20 KEY FINDINGS AND CONCLUSION

20.1 INTRODUCTION

This chapter summarises the key findings of *Volume 5*, the environmental assessment of the LNG Component of the Project.

20.2 CLIMATE AND CLIMATE CHANGE

Fluctuations in ambient air temperature were taken into account when assessing potential impacts to LNG plant capacity and operation.

Predicted change in precipitation is not expected to significantly impact site operations. Plant structural elements will be designed and constructed in accordance with *AS/NZS1170: Part II: Wind Actions*, taking into consideration the appropriate designed cyclonic regional wind speeds applicable to Gladstone as outlined in AS/NZS1170.

The maximum projected storm surge level by 2070 is 4.71 m Australian Height Datum (AHD), which takes into account the combined effect of a 10 per cent increase in Maximum Potential Intensity (MPI) of cyclones, a 1.3° poleward shift in tracks, 10 per cent increase in frequency of tropical cyclones and a 0.3 m rise in mean sea level. Mitigation measures include accounting for the potential increase in sea level rise at the LNG Facility by placing key LNG Facility infrastructure above 6 m AHD and allowing for storm surges and potential wave action in the design of marine facilities.

The buffer zone proposed in the Bushfire Management Plan is anticipated to mitigate any increased likelihood of bushfires as a result of climatic extremes and climate change.

20.3 TOPOGRAPHY AND GEOMORPHOLOGY

The majority of the LNG Facility site is elevated between 10 m and 25 m AHD, rising to more than 80 m near the eastern site boundary. The LNG plant footprint, within the LNG Facility, is located within a basin-like structure with hills on the southern, northern and western boundaries. The highest ground elevation within the footprint of the LNG Facility site itself is approximately 50 m AHD at the back (eastern site) of the LNG plant.

The western margin of the LNG Facility site is flanked by intertidal to supratidal salt and mangrove flats. The intertidal flats range from approximately 0.5 m to 3 m above sea level and extend approximately 100 m

to 250 m from the line of lowest astronomical tide (LAT).

The main factors controlling the geomorphological development on Curtis Island are water (as run-off and tidal movements), vegetation, soils and geology. Two main watercourses (ephemeral flow only) are located within the LNG Facility site[1], flowing through the site from the north-east to the south-west. There are several smaller first and second order perennial water courses which flow into the main creeks from the elevated areas on the south and north of the site.

Based on the field observations of the relatively low relief and the extensive coverage of the site by colluvium, the potential for extensive erosion and run-off across the site is not considered significant. However, run-off and erosion may be accelerated during periods of heavy rainfall, which are more common between December and February.

No evidence of seismic activity or landslides has been observed within the LNG Facility boundary or immediate surrounds. The initial assessment considered the risk of landslide, as defined in SP 1/03, acceptable for the LNG Facility site and associated pipeline and infrastructure.[2]

20.4 GEOLOGY AND SOILS

Preliminary geotechnical assessment identified no issues that would require significant amendment to the LNG Facility site layout. Infill geotechnical assessment will continue to inform detailed design.

A probabilistic seismic hazard assessment (PSHA) and a review of published seismicity data for the LNG Facility site have been undertaken. The LNG plant design has incorporated the finding of the PSHA.

The potential for soil erosion at the LNG Facility site, as it currently exists, is considered low due to the shallow depth of the soil profiles, the presence of extensive colluvium cover, vegetation coverage and the relatively gentle topography of the site. The erosion potential is dependent upon climatic conditions, and would increase during periods of heavy rainfall, particularly along water courses which are present on the LNG Facility site. Erosion and sediment control measures will be implemented during construction.

Acid sulfate soils (ASS) were identified in areas on Curtis Island and Friend Point on intertidal to supratidal sediments at elevations < 5 m AHD. The analysis of ASS from Friend Point and Curtis Island revealed that the sulfate content (SPOS - %S) ranged between <0.02 per cent to 3.72 per cent at

1 Environmental Resources Management Australia, 2009. *Queensland Curtis LNG Plant: Geology and Soils Report*.

2 *ibid.*

Friend Point and <0.02 per cent to 7.2 per cent at Curtis Island. The upper 0.3 m at both sites was generally oxidised, with SPOS < 0.02 per cent. The maximum concentration of SPOS occurred at depth of 0.5 m to 1 m at both locations and exhibited marked variation between sampling locations. An ASS Management Plan (ASSMP) will be implemented during construction.

The Good Quality Agricultural Land (GQAL) assessment determined the LNG Facility site has a land suitability of Class C3 - Pasture land – Land suitable for light grazing of native pastures in inaccessible areas. As Class C-3 is not considered GQAL, the use of the land as an LNG Facility will not have a direct impact or result in the loss of GQAL.

20.5 LAND USE AND INFRASTRUCTURE

The establishment of an LNG Facility on Curtis Island represents a change in historical and existing land use on Curtis Island. However, the construction and operation of the LNG Facility is consistent with the strategic planning direction in the Gladstone region. The expansion of the Gladstone State Development Area (GSDA) to include the Curtis Island Industry Precinct sets a clear framework for future industrial land use and investment on Curtis Island, and the proposed LNG Facility is one of several LNG projects that intend to locate within the precinct. The GSDA's Environmental Management Precinct will provide a significant buffer between the new industrial precinct and the remainder of Curtis Island.

The establishment of the Curtis Island Industry Precinct for use by LNG facilities on Curtis Island will provide continued economic activity in the region and capitalise on existing port infrastructure and capabilities within the region.

Impacts arising from the Project components in Gladstone will primarily be short-term during the construction period. Detailed design of the Export Pipeline route and the access road will be undertaken to minimise direct and indirect impacts on extractive minerals and resources.

Existing infrastructure in Gladstone has sufficient capacity to withstand the direct and indirect impacts of the construction and operations workforce. The operational LNG Facility will be self sufficient for power, water and waste water disposal and will not have a direct impact on infrastructure in mainland Gladstone.

20.6 LAND CONTAMINATION

According to the results of the Phase I Environmental Site Assessment (ESA), the only potential soil contamination activity identified at the LNG Facility site was a former cattle dip. Analytical results of the limited Phase II ESA

identified elevated concentrations of metals in shallow soil samples. However, the reported concentrations were below relevant site criteria.

Based on results of the Phase I and II ESA, there is no indication that significant contamination from organic and inorganic compounds exists in soil and groundwater. Management measures will be implemented to prevent contamination arising from Project activities.

20.7 TERRESTRIAL ECOLOGY

The LNG Facility site contains a biodiversity assemblage that is typical of coastal Queensland environments. Due to ongoing disturbance (the presence of feral species and historic land-use), habitat condition is considered to be degraded and contains few native species of conservation significance.

Terrestrial ecology within the LNG Facility site likely to be impacted include one Endangered Regional Ecosystem (RE) (12.3.3), two "Of Concern" REs (12.3.11 and 12.11.14), two fauna species of regional significance (Yellow-bellied Glider and Beach-stone Curlew), four bird species of state significance (Squatter Pigeon, Beach Stone-curlew, Eastern Curlew and Powerful Owl) and four migratory bird species of national significance (Bar-tailed Godwit, Eastern Curlew, Whimbrel and Common Greenshank).

Field surveys of the Endangered (*VM* Act) RE 12.3.3 (*Eucalyptus tereticornis* (Blue Gum) woodland to open forest on alluvial plains) communities that occur within the LNG Facility site and pipeline corridor found that these remnants were generally in good condition. Approximately 40 ha of this Regional Ecosystem are proposed to be removed from the LNG Facility site and pipeline corridor (areas within the road corridor have not been included as this is not part of the Project area), with this proposed clearing assessed as constituting a significant impact on this RE. An offset of 57 ha of similar vegetation has been proposed to account for negative direct impacts to the Regional Ecosystem. Specific recommendations have also been provided to avoid direct impacts on smaller remnants of this vegetation community by realignment of road and pipeline corridors where possible.

Approximately 8 ha of Of Concern Regional Ecosystem (dominant and sub-dominant) consisting of RE 12.3.11 (*Eucalyptus siderophloia, E. tereticornis*, *Corymbia intermedia* or Grey Ironbark, open forest on alluvial plains usually near coast) and 12.11.14 (*Eucalyptus crebra, E. tereticornis* (ironbark) woodland on metamorphics ± interbedded volcanics tree species) are proposed to be cleared within the LNG Facility site and pipeline corridor. Generally the dominant Of Concern RE 12.3.11 was found to be in good condition due to low weed density and was considered high-quality fauna habitat. This subdominant Of Concern RE 12.11.14 was found to be in a poor condition due to the openness of the native vegetation, regular fires and high weed density. Although the direct impacts on these REs has been determined

as not significant based on the proportionate area occurring within a 10 km radius, offset recommendations have been made to account for an equivalent of 12 ha or greater of Of Concern Regional Ecosystem.

No terrestrial plants, amphibians, reptiles or mammals of state or national conservation significance are expected to occur within the LNG Facility site. However, the LNG Facility is likely to affect reptiles, amphibians and mammals that exist within the site by habitat removal and ongoing disturbance. Habitat fragmentation and dispersal barrier effects due to the proposed road and pipeline corridors are direct impacts on existing fauna. Specific recommendations have been provided to minimise direct and indirect impacts and ameliorate unavoidable disturbance effects.

The Powerful Owl is known to inhabit the LNG Facility site and the cumulative impact of this and other adjoining proposals will remove a substantial area of potential foraging habitat and potential nest and roost sites for the species. Several breeding pairs of Beach Stone-curlews use habitat within and immediately adjacent to the LNG Facility site. Small numbers of Squatter Pigeons were recorded along the proposed mainland access road, although no potential Squatter Pigeon habitat was recorded within the LNG Facility site on Curtis Island. Recommendations to minimise the direct impacts of the Project on these species have been provided.

Primary threats to migratory bird species are associated with the road alignment at Kangaroo Island and Lairds Point. The proposed road alignment would result in the removal of neap tide roosting habitat and foraging habitat of the EPBC listed Eastern Curlew, which is a significant impact of the Project. Management recommendations have been provided to avoid, and where necessary, manage, the direct impacts of these activities on shorebirds in the vicinity of the Project, bearing in mind that QGC is not the proponent of the proposed roads.

Management measures have been designed to provide strategies for minimising the direct and indirect impact of the Project on the ecology of the area, and to limit adverse impacts on significant species. Provided that the specific management recommendations are implemented, offsets are established and maintained appropriately, and ongoing environmental management is a key component of the Project, the direct, indirect and cumulative impacts should be localised.

20.8 MARINE ECOLOGY

The main components of the Project with the potential to have direct and indirect impact on the marine environment are those associated with the construction and subsequent operation of the:

- pipeline crossing of The Narrows

- Materials Offloading Facility (MOF)
- loading jetty
- LNG Facility itself, including the discharge source points.

Direct impacts anticipated to occur during the construction phase arise as a result of the dredging and reclamation required to prepare and install infrastructure and dispose of dredge material. These include direct impacts on habitats such as seagrasses and mangroves from the footprint of structures and the reclamation area, as well as secondary impacts on water quality and behavioural changes from mobile marine species (such as the EPBC listed dugong) that are likely to be disturbed in the short term by the increased turbidity or noise.

Changes to local bathymetry and the currents/tidal flows through the Project area are associated with dredging activities. These changes have not been identified as likely to have significant direct impacts on sensitive marine receptors.

The increased presence of vessels and frequency of vessel movements during both construction and operations phases pose a risk to marine fauna, and will have some local direct impact on water quality from standard vessel discharges, the deployment and retrieval of anchors and chains and the use of propellers and thrusters. Vessel movements themselves pose a risk to the marine receptors such as turtles and marine mammals, such as dolphins. Two migratory EPBC listed dolphins may occur within the Port of Gladstone and could be impacted by Project activities. However, it is acknowledged that the Project is within the limits of the Port of Gladstone and as such, all vessel movements and activities will be undertaken in accordance with the requirements and procedures of the Port of Gladstone.

Similarly, given that the Port of Gladstone has been an operational port for many years, the existing marine receptors that use the port's waters for feeding, breeding and transiting are already doing so amid the disturbed conditions typical of a large port. The cumulative impact of vessel movements associated with the QCLNG Project and other proposed developments in the vicinity of the Port of Gladstone will be subject to evaluation, with overall responsibility lying with the Gladstone Port Corporation (GPC) as port operator.

Lighting impacts have been evaluated. In the absence of the most sensitive receptors (nesting adult turtles and turtle hatchlings) from within the identified impact zone, no further sensitive receptors have been identified to warrant further mitigation. The potential cumulative impacts from LNG Facility lighting, in addition to increased light from other nearby developments, is an issue to be evaluated by the GPC in progressing the overall port's plans for expansion in the future.

Solid wastes will be generated throughout the Project. However, the likelihood

of these solid wastes significantly impacting on the marine environment is negligible due to the implementation of industry standard waste management practices.

The largest marine discharge associated with the Project occurs during the construction phase and is associated with sewage and sullage discharges from the onshore construction site, as well as discharges from a reverse osmosis (RO) desalination plant. These liquids will be treated prior to discharge.

Other discharges that may have the potential to have direct and indirect impact on marine receptors include stormwater, deck drainage (off ships) and anti-fouling leachate. These discharges will be managed to ensure no unacceptable risk through the implementation of standard management plans and procedures.

Unplanned events, specifically either hydrocarbon or chemical spills, have the potential to occur over the course of the Project. During the construction phase, there is an escalated risk of small spills as a result of the increased number of vessel and number of activities occurring at any particular time. Vessels and onshore construction activities in the vicinity of the marine environment will have emergency response procedures to implement in the event of an incident. The consequence of a spill is related to the nature of the material spilt, the prevailing conditions at the time, the sensitivity of the receiving environment and the response measures instigated at the time of the spill. All vessel activities, during both construction and operations, will be under the jurisdiction and approved protocols of the GPC, as well as international maritime law, when transporting the LNG to market.

In the event that an incident occurs within the port limits, and is beyond the capability of the vessel to adequately respond, the GPC's response plans will be triggered. In these instances it is most likely that the GPC will lead the actual response with QGC providing support by making resources and vessels available.

The Project has the potential to increase the risk of introduced marine species entering the Port of Gladstone. This arises from the number of vessels likely to enter the port from overseas destinations. However, there are national and international requirements that specifically target the management of risk from introduced marine species. These include protocols specifying the exchange of ballast water at sea and the inspection of vessel hulls and cavities that are likely to host potential species that may cause either environmental or economic harm if released to the local environment. The Project will comply with all applicable Australian Quarantine Inspection Service (AQIS) standards.

The Project will have direct impact on intertidal areas and will result in the removal of marine plants with local and regional value. Mitigation measures will be developed in consultation with the Department of Environment and Resource Management (DERM) and the Department of Employment,

Economic Development and Innovation (DEEDI), to maintain the overall ecological values of the Port of Gladstone and intertidal area.

As the Project design progresses, additional mitigation measures may be identified and incorporated into the Project's Environmental Management Plans (EMPs) and broader environmental management system.

20.9 SURFACE WATER RESOURCES

The creeks observed across the site generally range in width between 2 m and 5 m with a typical depth of 0.5 m to 1.5 m, but ranging to more than 5 m in one watercourse in the upper slopes of the site towards the eastern site boundary. The water courses exhibit variable degrees of erosion, with the upper reaches showing higher erosion than the lower reaches.

Construction and operational activities will alter the existing surface water flows, and have the potential to impact on fresh and marine water quality. During construction, potential contaminants that could be mobilised include sediments and acid sulfate soils, both of which can have direct impact on the receiving environment. Draft management and mitigation measures addressing these issues have been developed.

20.10 GROUNDWATER RESOURCES

The LNG Facility does not propose to abstract groundwater during either the construction or operational phases of the Project.

Groundwater monitoring bores will be installed on the LNG Facility site to provide data on groundwater levels and groundwater quality (pH, electrical conductivity and dissolved metals) prior to commencement of construction and to inform development of a detailed site acid sulfate soils management plan.

The cumulative impact of LNG Facility construction and operational activities on groundwater resources is expected to be minor. Site stormwater containment measures will be employed.

20.11 COASTAL ENVIRONMENT

There will be an increase in LNG tanker shipping movements in and out of the proposed LNG jetty/terminal once the LNG Facility is operational. However, the Project is compatible with the management intent of the Curtis Coast Regional Coastal Management Plan (CCRCMP) and is unlikely to negatively impact on current and future functioning of the area.

The isolated location of the proposed LNG Facility on Curtis Island and associated wharf facilities minimise direct impacts on neighbouring urban communities, and other recreational uses of the foreshore that exist elsewhere in the Project area.

The LNG Facility is a coastal-dependant use in the context of the need to ensure the LNG storage and processing facility is in close proximity to the wharf facility and export vessels. In this context, the proposed location of the facility on Curtis Island is consistent with the CCRCMP policy.

Given the predicted direct, indirect and cumulative impacts from the LNG Facility, the LNG Facility is generally consistent with the desired coastal outcomes for CCRCMP key coastal sites, assuming construction and operation are managed in an ecologically sustainable manner.

Key findings from the water quality assessment include:

- The hydrodynamic impacts of the proposed works were found to have a negative minor direct impact, with the exception of the immediate vicinity of the proposed dredged Swing Basin, where significant dredging will change velocities, with a negative moderate direct impact.
- Tidal flushing times for the pre- and post-Project cases were estimated. There were negligible direct impacts on flushing behaviour with and without the Project.
- Near and far field numerical modelling of the proposed discharge of a brine waste stream from a RO desalination facility associated with the Project was undertaken. Both modelling activities found that there is negligible direct impact on local salinity due to this discharge.
- Sediment plume dispersion analyses were executed for representative Swing Basin dredging, bridge and pipeline construction activities using the far field model. Appropriate sediment re-suspension rates were estimated for the scenarios.

  In the case of Swing Basin dredging, greater concentrations were realised during neap tides, where dispersion was less as a result of reduced tidal velocities. An immediate impact zone of the order of several hundred metres in scale was identified during these times, and outside this area, maximum additional total suspended solids (TSS) concentrations of approximately 25 mg/L were predicted (over ambient). These values are in the order of the natural variability of TSS concentrations across the site. Concentration increases during spring tides were generally less than during neap tides.

  Similar behaviour was observed in the model results for the bridge and pipeline construction scenarios. The immediate impact zones were again in the order of hundreds of metres in dimension during neap tides (and considerably smaller during spring tides) with maximum additional TSS concentrations outside this zone of 15 to 17 mg/L.

Based on these findings, the impacts to hydrodynamics and marine water quality from the Project are characterised as short term (related to construction stages), with major local impacts from the dredging works with increased TSS. These increases are within the bounds of natural variability of the system and are not expected to have any significant direct impacts on marine environmental values of water. The environmental values of the Project area will be protected.

20.12 AIR

For normal operation of the LNG Facility, the air quality assessment indicates the following:

- The predicted maximum 1-hour and annual average ground-level concentrations of NO_2 at any sensitive place for the LNG plant during normal operating conditions, and including t background, are below the Environmental Protection Policy (Air) air quality objectives.
- The maximum concentrations of carbon monoxide are below air quality objectives across the modelling domain under normal operation conditions including background.
- The predicted maximum 24-hour average ground-level concentration of PM_{10} at any location within the modelling domain due to the Project, under normal operating conditions, in isolation is 1.8 µg/m^3. With the inclusion of the background the maximum is 30.8 µg/m^3, which is 61.6 per cent of the EPP (Air) air quality objective of 50 µg/m^3.
- None of the hydrocarbon species associated with emissions from the LNG Facility exceed the ambient air quality objectives at the most sensitive receptor.
- The contribution of the Project to photochemical activity in the Gladstone region is, at worst, minor and unlikely to be of any concern.
- Predicted maximum 1-hour average concentration of odorous compounds, from the LNG Facility in isolation, at the most affected sensitive receptor is well below both the odour threshold and the ambient air quality objective.

Non-normal operations were assessed on the basis of three scenarios, including:

- normal plant operations plus LNG carrier at wharf
- non-normal plant operations with dry gas flare upset conditions
- non-normal plant operations with marine flare upset conditions.

Under the normal plant operations plus LNG carrier at wharf scenario, the air quality assessment indicates the following:

- The predicted maximum 1-hour and annual average ground-level concentrations of NO_2 at any sensitive place, including background, are below the EPP (Air) air quality objectives;
- There are no exceedances predicted of the EPP (Air) air quality objective for the 1-hour, 24-hour and annual average ground-level concentrations of SO_2, due to the proposed shipping activity, when assessed in isolation. Predicted ground-level concentrations in exceedance of the 1-hour, 24-hour and annual average air quality objectives are located in close proximity to the existing Gladstone power station and due to power station emissions, with predicted ground-level concentrations of SO_2 in the vicinity of the QCLNG Project, well below the air quality objectives;
- The predicted maximum 1-hour, 24-hour and annual average ground-level concentrations of SO_2 at any sensitive place for the shipping activities, including background, are below the EPP (Air) air quality objectives.

Under the non-normal plant operations with dry gas flare upset conditions scenario, the air quality assessment indicates the following:

- There are no exceedances predicted of the EPP (Air) air quality objective for the 1-hour average ground-level concentration of NO_2 due to a dry gas flare event, when assessed in isolation. Predicted exceedances of the 1-hour average ground-level concentration EPP (Air) air quality objective are located in close proximity to the existing Gladstone power station and due to power station emissions. Predicted ground-level concentrations of NO_2 in the vicinity of the QCLNG Project are well below the EPP (Air) air quality objectives.
- The maximum concentrations of carbon monoxide are below air quality objectives across the modelling domain including background.
- Predicted ground level concentrations of hydrocarbons are very low and none are likely to be present in sufficient quantities to cause asphyxiation.

Under the non-normal plant operations with marine flare upset conditions scenario, the air quality assessment indicates the following:

- There are no exceedances predicted of the EPP (Air) air quality objective for the 1-hour average ground-level concentration of NO_2 at any sensitive receptor location when assessed in isolation and with background. An exceedance of the 1-hour average ground-level concentration EPP (Air) air quality objective for NO_2 is predicted in the proximity of the marine flare and wharf facilities, with predicted ground-level concentrations of NO_2 beyond the QCLNG Project operations area below the EPP (Air) air quality objectives.
- Maximum predicted concentrations of carbon monoxide are below air quality objectives across the modelling domain including background.
- Predicted ground level concentrations of hydrocarbons are very low and none are likely to be present in sufficient quantities to cause asphyxiation.

The aviation safety assessment modelling indicates an exceedance of the critical Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) height for both the normal and non-normal (flare) scenarios. QGC will continue to work with the Civil Aviation Safety Authority (CASA) to address this matter.

20.13 NOISE AND VIBRATION

The site selected for the LNG Facility is appropriate from a noise perspective as it is located well away from residential receptors and the natural terrain (ridge running north - south) provides shielding to the eastern site of Curtis Island. This results in negligible impacts for the nearest noise sensitive receptors.

Construction of the proposed LNG Facility should be inaudible under most conditions during the day and under all conditions during night time works. There are no noise criteria for day-time work. Construction noise may be audible at noise assessment location 5 (NAL5 - Tide Island) under neutral weather conditions.

Predicted worst-case noise levels from construction barges and ferries indicates noise levels will be inaudible at all NAL other than NAL5 (Tide Island). However, the levels will be below existing average L_{10} noise levels and will be transient.

Road traffic generated during construction will include vehicles travelling to the Auckland Point laydown areas. The main road to access the Auckland Point laydown area is Port Access Road which is designed as a heavy vehicle route. Impacts from road transport will be negligible.

The Auckland Point laydown area is located among existing rail and industrial areas. While some site activities may be audible, these are expected to have a low impact on the nearest residential areas.

Construction activities such as pile driving and vibratory rollers will not cause a vibration impact on sensitive receptors.

Predicted operational noise levels are below the relevant Queensland criteria for all sensitive locations under neutral and typical weather conditions.

Under adverse conditions (temperature inversion and calm winds), predicted operational noise levels are below the relevant criteria for all locations except Tide Island, the closest sensitive receptor to the proposed LNG Facility. The exceedance of 5dB(A) under adverse conditions is expected to occur only occasionally as temperature inversions infrequently form over water, and winds are calm for only 14 per cent of the time. As this is less than the 30 per cent referred to in the EPA EcoAccess Guideline *Planning for Noise Control*,

this exceedance is not expected to be significant.

In future, noise from the proposed LNG Facility may well be masked on Tide Island by noise from other industry, including the proposed Wiggins Island coal terminal.

The predicted linear-weighted noise levels meet the EPA Draft criterion for low frequency noise, thus no further assessment is required at this time as the levels are unlikely to cause complaints due to low frequency noise.

The nature of the noise generated by the LNG plant is a continuous noise, with no significant impulsive characteristics. Hence the EPA ($_{max}L_{pA}$) sleep disturbance criterion is not applicable to this assessment.

Predicted worst case noise levels (based on noise levels for ships under full power) for LNG vessels indicate noise will not impact on sensitive receptors other than Tide Island. Impact on Tide Island will be transient and hence shipping traffic is not expected to have a significant direct noise impact on the residence at Tide Island.

The LNG plant and equipment primarily involves rotating machinery, which will transfer relatively low levels of vibration to the ground. Hence operation of the LNG plant will not produce significant levels of ground vibration.

20.14 *ROAD, RAIL, AIR AND PUBLIC TRANSPORT*

The Road Impact Assessment (RIA) for the Project modelled 44 potential scenarios. The scenarios comprised a base case with assumptions of workforce size and transport demand, a number of construction camp options, and various transport logistics scenarios incorporating a number of road bridge options connecting Curtis Island with Gladstone City.

The RIA original assumptions, as modelled, reflect a worst-case scenario and demonstrate there is significant “headroom” factored into the RIA with a consequential reduction of 195 light vehicles per day and an equivalent of 135 heavy vehicles per day for 167 days associated with pipe transport on the state and council controlled road networks in Gladstone.

Under the original assumptions the base case requires the following intersections to be upgraded:

- Hanson Road/Blain Drive/Alf O’Rourke Drive
- Hanson Road/Port Access Road/Railway Street
- Port Access Road/Tug Berth Access Road
- Dawson Highway/Blain Drive/Herbertson Street.

Under the revised assumptions, some or all of these upgrade works may not

be required.

The proposed LNG Facility will not impose a significant direct impact on the state or local controlled road or rail networks, or to transport infrastructure, facilities or services. All transport related impacts associated with the LNG Facility are considered manageable, subject to outlined mitigation measures.

Maintenance contributions are not required for the Project reference case with construction camp option D due to the negligible pavement impact on state controlled roads. Rehabilitation contributions are also not required.

20.15 SHIPPING TRANSPORT

The highest number of shipping movements will be during the construction phase of the Project, including daily movement of personnel from Gladstone to Curtis Island . However, this is a necessarily limited period of time and much of the activity will be undertaken by low draught, high speed and manoeuvrable vessels, which should be able to operate without major impact on other harbour users.

During the operation phase, LNG and LPG vessels will represent an increase of 12.5 per cent on cargo vessel visits to the Port of Gladstone, and an approximate 15 per cent increase in Port of Gladstone total cargo throughput. These vessels are of a similar size to Capesize coal bulkers which currently frequent Gladstone harbour. The proposed LNG and LPG shipping represents appropriate operations for the current and future configuration of the Port of Gladstone as a strategic industrial port.

LNG vessels will use the outer route along the Great Barrier Reef, with access to Gladstone via the existing Capricorn and Curtis shipping channels.

20.16 VISUAL AMENITY

The LNG Facility is not expected to have a significant direct impact on views from local residences.

The LNG Facility is expected to impact on landscape values of major significance on Curtis Island. However, the impact on the Great Barrier Reef World Heritage Area is already attenuated in this location by the presence of the Port of Gladstone in the viewshed. Therefore, this area is not 'pristine' or representative of the "exceptional natural beauty" assigned to the World Heritage and National Heritage values. In addition, the designation of the Curtis Island Industry Precinct as an extension to the Gladstone State Development Area (GSDA) reflects the intent of the Queensland Government to develop the area as an industrial precinct. Given this, the landscape and

visual impact of the proposed LNG Facility is consistent with the designated land use and general expansion of industry around the Port of Gladstone.

Overall, the LNG Facility is expected to have a negative direct impact on landscape values of major significance.

20.17 WASTE MANAGEMENT

Waste minimisation, reuse and recycling policies and procedures will be implemented during construction and operation to minimise the direct impact of the Project as far as practicable.

20.18 HAZARD AND RISK

Hazard Identification/Environmental Hazards Identification (HAZID/ENVID) Studies were conducted to identify hazards within the proposed LNG Facility that could pose a risk to the public, operating personnel, the environment or property. The overall intent of this approach is to ensure that hazards are eliminated, minimised or controlled.

Currently there are no existing neighbouring industrial facilities on Curtis Island. However, other LNG plants are proposed adjacent to the Project site. To date, no risk assessments of these other proposed facilities have been made publicly available.

Regardless, examination of risk contours shows that the criterion for industrial land use (50×10^{-6} pa) is contained within the Project site boundary for all onshore boundaries (although there is some extension of these risk contours into marine areas). This suggests negligible impact to the risk contours of other facilities from the LNG Facility, assuming those other proposed facilities also meet the applicable risk criteria.

A shipping transit risk analysis and assessment concluded that routes to be used both within the port and during GBRMP transit were extremely safe. Navigational features, support systems, rules, guidelines, control measures and redundancy all contribute towards a low risk of an incident during LNG transit.

20.19 CUMULATIVE IMPACT

The environmental values most likely to be significantly impacted by the cumulative effect of the LNG Facility, together with other projects considered within the scope of the cumulative impact assessment, are terrestrial and marine ecology, noise, road transport (during construction) and visual amenity.

The increasing industrialisation of the landscape is consistent with the planning intention behind the GSDA and the designation of the new Curtis Island Industry Precinct and the Restricted Development Precinct on Kangaroo Island. Further, the Port Strategic Plan envisages an increase in planned port capacity to 300 million tonnes of export capacity per year within the next 50 years[3], nearly four times the 2008 port throughput.

20.20 CONCLUSION

Technical studies and impact assessments (presented in *Volume 5* of this Environmental Impact Statement) have not identified any unacceptable direct, indirect or cumulative environmental impacts relating to construction or operation of the Queensland Curtis LNG (QCLNG) Project's proposed LNG Component.

With the benefit of these technical studies and impact assessments, a set of proponent commitments related to the LNG Facility is proposed to be implemented during the detailed design, construction and operation phases.

Also, mitigation measures and Environmental Management Plans for the construction and operation phases have been prepared to minimise direct, indirect and cumulative impacts to as low as reasonably practicable.

Table 5.20.1 presents a high level assessment and summary of the proposed LNG Component's overall impact. None of the identified impacts on environmental factors were considered critical. Impacts were reassessed with mitigation strategies in place and are now considered to be moderate, minor or negligible for construction, operation and decommissioning of the LNG Component of the QCLNG Project.

3 Gladstone Ports Corporation Port of Gladstone 50 Year Strategic Plan (Update 2008): http://www.gpcl.com.au/pdf/final_low_cmm5087gpcl_50_year_strategic.pdf

Table 5.20.1 QCLNG Project EIS Summary – LNG Component and Associated Ancillary Activities and Infrastructure

ENVIRONMENTAL FACTORS	LNG COMPONENT & SHIPPING: LNG Facility (Onshore)	LNG Marine Facilities (MOF & Jetty)	Dredging (MOF)	Pipeline (The Narrows - LNG Facility)	Auckland Point (Construction)	RG Tanna Wharf (Operations)	Dredging (Swing Basin & Channel)	Shipping	MITIGATION: Avoid at Source	Abate at Source	Attenuate	Abate at the Receptor	Remedy	Compensate / Offset	RESIDUAL: Residual Impact Significance	EMERGENCY CONDITIONS: Dry or Marine Flaring	LNG Facility Explosion / Fire	Spill / Accidental Overflow	Vessel Collision / Grounding	Accidental Ballast Water Release	Bushfire	ANCILLARY INFRASTRUCTURE & ACTIVITIES [1]: Mainland Road & Bridge Approach	Curtis Island Bridge	Curtis Island Road	WBSDD Project (GPC)[8]	Onshore Spoil Disposal (Curtis Island) [2]	Spoil Disposal (Fisherman's Landing)
Climate and Climate Change (Design Implications)	N (-)	N (-)	N (-)	N (-)	N (-)	N (-)	N (-)	n/a	√	√					N (-)	n/a	n/a	n/a	n/a	n/a	N (-)	N (-)	N (-)	N (-)	N (-)	N (-)	N (-)	N (-)
Topography & Geomorphology (Visual & noise screening)	Mi (+)	Mi (+)	n/a	Mi (+)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Mi (+)	Mi (+)	Mi (+)	n/a	n/a	n/a	n/a	N (-)	N (-)	Mi (+)	n/a	N (-)	n/a
Topography & Geomorphology (Changes in landform)	Mi (-)	Mi (-)	n/a	N (-)	n/a	n/a	n/a	n/a	√	√					Mi (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	N (-)	Mi (-)	n/a	Ma (-)	Ma (-)
Geology and Soils (Erosion)	Mi (-)	Mi (-)	n/a	Mi (-)	n/a	n/a	n/a	n/a	√	√	√			√	N (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	n/a	Mi (-)	n/a	Mi (-)	n/a
Geology and Soils (Acid Sulfate Soils)	Mo (-)	Mo (-)	n/a	Mo (-)	N (-)	N (-)	n/a	n/a	√	√	√				Mi (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mo (-)	Mo (-)	Mi (-)	n/a	Mo (-)	n/a
Geology and Soils (GQAL)	N (-)	N (-)	n/a	N (-)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N (-)	n/a	n/a	n/a	n/a	n/a	n/a	N (-)	n/a	N (-)	n/a	N (-)	n/a
Land Use	N (+)	N (+)	n/a	N (+)	N (+)	N (+)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N (+)	n/a	n/a	n/a	n/a	n/a	n/a	N (+)	N (+)	N (+)	n/a	Ma(-) [3]	Ma (+)
Infrastructure (Power, water, wastewater, waste)	N (-)	N (-)	n/a	N (-)	N (-)	N (-)	n/a	N (-)	√	√					N (-)	n/a	n/a	n/a	n/a	n/a	n/a	N (-)	N (-)	N (-)	n/a	N (-)	N (-)
Land Contamination	Mi (-)	Mi (-)	n/a	N (-)	Mi (-)	Mi (-)	n/a	n/a	√	√				√	N (-)	n/a	n/a	Mi (-)	n/a	n/a	n/a	N (-)	n/a	N (-)	n/a	Mi (-) [4]	n/a
Terrestrial Ecology	Ma (-)	Ma (-)	n/a	Ma (-)	n/a	n/a	n/a	n/a	√			√		√	Mo (-)	n/a	Mi (-)	n/a	n/a	n/a	Ma (-)	Ma (-)	n/a	Ma (-)	n/a	Ma (-)	n/a
Marine Ecology	Mo (-)	Mo (-)	Mo (-)	Mo (-)	n/a	n/a	Mo (-)	Mo (-)	√	√	√			√	Mi (-)	n/a	n/a	Mo (-)	Mo (-)	Mo (-)	n/a	Ma (-)	Mo (-)	n/a	Mo (-)	n/a	Mo (-)
Surface Water Resources	N (-)	N (-)	n/a	N (-)	N (-)	N (-)	n/a	n/a	√						N (-)	n/a	n/a	N (-)	n/a	n/a	N (-)	N (-)	n/a	N (-)	n/a	N (-)	n/a
Groundwater Resources	Mi (-)	Mi (-)	n/a	N (-)	n/a	n/a	n/a	n/a	√	√					Mi (-)	n/a	n/a	Mi (-)	n/a	n/a	n/a	N (-)	n/a	N (-)	n/a	Mi (-) [5]	n/a
Coastal Environment	Mi (-)	Mi (-)	Mi (-)	Mi (-)	N (-)	N (-)	Mo (-)	Mi (-)	√	√					Mi (-)	n/a	n/a	Mo (-)	N (-)	n/a	n/a	Mi (-)	Mi (-)	n/a	Mo (-)	n/a	Mo (-)
Air (Air Quality)	Mi (-)	Mi (-)	n/a	N (-)	N (-)	N (-)	n/a	Mi (-)	√	√					Mi (-)	Mi (-) [6]	n/a	n/a	n/a	[6]	N (-)	N (-)	N (-)	N (-)	n/a	N (-)	N (-)
Air (Aviation Safety Risk)	Ma (-)	Ma (-)	n/a	n/a	n/a	n/a	n/a	n/a	√	√	√				Mo (-)	Ma (-) [6]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Noise	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	√	√					Mi (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)
Vibration	Mi (-)	Mi (-)	n/a	Mi (-)	Mi (-)	Mi (-)	n/a	n/a		√					Mi (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	Mi (-)	Mi (-)	n/a	Mi (-)	Mi (-)
Road, Rail, Air and Public Transport	N (-)	N (-)	n/a	N (-)	Mo (-)	Mi (-)	n/a	n/a	√	√	√				Mi (-)	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	Mi (-)	Mi (-)	n/a	n/a	n/a
Shipping Transport	n/a	n/a	n/a	n/a	n/a	n/a	Mi (-)	Mi (-)	√						Mi (-)	n/a	n/a	n/a	Mi (-)	n/a	n/a	n/a	N (-)	n/a	Mi (-)	n/a	Mi (-)
Visual Amenity	Ma (-)	Ma (-)	n/a	N (-)	N (-)	N (-)	n/a	n/a		√					Ma (-)	Ma (-) [7]	n/a	n/a	n/a	n/a	n/a	Ma (-)	Ma (-)	Mi (-)	n/a	Ma (-)	Ma (-)
Waste Management	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	√	√					Mi (-)	n/a	n/a	Mi (-)	Mi (-)	n/a	n/a	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)	Mi (-)

Potential impact significance ratings	
N	**Negligible:** Magnitude of change comparable to natural variation. Not significant to the decision to be made on the project.
Mi	**Minor:** Detectable but not significant. Impact warrants being brought to the attention of the decision-maker but does not require special conditions to be attached to the approval. Negative impacts can be controlled through the adoption of normal good practice. Monitoring is required to ensure mitigation for negative impacts is working properly, that benefits are realised and that the impact is not worse than predicted.
Mo	**Moderate:** Significant. Positive and negative impacts warrant being brought to the attention of the decision-maker and deserves careful attention in the decision. Negative impacts are amenable to mitigation. Monitoring is required to ensure mitigation for negative impacts is working properly, that benefits are realised and that the impact is not worse than predicted.
Ma	**Major:** Significant. Impact mitigation measures must be found to reduce negative impacts. Positive and negative impacts warrant being given considerable weight in the decision. Residual impacts must be compensated for if possible. Monitoring is required to ensure mitigation for negative impacts is working properly, that benefits are realised and that the impact is not worse than predicted.
C	**Critical.** Applies to negative impacts only. Intolerable and not amenable to mitigation. Alternatives must be found.
n/a	Not applicable (no impact)
+	Positive impact
-	Negative impact

Mitigation types
Avoid at source: Remove the source of the impact by designing the project so that a feature causing an impact is designed out or altered.
Abate at source: Reduce the source of the impact by adding something to the basic design to abate the impact (e.g. pollution control).
Attenuate: Reduce the impact between the source and the receptor.
Abate at the receptor: Reduce the impact at the receptor.
Remedy: Repair the damage after it has occurred.
Compensate / Offset: Replace in kind or with a different resource of equal value.

Other definitions
Residual impacts: Significance of impacts if feasible mitigation measures are integrated into design, construction and operation of the project.
Emergency conditions: Conditions that occur infrequently as a result of an accident or unplanned/extreme event. They represent non-normal operating conditions.

Notes
(1) QGC will not be the proponent for this Ancillary Infrastructure. The level of assessment and proposed mitigation measures are therefore preliminary.
(2) Onshore disposal is no longer the preferred option and was therefore not assessed in detail in the EIS.
(3) Will result in sterilisation of land for other industrial development within CIPP.
(4) Not assessed in detail as this is not the preferred option. The potential negative impact is rated as being of minor significance due to the potential for spoil to contain pollutants that could result in land contamination. If this option is pursued the assessment would need to consider geotechnical characterisation and management of spoil.
(5) Not assessed in detail as this is not the preferred option. Due to the potential for seepage from dredge spoil to groundwater the potential negative impact is rated as being of minor significance taking into consideration that there are no downstream groundwater users.
(6) Not amenable to modelling and assessment as this event is extremely unlikely to occur and scenarios are highly variable.
(7) Significance rating based on assessment of LNG Facility as a whole, including flaring, however, flaring will occur infrequently.
(8) The Western Basin Strategic Dredging and Disposal Project EIS is being undertaken by the GPC. The WBSDD Project encompasses dredging of five new channel areas and a major reclamation in the Western Basin