e.g., underground pipelines, whereas the impacts of others may increase e.g., operational LNG plant. Key cumulative impacts will include:

- Contrast with the current local landscape character from the presence of construction traffic and crews, construction compounds, large scale machinery including tall cranes, and exposed soil due to cut-and-fill activities. These construction activities are likely to be perceived adversely by sensitive viewer groups.
- Changes to the landscape character and views from the mainland as the forested Curtis Island is cleared and uncharacteristic construction equipment is introduced. The Arrow LNG Plant and APLNG, GLNG and QCLNG projects will have a noticeable impact on landscape character and views.

While still significant, the cumulative impacts described above of construction on the character of the mainland will be perceived to be lower, as this area is already significantly developed for industry and zoned for further development associated with the Gladstone State Development Area.

During the operation phase, the character of a large area around Gladstone is expected to change significantly, as many of the proposed developments are located on undeveloped sites. Although industrial development is already a key characteristic of the Gladstone area, the proposed developments will be highly visible.

The landscape and visual impact assessment (Appendix 17) identified several landscape character types (LCTs) in the Gladstone region (see Figure 23.2) and the impacts described below generally relate to impacts on these areas. Key cumulative impacts during operation will include:

- Considerable intensification and extension to the area of LCT 5: Industrial or extractive industries, with associated loss of some of the more ‘natural’ character areas including LCT 2: Undulating or flat forest, LCT 7: Coastal or estuarine plain, and LCT 8: Waterscape. This alteration in character is consistent with the proposals for the Gladstone State Development Area.

- Substantial alteration of the character of the Curtis Island landscape from a natural to industrial landscape. This change is significant for visual amenity of many vantage points located in Gladstone and for impacts on designated landscapes, particularly The Narrows. The proposal by Arrow Energy to construct a tunnel beneath Port Curtis means the Arrow LNG Plant will not contribute to cumulative visual impacts on The Narrows.

There will be significant impacts on a large number of landscape and visual receptors should the majority of the developments considered in the cumulative assessment take place. Key receptors to be impacted include:

- Designated landscapes including the Great Barrier Reef World Heritage Area, areas listed on the Australian Heritage Commission Register of National Estate (The Narrows, Garden Island Conservation Park) and significant landscapes of the Curtis Coast Regional Coastal Management Plan (Islands and Offshore Features: Curtis Island; Coastal Wetlands: Curtis Island and The Narrows, and Coastal Mountain Ranges: Curtis Island strike ridge and Mount Larcom Range) (see Figure 23.1).
- Three landscape character types, LCT 1: Forested mountain or ridge, LCT 2: Undulating or flat forest, and LCT 7: Coastal or estuarine plain.
- Nine viewpoints (Viewpoints 1, 2, 4, 6, 7, 8, 10, 11 and 12) (see Figure 23.3).

The impacts on visual receptors are likely to be more significant than those on landscape resources due to the large extent of prominent industrial development proposed. This development will affect many views of the Port Curtis landscape. The four LNG projects will extend industrial development from the mainland to the island. Even though some of the character of Port Curtis is influenced by existing industrial development on the mainland, Curtis Island is currently viewed as an inherently natural landscape feature and cumulative impacts on views of the island, including to the prominent strike ridge, will be significant.

In noting the above, the construction of the other LNG projects on Curtis Island commenced in 2011. Construction of the Arrow LNG Plant is not planned until 2014. The cumulative visual impact of the Arrow LNG Plant will be low, as construction activities within the Curtis Island Industry Precinct become a familiar sight to residents of Gladstone over the next three years.

Opportunities to mitigate cumulative impacts to landscape and visual values are limited, and are confined to mitigating impacts directly associated with the Arrow LNG Plant as described in Chapter 23, Landscape and Visual.

## Lighting

Impacts from lighting are associated with the changes to the night-time visual landscape. Many of the proposed developments considered in the cumulative impact assessment will introduce light into inherently darker landscapes. These projects will substantially increase overall artificial light levels and lead to an increase in the overall levels of sky glow, glare and light trespass throughout the Port Curtis area. Sky glow impact may extend into areas some distance from the facilities themselves.

As with impacts to landscape and visual values, mitigation measures for cumulative impacts of lighting are limited to mitigating impacts directly associated with the Arrow LNG Plant, as described in Chapter 23, Landscape and Visual.

### 32.3.7 Terrestrial Environment

This section describes cumulative impacts to the terrestrial environment, specifically the landform within which the project sits and terrestrial and freshwater ecology. The assessment is based on information in the Geology, Soils and Landform Impact Assessment (Appendix 2) and the Terrestrial Ecology Impact Assessment (Appendix 9).

Similar impacts on terrestrial ecology values in the Gladstone region were identified by most of the projects considered in the cumulative assessment. These included vegetation clearance, habitat fragmentation and disturbance to wildfire corridors, introduced flora and fauna, altered hydrology and pollution.

Specific impacts include an increase in the loss of habitat, particularly on Curtis Island, with reduced availability of habitat for species displaced by construction projects to disperse.

The combined clearing of regulated vegetation across all projects is likely to have the most significant cumulative impact on the flora and fauna of region. Table 32.3 details the cumulative impact of clearing regulated vegetation within the Gladstone region and within Queensland, as a result of current and approved projects within the Gladstone region.

**Table 32.3 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state**

| Regional Ecosystem (RE) and Status | Total Area Proposed to be Cleared by all Projects including Arrow LNG Plant (ha) | Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third Party Projects (%) | Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%) | Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%) |
|---|---|---|---|---|
| 11.11.15 (LC, -) *Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. | 149.30 | 0.00 | 0.38 | 0.03 |
| 11.11.18 (E, -) SEVT on old sedimentary rocks with varying degrees of metamorphism and folding. | 0.80 | 0.00 | 0.04 | 0.02 |
| RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains. | 486.90 | 9.50 | 8.09 | 0.26 |
| RE 12.1.2 (LC, -) Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains. | 121.10 | 49.10 | 0.77 | 0.42 |
| RE 12.1.3 (LC, -) Mangrove shrubland to low closed forest on marine clays and estuaries. | 20.48 | 28.30 | 0.12 | 0.04 |
| RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics. | 199.90 | 61.70 | 5.72 | 0.66 |

**Table 32.3 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state (cont'd)**

| Regional Ecosystem (RE) and Status[1] | Total Area Proposed to be Cleared by all Projects[2] including Arrow LNG Plant (ha) | Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third party Projects (%) | Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%) | Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%) |
|---|---|---|---|---|
| RE 12.11.6 (LC, -) *Corymbia citriodora, Eucalyptus creba* open forest on metamorphics ± interbedded volcanics. | 483.40 | 14.80 | 0.52 | 0.20 |
| RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics. | 3.90 | 100.00 | 0.13 | 0.10 |
| RE 12.2.2 (OC, CE) Microphyll/notophyll vine forest on beach ridges. | 0.40 | 0.00 | 0.02 | 0.01 |
| RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains. | 202.60 | 16.00 | 0.98 | 0.47 |
| RE 12.3.6 (LC, -) *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland on coastal alluvial plains. | 3.60 | 100.00 | 0.09 | 0.00 |
| RE 12.3.7 (LC, -) *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest. | 7.10 | 59.20 | 0.08 | 0.01 |

Notes: Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e., 12.11.14/12.11.4 and 12.11.6/12.11.14), the dominant RE area was chosen (in this case, 12.11.14 and 12.11.6 respectively).

[1] Regional Ecosystem status: CE = Critically Endangered, E = Endangered, OC = Of Concern, LC = Least Concern (Vegetation Management Act, EPBC Act).

[2] Projects included APLNG Project, WBDD Project, Fishermans Landing Northern Expansion Project, Arrow Surat Pipeline Project, Central Queensland Pipeline Project, Wiggins Island Coal Terminal Project, Gladstone Nickel Project, Gladstone Steel Plant Project, Moura Link-Aldoga Rail Project, Gladstone-Fitzroy Pipeline Project, Hummock Hill Island Community Project, Boyne Island Aluminium Smelter Extension of Reduction Lines Project, GLNG Project, QCLNG Project, Yarwun Alumina Refinery Expansion Project.

Table 32.3 shows that, of the overall area of regional ecosystems in the Gladstone Regional Council area, the proportion to be cleared as a result of identified projects is generally low, being less than or equal to 1.0% in most cases.

Regional Ecosystem 11.3.4 ('Of Concern'), *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains, will be the most significant loss of a regional ecosystem type within the Gladstone Regional Council area. The loss as a result of all projects in the cumulative assessment will be approximately 8.1%. At a state level, this loss is approximately 0.26%.

Regional Ecosystem 12.11.14 ('Of Concern'), *Eucalyptus crebra*, *Eucaplyptus tereticornis* woodland on metamorphics with or without interbedded volcanics, will be reduced by approximately 5.7% within the Gladstone Regional Council area, and 0.66% at a state level.

The 'Endangered' Regional Ecosystem 12.3.3, *Eucalyptus tereticornis* woodland to open forest on alluvial plains, will be reduced by approximately 0.47% at a state level.

The following impacts are likely to be more apparent within these ecosystems as a result of cumulative losses:

- Reduced existing habitat patches including the loss of habitat function for native fauna including shelter, breeding areas and foraging resources. This may result in reduced fauna abundance and diversity in the Gladstone region.
- The aggregated loss of hollow bearing trees required by a wide range of terrestrial fauna species for shelter and breeding, including arboreal mammals, microbats, owls, parrots and ducks. This could result in impacts on several threatened species, including the powerful owl, glossy black-cockatoo and several species of listed microbat.
- The cumulative loss of mangrove habitat, which supports several species of threatened fauna. Increased fragmentation of the coastal mangrove corridor may increase impacts to the water mouse and several species of migratory and non-migratory shorebird (including eastern curlew and beach stone-curlew).

Overall, the cumulative impact of the Arrow LNG Plant on habitat loss is considered low. In the case of LNG projects, development will take place within the Curtis Island Industry Precinct, which covers less than 3% of Curtis Island and lies adjacent to an Environmental Management Precinct. The Curtis Island National Park lies further to the north. These undeveloped areas provide alternative habitat opportunities. Similarly, on the mainland, most industrial development is proposed along the coastal strip and typically away from heavily forested areas.

Arrow Energy will provide environmental offsets for unavoidable impacts arising from the development of the Arrow LNG Plant. Similar conditions have been placed upon other LNG projects on Curtis Island. Areas requiring offsets will be further defined in consultation with regulatory agencies following completion of the Arrow LNG Plant front end engineering and design and prior to the commencement of construction (see Chapter 17, Terrestrial Ecology).

### 32.3.8 Waste Management

Impacts on the capacity of existing landfill, wastewater and recycling facilities to manage cumulative wastes from existing and future industry are described below.

#### Landfills

Several licensed landfills operate in the Gladstone region, the largest of which is the Benaraby Regional Landfill approximately 20 km south of Gladstone. It is assumed that all solid waste generated by the project will be disposed of at this landfill. A minimum of 1,364,100 tonnes of solid waste over a period of 30 years is likely to be generated by the project and other commercial waste generators in the area. The project is expected to generate approximately 1.64% of this waste. The operating life of the Benaraby Regional Landfill is unlikely to be affected by cumulative waste disposal, as the landfill has the capacity to accept waste from the Arrow LNG Plant and from other proposed projects in the area.

The licensed disposal rate of 50,000 t/y will only be exceeded if construction of the proposed projects occurs simultaneously, as the majority of waste is generated during construction activities. Should a significant overlap of project construction timetables occur, a temporary increase in capacity might be considered for Benaraby Regional Landfill, with facility representatives working with project developers to reduce the production of waste. Alternatively,

waste generators may need to find temporary storage or alternative options for disposal. Disposal charges may be incurred to compensate for the additional resources required to manage the waste.

### Wastewater

The Calliope River Sewage Treatment Plant and the South Trees Sewage Treatment Plant are the two main wastewater treatment facilities located within the city of Gladstone, with the Calliope River Sewage Treatment Plant treating approximately 97% of Gladstone's wastewater. Several smaller facilities operate at Yarwun, Aldoga, Boyne Island, Tannum Sands and Calliope Town.

In the Gladstone region, a minimum of approximately 6,120 ML/a of liquid waste (sewage) will require treatment and disposal over the next five years, and 5,983 ML/a thereafter for an additional 25 years. Of the waste requiring treatment and disposal in the first five years, approximately 2.2% is predicted to be generated by the Arrow LNG Plant.

Both the Calliope River Sewage Treatment Plant and the South Trees Sewage Treatment Plant have capacity available to take Arrow Energy's wastewater and are planning upgrades to increase their capacity. These upgrades will provide capacity to accept liquid waste from the Arrow LNG Plant and from other proposed projects in the area should these projects connect to Gladstone sewerage system.

### Recycling

Recycling collection facilities exist within the Gladstone Regional Council area for wastes such as oils, concrete, tyres, paper and cardboard, glass, and some plastics. Recyclable waste from commercial producers is typically collected by waste contractors who transport the recyclables for a fee to locations designated by the client, or store the recyclables at their depots until there is sufficient quantity to transport to processing facilities in southeast Queensland.

There are limited recycling processing opportunities in Gladstone. Several local scrap metal merchants receive scrap ferrous and non-ferrous metal for processing. Glass, plastic, paper and cardboard is either transported to Rockhampton or to southeast Queensland by train or truck to processing facilities located in and around Brisbane.

Approximately 41,600 t of recyclable waste will be generated over 30 years by the project and other commercial waste generators in the area. Approximately 11.9% of this waste is predicted to be generated by the Arrow LNG Plant.

To manage the limited opportunities for recycling waste materials in Gladstone, waste contractors will be consulted to arrange temporary storage and alternative options for disposal (see Chapter 31, Waste Management).

## 32.4 Conclusion

The assessment of cumulative impacts has considered all relevant existing and proposed projects. The avoidance, mitigation and management strategies provided in each of the impact assessment chapters in this EIS were developed to address the effects of cumulative impacts on environmental values as well as the effects on these values from stand-alone project impacts.

For the most part, the different aspects of project impacts occur across a small and localised area and do not spatially intersect with third party project impacts. Project impacts that do intersect with third party impacts generally do not result in cumulative impacts that have been assessed as significant, particularly after the application of mitigation measures developed for the Arrow LNG Plant (see Attachment 6, Environmental Management Plan).

Key cumulative impacts are those associated with increased road and shipping traffic, increased demand for housing, local workers and social services, and terrestrial habitat clearance.

The project will be developed during a major expansion of the Port of Gladstone for the LNG industry and several other major industrial projects. The cumulative impacts to the marine environment and to the social and economic setting of this development will be managed and coordinated with regulators and third party proponents to minimise impacts as far as practicable. Arrow Energy will, for example, participate in developing a joint shipping activity management plan with other harbour users, prepare a traffic management plan that reflects the actual timing of other projects in relation to Arrow Energy's project timelines, and will actively contribute to government and industry groups set up in Gladstone to coordinate activities of the various projects, including the implementation of action plans developed in the social impact management plan to collaboratively address cumulative social impacts.

Impacts to terrestrial ecology will require careful management and coordination between third party proponents and regulatory authorities. Coordinated management will reduce the potential cumulative effect of habitat reduction that may impact threatened flora and fauna. In addition, where impacts to habitats are unavoidable, suitable offsets will be developed in consultation with appropriate government agencies to compensate for such losses.

In summary, the application of mitigation methods combined with cooperation and coordination with regulatory authorities and third-party project proponents is expected to reduce negative cumulative impacts to levels that are both manageable and acceptable, while enhancing positive social and economic benefits that will arise from project investment.

## 32.5 Commitments

The mitigation measures proposed in each of the EIS chapters will assist in managing the potential cumulative impacts related to the environmental values. Those measures of particular relevance to addressing cumulative impacts are presented in relevant chapters and also set out in Table 32.4 below.

**Table 32.4 Commitments: Cumulative Impacts**

| No. | Commitment |
|---|---|
| C17.02 | Determine areas (if any) requiring to be offset in consultation with DERM and DSEWPC and other government stakeholders prior to commencement of construction. This is likely to include the two areas of 'Endangered' (VM Act) remnant vegetation (RE 12.3.3; Assets 27 and 31) within the LNG plant site, and the *Cupaniopsis* sp.indet population. |
| C19.02 | Establish a marine offsets strategy for the project to compensate for the loss of marine and estuarine habitat as a result of the project. |
| C19.04 | Contribute to the development of a Port of Gladstone shipping activity strategy and management plan. Comply with applicable speed limits for the Port of Gladstone-Rodds Bay Zone B dugong protection area, as detailed in the management plan. |
| C26.71 | Continue to participate in the Industry Leadership Group for Coal Seam Gas Resource Projects. |
| C26.72 | Participate in the existing Regional Community Consultative Committee for Gladstone. |
| C26.73 | Participate in Coal Seam Gas Industry Monitoring Group established by APLNG and QCLNG. |
| C26.74 | Liaise with the relevant body that can coordinate investment efforts across all proponents. |
| C26.75 | Continue to engage the Office of the Coordinator-General to manage housing and accommodation across the industry. |
| C26.76 | Continue to work with existing training providers to coordinate assistance for relevant training programs. |

**Table 32.4 Commitments: Cumulative Impacts (cont'd)**

| No. | Commitment |
|---|---|
| C26.77 | Collaborate with the job service established by other proponents for local businesses. |
| C28.01 | Develop a traffic management plan for the project in consultation with DTMR and Gladstone Regional Council. Methods to ensure public safety at project sites, avoid obstruction to other road users, address seasonal weather influences on transport arrangements and manage any issues including driver fatigue will be detailed in the plan. The traffic management plan will address the movement of oversized loads. Common with Chapter 29, Hazard and Risk. |
| C28.07 | Consult with providers of air services to Gladstone on the timing of construction and operations weekly shifts to aid commercial decision making by service providers on the frequency of services and capacity of aircraft. |
| C28.09 | Develop a shipping activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port. Common with Chapter 29, Hazard and Risk. |