Port of Gladstone
Gatcombe and Golding Cutting Channel Duplication Project

Additional Information to the Environmental Impact Statement

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Appendix E1 Methodology for ecological impact and risk assessment

Appendix E1
Methodology for ecological impact and risk assessment

1 Structure of impact and risk assessment sections

This section provides an overview of the impact and risk assessment for the ecological values/receptors identified in the existing environment sections, in the context of the Project activities. Each impact and risk assessment section includes:

- Identification of potential impacts on ecological values/receptors associated with each Project activity
- Risk rating tables for the potential impacts
- Identification of the key potential impacts and identification of the relevant management plans that will minimise and mitigate the potential impacts
- Assessment of the cumulative impacts on an ecological value/receptor
- Assessment of threatening processes for conservation significant and migratory species
- Significant residual adverse impact assessments in accordance with the relevant impact guidelines for MNES and MSES.

The sections below provide the methodology implemented for each of the components listed above.

2 Overview and purpose

To assess and appropriately manage the potential impacts and risks to ecological values as a result of Project activities, a risk assessment process has been implemented (herein referred to as the 'risk assessment'). The risk assessment methodology adopted is based on principles outlined in the:

- AS/NZS ISO 31000:2009 Risk management – Principles and guidelines
- HB 203:2012 Handbook: Managing environment-related risk.

The risk assessment identifies and assesses the potential risks to ecological values/receptors for both the construction and operational phases of the Project, focussing specifically on the ecological values outlined in the Project EIS Appendix I1 (Sections 3 to 17), and supplemented or replaced with information in the AEIS Chapter 9.

This ecological risk assessment is one component of the overall Project EIS risk assessment. Cumulative impacts on ecological values are assessed and discussed in Chapter 21 and Appendix P of the Project EIS.

The purpose of this risk assessment is to identify potential adverse and beneficial impacts to ecological values/receptors, prioritise environmental management actions and mitigation measures, and to inform the Project decision making process.

Figure 1 outlines the general risk assessment process methodology, relating to each of the key steps to the processes outlined in the Standard and Handbook listed above.

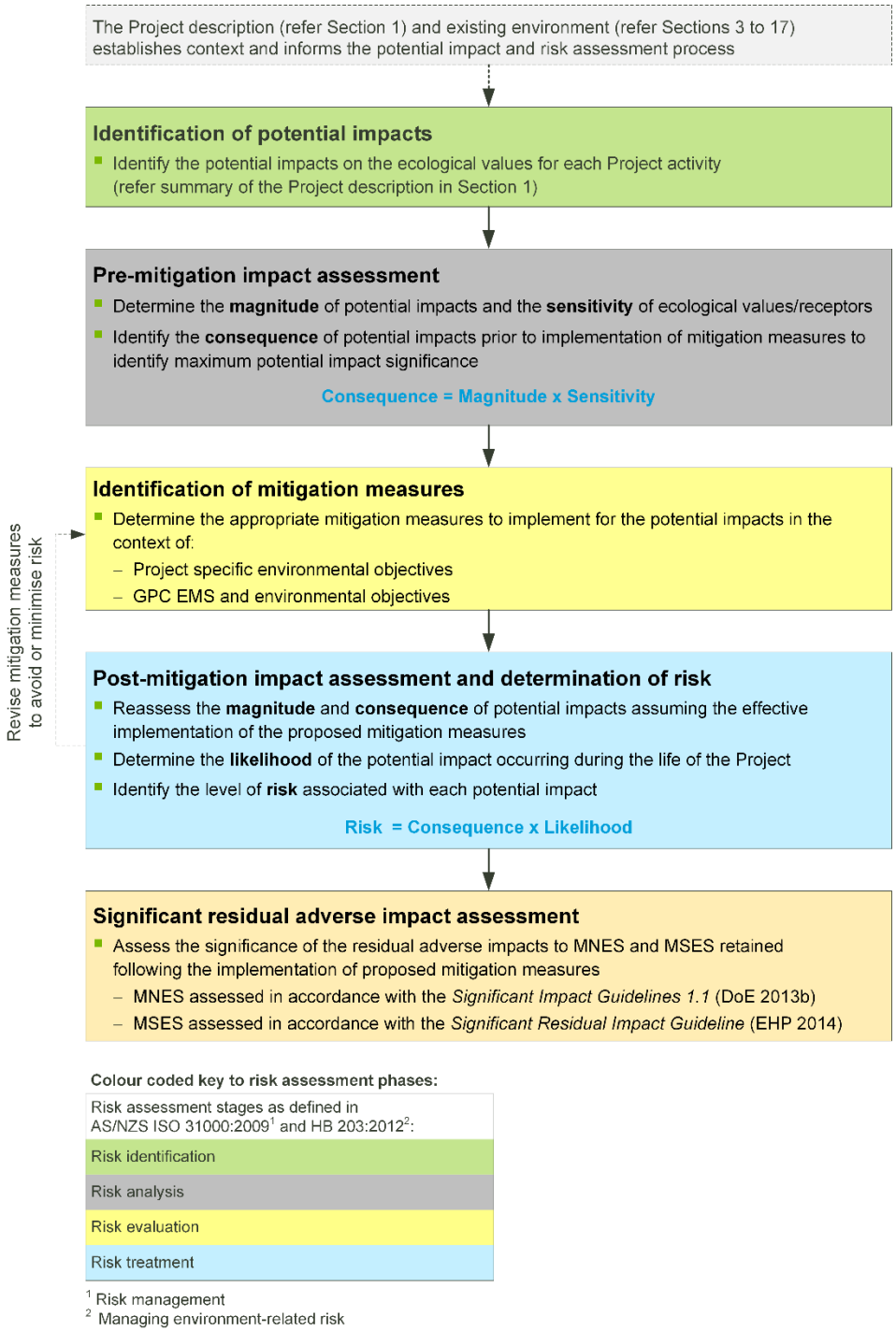

Figure 1 **Potential impact and risk assessment overview**

3 Ecological risk assessment objectives

The overarching objectives of the risk assessment are to appropriately determine the potential impacts to ecological values and to manage these impacts through the environmental management hierarchy of: *avoid, minimise and mitigate/offset*. This is generally achieved through the iterative nature of the risk assessment process, which includes a feedback mechanism to review and revise the proposed mitigation measures where the resultant risk levels are determined to be unacceptable (refer Figure 1).

The risk assessment also aims to prioritise potential key risks and residual adverse impacts that are likely to require further assessment and mitigation.

These objectives of the risk assessment align with GPC's environmental commitments to manage, develop and operate their business in a manner which:

- Minimises environmental harm and preserves the inherent worth of the environment for future generations, through the adoption of leading practice environmental management
- Ensures continual improvement in environmental performance
- Ensures compliance with all relevant legislative requirements.

4 Key terminology

Table 1 provides the key terminology used throughout this section and the potential impact and risk assessment sections (refer the Project EIS and AEIS (Chapter 9 (nature conservation)), and is provided for ease of cross-reference.

Table 1 Key terminology used for the assessment of potential impacts and risks

Term	Definition
Consequence	The outcome of an event which has an effect on objectives. A single event can generate a range of consequences which can have both positive and negative effects on objectives. Initial consequences can also escalate through knock-on effects.
Impact or potential impact	For the purposes of this assessment, it is taken to mean adverse changes to the ecological values/receptors as a result of Project activities[1].
Likelihood	The chance that something might happen. Likelihood can be defined, determined, or measured objectively or subjectively and can be expressed either qualitatively or quantitatively.
Receptor (or ecological value)	A receptor is a sensitive value. Receptors may be subject to impacts as a result of stressors, or sources of risk.
Residual impact	A residual impact is defined as an impact that remains direct and/or indirect following the implementation of mitigation measures.
Residual risk	Residual risk is the risk that remains after the implementation of a risk treatment option (or mitigation measure).
Risk	Is the effect of uncertainty on objectives, and an effect is a positive or negative deviation from what is expected.
Risk source	A tangible or intangible element that alone or in combination has the intrinsic potential to give rise to risk. For example, a Project activity can be a source of risk or a stressor (refer 'stressor').
Risk treatment	A process to modify risk. A risk treatment can involve the avoidance of an activity which gives rise to risk, removing the risk sources, changing the likelihood of an impact or risk occurring, changing the consequence/significance of a risk, and retaining the risk where acceptable.
Sensitivity	In relation to an ecological value/receptor, the sensitivity is defined as the degree to which the sensitive value will change or respond to a change that has resulted from a Project activity, action and/or processes.
Significant impact	In accordance with the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Significant residual adverse impact or significant residual impact	A residual adverse impact which is deemed to be significant (in accordance with the relevant guidelines[2]), and that remains after the implementation of avoidance and mitigation measures.

Term	Definition
Stressor	A stressor is a chemical or biological agent, environmental condition, external stimulus or an event that causes stress or impact to a sensitive ecological value (receptor). For the purposes of this EIS a stressor includes, but is not limited to, Project activities that have the potential to result in a direct and/or indirect impact.

Table notes:

1 The definition of 'impact' under Section 527E of the EPBC Act is applicable to this assessment, and a full definition taken from the EPBC Act is provided in the glossary of this report. The definition provided in this table is a simplified version for the purposes of clearly describing the potential impact and risk assessment methodology.

2 MNES are assessed in accordance with the Significant Impact Guidelines 1.1 (DoE 2013b) and MSES are assessed in accordance with the Significant Residual Impact Guideline (EHP 2014).

5 Limitations of the risk assessment

The risk assessment methodology relies on the accuracy and applicability of the technical information sources and the professional judgement of suitably qualified environmental professionals.

Although this potential impact and risk assessment utilises the best available information, there are uncertainties associated with the risk assessment process, as outlined in the AS/NZS ISO 31000:2009 (Risk management – Principles and guidelines), including uncertainties regarding:

- Natural variability in the environment (including variability due to abiotic and biotic factors)
- The exact mechanisms of the interfaces between the activities and surrounding ecosystems, and within the environment between different ecosystems
- The effectiveness of existing and proposed mitigations measures and controls.

Furthermore, the impact and risk assessment process is based on subjective classification of sensitivity of ecological values, magnitude of impacts, likelihood of potential impacts and associated risk levels. As such, the results of the risk assessment for this Project are relative and do not necessarily apply to any other assessment, Project or situation.

6 Identification of potential impacts

The EIS Project description (refer the Project EIS (Chapter 2)) has been utilised to list all of the relevant proposed Project activities/actions (i.e. stressors) that have the potential to impact (directly or indirectly) on ecological values (i.e. receptors), which are described in the Project EIS Appendix I1 (Sections 3 to 17) and supplemented or replaced with information in the AEIS Chapter 9.

The Project activities identified as potential stressors include:

- Establishment of the WBE reclamation area and BUF, including:
  - Site preparation
  - Establishment of the site compound, offices and temporary areas
  - Source and transport of reclamation bund wall material
  - Placement of core and armour material, and geotextile fabric
  - Sheet piling (or similar earth retaining structure) and fill placement for the BUF.
- Dredging activities, including:
  - Initial dredging works for the barge access channel
  - Dredging to duplicate the Gatcombe and Golding Cutting shipping channels

  - Dredging vessel movements
  - Unloading and placement of dredged material in the Western Basin (WB) and WBE reclamation areas
- Removal and installation of navigational aids
- Stabilisation and maintenance activities at the WB and WBE reclamation areas
- Operation of the duplicated shipping channel
- Maintenance dredging.

Table 2 provides and overview of the Project activities and the key potential impacts on ecological values/receptors that are addressed within the risk assessment. It is important to note that all relevant potential impacts on ecological values are discussed in the Project EIS and AEIS (Chapter 9 (nature conservation)).

Table 2 Project activities and key potential impacts or sources of risk to ecological values/receptors

Project activity	Activity description	Key potential impacts
1. Establishment of the Western Basin Expansion reclamation area and BUF		
Site preparation within terrestrial and intertidal environments for the Project disturbance area Establishment of site compound, office and temporary areas **Note:** Impacts associated with the operation of these areas is covered under the dewatering activities	▪ A construction compound for the WBE reclamation area is likely to be located on the existing Fisherman's Landing and/or Western Basin reclamation area. ▪ A site office for up to 20 construction staff will be utilised during the reclamation bund wall and BUF construction and up to 196 people during the dredging operation. A carpark for office and workshop staff will also be established within the construction compound area.	▪ This activity will not require vegetation clearing as the bund walls of the reclamation area and BUF are located in the marine environment, and the location of the construction compound is located in a cleared area ▪ Increase in pollutants/general waste in adjacent marine and/or terrestrial environments ▪ Displacement and disorientation of fauna due to artificial lighting.
Transport of reclamation bund material from the existing Targinnie/Yarwun quarry area	The source of material for the bund walls will be the existing quarries in the Targinnie/Yarwun quarry area. This material is likely to be transported to the reclamation area and BUF via the public road network. Sheet piles (or similar earth retaining structure) to be transported to the BUF site via the public road network. The estimated total haulage movements from the existing Targinnie/Yarwun quarry area required for the construction of the reclamation area are: ▪ Stage 1 bund wall (southern area and BUF) – 29,092 truck movements on 3.5km of public roads, over an 18 month construction period ▪ Stage 2 bund wall (northern area) – 44,248 truck movements on 3.5km of public roads, over an 18 month construction period.	▪ Injury and/or death of terrestrial fauna as a result of increased truck movements ▪ Increase in noise and dust in adjacent terrestrial environments as a result of increased vehicle movements ▪ Introduction of weed and/or pest species into areas adjoining vehicle routes and the reclamation areas as a result of vehicle movements ▪ Spills of fuel or other hydrocarbons from truck movements entering into downstream terrestrial, intertidal and marine environments.

Project activity	Activity description	Key potential impacts
Placement of core and armour material, geotextile fabric and BUF construction	Core material will be placed directly over the existing sediments and shaped by bulldozer, grader or long arm excavator (depending on the location) to form the required profile. The crest will be a minimum of approximately 6m wide to allow construction vehicles to transport material above the marine water level and intertidal areas. To create a secure foundation, the rock armour will sink through the soft silt bed, founding on the underlying stratum and pushing out a mud wave. Geotextile material will be placed against the inner face of the outer bund walls. A series of decant ponds will be constructed internal to the outer bund wall to allow the dewatering of fine material to settle from the tailwaters. Two short bund walls to be constructed for the BUF with installation of sheet piles or similar earth retaining structure to form a "U" shaped barge dock. Area within walls to be filled with existing dredged material from WB reclamation area.	▪ Loss or damage to benthic communities, including seagrass, algae and macroinvertebrates ▪ Injury and/or death of fish and other nekton ▪ Loss and/or fragmentation of intertidal and marine fauna habitat ▪ Entrapment of fauna within the constructed bund (i.e. when the bund is closed) ▪ Water quality impacts associated with siltation and sedimentation and potential impacts on other fauna and flora taxa (e.g. seagrass, fish, crabs) ▪ Changes to marine water velocities resulting in erosion and siltation of foreshore, intertidal and/or marine areas ▪ Displacement and disorientation of fauna as a result of increased noise and vibration and artificial lighting during construction and associated impacts on fauna movement and dispersal ▪ Loss or damage to terrestrial and/or intertidal vegetation and fauna habitat as a result of changes to stormwater flooding ▪ Potential release of contaminants during construction (e.g. spills, waste materials) into adjacent environments ▪ Introduction of additional hard substrate in the marine environment which has the potential to alter marine species biodiversity in proximity to the bund walls ▪ Loss of intertidal and marine habitat connectivity and associated impacts on fauna movement and dispersal.
2. Dredging activities		
Initial dredging for a barge access channel from the existing Port shipping channels to a BUF	▪ Dredging of approximately 0.25Mm^3 with a CSD and TSHD to the north of the Fisherman's Landing swing basin and berth pocket to provide a barge access channel with a design depth of -7.0m LAT (approximately 6.5 weeks of dredging). The dredged material from the barge access channel will be placed directly into the WB reclamation area by the CSD and TSHD.	**Marine areas** ▪ Direct loss or damage to benthic communities, including seagrass, algae and macroinvertebrates ▪ Injury and/or death of macroinvertebrates, fish and nekton ▪ Interaction of marine fauna with the dredging vessels (e.g. megafauna, marine turtles, shorebirds/migratory birds)

Project activity	Activity description	Key potential impacts
Dredging of the Gatcombe and Golding Cutting Channel Duplication area and dredged material placement in the WB and WBE reclamation areas	■ Dredging the Gatcombe and Golding Cutting Channel Duplication area (12.6Mm^3) with a large sized TSHD (i.e. 20,000m^3 hopper capacity). The dredged material within the hopper of the TSHD will be loaded into barges and transported to the BUF for unloading and placement in the WB and WBE reclamation areas. ■ Dredged material will be dewatered in the reclamation areas through a series of decant ponds. Dredging decant water will be released to Port Curtis from the reclamation areas at a licenced discharge points in accordance with licence conditions (e.g. water quality of total suspended solids (TSS) less than or equal to 100mg/L).	■ Loss or damage to reef communities during dredging of the Gatcombe and Golding Cutting Channel Duplication area ■ Introduction of marine weed, pests or pathogens via dredging equipment ■ Impact on marine ecology from decrease in water quality, including release of toxicants from benthic sediments ■ Decrease in the condition and/or extent of adjacent benthic communities as a result of reduced light conditions and/or sedimentation from the dredging plume ■ Impacts of dredging and resuspension plumes on marine flora and fauna species ■ Displacement and disorientation of fauna as a result of increased noise, vibration and artificial lighting during dredging activities and associated impacts on fauna movement and dispersal ■ Potential release of contaminants from dredging vessels (e.g. spills, waste materials) ■ Loss or damage to benthic communities, including seagrass, algae, macroinvertebrates and intertidal/marine fauna habitat from the construction of the WBE reclamation area and BUF and as a result of the placement of dredged material ■ Impacts on adjacent marine flora and fauna species due to bund wall failure and/or significant seepage resulting in release of dredged material sediment plumes through the bund wall into the marine environment ■ Introduction of contaminants and PASS from the dredged sediments into marine areas ■ Damage to benthic habitat through scouring of seabed at licenced discharge points Underwater noise impacts on marine fauna associated with BUF sheet pile driving and associated impacts on fauna movement and dispersal **Terrestrial areas** ■ Introduction of contaminants and PASS from the dredged sediments into reclamation areas ■ Contamination of surface water and/or groundwater due to spills from site compound storage of hydrocarbons and other potential contaminants.

Project activity	Activity description	Key potential impacts
3. Removal and installation of navigational aids		
Removal of existing navigational aids	The removal of the navigational aids will use air blasting techniques involving a barge, pile extractors and divers. Navigational aids will be delivered to an existing Port facility.	■ Underwater noise impacts (i.e. displacement and/or disorientation) on marine fauna associated with the removal of piles ■ Interaction of marine fauna with the barge (e.g. megafauna, marine turtles, shorebirds/migratory birds) ■ Potential release of contaminants from the vessels/plant (e.g. spills, waste materials).
Installation of relocated and new navigational aids	Piles will be transported by barge, lowered into position on the seabed by crane, and hammered into position using a pile hammer until required depth is reached (dependant on specified soil resistance). Works will be undertaken at the surface to install the pile cap and pile protection material application will be undertaken by divers.	■ Underwater noise impacts on marine fauna associated with pile driving and associated impacts on fauna movement and dispersal ■ Interaction of marine fauna with the barge (e.g. megafauna, marine turtles, shorebirds/migratory birds) ■ Potential release of contaminants from the vessels/plant (e.g. spills, waste materials).
4. Rehabilitation and final landform		
Surface stabilisation works and operational management within reclamation area	Following the completion of the dredged material placement operations within the reclamation area, surface stabilisation works will occur for the portion of the reclamation area that has achieved the final design surface level. These works are likely to include capping the final surface with material of an appropriate grade or planting of appropriate species. Operational management within the reclaimed area will also be undertaken to minimise dust and/or erosion as required.	■ Sedimentation within adjacent environments from erosion within the reclamation area ■ Increase in noise and dust levels in adjacent terrestrial environments ■ Introduction or spread of pest and/or weed species into adjacent areas ■ Spills of fuel or other hydrocarbons from vehicles into downstream environments.
Final landform	The WB and WBE reclamation areas will be stormwater management ponds (southern area and northern area) and a potential Port development area (northern area).	■ This report assesses potential impacts associated with establishing suitable and stable landform(s), and does not include assessment of potential impacts associated with the potential future land uses (e.g. Port and industrial).
5. Operation of the duplicated shipping channel		
Final duplicated channel use	The duplicated shipping channel will be used to accommodate the vessel movements associated with the existing approved Port throughput (refer Chapter 1 (introduction) of the EIS). The duplicated channel will also reduce the vessel incident risks within the Gatcombe and Golding Cutting Channels.	■ Permanent change in hydrodynamics due to duplicated channels.

Project activity	Activity description	Key potential impacts
6. Maintenance dredging		
Maintenance dredging	Maintenance dredging will be required initially following the Channel Duplication dredging works to stabilise the channel batters. Ongoing Project maintenance dredging volumes are anticipated to be 10,000m^3 to 20,000m^3 per year for the first two years and thereafter the duplicated channels will not contribute any significant change to the existing Port annual maintenance dredging volume. Dredged material will be placed offshore as part of the Port's annual maintenance dredging campaign (subject to Commonwealth and State approvals).	■ Introduction of marine weed, pests or pathogens via dredging equipment ■ Decrease in the condition and/or extent of adjacent benthic communities as a result of reduced light conditions and/or sedimentation from the dredging plume ■ Impacts of dredging and resuspension plumes on marine flora and fauna species ■ Displacement and disorientation of fauna as a result of increased noise, vibration and artificial lighting during dredging activities and associated impacts on fauna movement and dispersal ■ Potential release of contaminants from the dredging vessels (e.g. spills, waste materials) ■ Potential impacts will also be assessed as part of the approval process for the annual Port wide maintenance dredging and offshore placement.

7 Pre-mitigation impact assessment

7.1 Context

This step of the risk assessment includes the determination of the **sensitivity** of the ecological values/receptors (refer Section 7.2) and the **magnitude** (refer Section 7.3) of the potential impacts identified. The magnitude of the potential impacts are assessed without considering the implementation of proposed mitigation measures as a conservative approach to determining impact consequence (i.e. maximum potential impact identified).

The **magnitude** of the potential impact and the **sensitivity** of the ecological value are used to determine the **consequence** of the potential impacts (refer Section 7.4). This assists in identifying the management priorities for the Project prior to determining appropriate mitigation measures.

7.2 Sensitivity of ecological values/receptors

To assess the consequence of potential impacts on ecological values/receptors, sensitivity categories are applied to each ecological value/receptor. The sensitivity categories are split into four discrete groups, as described in Table 3. These groupings are based on qualitative assessments utilising information related to the sensitivity of the ecological values, in addition to the likelihood of a significant receptors occurrence (e.g. fauna species) within the receiving environment.

Table 3 Sensitivity criteria for ecological values/receptors within the study area

Sensitivity	Description[1]	Examples of ecological values
Low	The ecological value is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations (e.g. historical societies and/or Universities). The ecological value is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value (low condition value). It is not unique or rare and numerous representative examples exist throughout the system/area. It is abundant and widely distributed throughout the host systems/areas. There is no detectable response to change or change does not result in further degradation of the ecological value. The abundance and wide distribution of the ecological value ensures replacement of unavoidable losses is achievable.	▪ Non conservation significant flora and fauna species under the EPBC Act and/or the NC Act and their habitat.
Moderate	The ecological value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers. The ecological value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements. It is relatively well represented in the systems/areas in which it occurs but its abundance and distribution are limited by threatening processes. Changes resulting from Project activities may lead to degradation of the prescribed value but replacement of unavoidable losses is possible due to its abundance and distribution. Includes the GBRWHA OUV attributes that comply with one or more of the above criteria.	▪ Non conservation significant marine fish and other nekton (refer Project EIS (Section 9.10)) ▪ Mangrove communities located adjacent to WBE reclamation area (refer Project EIS (Section 9.4)) ▪ Benthic macroalgae (refer Project EIS (Section 9.12))
High	The ecological value is listed on a recognised or statutory state, national or international register as being of conservation significance (e.g. EPBC Act, NC Act, Fisheries Act), including species listed as: ▪ **Vulnerable** or **migratory** under the **EPBC Act** and/or ▪ **Vulnerable** or **Near threatened** under the provisions of the **NC Act**. The ecological value is intact and retains its intrinsic value (i.e. high condition value). The ecological value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, or territory. It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the ecological value. Includes GBRWHA OUV attributes that comply with one or more of the above criteria.	▪ Coastal Saltmarsh TEC (refer Project EIS (Section 9.4) and AEIS (Section 9.2) ▪ Dugong and their habitat (refer Project EIS (Section 9.20) and AEIS (Section 9.10) ▪ Migratory shorebird habitat (excluding important roosting sites) (refer Project EIS (Section 9.14) and AEIS (Section 9.7) ▪ Green and Flatback turtles and important habitat (refer AEIS (Section 9.8)) ▪ Deep water seagrass meadows (refer Project EIS (Section 9.6) and AEIS (Section 9.3)) ▪ Coral reef communities (refer Project EIS (Section 9.8) and AEIS (Section 9.4)).

Sensitivity	Description[1]	Examples of ecological values
Very High	The ecological value is listed on a recognised or statutory state, national or international register as being of very high conservation significance (e.g. EPBC Act, NC Act, Fisheries Act), including species listed as: ■ **Critically endangered** or ■ **Endangered** under the **EPBC Act** and/or ■ Species listed as **endangered** under the provisions of the **NC Act**. The ecological value is intact and retains its intrinsic value (i.e. very high condition value). The ecological value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the country or the world. It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the ecological value. Includes the GBRWHA OUV attributes that comply with one or more of the above criteria.	■ Habitat for Eastern curlew located at Friend Point (refer Project EIS (Section 9.14) and AEIS (Section 9.7)) ■ Coastal seagrass meadows (refer Project EIS (Section 9.6) and AEIS (Section 9.3)) ■ Loggerhead, Hawksbill ad Olive ridley turtles and important habitat (refer Project EIS (Section 9.18)) ■ Important roosting sites for migratory shorebirds (refer Project AEIS (Section 9.9)).

Table note:

1 The OUV of the GBRWHA for natural heritage for the Port of Gladstone have been identified in DoE (2013a) and are discussed further in the Project EIS (Section 9.23)).

7.3 Magnitude of potential impacts

The magnitude of a potential impact is a product of the **duration** of the potential impact (refer Table 4) and the **spatial scale** or extent of the impact (refer Table 5).

Once the duration and spatial scale of a potential impact are identified, the consequence of the impact can be determined using the magnitude matrix (refer Table 6). The magnitude categories are negligible, low, moderate, high and very high, as described in Table 7.

Table 4 Timeframes for duration terms for the determination of the magnitude of a potential impact

Estimated duration	Duration of impact or timeframe for recovery
Temporary	Days to months (e.g. 3 to 6 months or 1 season (wet/dry))
Short term	Up to 1 year (i.e. 6 to 12 months or up to 2 seasons (wet/dry))
Medium term	From 12 months to 4 years
Long term/long lasting	From 5 to 9 years
Permanent or irreversible	In excess of 10 years or a generational change

Table 5 Spatial extent of potential impact

Guide to estimated spatial extent	Marine environment	Terrestrial environment
Undetectable	Not noticeable or detectable within Port waters.	Not noticeable or detected within any area.
Contained extent	A localised impact contained within the direct vicinity of the activity and can include directly adjacent areas and/or the overall area of impact is relatively small (e.g. an area up to 2km^2).	Contained impact within the direct area of the activity and can include directly adjacent areas up to 100m from the activity and/or the overall impact areas is relatively contained (e.g. less than 10ha of direct and indirect impact areas).
Local area	Impacts occur within the waters of the direct area of the activity as well as in adjoining waters, with impacts experienced more than 100m and less than 2km from the activity, and/or the impact area is moderate to large in size (e.g. an area up to 20km^2).	Impact of the activity is measurable between 100m and 2km, and/or the overall impact area is moderate to large in size (e.g. in the order of 10s of hectares).
Extensive	Uncontained and potentially far reaching to surrounding waters (e.g. outside of Port limits, Commonwealth marine areas, Rodds Bay, upper part of The Narrows, seaward side of Facing and Curtis Islands), and/or the area of impact is very large and likely extends beyond the Port limits (e.g. an area exceeding 20km^2).	Impact of the activity is measurable greater than 2km from the activity and/or the extent of the impact occurs beyond the South East Queensland bioregion, and/or the overall impact area is extensive (e.g. in the order of 100s of hectares).

Table note:

The relevant spatial extent guide (i.e. marine or terrestrial) will be selected for intertidal ecological values/receptors on a case by case basis depending on how the ecological value/receptor interacts with the Project activities and its role and function within the broader ecosystem

Table 6 Magnitude matrix

Duration of potential impact	Spatial scale of potential impact			
	Undetectable	Contained extent	Local area	Extensive
Not defined as impact is undetectable	Negligible	N/A	N/A	N/A
Temporary	N/A	Low	Low	High
Short term	N/A	Low	Moderate	High
Medium term	N/A	Moderate	Moderate	Very high
Long term	N/A	Moderate	High	Very high
Permanent or irreversible	N/A	Moderate	High	Very high

Table 7 Criteria for magnitude for potential impacts

Magnitude	Description
Negligible	The impact is **not detectable** and has no noticeable change to the existing situation.
Low	The impact is generally recognised as being **contained** and **temporary** or **short term** in duration; OR if the impact extends to the **local area**, the impact is **temporary**.
Moderate	The impact is generally recognised as extending to the **local area**, and lasting from the **short** to **medium term**; OR if the impact is **contained**, the impact is **medium term** to **permanent** in duration.
High	The impact is generally recognised as extending to the **local area** and lasting for the **long term**; OR if the impact is **extensive**, the impact is **temporary** to **short term** in duration.
Very high	The impact is generally recognised as being **extensive** and **medium** to **long term** in duration or resulting in **potentially permanent** and **irreversible** changes**;** OR any other impact, regardless of spatial extent, that would be considered **permanent** or **irreversible**.

7.4 Consequence of potential impacts

The consequence of a potential impact is a function of the **sensitivity** of the ecological value/receptor and the **magnitude** of the potential impact, as defined in Sections 7.2 and 7.3 .

The consequence of potential risks are determined both prior to the implementation of mitigation measures, and following the implementation of mitigation measures.

Although the sensitivity of the ecological value/receptor will not change throughout the impact and risk assessment process (i.e. is generally a qualitative description of the condition of the receptor, and how well it is represented within the local area, region, state and/or nationally) (refer Section 7.2), the magnitude of the potential impact can change from the pre-mitigation step to the post-mitigation step of the risk assessment (i.e. proposed mitigation measures are likely to reduce the duration and/or the spatial extent of the potential impact) (refer Section 7.2). Estimating the consequence of potential impacts before and after the implementation of mitigation measures provides a comparative analysis of the potential benefits of the proposed mitigation measures.

The consequence matrix is presented in Table 8. There are five categories for the consequence of potential impacts (i.e. negligible, low, moderate, high and very high), which are generally defined in Table 9.

Table 8 Consequence assessment matrix

Magnitude of impact	Sensitivity of ecological value			
	Low	Moderate	High	Very high
Negligible	Negligible	Negligible	Low	Low
Low	Low	Low	Moderate	High
Moderate	Low	Moderate	High	Very high
High	Moderate	High	Very high	Very high
Very high	Moderate	High	Very high	Very high

Table 9 Consequence category definitions

Consequence rating	Description
Negligible	Minimal change to the existing situation, including impacts which are beneath levels of detection, impacts that are within the normal bounds of natural variation or impacts that are within the margin of forecasting error. Recovery periods associated with these impacts are within 3 to 6 months.
Low	These impacts are recognisable, but acceptable within the decision making process. They are still important in the determination of environmental management requirements. These impacts tend to be shorter, or temporary (recovery periods of greater than 6 months and up to 12 months are likely) and at the local scale.
Moderate	These impacts are relevant to decision making, particularly for the determination of environmental management requirements. Ecological values/receptors are moderately sensitive and have moderate resilience/adaptive capacity and/or the impacts are local or regional significance. These impacts tend to range from short to long term (recovery periods of 1 to 4 years are likely), and occur over medium scale areas or focussed within a localised area.
High	These impacts are of importance to the decision making process. Ecological values/receptors are moderately to highly sensitive, have low to moderate resilience/adaptive capacity and/or the impacts are of State and National significance. They tend to be permanent or otherwise medium term to long term (recovery periods of 5 to 9 years are likely), and can occur over medium or large scale areas.

Consequence rating	Description
Very high	These impacts are considered to be critical to the decision making process. Ecological values/receptors are extremely sensitive, have low resilience/adaptive capacity and the impacts are of national significance. They tend to be permanent, or irreversible (if recovery is possible, it is likely to take in excess of 10 years), or otherwise long term, and can occur over large scale areas.

7.5 Identification of mitigation measures

Following the initial assessment of the **consequence** of potential impacts, proposed mitigation measures are identified in the context of the environmental objectives for GPC activities and operation, and for the Project (refer Section 3). The mitigation measures have the potential to reduce the consequence rating and level of risk associated with impacts in a number of ways:

- Avoid a risk by preventing an activity or process from occurring (e.g. physical separation of an activity or process from ecological values/receptors)
- Reduce the likelihood of a risk eventuating (e.g. transforming an activity to reduce the likelihood of a potential impact occurring)
- Retain the risk and develop plans to manage the outcomes if the risk is realised (e.g. emergency and disaster planning).

Once potential mitigation measures are identified, **magnitude** and **consequence** are then reassessed using the methods outlined in Sections 7.3 and 7.4, respectively.

The reassessment of **magnitude** and **consequence** assumes that the proposed mitigation measures are implemented effectively. The mitigation measures applicable to each of the ecological values/receptors are discussed further in the Project EIS (Chapter 9 (nature conservation)).

7.6 Post-mitigation impact assessment and determination of risk levels

As outlined above, **magnitude** (refer Section 7.3) and **consequence** (refer Section 7.4) are reassessed assuming the effective implementation of the proposed mitigation measures. The risk level of the potential impact occurring (with the implementation of the proposed mitigation measures) is the product of the **consequence** and **likelihood** of the potential impact.

7.7 Likelihood

Likelihood refers to the chances of a potential impact occurring, assuming the effective implementation of the proposed mitigation measures. **Likelihood** is described semi-quantitatively in Table 10. There are five categories, ranging from rare (i.e. less than 1% chance of occurring over the life of the Project) to almost certain (i.e. greater than 90% probability of occurring).

Table 10 Likelihood definitions for potential impacts occurring over the life of the Project

Description	Frequency
Rare	Highly unlikely to occur but theoretically possible during the life of the Project. Probability is less than 1% chance of occurring.
Unlikely	Unlikely but not trivial. May occur during construction/life of the Project but probability well < 50%.
Possible	Less likely than not, but still considerable; probability of about 50% chance of occurring over the life of the Project.
Likely	Likely to occur during construction/life of the Project or during a 12 month timeframe; probability up to 90% chance of occurring.
Almost certain	Very likely and expected to occur during construction/life of the Project or during a 12 month timeframe; likely to occur multiple times during relevant period. Probability of 90% or greater chance of occurring.

7.8 Risk

Risk is the effect of uncertainty on objectives or desired/expected outcomes (e.g. uncertainty around the expected outcomes managing a potential impact). For this risk assessment, the uncertainty is the result of the lack of information relating to the understanding or knowledge of a potential impact, its consequence, or the likelihood of it occurring.

The risk level of potential impacts is a product of the **consequence** of the potential impacts and the **likelihood** of their occurrence assuming the effective implementation of the proposed mitigation measures (refer Table 11 and Table 12).

Table 11 Risk matrix

Likelihood	Consequence				
	Negligible	Low	Moderate	High	Very high
Rare	Negligible	Negligible	Low	Medium	Medium
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	High	High
Likely	Negligible	Medium	Medium	High	Very high
Almost certain	Low	Medium	High	Very high	Very high

Table 12 Risk category definitions

Risk	Definition
Negligible risk	No additional management required
Low risk	Manageable by standard mitigation and similar operating procedures
Medium risk	An issue requiring project specific controls and operating procedures
High risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on MNES
Very high risk	An issue requiring a change in Project scope and/or timing; almost certain to result in a 'significant' impact on a MNES

8 Threatening processes and significant residual adverse impact assessment

8.1 Threatening processes for TECs, conservation significant and migratory species

Threatening processes which may lead to the progressive loss of TECs, conservation significant and migratory species, including ecologically significant habitat, have been assessed with regards to the potential Project impacts. Threatening processes for ecological values/receptors have been identified from the relevant species recovery plan, conservation listing advice and/or threat abatement plan.

Potential Project impacts were assessed to identify if there is potential to contribute further to the relevant TEC or species current identified threatening processes. Residual impacts on a threatening process have the potential to result where an impact has a high or very high risk rating. For those TECs or species where an impact has been assessed to have a high or very high risk rating, a significant residual adverse impact assessment has been conducted.

8.2 Significant residual adverse impact assessment

Following the determination of the post-mitigation risk level for Project activities, the remaining level of risk (i.e. residual risk) can then be assessed to determine if the residual adverse impacts are likely to be **significant**, and where additional mitigation measures or strategies may be required (e.g. provision of environmental offsets). Significant residual adverse impact assessments have been conducted for species considered to have a moderate or high likelihood of occurrence within the Project impact areas.

Significant residual adverse impact assessment assessments were undertaken where the Project impacts have the potential to result in:

- Very high or high risk (post mitigation measures) on a species
- A residual impact to a key threatening process.

The guidelines below are utilised for the significant residual adverse impact assessments for potential impacts on particular ecological values (e.g. seagrass meadows), presented in the Project EIS (Chapter 9 (nature conservation)):

- For MNES: *Significant Impact Guidelines 1.1* (DoE 2013b)
- For MSES: *Significant Residual Impact Guideline* (EHP 2014).