Great Keppel Island

REVITALISATION PLAN

# 3. ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS

# CONTENTS

# 3. ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS

Chapter 3 describes the existing environmental values of the Project area and identifies the potential impacts of the Project on these identified values. Mitigation measures or direct offsets are identified in relation to all potential impacts.

The following matters are addressed in this chapter:

- Climate, natural hazards and climate change (**Section 3.1**);
- Land (**Section 3.2**);
- Nature conservation (**Section 3.3**);
- Matters of national environmental significance (**Section 3.4**);
- Water resources (**Section 3.5**);
- Coastal environment (**Section 3.6**);
- Air quality (**Section 3.7**);
- Greenhouse gas emissions (**Section 3.8**);
- Noise and vibration (**Section 3.9**);
- Waste (**Section 3.10**);
- Transport (**Section 3.11**);
- Indigenous cultural heritage (**Section 3.12**); and
- Non-Indigenous cultural heritage (**Section 3.13**).

This chapter contains risk assessments in the determination of Project related impacts. The risk assessment process is the overall process of risk identification, risk analysis, and risk evaluation and considers the likelihood of a risk's occurrence and the potential impacts that may be caused.

The risk assessment process can be tabulated to give a rating between 1 and 25. This table is known as a Risk Evaluation Matrix and has been used to quantify the risks for potential impacts which may occur during construction and operation of the Project. **Table 3.1** shows the risk evaluation matrix used for the Project.

**TABLE 3.1 RISK EVALUATION MATRIX**

| | Consequence | | | | |
|---|---|---|---|---|---|
| **Likelihood** | Catastrophic Irreversible-Permanent (5) | Major - Long Term (4) | Moderate-Medium Term (3) | Minor-Short Term Manageable (2) | Insignificant-Manageable (1) |
| Almost Certain (5) | **(25) Extreme** | **(20) Extreme** | **(15) High** | **(10) Medium** | **(5) Medium** |
| Likely (4) | **(20) Extreme** | **(16) High** | **(12) High** | **(8) Medium** | **(4) Low** |
| Possible (3) | **(15) High** | **(12) High** | **(9) Medium** | **(6) Medium** | **(3) Low** |
| Unlikely (2) | **(10) Medium** | **(8) Medium** | **(6) Medium** | **(4) Low** | **(2) Low** |
| Rare (1) | **(5) Medium** | **(4) Low** | **(3) Low** | **(2) Low** | **(1) Low** |

The hazard and risk assessment has been undertaken in accordance with *AS/NZS 4360:2004 Risk Management* and the associated assessment methodology.

**Note:**

**Extreme:** Requires immediate action to reduce level of risk. Project not to proceed without detailed risk assessment and senior management approval.

**High:** Requires specific measures and management action to reduce level of risk before proceeding.

**Medium:** Can generally be managed with standard systems and procedures.

**Low:** Normally managed through normal compliance with legislation, codes of practice, guidelines, standards.

# 3.1 Climate, Natural Hazards and Climate Change

OPUS Engineers were engaged by the Proponent to undertake the climate change assessment for the EIS. Refer to the full report for the findings, potential impacts and suggested mitigation measures in **Appendix X - Climate Change Technical Report**.

## 3.1.1 Natural Hazards and Climate Change Adaptation

### 3.1.1.1 Existing Climatic Conditions

#### (a) Rainfall

The Island is characterised by a mild, sub-tropical climate. Rainfall is quite variable with average annual rainfall varying from a low of 494 millimetres per year up to 1,936 millimetres per year, and averaging about 975 millimetres per year (BOM, 2011).

Rainfall occurs during the summer months with February typically being the wettest month having a mean monthly rainfall of 170.1 millimetres and 95th percentile of 439.5 millimetres. The monthly rainfall can vary considerably on the Island, particularly in terms of the volume of rainfall occurring during the summer months.

Based on daily rainfall data compiled for the Island by the Queensland Government for the period from January 1957 to December 2009, the maximum rainfall for a 24 hour period was recorded as 344 millimetres, which occurred on 18 February 1961.

Reference to climate data recorded at the Heron Island Research Station indicates that on average, at least one millimetre of rainfall is recorded on approximately 84.7 days per year (BOM, 2011), which is slightly higher than mainland sites at Yeppoon (76.1 days per year on average) and Rockhampton Airport (62.8 days per year on average). The number of rain days per month is generally higher during the wetter, summer months from December to March, averaging around 6-10 days per month (BOM, 2011).

#### (b) Evaporation

Evaporation rates on the Island are relatively high. Daily pan evaporation data compiled for the Island by DERM for the period from January 1957 to December 2009 indicates an average pan evaporation rate for the Island of approximately 1,848 millimetres per year, with a 10th percentile of 1,715 millimetres per year and a 90th percentile of 1,997 millimetres per year. Comparing this to rainfall data over the same time period indicates that there is an average annual rainfall deficit of approximately 803 millimetres per year. During a year of above average evaporation and below average rainfall, the annual rainfall deficit may be up to 1,309 millimetres per year, while in a year of below average evaporation and above average rainfall, the annual rainfall deficit may be as low as 237 millimetres per year.

### (c) Temperatures

Average maximum daily temperatures on the Island range from 21 degrees celcius in winter up to 29.5 degrees celcius in summer, although maximum temperatures up to approximately 35 degrees celcius may occur. Average minimum temperatures on the Island range from approximately 16.5 degrees celcius in winter up to 24 degrees celcius in summer, with minimum temperatures as low as five degrees celcius recorded on nearby islands in the Region.

### (d) Relative Humidity

Historic BOM data shows that relative humidity recorded at coastal and island monitoring sites in the vicinity of the Island, including at Yeppoon and Heron Island varies little between 9:00am and 3:00pm. Relative humidity on the Yeppoon coast averages between 60 percent and 80 percent throughout the day, year round with minimal variation. Relative humidity on Heron Island varies more substantially throughout the year with the lowest relative humidity occurring in September at about 67 percent (9:00am) and 63 percent (3:00pm), and the highest relative humidity occurring in February / March at about 74 percent (9:00am) and 71 percent (3:00pm). Relative humidity on the Island is likely to be most comparable to Heron Island being an island located roughly the same distance from the mainland.

### (e) Wind Regime

There is no available wind pattern data for GKI however wind patterns on the Island are likely to be similar to Heron Island to the south. Heron Island experiences predominantly south-easterly winds, morning and afternoon throughout January to May, with an increase in southerly winds occurring in June, July and August. September through to December are characterised by south-easterly, easterly, north-easterly and northerly winds in almost equal proportion. Wind speeds are quite variable, with the dominant wind in each month roughly being 10 percent greater than 40 kilometres per hour, 20 percent in the 30-40 kilometres per hour range, 30 percent in the 20-30 kilometres per hour range, 30 percent in the 10-20 kilometres per hour range and 10 percent in the less than 10 kilometres per hour range. The wind speed on the Island is usually influenced by cyclonic activity in the summer months.

### 3.1.1.2 Natural Hazards

#### (a) Tropical Cyclones

Tropical cyclones in the Queensland region mostly form from lows within the monsoon trough between the months of November and April. On average 4.7 tropical cyclones per year affect the Queensland Tropical Cyclone Warning Centre's area of responsibility, which extends from Torres Strait to northern New South Wales (BOM, 2011). Tropical cyclones rarely form south of 25° latitude in Queensland due to the cooler sea surface temperatures. Being located at approximately 23.16° latitude, the Island is located within the tropical cyclone zone.

There is a strong relationship with eastern Australian tropical cyclone impacts and the El Niño-Southern Oscillation phenomenon. On average, the Island area is expected to experience up to approximately 0.4 cyclones per year, while in La Niña years the area may expect to experience up to approximately 0.6 cyclones per year.

There have been 207 known impacts from tropical cyclones along the east coast of Queensland since 1858. Such impacts include coastal erosion and flooding, property damage and loss of life (BOM, 2011). Between 1956 and 2006, 12 cyclones have been identified as affecting the GKI area, namely:

- Tropical Cyclone Rewa (1994);
- Tropical Cyclone Fran (1992);
- Tropical Cyclone Pierre (1985);
- Severe Tropical Cyclone Simon (1980);
- Tropical Cyclone Paul (1980);
- Severe Tropical Cyclone Kerry (1979);
- Tropical Cyclone Dawn (1976);
- Tropical Cyclone David (1976);
- Tropical Cyclone Emily (1972);
- Tropical Cyclone Fiona (1971);
- Tropical Cyclone Dinah (1967); and
- Un-named Tropical Cyclone (1961).

#### (b) Bushfires

Wildfires are a risk on dry tropical islands due to vegetation types and typically long dry summers prior to the wet season. The Island has experienced a number of bushfires in the past. There has been no reported loss of life or significant damage to infrastructure as a result of wildfires on the Island.

### (c) Storm Surge

Storm surges are often associated with cyclonic activity. Storm surge is a rise above the normal water level along a shore resulting from strong onshore winds and / or reduced atmospheric pressure. Although storm surges generally accompany tropical cyclones as they come ashore, they may also be formed by intense low-pressure systems in non-tropical areas. The greatest impacts occur when a storm surge arrives on top of a high tide and when combined with powerful waves generated by cyclonic winds.

Storm surges may result in flooding and shoreline erosion, with associated damage to infrastructure and property, including potential to wash away roads and damage buildings, and to cause ships to run aground. Storm surge is also a risk to public safety, and has been known to result in a number of drownings in Queensland in previous years (BOM, 2011). The height of storm surge, where in relation to a cyclone, depends on a number of factors, including the intensity of the cyclone, the forward moving speed of the cyclone, the angle at which the cyclone crosses the coast, the shape of the sea floor and local topography.

The current 100 year average recurrence interval (ARI) storm surge level estimated for the Queensland coast around 23° latitude is approximately 0.3 metres (QCCCE, 2010). Analysis undertaken by Water Technology (2011) for the GKI Revitalisation Plan, taking into account local conditions, has estimated the following storm tide recurrence intervals for various locations on the Island (refer **Table 3.2**). Storm tide levels specified in **Table 3.2** reflect the height of mean sea level plus storm surge level relative to the Australian Height Datum (AHD) at each location.

**TABLE 3.2 ESTIMATED STORM TIDE LEVELS FOR VARIOUS RECURRENCE INTERVALS**

| ARI | Yeppoon m AHD | Putney Beach m AHD | Fisherman's Beach m AHD |
|---|---|---|---|
| **50 year** | 2.75 | 2.32 | 2.37 |
| **100 year** | 2.94 | 2.67 | 2.74 |
| **500 year** | 3.49 | 2.75 | 2.83 |

*Source: Water Technology, 2011*

### (d) Projected Climatic Changes

The climate of the Earth is a complex and dynamic system, changing continually over a range of timescales and as a result of a range of factors, internal and external to the climate system, natural and anthropogenic. Since 1988 the scientific findings on atmospheric change and the potential for human induced changes in the Earth's climate have been reviewed and summarised by the Intergovernmental Panel on Climate Change (IPCC) and four major reports have been issued (IPCC 1990; IPCC 1996; IPCC 2001 and IPCC 2007).

The IPCC defines 'climate change' as:

> *"a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer."*

The IPCC's fourth assessment report (AR4) remains the authoritative reference for climate change policy development by the Queensland Government (DERM, 2010). A review of the IPCC AR4 along with various other national, state and regionally specific reports addressing the issue of climate change has been undertaken to identify and where possible quantify the potential impacts of climate change on the Project. National, state and regionally specific reports considered most relevant for this purpose include:

- *Queensland Coastal Plan 2011, Department of Environment and Resource Management, 2011;*
- *Climate Change in Queensland: What the Science is Telling Us, Queensland Climate Change Centre for Excellence, Department of Environment and Resource Management, 2010;*
- *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012, GBRMP Authority, 2009;*
- *Climate Change Risks to Australia's Coast: A First Pass National Assessment, Department of Climate Change, 2009; and*
- *Climate Change in Australia: Technical Report 2007, CSIRO and BOM, 2007.*

In determining climate change factors to be applied to risk assessments for the GKI Revitalisation Plan, priority has been given to the use of the most site specific and / or most recent data from the sources listed above. A detailed discussion of relevant climate change projections derived from the above sources as applicable to the GKI Revitalisation Plan is provided in **Appendix X - Climate Change Technical Report** while a summary of the climate change factors adopted for risk assessment and planning purposes from 2030 to 2100 is provided in **Table 3.3**.

## TABLE 3.3 QUANTITATIVE CLIMATE CHANGE FACTORS APPLIED TO RISK ASSESSMENTS

| | Year | | | |
|---|---|---|---|---|
| **Climate Variable** | **2030** | **2050** | **2070** | **2100** |
| Mean Sea Level | +0.2m[1] | +0.4m[2] | +0.7m[1] | +0.8m[3] |
| Mean Surface Temperature | +1.4°C[5] | +2.0°C[4] | +3.4°C[6] | +4.0[7] |
| Mean Rainfall | -5%[6] | -7%[4] | -9%[6] | -- |
| Rainfall Intensity | -- | -- | 2-hour event: +48%<br>24-hour: +16%<br>72-hour event: +14% | -- |
| Solar Radiation | +1%[8] | +1%[8] | +1%[8] | -- |
| Relative Humidity | -1%[8] | -1%[8] | 1%[8] | -- |
| Potential Evaporation | +2%[8] | +7%[4] | +10%[6] | -- |
| Average Wind Speed | +7.5%[6] | +15%[6] | +15%[6] | -- |
| Storm Surge (Q100) | | +0.3m (excluding mean sea level rise)[8] | -- | -- |
| Mean Sea Surface Temperature | +0.5°C[5] | +1.2°C[5] | -- | -- |

1. *'Table 2.1 Three sea-level rise scenarios, 2030-2100 (metres)' in Climate Change Risks to Australia's Coast: A First Pass National Assessment, Department of Climate Change, 2009.*
2. *'Table 1. Project changes in climate for the GBR for 2020 and 2050' in Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012, GBRMP Authority, 2009 within projected range of +0.13 to +0.68 assumes consistent 0.1m increase per decade between 2030 and 2070.*
3. *Queensland Coastal Plan, Department of Environment and Resource Management, 2011.*
4. *'Table 1. Summary of climate projections for 2050 and key impacts for 13 Queensland regions' in Climate Change in Queensland: What the Science is Telling Us, Queensland Climate Change Centre for Excellence, Department of Environment and Resource Management, 2010 based on High Emissions (A1F1) Scenario for Central Queensland region.*
5. *'Table 1. Project changes in climate for the GBR for 2020 and 2050' in Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012, GBRMP Authority, 2009 at upper limit of projected range.*
6. *Climate Change in Australia: Technical Report 2007, CSIRO and BOM, 2007 based on High Emissions (A1F1) Scenario.*
7. *Fourth Assessment Report, Intergovernmental Panel on Climate Change, 2007 based on best estimate for High Emissions (A1F1) Scenario.*
8. *Climate Change in Australia: Technical Report 2007, CSIRO and BOM, 2007 based on Best Estimate across all emissions scenarios.*

#### 3.1.1.3 Potential Impacts and Impact Mitigation Measures

Predicted changes in a range of climatic variables as described above, have the potential to significantly impact, directly and indirectly, upon the Project during both construction and operation phases. A risk assessment of potential climate change impacts for each phase of the Project was therefore undertaken as described in **Appendix X - Climate Change Technical Report**.

For the purpose of assessing potential impacts, the projected climate change factors for 2030 were adopted for construction phase impacts given the anticipated 12 year construction period while the projected climate change factors for 2070 were adopted for assessment of operational phase impacts or 2100 (where available).

A risk assessment of potential climate change impacts for each phase of the Project has been undertaken along with proposed mitigation measures to address each identified risk. A standard risk assessment matrix as presented in **Table 3.1** has been used for the purpose of assessing climate changes risks associated with this Project.

**(a) Construction Phase**

A summary of potential impacts and proposed mitigation for the construction phase is provided in **Table 3.4**. Construction of the Resort and associated facilities will be undertaken in stages, with the first stage comprising the hotel, marina facility and internal infrastructure (i.e., roads, water, sewerage, electricity) expected to take approximately 18 months to complete.

**TABLE 3.4 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR CONSTRUCTION PHASE**

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increase in cyclone intensity, including increase in extreme daily rainfall, maximum wind velocity and storm surge. | Increased risk to safety of construction staff on the Island during severe cyclonic events. | High | Medium | Construction works during the cyclone season will be minimised where practical.<br>Evacuation plans will be developed to ensure all construction staff can be safely evacuated in the event of a severe cyclone. The requirements of the evacuation plan and procedures for communicating advice on cyclone threats will be presented during staff inductions.<br>No buildings or other structures will be constructed within the erosion prone area unless foundations are designed to withstand potential erosion of sandy substrate.<br>Buildings will be designed in accordance with relevant building codes for Central Queensland, allowing for projected increases in wind speed.<br>Stormwater diversion systems will be designed to prevent inundation of work sites and erosion and sediment control measures will be designed to remain effective during more intense rainfall events. A 20 percent buffer will be applied to maximum design flows to allow for a possible 16 percent increase in the intensity of a 24-hour rain event projected for 2070.<br>Construction of the marina will occur in Stage 1. This will establish a permanent barge access for the Island that does not need beach access. The barge access will be designed to incorporate nominated sea level rises. Until completion of the permanent barge access, the barge access will be the same as the current situation, which requires access across the beach. Access across the beach will not be significantly affected by the small sea level rise that may occur prior to completion of the permanent barge access in Stage 1. |
| | Direct damage to built infrastructure and construction materials, and possible inundation of construction sites through storm surge and more intense rainfall. | High | Medium | |
| | Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity. | Medium | Low | |
| | Increased shoreline erosion resulting from wave action and storm surge, creating difficulties for barge access etc prior to construction of marina facility. | Medium | Medium | |
| | Possible delays to construction where severe cyclones force evacuation of Island. | Medium | Low | |

**TABLE 3.4 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR CONSTRUCTION PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increase in rainfall intensity. | Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity. | Medium | Low | Stormwater diversion systems will be designed to prevent inundation of work sites and erosion and sediment control measures will be designed to remain effective during more intense rainfall events.<br>A 20 percent buffer will be applied to maximum design flows to allow for a possible 16 percent increase in the intensity of a 24 hour rain event projected for 2070. |
| | Increased potential for inundation of construction sites as more intense rainfall exceeds capacity of stormwater diversion systems. | High | Low | |
| Decreased average rainfall and higher probability of drought periods. | Increased potential for dust generation and erosion as grass coverage more difficult to establish and maintain. | Low | Low | Construction works will be staged to minimise the extent of ground surface exposed at any one time.<br>Sufficient water supply will be available during construction to undertake dust suppression as required, preferably sourced from recycled water supplies. |
| Increased average temperature. | Increased bushfire hazard resulting in increased risk to built infrastructure and public safety. | High | Low | Prior to construction works commencing on the Island, a bushfire management plan will be prepared in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood. This will include identification of adequate water supply sources for fire fighting purposes. |

**TABLE 3.4 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR CONSTRUCTION PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increased average evaporation. | Increased bushfire hazard resulting in increased risk to built infrastructure and public safety. | **High** | **Low** | Prior to construction works commencing on the Island, a bushfire management plan will be prepared in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood. This will include identification of adequate water supply sources for fire fighting purposes. |
| | Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain. | **Low** | **Low** | Construction works will be staged to minimise the extent of ground surface exposed at any one time.<br>Sufficient water supply will be available during construction to undertake dust suppression as required, preferably sourced from recycled water supplies. |
| Increased mean sea levels. | Projected sea level rise by 2030 of +0.2 metres may create difficulties for barge access etc prior to construction of marina facility. | **Low** | **Low** | Construction of the marina will occur in Stage 1. This will establish a permanent barge access for the Island that does not need beach access. The barge access will be designed to incorporate nominated sea level rises. Until completion of the permanent barge access, the barge access will be the same as the current situation, which requires access across the beach. Access across the beach will not be significantly affected by the small sea level rise that may occur prior to completion of the permanent barge access in Stage 1. |
| Increased concentration of $CO_2$ in oceanic waters. | Nil | **N/A** | **N/A** | N/A |

### (b) Operational Phase

A summary of potential impacts and proposed mitigation for the operational phase is provided in **Table 3.5**.

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE**

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increase in cyclone intensity, including increase in extreme daily rainfall, maximum wind velocity and storm surge. | Increased risk to safety of guests, visitors and staff on the Island during severe cyclonic events. | High | Medium | Evacuation plans will be developed to ensure all staff, guests and visitors can be safely evacuated in the event of a severe cyclone. The requirements of the evacuation plan and procedures for communicating advice on cyclone threats will be presented to all staff during inductions and information provided to guests on arrival.<br><br>No buildings or other structures will be constructed within the erosion prone area unless foundations are designed to withstand potential erosion of sandy substrate.<br><br>Buildings will be designed in accordance with relevant building codes for Central Queensland, allowing for projected increases in wind speed and cyclone intensity.<br><br>Building pad levels will be located above 3.74 metres AHD at Putney Beach and 3.82 metres AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise.<br><br>Stormwater infrastructure will be designed with an increased capacity sized to account for projected increases in rainfall intensity, including 48 percent increase for two-hour event, 16 percent increase for 24 hour and 14 percent increase for 72 hour event.<br><br>Open recycled water storages will be designed with an increased capacity sized to account for projected increases in rainfall intensity, including 48 percent increase for two-hour event, 16 percent increase for 24 hour and 14 percent increase for 72 hour event. |
| | Direct damage to built infrastructure. | High | Medium | |
| | Increased shoreline erosion resulting from wave action and storm surge resulting in accessibility and amenity issues. | Medium | Medium | |
| | Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity. | Medium | Low | |
| | Increased potential for flooding as more intense rainfall events exceed the design capacity of stormwater drainage infrastructure. | High | Low | |
| | Increase potential for overflow of recycled water storage facilities as more intense rainfall events exceed design capacity resulting in potential impacts on water quality. | High | Low | |
| | Increased physical damage to coral reef ecosystems resulting in impacts on biodiversity and declining tourist numbers. | High | High | |

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increase in rainfall intensity. | Increased potential for flooding as more intense rainfall events exceed the design capacity of stormwater drainage infrastructure. | High | Low | As above.<br>Ensure activities are undertaken in a manner that maintains or enhances the health of the reef to create greater resilience to mainland flooding and other severe weather events (e.g., severe cyclones) including:<br>• minimising physical damage to reefs through control of moorings, boat traffic, scuba diving and snorkelling activities; and<br>• preventing decline in reef water quality by ensuring all stormwater and recycled water that directly or indirectly discharged to natural waters is appropriately treated. |
| | Increase potential for overflow of recycled water storage facilities as more intense rainfall events exceed design capacity. | High | Low | |
| | Potential for mainland flooding and associated discharge of sediment / nutrient laden runoff to impact on coral reef ecosystems resulting in impacts on biodiversity and declining tourist numbers. | High | Medium | |
| Decreased average rainfall and higher probability of drought periods. | Decreased reliability of rainfall dependent water supplies (eg. rainwater tanks, groundwater bore supplies). | High | Low | A sustainable water supply strategy will be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island.<br>Rainwater storages will be sized to maximise capture during increasingly intense rainfall events.<br>Use of recycled water for irrigation will be maximised. |
| | Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain. | Low | Low | |
| | Increased demand for irrigation water supplies for maintenance of golf course and landscaped areas. | Medium | Low | |
| | Increased bushfire hazard resulting in increased risk to built infrastructure and public safety. | High | Low | A bushfire management plan will be prepared for the GKI Revitalisation Plan in consultation with local fire services authorities and in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood. |

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increased average temperature. | Increased bushfire hazard resulting in increased risk to built infrastructure and public safety. | High | Low | A bushfire management plan will be prepared for the GKI Revitalisation Plan in consultation with local fire services authorities and in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood.<br><br>The bushfire management plan will include provision for access for fire-fighting equipment and evacuation of visitors and staff, firebreaks to protect buildings and critical infrastructure, and adequate water supply sources for fire fighting purposes.<br><br>The marina will include a berth and associated facilities as required by emergency services.<br><br>A sustainable water supply strategy will be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island.<br><br>Rainwater storages will be sized to maximise capture during increasingly intense rainfall events.<br><br>Design principles will be incorporated into all buildings within the GKI Revitalisation Plan to maximise natural ventilation and solar access, to reduce demand for air conditioning, including use of appropriate building materials and site aspect, and retention of native vegetation for shading. |
| | Increase in demand for air-conditioning and subsequent increase in energy consumption. | Medium | Low | |
| | A potential increase in water demand as a result of higher temperatures and evaporation resulting in increased pressure on water supplies. | Medium | Low | |
| | Changes in temperatures may result in migration of certain tropical and temperate terrestrial and marine species southward, and increased coral bleaching (DCC, 2009). | High | High | |
| | Increased geographical spread of diseases such as malaria, dengue fever etc due to more favourable conditions for vectors. | High | Medium | |
| | Increased heat-related illness in humans. | High | Medium | |

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increased average evaporation. | Increased bushfire hazard resulting in increased risk to built infrastructure and public safety. | High | Low | A bushfire management plan will be prepared for the GKI Revitalisation Plan in consultation with local fire services authorities and in accordance with State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood.<br>Use of open storages for water supplies (other than recycled water storage) should be minimised to reduce exposure to evaporation.<br>A sustainable water supply strategy will be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island. |
| | Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain. | Low | Low | |
| | Increased demand for irrigation water supplies for maintenance of golf course and landscaped areas. | Medium | Low | Stormwater harvesting infrastructure, including rainwater tanks, will be designed with a capacity to maximise collection of rainwater to offset increased evaporation rates. |

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increased mean sea levels. | A sea level rise +0.8 metres is projected by 2100. Potential damage to built infrastructure due to increased shoreline erosion.<br>Rising sea levels, combined with changes in the frequency and magnitude of extreme weather events, are likely to cause soft shorelines to recede (DCC and EE, 2010) particularly if the frequency of such events increases resulting in insufficient time for natural coastal replenishment processes to replace eroded sediments. | **Extreme** | **Medium** | Only buildings and structures with foundations designed to withstand erosion of sandy substrate will be constructed within erosion prone areas, including potential erosion prone areas associated with projected sea level rise.<br>An assessment of storm surge risks has accounted for projected sea level rise and increased cyclonic intensity. Building pad levels will be located above 3.74 metres AHD at Putney Beach and 3.82 metres AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise.<br>Design of essential coastal infrastructure (e.g., marina, public access infrastructure) within the coastal hazard zone will be designed to adapt to a 0.8 metre sea level rise by 2100. |
| | Increased risk of saline intrusion into aquifers impacting on quality of groundwater supplies. | **High** | **Low** | A sustainable water supply strategy will be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island.<br>Although potable groundwater reserves exist on the Island, use of groundwater to provide water supply to the Resort during operation is not proposed. As such, the Resort will not place any increased pressure on groundwater reserves ensuring greater resilience to possible saline intrusion resulting from sea level rise. |
| | Potential impacts on various ecosystems resulting in possible declines in biodiversity and tourist numbers. For example:<br>• possible loss of habitats in near-shore environments such as beaches, mangroves, saltmarshes and sea grass beds as a result of shoreline erosion; and<br>• possible loss of coastal freshwater wetlands due to salinisation of and inundation of low-lying areas (DCC and EE, 2010). | **Extreme** | **Medium** | Regular monitoring of water quality and reef ecosystem health, will be conducted by the Proponents environmental advisers as well as scientists from the Research Centre will undertake specific research projects aimed at improving understanding and protection of the reef.<br>In addition, it is anticipated that monitoring undertaken as part of the GKI Revitalisation Plan will include:<br>• monitoring of water quality in estuarine and coastal waters;<br>• monitoring of inter-tidal and riparian vegetation; and<br>• monitoring of releases to water from irrigation / discharges of recycled water and stormwater. |

**TABLE 3.5 SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS AND PROPOSED MITIGATION FOR OPERATIONAL PHASE** (CONTINUED)

| Climate Change Factor | Potential Impacts | Risk Level (Unmitigated) | Risk Level (Mitigated) | Proposed Mitigation |
|---|---|---|---|---|
| Increased concentration of $CO_2$ in oceanic waters. | Decreased health of coral reef ecosystems impacting on biodiversity and possibly resulting in decline in tourist numbers. For example:<br>• possible decrease in coral growth and coral reef maintenance due to increased acidification of sea water resulting from increased dissolved $CO_2$, which reduces the availability of carbonate ions that many marine organisms use to build solid carbonate shells and skeletons (DCC, 2009); and<br>• possible impacts on respiration of fish and larval development through changed solubility of nutrients and toxins (DCC, 2009). | **High** | **High** | Regular monitoring of water quality and reef ecosystem health will be conducted, as well as specific research projects aimed at improving understanding and protection of the reef.<br>In addition, it is anticipated that monitoring undertaken as part of the GKI Revitalisation Plan will include:<br>• monitoring of water quality in estuarine and coastal waters;<br>• monitoring of inter-tidal and riparian vegetation; and<br>• monitoring of releases to water from irrigation / discharges of recycled water and stormwater. |

In addition to minimising the impacts of climate change on the Island, it is recognised that minimising the Project's contribution to human-induced climate change is necessary to ensure the future viability of coral reef and other ecosystems that attract visitors to the Island and is therefore necessary for ensuring the viability of the Project itself. As such, the following measures are proposed to minimise the carbon footprint of the Project:

- primary electricity supply will be derived from solar photovoltaic cells installed on the Resort buildings, with only supplementary and emergency electricity sourced from standby diesel generators and a mainland electricity cable connection. Sufficient solar panels will be installed to meet the energy demands of the GKI Revitalisation Plan plus five percent with excess energy generated to be returned to the mainland grid;
- buildings are to be designed to minimise energy consumption for heating and cooling by maximising use of natural ventilation and solar access; and
- proposed buildings and infrastructure will be located to minimise the clearing of native vegetation. As part of the GKI Revitalisation Plan, planting of vegetation will occur to offset losses in biodiversity and carbon sequestration capacity.

Other initiatives proposed as part of the GKI Revitalisation Plan will also contribute to maintaining the resilience of coral reef and other ecosystems to climate change including:

- establishment of a research centre within the Keppel Island Group;
- funding of the Research Centre and associated research and educational activities through establishment of a Biodiversity Fund comprised of a portion of GKI Resort Pty Ltd's profit and visitor donations. Specific research projects will be aimed at improving understanding and protection of the reef; and
- conducting regular monitoring of water quality and the condition of coral reefs and coastal ecosystems to assist in early identification of potential impacts and to inform the development of strategies to further mitigate or adapt to potential climate change impacts.

Further discussion on potential impacts of climate change and proposed mitigation measures are provided in Table 10 and 11 of **Appendix X - Climate Change Technical Report**.

#### 3.1.1.4 Great Barrier Reef Tourism Climate Change Action Strategy

Given the potential for climate change to impact on the operation of the Resort, the Proponent has identified a moral and economic need to implement measures to minimise the carbon footprint of the Resort, to increase awareness of staff and visitors about the risks of climate change and where practical, implement other measures to contribute to reducing the impacts of global climate change.

This is consistent with the objectives of the *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012* (GBRMPA, 2009), which was developed to provide the tourism industry with a strategy to improve reef health and the viability of the marine tourism industry, recognising that the future health of the GBR and the sustainability of the tourism industry are inextricably linked and both are vulnerable to climate change.

As such, the proposed GKI Revitalisation Plan has been assessed against the objectives and strategies outlined in the *Great Barrier Reef Tourism Climate Change Action Strategy* 2009-2012 (refer **Table 3.6**).

**TABLE 3.6 RESPONSE TO GREAT BARRIER REEF TOURISM CLIMATE CHANGE ACTION STRATEGY 2009-2012**

| Objectives and Strategies | Project Response |
|---|---|
| **Objective 1: Raise Awareness about climate change impacts to the Great Barrier Reef** | |
| **Strategy 1.1.** Raise the awareness of Reef marine tourism operators about climate change | All staff and associated tourism operators will be provided with climate change awareness training as part of their induction, including a requirement to demonstrate commitment to the Proponent's sustainability policies and advice on how staff and tourism operators can contribute to reducing the carbon footprint of their activities. |
| **Strategy 1.2.** Raise the awareness of visitors | A range of information will be provided to visitors to increase their awareness of the potential impacts of climate change on the natural ecosystems they've come to see and experience, as well as advice on how visitors can reduce their contribution to the Resort's carbon footprint during their stay. This may range from information presented during guided tours to signage around the Resort advising guests on opportunities to conserve energy during their stay. |
| **Strategy 1.3.** Raise the awareness of government agencies and tourism industry partners | GKI Resort Pty Ltd will seek to actively participate in tourism industry forums and other opportunities to achieve the objectives of the Great Barrier Reef Tourism Climate Change Strategy, including participating in the Tourism Climate Change Action Group. |
| **Objective 2: Reduce carbon footprints** | |
| **Strategy 2.1.** Audit and reduce operational greenhouse gas emissions | The Project will be designed to be "carbon positive" in terms of electricity consumption. This will be achieved by incorporating solar panels into the Resort, which will generate sufficient energy to meet the needs of the Resort and ancillary activities, while returning excess energy to the mainland electricity grid.<br><br>Design principles for the GKI Revitalisation Plan will ensure buildings are designed to maximise natural ventilation, solar access, and incorporate energy efficient lighting and appliances to reduce demand for non-renewable energy resources. Where appropriate, Green Star building design standards will be adopted. |
| **Strategy 2.2.** Offset emissions | In addition to generating more than enough energy to meet the electricity needs of the Resort and ancillary activities, all vegetation cleared for construction of the Project will be offset (refer **Appendix P**).<br><br>Consideration may also be given to establishing a carbon offset option for visitors to the Island that could be voluntarily applied to the cost of the ferry transfer. |

**TABLE 3.6 RESPONSE TO GREAT BARRIER REEF TOURISM CLIMATE CHANGE ACTION STRATEGY 2009-2012** (CONTINUED)

| Objectives and Strategies | Project Response |
|---|---|
| **Objective 3: Support climate change monitoring, reporting and research** | |
| **Strategy 3.1.** Support research that fosters understanding of climate change and its impacts | As part of the GKI Revitalisation Plan, the Proponent plans to establish a research centre, which will provide the first dedicated research facility within the Keppel Island Group. The research centre will be designed and managed by CQUniversity Australia, and will provide a facility where researchers can undertake their work and students can obtain a hands-on educational experience.<br><br>The research centre will be funded through a Biodiversity Fund developed by the Proponent to ensure sufficient financial resources are available to fund research and education initiatives at the centre in the long term. The Biodiversity Fund will be comprised of a portion of the GKI Resort Pty Ltd's profit as operating capital for the facility. Visitors will be able to donate additional funds, while a range of other tourism business activities are also envisaged to contribute to funding research and educational activities at the centre. |
| **Strategy 3.2.** Support Reef monitoring and reporting programs | It is anticipated that the research centre with the Proponents environmental staff, will undertake regular monitoring of water quality and reef ecosystem health, as well as undertaking specific research projects aimed at improving understanding and protection of the reef.<br><br>In addition, it is anticipated that monitoring undertaken as part of the GKI Revitalisation Plan will include:<br>• monitoring of water quality in estuarine and coastal waters;<br>• monitoring of inter-tidal and riparian vegetation; and<br>• monitoring of releases to water from irrigation / discharges of recycled water and stormwater. |
| **Objective 4: Improve the resilience of the Great Barrier Reef** | |
| Strategy 4.1. Minimise physical impacts to the Reef | Construction of the marina will provide a dedicated mooring place for vessels accessing the Island. This is expected to reduce the potential damage to reefs that may be caused by the current moorings of boats offshore to the Island. |
| Strategy 4.2. Minimise negative impacts to water quality from daily operations or construction activities | Stormwater runoff from potentially contaminated areas will be treated prior to release to receiving waters. For example, grassed swales and bio-retention basins will be used for treatment of stormwater runoff from the golf course to reduce nutrient and sediment loads.<br><br>Irrigation of recycled water on the golf course and other landscaped areas of the Resort will be designed and managed to prevent excessive leaching of nutrients to groundwater and surface waters, including treatment to reduce nutrient levels in sewerage effluent and scheduling irrigation to minimise deep drainage and runoff.<br><br>Erosion and sediment control plans will be developed and implemented for all construction phases of the Project. |

**TABLE 3.6 RESPONSE TO GREAT BARRIER REEF TOURISM CLIMATE CHANGE ACTION STRATEGY 2009-2012** (CONTINUED)

| Objectives and Strategies | Project Response |
|---|---|
| **Objective 5: Integrate climate change into business operations and planning** | |
| **Strategy 5.1.** Plan for declining reef conditions and changing climate | Although the natural wonders of the Great Barrier Reef are undoubtedly the primary attraction to tourists visiting the Island, by providing a range of non-reef based activities such as the golf course, water sports, day spa, interpretive historical and natural island walks, etc, the Proponent is seeking to provide some resilience in the business to the potential impacts of climate change. |
| **Strategy 5.2.** Develop business strategies to mitigate the impacts of climate change | Business planning will consider the potential impacts of climate change in terms of ensuring built infrastructure is designed and located to withstand or adapt to predicted climatic change.<br><br>Appropriate plans will be developed to ensure that staff and visitors can be safely and efficiently evacuated from the Resort and Eco Villas in the event of severe tropical cyclones.<br><br>Business plans will consider the potential loss of revenue resulting from declines in tourist numbers following severe weather events that impact on reef attractions (e.g., severe cyclones, flooding). |
| **Strategy 5.3.** Maintain industry viability | Establishment of the research centre, being the first based within the Keppel Island Group, will support researchers in their studies of the impacts of climate change and other threats to the Great Barrier Reef. This research will inform actions to be implemented to protect the coral reef and island ecosystems, which provide the foundation to tourism industry viability. |
| **Strategy 5.4.** Develop environmental management and engineering strategies | Design principles for the GKI Revitalisation Plan will incorporate allowances for reasonably predicted climate change factors based on current research. This includes allowance for:<br>• increased cyclonic intensity (e.g., increased maximum wind speeds, storm surge, wave action);<br>• increased sea levels in design and placement of built infrastructure; and<br>• allowance for increased rainfall intensity, decreased average rainfall and increased evaporation in design of water cycle infrastructure. |
| **Objective 6: Influence and facilitate change** | |
| **Strategy 6.1.** Establish incentives to facilitate change | GKI Resort Pty Ltd will establish a research centre and Biodiversity Fund to support research initiatives to improve understanding and protection of the GBR. |
| **Strategy 6.2.** Foster industry capacity to implement change | GKI Resort Pty Ltd will seek to actively participate in tourism industry forums and other opportunities to achieve the objectives of the Great Barrier Reef Tourism Climate Change Strategy, including participating in the Tourism Climate Change Action Group. |

#### 3.1.1.5 Summary

The GKI Revitalisation Plan will be designed and constructed to both mitigate where possible the adverse impacts of predicted climate change while also minimising the Project's contribution to global greenhouse gas emissions.

Key climatic changes likely to impact on the GKI Revitalisation Plan have been identified as:

- decreased total rainfall;
- increased rainfall intensity;
- increased intensity of tropical cyclones, including:
    - increased maximum wind speeds; and
    - increased storm surge etc;
- increased evaporation;
- increased temperatures; and
- increased sea levels.

These factors will be incorporated into the design of the GKI Revitalisation Plan to ensure built infrastructure is either located to avoid these impacts or is able to adapt and become resilient to these climatic changes. This includes:

- ensuring buildings and other infrastructure are designed to latest design standards which have allowed for projected increases in wind speeds and cyclonic intensity;
- ensuring built infrastructure is located above projected storm surge levels accounting for sea level rise (e.g., building pad levels will be located above 3.74 metres AHD at Putney Beach and 3.82 metres AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise);
- ensuring stormwater and wastewater infrastructure is designed for maximum flows accounting for increased rainfall intensity; and
- ensuring sustainable water supplies will be available despite a decrease in average rainfall and increased average evaporation rates.

To minimise the carbon footprint of the GKI Revitalisation Plan, the following measures will be implemented:

- primary electricity supply will be derived from solar photovoltaic cells installed on the roof tops of resort buildings, with only supplementary and emergency electricity sourced from standby diesel generators and mainland electricity cable connection. Sufficient solar panels will be installed to meet the energy demands of the GKI Revitalisation Plan plus five percent with excess energy generated to be returned to the mainland grid via submarine cable;
- buildings will be designed to minimise energy consumption for heating and cooling by maximising use of natural ventilation and solar access; and
- proposed buildings and infrastructure will be located to minimise the clearing of native vegetation. As part of the GKI Revitalisation Plan, planting of vegetation will occur to offset losses in biodiversity and carbon sequestration capacity.

Aspects of the Great Barrier Reef Tourism Climate Action Plan have been incorporated into the proposed GKI Revitalisation Plan to reduce the ecological footprint and maintain the resilience of the surrounding ecosystems of the Island to climate change, including:

- establishment of a research centre within the Keppel Island Group;
- funding of the research centre and associated research and educational activities through establishment of a Biodiversity Fund and visitor donations; and
- conducting regular monitoring of water quality and the condition of coral reefs and coastal ecosystems.

# 3.2 Land

## 3.2.1 Land Use and Tenure

### 3.2.1.1 Tenure

The proposed GKI Revitalisation Plan predominantly applies to the areas of GKI that are currently leased by GKI Resort Pty Ltd (the Proponent).

The GKI Revitalisation Plan Precincts (refer **Figure 2.7** in **Section 2.2.3**) comprise the following areas:-

- Environmental Protection Precinct – 575 hectares of environmental protection;
- Fisherman's Beach Precinct – approximately 141 hectares;
- Clam Bay Precinct – approximately 225 hectares; and
- Marine Services Precinct – approximately 31.5 hectares of marine waters.

The real property description, area and land tenure of the existing Island lots currently leased by the Proponent are outlined in **Table 3.7** (repeat of **Table 2.1**) and in **Figure 2.4** - Land Tenure Map. This land comprises a total area of approximately 914 hectares.

**TABLE 3.7 GKI LAND TENURE PROPONENT LEASED AREAS**

| Lot Number | Plan Number | Lot Area (ha) | Land Ownership Tenure | Lease Purpose |
|---|---|---|---|---|
| Lot 21 | SP192569 | 875 | GKI Resort Pty Ltd (Lands Lease) | Recreation |
| Lot 1 | AP2516 | 0.013 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 43 | CP843165 | 0.0003 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 2 | LN2615 | 7.986 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 31 | LN2704 | 17.75 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 45 | LN2763 | 3 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 46 | LN2763 | 0.2852 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 44 | LN2831 | 1.794 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot 8 | LN2832 | 8.109 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot A | AP2516 | 0.107 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| Lot A | AP5428 | 0.037 | GKI Resort Pty Ltd (Lands Lease) | Tourism |
| **Total Area** | | **914.1** | | |

The areas contained within the Environmental Protection Precinct are proposed to have a Conservation Area lease purpose under the Land Act 1994 or similar tenure arrangement under a Lands Lease.

The areas contained within the Fisherman's Beach Precinct and Clam Bay Precinct are to have a 'consevation' lease purpose (under a Lands Lease).

The Marine Services Precinct is proposed to have a "Marine Services and Tourism" lease purpose (under a Lands Lease).

The Utilities Services Corridor is proposed to have a "Utilities Infrastructure" lease purpose (under a Lands Lease).

In addition to land currently leased by the Proponent, additional land leases and resource entitlements are required to facilitate the construction and operation of the GKI Revitalisation Plan. **Table 3.8** identifies additional land required to facilitate the construction of the proposed airstrip. Additionally, a volumetric road closure is required for the airstrip over a section of the road between Lot 11 on AP22326 and Lot 1 AP16085 (refer **Figure 3.1** and Map 2 – Development Parameters Plan in **Appendix N**). The volumetric road closure will allow for continued use of the road which provides access to several allotments.

**TABLE 3.8 AIRSTRIP LAND TENURE REQUIREMENTS**

| Lot Number | Plan No. | Lot Area | Land Tenure |
|---|---|---|---|
| Lot 11 | AP11326 | 4.8 ha | No Title (State Land)[1] |
| Lot 1 | AP16085 | 19.4ha | No Title (State Land) [1] |
| Lot 8 | SP129154 | 2.988 ha | Other – Department of Natural Resources |
| **Total** | | **27.19 ha** | |

*1. A permit to occupy under the Land Act 1994 for the purpose of "Investigation only" for the permittee GKI Resort Pty Ltd applies to Lot 1 AP16085 and Lot 11 AP11326 (the proposed airstrip area).*

The total land based area of the GKI Revitalisation Plan is approximately 941 hectares (914 plus 27 hectares).

Additional land to which no current title exists is required for the following GKI Revitalisation Plan elements:

- proposed marina in the Marine Services Precinct; and
- proposed utilities services corridor between the Island and mainland.

The Proponent currently holds a permit to occupy under the Land Act 1994 for the purpose of "Investigation only" for the proposed Marine Services Precinct, identified as Lot A on AP20991.

The real property description, area and land tenure of Island lots other than those identified above are outlined in **Table 3.9** (refer also **Figure 3.2**).

**TABLE 3.9 GKI OTHER LAND TENURE**

| Lot Number | Plan Number | Lot Area | Land Tenure |
|---|---|---|---|
| Lot 12 | AP11326 | 1580m² | No Title (State Land) |
| Lot 4 | AP11326 | 300m² | Other Land (Lands Lease) |
| Lot 5 | AP11326 | 1,300m² | No Title (State Land) |
| Lot 50 | CP866044 | 2,800m² | Other Land – Livingstone Shire Council (Reserve) |
| Lot 1 | CP882198 | 1,451m² | Other Land – The State of Queensland (State Land) |
| Lot 1 | CP900493 | 1,727m² | Other Land – Keppel Haven Property (Lands Lease) |
| Lot 2 | CP900494 | 1.3 ha | Other Land – Livingstone Shire Council (Reserve) |
| Lot 3 | CP900494 | 1,554m² | No Title (State Land) |
| Lot 10 | LN1428 | 756m² | Other Land (Freehold) |
| Lot 11 | LN1428 | 787m² | Other Land (Freehold) |
| Lot 12 | LN1428 | 814m² | Other Land (Freehold) |
| Lot 13 | LN1428 | 868m² | Other Land (Freehold) |
| Lot 14 | LN1428 | 943m² | Other Land (Freehold) |
| Lot 15 | LN1428 | 1,022m² | Other Land (Freehold) |
| Lot 16 | LN1428 | 1,098m² | Other Land (Freehold) |
| Lot 9 | LN1498 | 9,105m² | Other Land (Freehold) |
| Lot 18 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 19 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 20 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 21 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 22 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 23 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 26 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 27 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 28 | LN1658 | 1,012m² | Other Land (Freehold) |
| Lot 37 | LN1761 | 898m² | Other Land (Freehold) |
| Lot 39 | LN2681 | 5,550m² | Other – Lions Club of Yeppoon (Lands Lease) |
| Lot 29 | LN2747 | 8.95 ha | Other Land – Livingstone Shire Council (Reserve) |
| Lot 29 (Lease A) | LN2747 | 3.69 ha | Other Land – Keppel Haven Resort (Lease A) |
| Lot 1 | PER207764 | 90m² | Other Land - Keppel Haven Property (Lands Lease) |
| Lot 1 | PER207768 | 25m² | Other – Keppel Haven Resort (Private Ownership) |
| Lot 1 | RP611254 | 501m² | Other Land (Freehold) |
| Lot 2 | RP611254 | 502m² | Other Land (Freehold) |
| Lot 50 | SP190989 | 31.37ha | Woppaburra Land Trust |
| Lot 55 | SP190989 | 1,100m² | Other Land (Lands Lease) |
| Lot 56 | SP190989 | 4,756m² | Other Land (Lands Lease) |
| Lot 53 | SP190990 | 75.54ha | Woppaburra Land Trust |
| Lot 52 | SP190991 | 25.16ha | Woppaburra Land Trust |
| Lot 51 | SP190992 | 38.73ha | Woppaburra Land Trust |
| Lot 29 | SP190994 | 642m² | Woppaburra Land Trust |
| Lot 46 | USL42204 | 2.8 ha | Woppaburra Land Trust |

*The tenure under the GKI Revitalisation Plan is to remain as a lease under State Government ownership.*

#### 3.2.1.2 GBRMP Boundary

The proposed GKI marina is located seaward of Putney Beach as shown in **Figure 3.1** and is located within the GBRMP. The proposed marina area is intended to be retained within the GBRMP and State Coastal Marine Park following its construction. While the Draft EIS is out for public review, the Proponent will work with the Commonwealth assessment agencies to ensure that the marina design will not change the boundary of the Marine Park. In the event that the EIS is approved, a detailed set of construction drawings will be prepared and submitted to GBRMPA, along with all other necessary regulatory departments, which will be required to be approved prior to any construction works commencing on the marina. These drawings will include construction details demonstrating specifically how the marina structures will minimise environmental impacts and ensure that there are no changes to the boundary of the GBRMP as defined by the *Great Barrier Reef Marine Park Act 1975 (Commonwealth)*.

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**Figure 3.1 GKI GBRMP ZONING AND MARINA LOCATION**

**Legend**

Marina Layout
Marina Footprint
Mean Low Water Springs

**GBRMP Zoning**

Buffer Zone
Conservation Park Zone
General Use Zone
Habitat Protection Zone
Marine National Park Zone
Preservation Zone
Scientific Research Zone

Scale 1:5,000 (A3)

0 50 100 200

Meters

Map Projection: Map Grid of Australia 1994 Zone 56

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**Great Keppel Island Great Barrier Reef Marine Park Zoning and Marina Location**

**Figure GKI011 Revision A**

10 May 2012

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### 3.2.1.3 Land Use

#### (a) Existing Land Uses

The Island is currently occupied by the following land uses (refer also **Figure 3.2** – Existing Land Use Map):

- *Accommodation Buildings* (tourist accommodation) behind Fisherman's Beach, including the former resort which comprised 190 guest rooms and closed in early 2008;
- *Accommodation Building* (tourist accommodation) behind Svendsen's Beach;
- State Heritage listed *Leeke's Homestead* (refer **Section 3.13** for further discussion);
- *Detached dwelling(s)* and Commercial Purposes behind the northern part of Fisherman's Beach;
- *Accommodation building* (tourist accommodation) on the hillside behind Fisherman's Beach (former resort white-roofed accommodation units);
- *Major Utility* (existing airstrip); and
- *Accommodation Building* (Keppel Haven / Holiday Village Backpacker) behind Putney Beach / Fisherman's Beach.

A discussion of the impacts of the GKI Revitalisation Plan on sensitive receiving environments is provided in **Section 3.7** and **Section 3.9**.

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**Figure 3.2 EXISTING LAND USE MAP**

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**(b) Local Planning Scheme**

GKI is included within the Comprehensive Development Zone of the Livingstone Shire Council IPA Planning Scheme ('Planning Scheme'), which applies to that part of the Rockhampton Regional Council area located in the former Livingstone Shire. All areas within the Comprehensive Development Zone are subject to a detailed Structure Map and locality code; in this case these are the Great Keppel Island Structure Map and the Great Keppel Island Code. The Structure Map allocates the Island into specific land use precincts which include the following:

- Accommodation and Associated Facilities;
- Village Commercial;
- Conservation; and
- Aquifer.

Section (b) of the table of development for the Comprehensive Development Zone specifies the levels of assessment for various uses on the Island. Uses that are nominated in Column 2 of the Great Keppel Island Schedule (Section 3.20(3)) are:

- Self assessable if in the precinct nominated in Column 1 of the Great Keppel Island Schedule corresponding to the purpose nominated in Column 2 of the Great Keppel Island Schedule;
- Code assessable if not impact assessable or if nominated as self assessable but are unable to comply with the applicable self assessment solutions or the nominated circumstance for self assessment; and
- Impact assessable if:
    - Comprising buildings or structures higher than 7.5 metres above ground level; or
    - Not for a particular use nominated in Column 2 of the Great Keppel Island Schedule in **Section 3.20(3)**.

The Great Keppel Island Schedule is quite specific in the uses it lists, and relates to the Great Keppel Island Structure Map. This map identifies only a small part of the Island as being within precincts where development can take place. Specifically, the GKI Revitalisation Plan is located within all Structure Plan precincts, excluding Village Commercial which is currently occupied by *Detached dwellings and Commercial Purposes*. As such, a large component of the proposed GKI Revitalisation Plan will be classified as *Impact Assessable* under the Planning Scheme. Notwithstanding, the proposed Fisherman's Beach Precinct will include a concentration of development in the 'Accommodation and Associated Facilities' precinct, and development within this area will be generally consistent with the Planning Scheme. Additionally, the majority of the 'Conservation' precinct will be located within the 'Environmental Protection Precinct' which will parallel the intent of the Planning Scheme whilst requiring rehabilitation of this area and its protection in perpetuity

The following Codes are applicable to Great Keppel Island:

- Great Keppel Island Code; and
- Natural Features Code:
    - Protected Features Special Management Area;
    - Erosion Prone Special Management Area;
    - Acid Sulfate Soils Special Management Area;
    - Steep Land Special Management Area;
    - Wetland Special Management Area; and
    - Storm Tide Hazard Special Management Area.

As described in **Chapter 1** and **Chapter 2**, the proposed draft GKI Revitalisation Plan – Plan of Development (GKI Plan of Development) functions as part of the preliminary approval pursuant to section 242 of the *Sustainable Planning Act 2009* which varies the effect of the Planning Scheme by specifying:

- exceptions to the type of development that may take place within the GKI Plan of Development Area; and
- a detailed code which forms part of the common material against which subsequent development applications within the GKI Plan of Development Area will be assessed.

The GKI Plan of Development also includes the following supporting maps:-

- Map 1 – Precinct Plan; and
- Map 2 – Development Parameters Plan.

The GKI Plan of Development should be read in conjunction with the development approval and the Environmental Management Plan (EMP) for the GKI Resort.

#### 3.2.1.4 Potential Impacts and Mitigation Measures

In the absence of appropriate statutory planning controls and controlling leases the GKI Revitalisation Plan has the potential to negatively impact on the values of Great Keppel Island. However, to mitigate the potential negative impacts arising from land use and development the following measures are recommended:

- the GKI Revitalisation Plan – Plan of Development provides a statutory framework that varies the effect of the Livingstone Shire Planning Scheme 2005, and provides alternative development controls for land the subject of the proposed Revitalisation Plan;
- the GKI Revitalisation Plan will be subject to Lands Lease land tenure arrangements and will therefore remain in the ownership of the State Government in perpetuity; and

- the lease purposes will vary according to the intent for development outcomes within the various precincts within the Plan of Development and the lease conditions will form a secondary layer of control to that afforded by the Plan of Development, and will focus on land management versus development assessment. In particular, the natural values of the Environmental Protection Precinct will be protected and enhanced through application of a 'Conservation' lease purpose (under a Lands Lease), including supporting environmental management initiatives identified in **Appendix O – Environmental Management Plan**.

## 3.2.2 Scenic Amenity

The Proponent engaged Chenoweth Environmental Planning and Landscape Architecture (CEPLA) to prepare the scenic amenity impact assessment report for the EIS – refer **Appendix AL – GKI Visual Assessment Technical Report.**

This chapter provides an assessment on the scenic amenity issues related to the proposed GKI Revitalisation Plan and measures to mitigate these impacts.

### 3.2.2.1 Description of Environmental Values

Great Keppel Island, the largest island in the Keppel Group of islands offshore from Yeppoon and Emu Park in Central Queensland, is visually prominent across Rosslyn Bay, as an important part of the character and identity of the Capricorn Coast (now repealed). As part of the Keppel Group, it is recognised as an 'iconic place' under the *Iconic Queensland Places Act 2008* (Repealed IQP Act) which has since been repealed but continued recognition of locations under SPA. Importantly, the Island is also part of the GBRWHA, the listing of which was based on international criteria including outstanding universal aesthetic values.

As described in **Appendix A.L**, the Island is mountainous, rising to Mt Wyndham (RL 174) and 'Bald Rock Peak', with several ranges and hills which extend into rocky headlands, dividing the landform and viewsheds into a main central valley which drains to Blackall Creek and the Leeke's Estuary tidal wetlands, and also dividing the shoreline into a series of bays, coves and beaches.

The western corner of the Island is developed with an airstrip, the existing (but abandoned) Great Keppel Resort and a small residential and tourism-related settlement behind Fisherman's and Putney Beaches. The remainder of the Island appears relatively undisturbed, although it has been grazed and used for rural purposes for many decades and there is an existing rural dwelling (Svendsen's) at Little Peninsula to the north of Leeke's Estuary.

The Island's geomorphology and size create a diverse and attractive landscape, with a combination of steep mountains and forested ranges, windswept craggy peaks and rocky headlands, secluded valleys and bays, sweeping beaches and small coves with inshore rocks and reefs, and the northern sand dunes. This range of scenery is not uncommon along sections of tropical coastline where the mountains are close to the sea, but on islands there is additional diversity associated with the perimeter shoreline and exposure to wind and sea in all directions and the scenic diversity is particularly high in the context of other GBR islands.

The diversity of land and shoreline form is enhanced by the variety of vegetation types and heights on the Island, ranging from tidal wetlands, foreshore Casuarinas and open eucalypt forest to dense wind-pruned communities, steep exposed grassy slopes and headland vegetation, as well as cleared and grazed areas and some weed infestation.

### (a) Character

The landscape character of the Island is particularly varied due to the landform, shoreline and vegetation diversity, and the difference between sheltered and exposed areas. All parts contribute to its overall character of a large and diverse tropical mountain island with minor low key development and casual lifestyle. This diversity comprises a number of recognisable landscape character areas including:

- the settlement node of Fisherman's Beach/Putney Beach low-key village, resort and airstrip;
- sandy beaches, bays and intervening rocky headlands;
- swamps and inlets, either estuarine (Leeke's Estuary and Putney Creek), or freshwater wetlands;
- valley floors and lowland areas, with natural bushland or areas cleared for grazing, drained by ephemeral streams;
- low hills and lower slopes or foothills, generally with natural bushland;
- forested mountains, upper hillslopes and ridgelines with rugged appearance, offering panoramic views;
- wind-swept bluffs and steep exposed slopes with natural grassland and stunted vegetation; and
- the northern sand dunes.

Another important amenity factor in landscape character may be termed its 'island-ness'. As seen from across Rosslyn Bay, the Island is a single mountain-like landform on the horizon, close enough to the mainland to be accessible but far enough away to be alluring as an 'island escape'. Also, it is large enough to offer a wide variety of scenery and activity opportunities, but small enough to be perceived as a discrete island. This distinctive combination of accessibility and remoteness, together with the rich variety of landscape and seascape scenery, makes the Island a special place.

### (b) Analysis of Viewsheds, Settings and Scenic Quality

**Appendix AL** includes a review of relevant literature regarding landscape evaluation techniques, indicating that the most appropriate techniques for visual impact assessment of the proposed GKI Revitalisation Plan were physical description and expert evaluation. Many of the key landscape and aesthetic values are already well-established and documented as World Heritage Values and iconic place values, as a context for the current study. Nonetheless, alternative approaches used in Queensland, such as scenic preference studies, support the high values accorded to 'naturalness' in this assessment.

The landscape values associated with the Island and surrounding area include scenic amenity, character, sensitivity, iconic seascape and contribution to World Heritage aesthetic values. While specific landform elements and features contribute to these values, landscape appreciation is more holistic. Landscape beauty is seen and appreciated within broad settings, observed while enjoying or moving through a viewshed. Accordingly, the main viewsheds of the Island were mapped as part of this EIS which formed the basis for assessment of relative naturalness (absence of visible built form) as a constraints and opportunities framework for project planning and design, and for impact assessment.

The Island was divided into four main viewsheds for the assessment (Western, South-eastern, Eastern and Central), further subdivided internally into a number of simple legible Landscape Settings (refer **Table 3.10**). The literature review indicated that the following six Scenic Quality Indicators were considered appropriate and well-tested in Queensland coastal landscape studies:

- naturalness;
- presence of water and land-water edges;
- uniqueness in land and water features;
- relative topographic relief and ruggedness;
- vegetation diversity and landscape variety generally; and
- patchwork effects in agricultural landscapes and edge diversity in forests.

Based on these indicators, the Island's settings and their Scenic Quality ratings are provided in **Table 3.10**.

**TABLE 3.10 LANDSCAPE SETTINGS AND SCENIC QUALITY**

| Main Viewshed | Landscape Settings | Scenic Quality |
|---|---|---|
| Western | • Putney Beach. | High |
| | • Fisherman's Beach. | High |
| | • Resort, Airstrip and Settlement. | Moderate* |
| | • Monkey Beach – Morris Lookout. | Very High |
| | • Long Beach – Mt Wyndham. | Very High |
| South-eastern | • Clam Bay – Wyndham Cove. | Very High |
| | • Red Beach. | Very High |
| Eastern | • Wreck Bay. | Very High |
| | • Butterfish Bay, Sandhills and Big Peninsula. | Very High |
| Central | • Svendsens Beach. | Very High |
| | • Leeke's Beach, creek mouth and secluded valley. | Very High |
| | • Central Valley and tidal wetlands. | High |

** The extent of natural bushland and the vegetated mountain range behind the development node offset the parts of this setting which have a low or moderately low scenic quality.*

*NOTE: Scenic quality of a setting relates to the attributes within that setting, not to the quality of views outwards to other areas or waters.*

While the viewsheds provide an effective framework for analysing the Island's landscapes internally, additional information was needed to assess the visibility and sensitivity of the Island from external (offshore and mainland) viewpoints. Four broad 'viewshed sectors' were computer-modelled for visibility as follows:

- west-northwest sector i.e., ferry route and North Keppel Island;
- south-west sector i.e., mainlands (Emu Park and Keppel Sands);
- east-southeast sector (water views); and
- north-northeast sector.

Viewshed analysis using Digital Terrain Modelling (DTM) and taking into account vegetation heights confirmed that the mountain tops, ridges and upper slopes are 'highly visible' from various directions, but the visibility of lower slopes and valleys was generally limited to discrete arcs of view from one direction. Analysis of each sector in this manner revealed that all existing development on the Island (behind Fisherman's and Putney Beaches) was restricted to the western viewshed, and the central viewshed was largely free of built form and disturbance apart from Leeke's Homestead and some grazed areas. Importantly, the eastern and south-eastern viewsheds are currently free of visible development and disturbance.

Major views to the Island from across Rosslyn Bay and from other ocean viewpoints are dominated by Mt Wyndham and 'Bald Rock Peak' which, although relatively modest compared to other continental islands in the northern parts of the GBRWHA, are distinct landmarks in a local context. At closer viewing distances, the major peninsulas: Big Peninsula, Bald Rock Point, 'Red Beach Point' and Monkey Point, and the smaller points at Little Peninsula, Creek Rocks and Putney Point, are also focal points (refer **Photograph 3.1** and **Figure 3.3**). This landform contributes to scenic quality by establishing a frame of diversity and contrast, and by dividing the Island into viewsheds and settings. In particular, the topography includes the large central valley of the Blackall Creek / Leeke's Estuary catchment, which is largely screened from external offshore views.

Major views outwards to surrounding waters and islands are available from First Lookout on the vehicle track to Leeke's Beach, Morris Lookout near the former resort, and from bushwalking trails along ridges and peaks wherever vegetation allows views. Most of these views also include, as foreground and midground elements, the forested valleys and hills, rocky headlands, beaches and bays of the Island.

**Photograph 3.1 AERIAL OF GKI**

### (c) Sensitivity

Assessment of views and visibility also included consideration of 'sensitive receptors', which in this case included not only the main ferry route and lookouts, but also the existing settlement behind Fisherman's Beach and Putney Beach. In general, the low rise dwellings and accommodation facilities are at low elevation and are well screened by existing vegetation, with no expansive views of other parts of the Island. They do not represent a visual constraint to planning and development of buildings and infrastructure on land well-buffered from their immediate surrounds.

The existing network of walking tracks on the Island, especially those remote from the former resort and settlement node, offer multiple opportunities for appreciation of natural scenery within the Island and around its shoreline, including ridges and peaks with panoramic views across the Island and out to sea.

The Visual Absorption Capacity (VAC) (i.e., the capacity of the existing landscape to absorb development without significant change to scenic values) was mapped according to **Table 3.11**.

**TABLE 3.11 VISUAL ABSORPTION CAPACITY: GKI**

| | | VEGETATION SCREENING POTENTIAL | | |
|---|---|---|---|---|
| Visual Absorption Capacity for built form | | Tall dense vegetation | Semi-dense or low-medium height vegetation | Open, sparse or low vegetation |
| | | Rainforest | Open eucalypt / Acacia forest, woodland and dense mangroves >3m tall | Beaches*, Bare areas, Grassland, Scattered trees and stunted vegetation <3m tall |
| SLOPE | FLAT <1:10 | 1 Very High | 2 High | 2 High |
| | GENTLE 1:10 to 1:5 | 2 High | 3 Moderate | 3 Moderate |
| | MODERATE: 1:5 to 1:3 | 2 High | 3 Moderate | 4 Low |
| | STEEP: >1:3 | 3 Moderate | 4 Low | 5 Very Low |

** Open sandy beaches are rated "Very Low" VAC, notwithstanding that they are flat landforms*

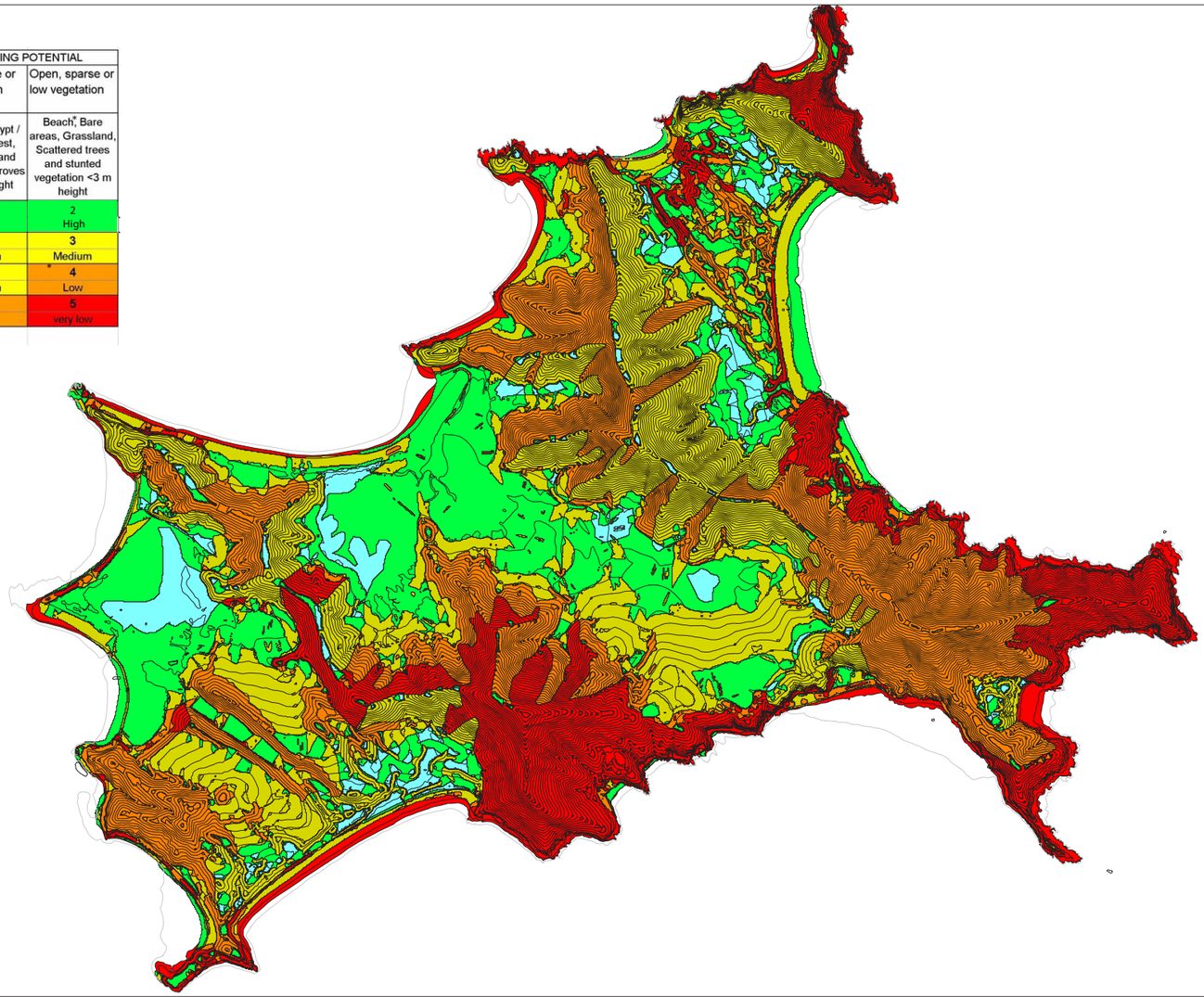
The resulting VAC map (Figure 3 of **Appendix AL)**, together with the visibility analysis, allowed the Island to be mapped in five Visual Amenity Constraint categories (Figure 4 of **Appendix AL**) as shown in **Figures 3.3** and **3.4** and described in **Table 3.12**.

## Figure 3.3 VISUAL ABSORPTION CAPACITY

| | | VEGETATION SCREENING POTENTIAL | | |
|---|---|---|---|---|
| | | Tall Dense vegetation | Semi-dense or low-medium vegetation | Open, sparse or low vegetation |
| | | Rainforest | Open eucalypt / Acacia forest, woodland and dense mangroves to 3 m height | Beach*, Bare areas, Grassland, Scattered trees and stunted vegetation <3 m height |
| SLOPES | FLAT < 1:10 | 1 Very High | 2 High | 2 High |
| | GENTLE 1:10 TO 1:5 | 2 High | 3 Medium | 3 Medium |
| | MODERATE 1:5 TO 1:3 | 2 High | 3 Medium | 4 Low |
| | STEEP >1:3 | 3 Medium | 4 Low | 5 very low |

**Visual Absorption Capability Matrix**

* See report



**Legend**

- 1: Very High V.A.C
- 2: High V.A.C
- 3: Medium V.A.C
- 4: Low V.A.C
- 5: Very Low V.A.C

N

0 1 2

kilometres

GREAT KEPPEL ISLAND
VISUAL IMPACT PROPOSAL

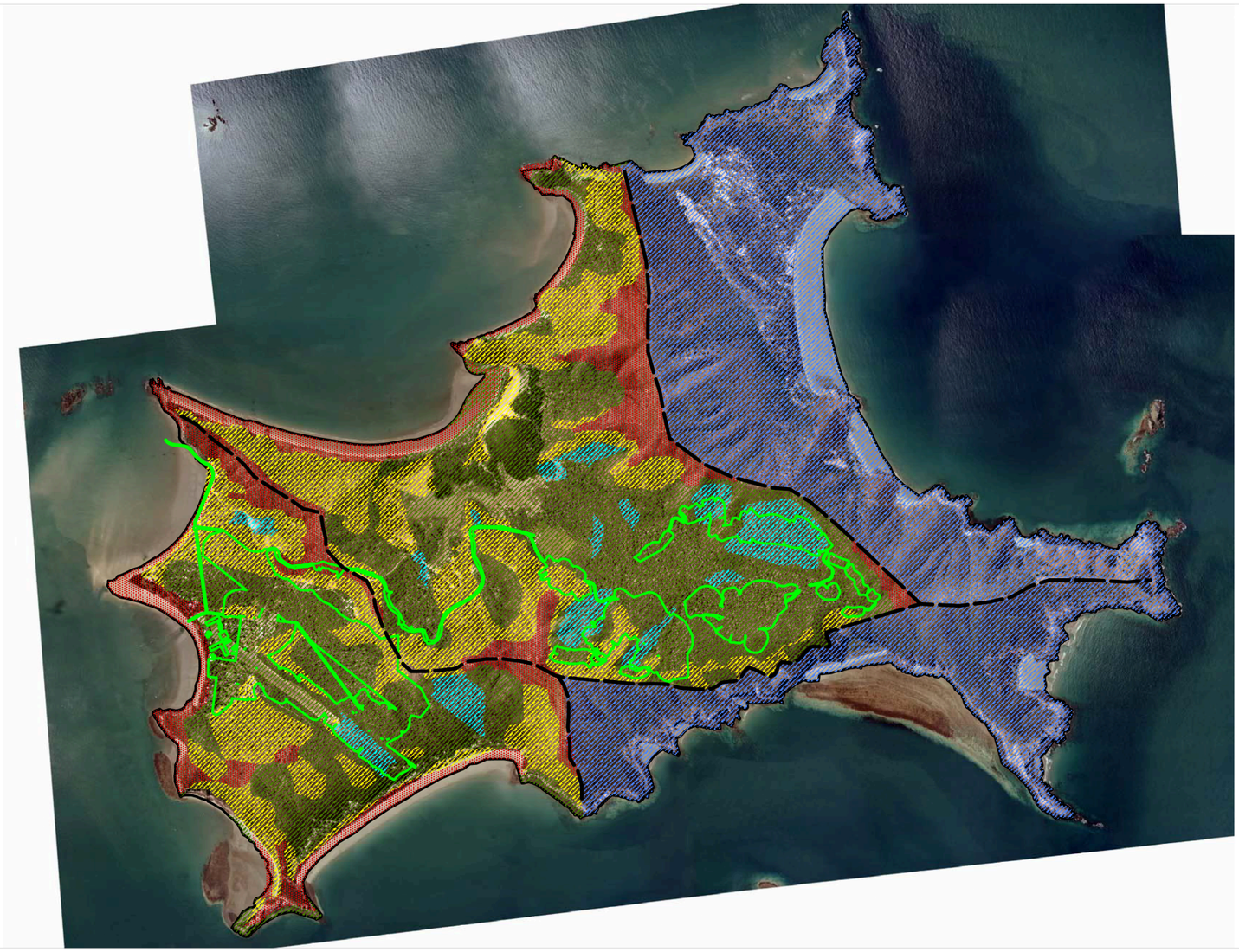
**Visual Absorption Capacity**

**FIGURE 3**

CHENOWETH
ENVIRONMENTAL PLANNING & LANDSCAPE ARCHITECTURE

File:VAC.WOR
Date: 22/05/2011
11CH001 Dwn: AT

**Figure 3.4 VISUAL CONSTRAINTS**



**LEGEND***

- Category 1 - Priority Viewsheds
- Category 2 - Highly Constrained
- Category 3 - Sensitive
- Category 4 - Limited Visibility
- Category 5 - Semi-secluded
- Viewshed
- Development Footprint

N

0 1 2

kilometres

GKI Visual Impact Study

**Visual Constraints**

**FIGURE 4**

CHENOWETH
ENVIRONMENTAL PLANNING & LANDSCAPE ARCHITECTURE

File:visual constraints.WOR
Date: 29/03/11
11CH01 Dwn: AN

* See accompanying text regarding areas, values and recommendations for each category

**TABLE 3.12 VISUAL AMENITY CONSTRAINTS**

| Constraint Category | Description | Areas, Viewsheds and View Sectors (Figure 1) | Scenic Amenity and Landscape Character Values |
|---|---|---|---|
| **1: Priority Viewsheds** | Coastal landscape settings with completely natural appearance, with no visible evidence of development or disturbance, as seen from any external viewpoint or internal lookout. | Eastern (E) and South-Eastern (SE) Viewsheds, defined by high ridge of the Butterfish-Bald Rock Range and the Clam Bay Escarpment, including high ridges, steep upper slopes, dunes, beaches, headlands and secluded beaches. | Significant contribution to perception of the Island as a natural and undisturbed Island; and to World Heritage Values as adding to scenic diversity and part of its "*rich variety of landscapes and seascapes*" |
| **2: Highly Constrained** | Landmarks and other visually prominent places and areas visible from multiple offshore viewpoints in two or more external view sectors (**Figure 1** of **Appendix AL**), or from beaches. | Ridgeline peaks and steep upper slopes on the Butterfish-Bald Rock Range, the Putney-Mt. Wyndham Range, Monkey Range and all headlands visible from two or more external sectors, plus all Island beaches not in Category 1. | These areas form the topographic frame, skylines and viewsheds which are the basis for landscape settings, and are highly valued for creating a distinctive sense of place; and (in the case of beaches) form the land-sea interface and define the coastal and tropical Island experience. |
| **3: Sensitive** | Lower vegetated slopes and other areas which are visible as seen from one external view sector, or have high visibility locally on the Island (e.g., lookouts) or are moderately visible from two or **more external view sectors**. | Foothill areas of the Island ranges and lower slopes exposed to external (offshore) views, plus areas at lower elevation exposed to view through gaps in the screening vegetation; | The overall image and perception of the Island as largely undeveloped, with buildings and landform alteration confined to discrete nodes, relies upon the broad matrix of vegetated hillslopes visible from offshore and the mainland. |

**TABLE 3.12 VISUAL AMENITY CONSTRAINTS** (CONTINUED)

| Constraint Category | Description | Areas, Viewsheds and View Sectors (Figure 1) | Scenic Amenity and Landscape Character Values |
|---|---|---|---|
| **4: Limited Visibility** | Areas visible from several external viewpoints in one sector or from a limited number of external viewpoints in two or more sectors (**Figure 1** of **Appendix AL**), or from elevated lookouts on roadways. | Gently sloping valleys in the Central Viewshed (i.e., the Blackall-Leeke's Valley area) and the Western Viewshed (either side of the airstrip) between the hills and set back from the foreshore; | These areas form most of the bushland in valleys seen mainly as masses of vegetation (treetops) occupying the valleys, screening and buffering the existing tracks and small areas of clearing or disturbance from external views.<br><br>There is generally good visual absorption capacity, in that minor buildings 'embedded' in these bushland areas can be readily screened from external view; |
| **5: Semi-secluded** | Areas predominately screened by topography and existing vegetation from external view sectors and from elevated lookouts on roadways, although they may be visible from walking trails and from the air. | Mainly in the central Blackall-Leeke's Valley, in side valleys 'tucked' into the eastern and western foothills, and also screened from the south by the Clam Bay escarpment, by Halfway and Humpy Islands. The existing airstrip also falls into this category, although of course it is highly visible from the air. Other small semi-secluded patches are a low-lying area along Putney Creek and steep hillslopes south of Mt Wyndham. | Although these semi-secluded areas may have wilderness values, in terms of scenic amenity they contribute little to the attractiveness or World Heritage Values of the Island. |

#### 3.2.2.2 Response to Potential Visual Impacts

As detailed in **Appendix AL**, a constraints-based approach to planning and design of the GKI Revitalisation Plan has been adopted, albeit with several 'fixed' requirements as follows:

- the existing Fisherman's Beach node of resort, airstrip and settlement is the focus of redevelopment;
- a marina and longer airstrip are essential and have specific site selection criteria;
- a golf course and associated villas are required on suitable terrain; and
- a large proportion of the subject land will be retained for environmental purposes.

Apart from these 'fixed' requirements, the iterative constraints-based approach has taken into consideration the visual amenity constraints mapped in Figure 4 of **Appendix AL** and **Table 3.12**.

Areas mapped as Category 1 and 2 are constraints on the location of new built form and major earthworks, whereas Categories 4 and 5 areas represent opportunities for built form development afforded by the landform, viewshed boundaries and Visual Absorption Capacity. Areas mapped as Category 3 (Sensitive) have both visual constraints and opportunities for low density site- sensitive development.

The WATG Revitalisation Plan and GKI Revitalisation Plan: Plan of Development are the outcomes of the above process, and a number of changes have been made to proposed precincts in order to minimise visual impacts, as detailed in **Appendix AL**. Most of the development will be located in areas mapped as Visual, constraints Category 4 or 5, with the exception of the proposed marina which cannot be 'hidden' in the landform.

**(a) Visual Impact Mitigation Measures**

There are several project elements requiring specific visual impact mitigation measures as follows, coded for cross-reference in the risk assessment table (**Table 3.13**).

**A:** The proposed marina and associated buildings will be in a highly visible location with respect to Putney Beach and the Passage, and will be unavoidably a brightly lit and busy node. However, a range of measures in the design phase will mitigate these impacts:

**A1.** development in the Marine Services Precinct will occupy only a small proportion of the Island's coastline, it will affect a relatively limited Landscape Setting (refer Figure 1 of **Appendix AL**);

**A2.** all buildings will be on the shore, not on the breakwaters, and building height will be below the elevation of Putney Point hence will be screened from Leeke's Beach;

**A3.** the height of built form will be consistent with height of yacht masts;

**A4.** the visual impression of the combined marina breakwaters, moored boats, shops and apartments will be a long curving cluster of built forms of moderate height fitting into a corner of the bay, such that only part of the complex will be visible from within the Putney Beach Landscape Setting;

**A5.** variation in height, scale and groupings of buildings, which in addition to their staggered front setbacks from the marina edge, will appear as an informal, busy and attractive complex;

**A6.** articulated facades and balconies on the three storey apartments, deep overhangs to shade large picture windows, variation in their front alignment and some minor variation in the horizontal line of flat roof-tops, to further avoid the appearance of a wall of uniform built form;

**A7.** generally subdued colours and tones to enhance visual integration with the headland and forested mountain backdrop;

**A8.** narrow vertical elements (e.g., waterfront and street lighting, flagpoles) to reinforce the verticality of yacht masts and break up the appearance of buildings behind; and

**A9.** maximum use of bollard lighting, and where necessary downward-directed mast lights with minimal glare, below the height of the Putney Point ridge, and (apart from Marina entry lights) inside a line drawn between Putney Point and the trees on the Sand Spit.

Notwithstanding the above design measures aimed at visually integrating the marina in its location, it will be unavoidably visible.

**B:** Earthworks for the new **airstrip**, will remove an existing small hill and re-shape part of a ridge to create aircraft safety clearance zones, and create an earth embankment behind Putney Beach. However the affected ridge saddle is less visible (Category 3: Sensitive) than the remainder of the Mt Wyndham Range, and the earthworks will affect only a small part (approximately 10 hectares) of the Western Viewshed. The hillside re-shaping will not be seen from sensitive receptors nor will it affect the skyline as seen from any existing viewpoint. Measures adopted in the design phase, and also in the construction phase, will reduce these potential impacts as follows:

**B1.** the earthworks will be shaped to create surface variation with a natural appearance; and

**B2.** the exposed hillside will be promptly revegetated, as will the fill embankment behind Putney Beach, with rehabilitation designed as irregular patches.

**C:** The **golf course and Eco Resort Villas** of the Clam Bay Precinct, and also in the Fisherman's Beach Precinct (South), will be potentially visible from ridge-line bushwalking trails and lookouts. In addition, some buildings are potentially visible from southern offshore viewpoints; for example the golf course facility building is in an elevated Category 3 (Sensitive) position with medium VAC, and the south-eastern group of Clam Bay Eco Resort Villas will also be an elevated hillside location. Visual impact mitigation measures in the design phase for the golf course include:

**C1.** clearing and earthworks for greens and fairways will be restricted to land below 60 metre elevation and three percent slope;

**C2.** bands of trees at least five metres wide will be retained across the golf course approximately perpendicular to external lines of sight, such that the external views will not include swathes of visible lawn or grassed fairways, as detailed in **Appendix AL**;

**C3.** fairways will be integrated with adjacent native vegetation on foothills and watercourse buffers by informal edges of local native plant species;

**C4.** the seaward edges of fairways behind Clam Bay will be landscaped to avoid parts of the golf course being visible from the south, including vegetated mounds if and where necessary; and

**C5.** sections of walking trails which potentially overlook the golf course and Eco Resort Villas (e.g., ridgetop trails which pass through vegetation gaps or stunted vegetation) will be screened with supplementary planting.

With respect to the villas and the **golf course facilities building**, visual impact mitigation measures at the design phase include:

**C6.** building height (roof ridge line) restricted to 8.5 metres above ground;

**C7.** design controls on roof form, articulation, fenestration and colours and on retaining walls, as detailed in **Appendix AL**;

**C8.** bands of retained trees, supplemented by screen planting and street trees;

**C9.** for the clubhouse building, a built form which is fitted into the hill with a flat or low profile skillion roof, a stepped back second storey and screen planting; and

**C10.** reflective solar panels which are visually unobtrusive and screened (in terms of long distance offshore views) by tree canopies.

**D:** The **hill behind Fisherman's Beach** has a low VAC and is occupied by the former resort villas, which are visible externally. The two-storey Eco Resort Villas proposed for this site are within the development node encouraged by Planning Scheme Map PSM5, but nonetheless require visual impact mitigation during the design phase similar to C6 to C9 above, plus, measures appropriate for steep slopes such as:

**D1.** flatter and darker roofs;

**D2.** buildings partly suspended or cantilevered out from the hillside and height controls to give a visual impression of no more than three levels and avoid a 'stacked' appearance; and

**D3.** effective landscape planting for visual integration.

**E:** The proposed **three-storey buildings (Fisherman's Beach Hotel and Eco Resort Apartments)** within the existing development node will mainly be located in areas of high VAC and low visual constraints. They are also part of the former resort and settlement node, and in an area in which development is encouraged by Planning Scheme Map PSM5. Nevertheless they are likely to be visible above the heights of tree canopies as seen from offshore and other viewpoints, hence sensitive design and landscape integrations are appropriate, adopting measures such as C7 to C9 above, plus:

**E1.** non-bulky buildings with tropical design elements and controls on roof form, articulation and colours, integrated with their landscape and relating visually to their setting.

**F:** The potential for **roads, cuttings and infrastructure** to create visual scarring is limited to the new road connection between the Fisherman's Beach and Clam Bay Precincts. Visual impact mitigation will be achieved at the design and construction phases (and to a lesser extent during operation) by:

**F1.** road alignment will avoid linear hillside scarring perpendicular to contours and within view of sensitive receptors and external viewpoints;

**F2.** road cuttings on hillsides in areas of Low or Very Low VAC will minimise vegetation clearing and earthworks footprint by dark-coloured retaining walls with planted terraces, soil nailing or gabion supports, instead of vegetated cut batters; and

**F3.** during construction, the area of bare earth exposed at any one time, and the period of exposure, will be minimised.

The various components of the Project require particular visual mitigation measures, but they are exceptions. The three-storey components represent a total of approximately only 20 hectares in four separate precincts, the marina is only a small proportion of the Island's coastline, and the new enlarged airstrip will only be visible to external observers as a landscaped earthen embankment at its northern end.

#### 3.2.2.3 Visual Impact Modelling

As detailed in the **Appendix AL**, the likely appearance of the Project, as seen from five offshore viewpoints has been modelled in Figure 5B to 5F, with a key map as Figure 5A of **Appendix AL**.

It should be noted that, at this early stage of the Project design phase, when no built form has been subject to architectural design, the built form shown in Figure 5 of **Appendix AL** is represented as simple two or three storey blocks. Existing retained vegetation is shown as modelled canopy forms to indicate screening, and where necessary additional landscape planting is shown. Key issues arising from this modelling are discussed below.

**(a) Views from Rosslyn Bay**

As shown in Figure 5E of **Appendix AL** (view from offshore Wyndham Cove) and 5F of **Appendix AL** (view from offshore Long Beach), no built form or part of the golf course will be visible from these viewpoints. Airstrip clearance zone earthworks will be screened from view by a bend in the Mt Wyndham Range.

Figure 5D of **Appendix AL** (view from Clam Bay) indicates that a small group of proposed Eco Resort Villas in the southern central valley, on the foothills of the 'Bald Rock Peak', are potentially visible above the stunted vegetation of the Clam Bay escarpment. This area is Low VAC (Figure 3 of **Appendix AL**) but categorised as "Limited Visibility" because it is screened by topography as seen from most viewpoints. Nevertheless the potential visibility of these villas as seen from part of Clam Bay indicates that site-specific mitigation measures are appropriate here, including retention and planting of trees in bands. The photomontage modelling in Figure 5D of **Appendix AL** has taken into account tree retention and screen planting within groups of villas.

**(b) Views from the Ferry Route and Offshore Fisherman's Beach**

The visibility of built form as modelled in Figure 5B of **Appendix AL** (view from offshore Fisherman's Beach) indicates that buildings in this precinct will be visible from offshore and the ferry route, but the built form will be relatively long and low, below the local tree canopy height and below the forested hill skyline behind, apart from the proposed Eco Resort Villas on the former resort villa hillside.

The villas proposed for the existing airstrip land will be screened by topography, as will the new airstrip and the pocket of runway Eco Resort Villas on its northern side and accommodation apartments and will be completely screened by topography.

Although not modelled in Figure 5B of **Appendix AL**, existing residences (sensitive receptors) behind the Sand Spit will not be visually affected, because the generally flat landform and existing trees will screen them from view.

**(c) Views from Offshore Leeke's Beach**

All development in the central valley will be completely screened by foreshore and lowland trees from the shoreline on Leeke's Beach. However as shown in Figure 5C of **Appendix AL**, offshore views across Leeke's Beach potentially include distant villas at the southern end and side slopes of the central valley, and along the skyline of the Clam Bay Escarpment. However additional tree retention and screen planting in the golf course and between the buildings, will mitigate these potential impacts by screening and integration to ensure that only the tops of villas are seen from offshore and the distant skyline will have a wooded appearance.

#### 3.2.2.4 Risk Assessment

A risk assessment of potential visual impacts for each phase of the Project (design, construction and operation) has been undertaken and is described in **Table 3.13** with and without the mitigation measures outlined in A1 to F3.

**TABLE 3.13 RISK ASSESSMENT – WITH AND WITHOUT MITIGATION**

| Phase* | | | Description of Impact | Impact Level (unmitigated) | Impact Level (mitigated) | EIS References in Section 3.2.2 Mitigation Measures A - F | Technical Report Reference 6.1 and 6.2 plus: |
|---|---|---|---|---|---|---|---|
| D | C | O | | | | | |
| • | • | • | Visual intrusion on coastline and World Heritage waters by marina construction, built form, lighting and boating use. | **High (16)** | **Medium (8)** | A1 – A9 (design phase) | 6.2.3(a) and 6.3.2, 6.3.9, Table 6 |
| • | • | | Noticeable changes to landform for new airstrip. | **Medium (8)** | **Low (4)** | B1 – B2 (design and construction phases) | 6.2.3(c) and 6.3.1 |
| • | • | • | Visual intrusion on Keppel Bay by hillside Eco Resort Villas in Fisherman's Beach Precinct. | **Medium (10)#** | **Low (2)#** | C6 – C9 and D1 – D3 (design and construction phases) | 6.2.3(b) |
| • | • | • | Visual intrusion on Keppel Bay by 3-storey Hotel visible above Fisherman's Beach tree canopies. | **Medium (8)** | **Low (4)** | C6 – C9 and E1 (design and construction phases) | 6.2.3(e), 6.3.5, 6.3.6 |
| • | • | • | Visual intrusion on World Heritage waters, by villas, clubhouse, solar panels and lights visible through trees and on distant skyline, behind Clam Bay and Long Beach. | **Medium (8)** | **Low (4)** | C1 – C4, C6 - C10 (design and construction phases) | 6.2.3(d), 6.3.3, 6.3.4 |
| • | • | | Change in Island character as seen from World Heritage waters, associated with visible parts of golf course. | **Medium (8)** | **Low (3)** | C1 – C4, C6 - C10 (design and construction phases) | 6.3.3, Table 6 |
| | | • | Change in Island bushland character because some ridge-line sections of bushwalking tracks will be within view of Clam Bay Precinct and golf course. | **Medium (8)** | **Low (3)** | C5 (operational phase) | 6.3.8, Table 6 |
| • | • | | Visual scarring of a hillside associated with road across ridge. | **Medium (10)** | **Low (3)** | F1 – F3 (design and construction phases) | 6.3.7 |
| • | | • | Night time 'small town' glow of lighting. | **Medium (6)** | **Low (2)** | Refer 3.2.4 | 6.3.9, 7.4 |
| • | | • | General perception of over-development and character change. | **Medium (6)** | **Low (4)** | Refer 3.2.3 | 7.2, Table 6 |

** (D) Design, (C) construction and (O) operational phases*

*# Balanced by beneficial visual impact associated with removal of existing visually-intrusive hillside villas*

In overview, many of the potential risks of significant visual impact have been addressed in the design phase of the GKI Revitalisation Plan. The natural landform of the Island allows the Project to be split into three separate precincts, each with visual impacts confined by ridges and headlands. The GKI Revitalisation Plan will continue to focus on the former resort node at Fisherman's Beach, which is already a developed and non-natural area. Most of the development areas will require little re-shaping of the natural landform (apart from the marina and airstrip), native vegetation will be retained between and through the precincts, natural forested skylines will be retained and the built form will be modest and largely below the local tree canopy levels. Low density development of this nature has a generally low risk of causing significant visual impacts.

## 3.2.3 Iconic Values

### 3.2.3.1 Description of Relevant Iconic Values and Protected Planning Provisions

The Central Capricorn Coast was an iconic place under the now repealed IQP Act (repealed), and includes "the Keppel Group of Islands that form an integral feature of the natural inshore seascape". The purpose of the IQP Act (repealed) was "to protect places with characteristics or qualities in their natural or built environment that reflect or contribute in a substantial way to Queensland's character." The Iconic Places values of the Island relate to the naturalness of this group of islands as part of the inshore seascape i.e., as seen from the Capricorn Coast mainland across Rosslyn Bay. Those parts of the Island visible from the mainland and Rosslyn Bay i.e., the mountainous landform on the horizon and the western viewshed, including the existing development node and the Fisherman's Beach Precinct, contribute to the character of the Capricorn Coast.

The Planning Scheme of the former Livingstone Shire includes (s 3.22) a *Great Keppel Island Code* with overall outcome (i) related to character and landscape values:

(i) Development comprises low-intensity resort facilities, camping accommodation including associated works and is:

**(a)** located in accordance with the precincts illustrated on PSM-5 – Great Keppel Island Structure Map, and

**(b)** integrated with the natural environment facilitating visitor's enjoyment of the Island's natural character, and

**(c)** well designed, sensitive to climatic conditions and provides for the protection of dominant landscape features, including forested ridgelines, rocky outcrops and foreshore areas.

*Structure Plan Map* PSM5 shows "Accommodation and Associated Facilities" development concentrated behind Fisherman's Beach and Putney Beach corresponding to the existing development node. The remainder of the Island is shown as "Conservation".Special Management Areas also apply to GKI under the Planning Scheme, but *Overlay Map* 09, showing areas of landscape sensitivity, is limited to the mainland and does not include the Island.

#### 3.2.3.2 Potential Impacts and Mitigation Measures

The Iconic Place values of the Island are associated specifically with those parts visible from the mainland, across Rosslyn Bay. The parts of the Project facing the mainland are a redevelopment of the former resort and airstrip node, corresponding approximately to the location and level of development encouraged by Planning Scheme Map PSM-5. The Marine Services Precinct and Clam Bay Precinct are not part of this Western Viewshed and accordingly do not affect Iconic Place values. In this sense the GKI Revitalisation Plan will have little or no additional visual impact on the values of the Keppel Group of islands as an Iconic Place under the IQP Act.

However in a broader sense the Iconic Place values of the Island could include the overall perceived naturalness and 'existence value' of the Island as a contrast to and 'place of escape' from the mainland. In this broader sense, the Project will cause a change in perceptions about the Island. Irrespective of how well the development precincts are screened from view or sensitively integrated into a predominantly natural setting, the community will 'know' that the Island has changed and is now more intensively developed, compared to their previous perceptions. While this intangible impact is recognised, it is not amenable to mitigation except through marketing and appropriate positioning, plus sufficient elapsed time for the redeveloped facilities to be perceived as the new benchmark.

While the proposed development will occupy a footprint more extensive than envisaged in PSM5 of the Livingstone Shire Planning Scheme, it will nonetheless be *"…integrated with the natural environment facilitating visitor's enjoyment of the Island's natural character"* as intended by the Code (s 3.22 (i) (B)). The development will be consistent with s.3.22(i)(C): *"well designed, sensitive to climatic conditions and provides for the protection of dominant landscape features, including forested ridgelines, rocky outcrops and foreshore areas."* All the dominant forested ridges will remain free of development, and will remain as natural skylines.

### 3.2.4 Lighting

Lights from the Fisherman's Beach Precinct, including the proposed hillside Eco Resort Villas, will be visible from Rosslyn Bay and the mainland over a distance of 12 – 20 kilometres. Providing the lights are seen as a distant 'twinkling' rather than a bright glare, they will be consistent with the existing character and degree of development of the Island as seen from the bay and mainland, and to that extent are consistent with the Iconic Places values of the Keppel Group of islands.

Distant lights associated with the proposed Eco Resort Villas in the Clam Bay Precinct will also be visible from offshore, and under clear conditions are likely to be seen from the North Keppel Island lookout, although it is unlikely to be accessed at night.

The proposed main lighting impacts will be associated with the Marine Services Precinct, and even with the mitigation measures (Mitigation Measure A9) this area will be a brightly lit node of night-time activity. The visual impacts will be largely confined to the immediate setting of Putney Beach and the passage. However the passage is not an anchorage and Miall Island is uninhabited and unused, so few people apart from Island residents and visitors will be affected. The sensitive receptor residences likely to be within view of the marina lights are those behind Putney Beach, rather than the houses behind Fisherman's Beach which will be largely screened.

The potential for lighting of the airstrip, marina and resort combination to cause a night-time glow is difficult to evaluate. However as noted by CEPLA it is very unlikely that a night time glow would be equivalent to that of a small town because:

- there will be few vehicle lights and no major intersections, and street within the Eco Resort Villa areas will be low-key and resort-like, unlike urban areas;
- apart from the marina and airstrip, there will be little if any mast lighting;
- there will be no shopping centres or industry; and
- most significantly, ridges and headlands will separate the three precincts.

#### 3.2.4.1 Potential Impacts and Mitigation Measures

The visual impact mitigation measures described in **Section 3.2.2.2 (a)**, including screening, softening and visual integration of built form and roofs will reduce the night-time impacts of lighting associated with the GKI Revitalisation Plan.

Notwithstanding, potential lighting impacts include the following:

- parts of the Fisherman's Beach Precinct where the buildings may be quite well screened by day, are likely to be more apparent at night as light casts through the trees;
- the Marine Services Precinct, where the development will be unscreened and visibly apparent by day and night;
- minor lighting impacts associated with Clam Bay Precinct where the external viewpoints are so distant that the Clam Bay Resort buildings will be equally visible by day and night.

The Marine Services Precinct will represent a change from the existing 'dark night' condition to a small harbour with navigation lights visible from GBRMP waters to the west and World Heritage islands, and to a brightly lit node as seen from Putney Beach and the ferry route. While the marina will be below the horizon as seen from the mainland, there is potential for the three storey buildings and night-time glow to be seen from across Keppel Bay.

Navigation lights marking the marina entrance are essential, widespread and expected in GBR waters, and are not considered to be inconsistent with GBR World Heritage aesthetic values. No mitigation measures are proposed for navigation lights. The associated bright lights of the proposed Marine Services Precinct will also have a direction-finding and place-marking function for boating, but bright glare visible across large areas of ocean could detract from GBR World Heritage aesthetic values. The location of the marina at Putney Beach, with screening by Putney Point, Sand Spit and Middle Island, will restrict the offshore viewshed as shown in **Figure 3.5** .

## Figure 3.5 POTENTIAL VIEWSHED OF PROPOSED MARINA BREAKWATER AND 3 STOREY BUILDING


Source: Google Earth 2010

Visible area

Ferry Route

Great Keppel Island
Visual Assessment

**FIGURE 6**
**Potential Viewshed of Proposed Marina Breakwater & 3 Storey Building**

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JOB 11CH001, AT, 02.11.2011

The following visual impact mitigation measures are recommended:

- Maximum use will be made of bollard lighting for night-time safety and direction finding, with taller mast lighting used only where necessary;
- Lighting in the Fisherman's Beach and Clam Bay Precincts, including lighting of the interconnecting road, will be downward-directed with minimal glare spillage, with no flood-lighting of trees or external walls above the surrounding vegetation screening height;
- Lighting of rooms associated with decks and large picture windows (if any) in the hillside Eco Resort Villas in the Fisherman's Beach Precinct will be fitted with dimmers and timers;
- Design of marina lighting to be below the height of the Putney Point ridge, and (apart from marina entry lights) inside a line drawn between Putney Point and the trees on the Sand Spit; and
- Lighting in the Marine Services Precinct will be downward-directed, with glare restricted to local parts of Putney Beach and the passage, with minimal glare apparent from Leeke's Beach and Chocolate Rocks.

## 3.2.5 Topography, Geology and Soils

This section describes the topography, geology, and soil characteristics of the areas of the Island proposed for inclusion in the GKI Revitalisation Plan. Their existing values, potential impacts and mitigation measures are identified and discussed.

### 3.2.5.1 Topography

Topography on the Island is dominated by two north-west to south-east trending ridges (refer **Figure 3.6**). The southern ridgeline is relatively steep and is dominated by Mt Wyndham with a maximum elevation of approximately 175 metres AHD. Elevations along the northern ridgeline range between approximately 75 metres AHD in the north-west and 155 metres AHD in the south-east. These ridges extend to the beaches to form rocky headlands and cliffs. A series of sandy beaches and beach ridges exist between the headlands.

Coastal sand dunes exist between Wreck Bay and Butterfish Bay on the eastern side of the Island, as well as in the southwest area of the Island between Long Beach, Fisherman's Beach and Putney Beach. A flat to undulating topography is present in the dune sand areas. The topography becomes slightly undulating on the eastern side of the Island towards Wreck Bay.

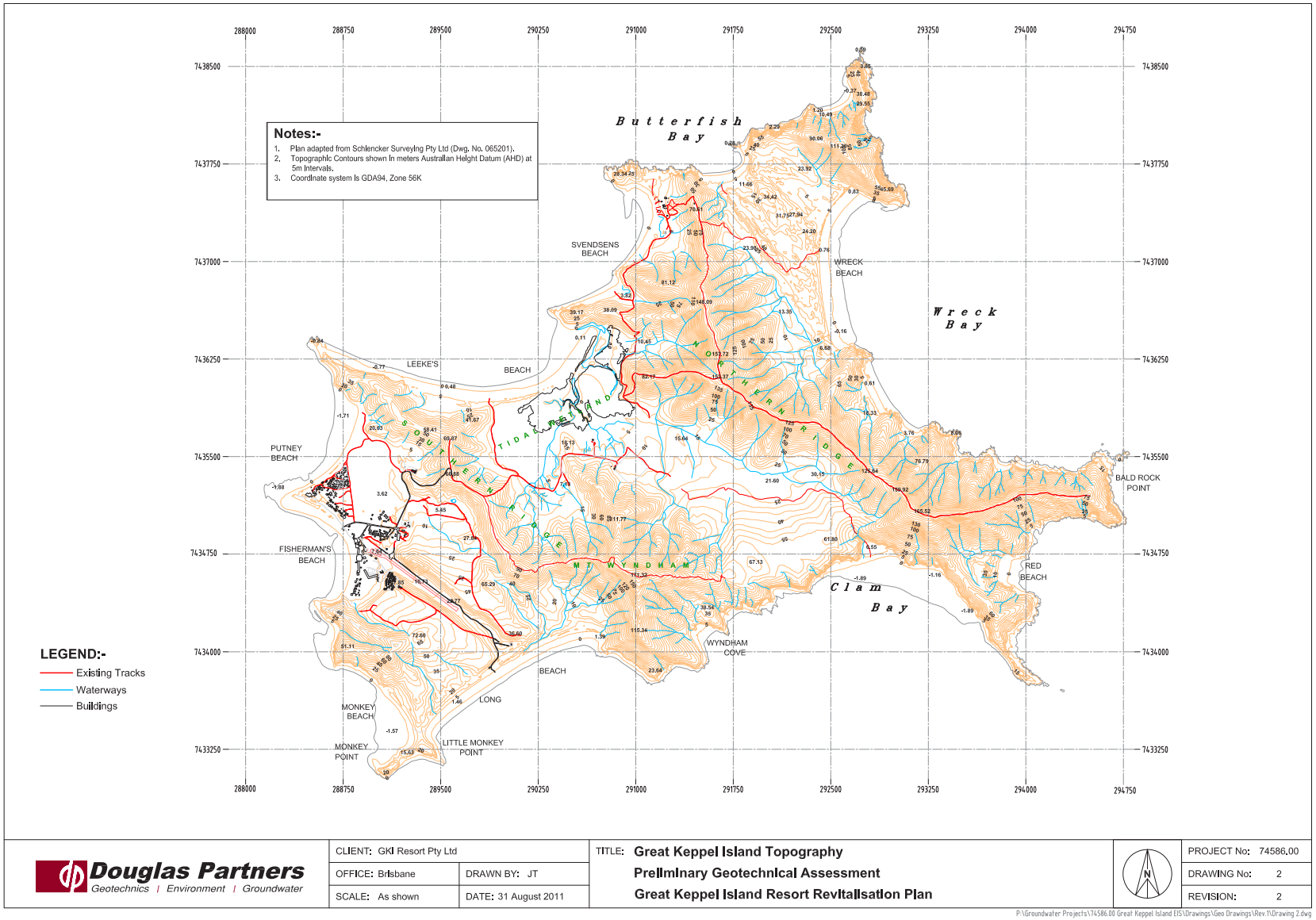
A valley exists in the central area of the Island between the two major ridges. It falls from an elevation of approximately 65 metres AHD behind Clam Bay to sea level at Leeke's Beach in the north-west.

Leeke's Creek, Putney Creek, and Blackall Creek drain the ridges toward the west. Some tidal wetlands exist behind Putney Beach and Leeke's Beach. Other minor perennial creeks are relatively short and flow directly into the Pacific Ocean.

According to the revised GKI Revitalisation Plan, it is expected that minimal excavations would be required to implement construction of the Project apart from the construction of the new airstrip which will require removal of a small hill. Excavations are expected to be concentrated in the proposed marina area, primarily as dredging and minor excavation works to accommodate the new airstrip.

Topography of the Island is therefore not expected to require significant alteration for development of the Project or during construction works. The extent of excavation works has not yet been defined. Due to the expected high infiltration of rainfall through the sandy soils, it is not expected that earthworks would alter existing drainage patterns.

## Figure 3.6 GKI TOPOGRAPHY PRELIMINARY GEOTECHNICAL ASSESSMENT

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| Douglas Partners Geotechnics \| Environment \| Groundwater | CLIENT: GKI Resort Pty Ltd | TITLE: Great Keppel Island Topography<br>Preliminary Geotechnical Assessment<br>Great Keppel Island Resort Revitalisation Plan | PROJECT No: 74586.00 |
| | OFFICE: Brisbane DRAWN BY: JT | | DRAWING No: 2 |
| | SCALE: As shown DATE: 31 August 2011 | | REVISION: 2 |

P:\Groundwater Projects\74586.00 Great Keppel Island EIS\Drawings\Geo Drawings\Rev.1\Drawing 2.dwg

### 3.2.5.2 Geology

Published geological maps for the Rockhampton Region (Department of Natural Resources, Mines and Water (DNRMW), 2006) indicate that the Island is primarily underlain by the Carboniferous aged Shoalwater Formation of the Curtis Island Group (refer **Figure 3.7**).

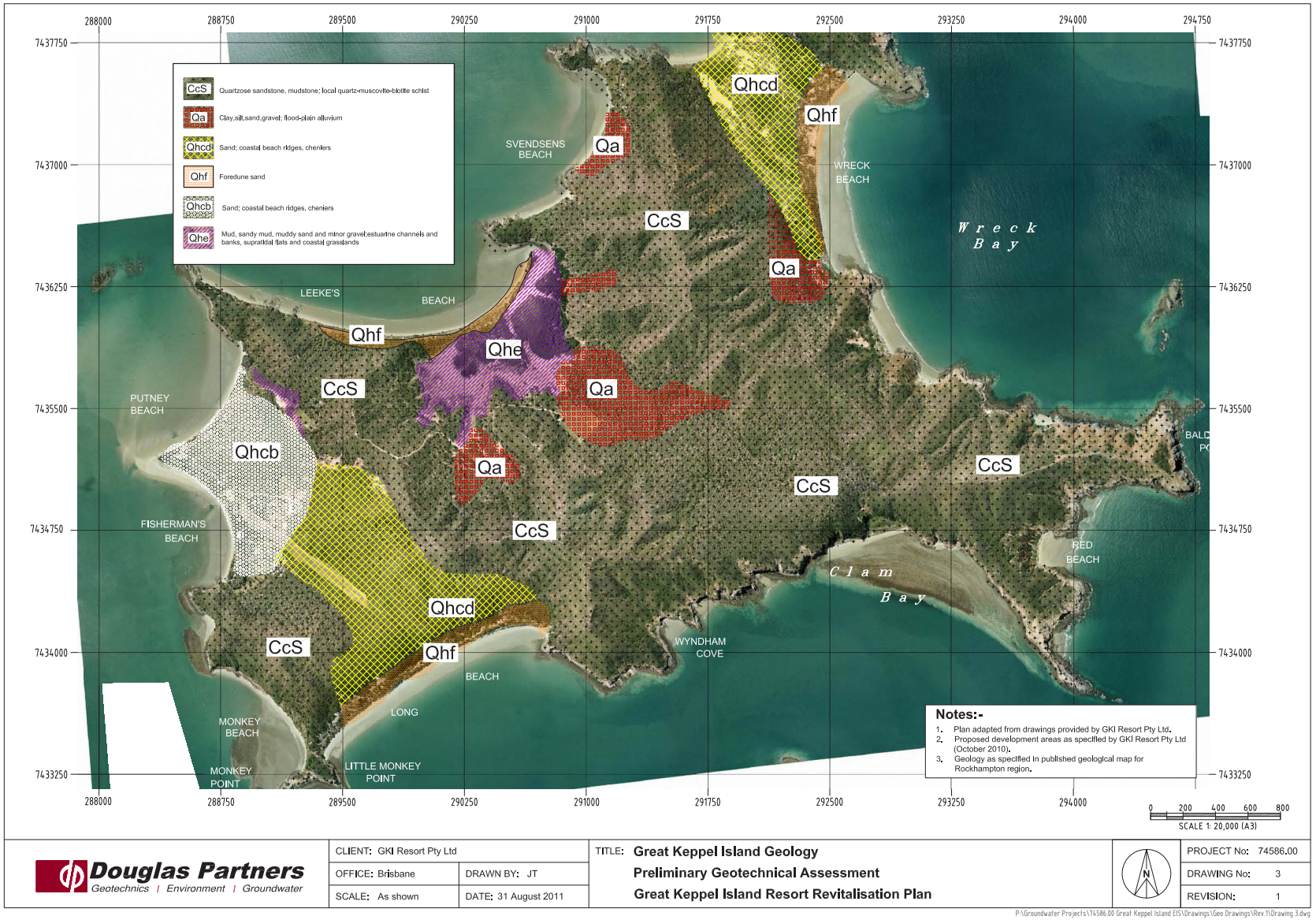
The Shoalwater Formation is characterised by highly deformed and metamorphosed thin to thick bedded quartose and lithic sandstones (Max Winders, 2006). Kirkegaard *et al.* (1970) interpreted the deformed rocks of the Curtis Island Group as being part of the most easterly unit of the New England Fold Belt. According to Smith (1998), this sequence experienced four periods of deformation, which resulted in a cleavage dipping gently to the west, a crenulated cleavage moderately to steeply to the east and several systems of folds and rare boudinage systems.

The Shoalwater Formation overlies the early Palaeozoic Wandilla formation, which is quite widespread along the mainland coast facing the Keppel Isles (DNRMW, 2006). Late Palaeozoic quartose, arenite and mudstone of the Shoalwater formation make up the major hills and slopes on the Island.

Thin veneers of Quaternary sand, alluvium and estuarine mud overlie the Carboniferous sequence in three separate lower lying areas of the Island (DNRMW, 2006). The north-eastern area of the Island between Wreck Beach and Butterfish Bay, as well as the south-western area between Long Beach, Fisherman's Beach and Putney Beach are mapped as containing Quaternary deposits including fore dune, beach ridge, and dune sands. Central areas of the Island are mapped as comprising fine grained alluvial sediments such as estuarine mud and sand, clay, silt, and minor gravel. Sands and other alluvial deposits occur in the drainage basin of Leeke's Creek and Blackall Creek (Max Winders, 2006).

There is no direct fossil evidence in the Shoalwater Formation and none is documented in Murray (1975) or Kirkegaard *et al.* (1970). Due to the age of the formation, as well as the periods of metamorphism and deformation that occurred, it is considered unlikely that significant fossil specimens would be present on the Island.

## Figure 3.7 GKI GEOLOGY PRELIMINARY GEOTECHNICAL ASSESSMENT



### (a) Site Investigations

Preliminary geotechnical assessments carried out by Douglas Partners (**Appendix Z (v)**) provided information on subsurface conditions at the proposed development sites. The investigation included a preliminary assessment of the surface geology in accessible areas proposed for development, comparison with the published geology, and identification of potential geotechnical risks to the development.

Soil samples were collected at 20 predetermined locations throughout the proposed areas of development in order to provide a preliminary assessment of geotechnical and acid sulfate soil properties (Douglas Partners Pty Ltd 2011a). Sampling locations were recorded using a Global Positioning System (GPS) with an accuracy of ± 10 metres. Locations were drilled with a 75 millimetre diameter hand auger to a maximum depth of 1.2 metres and bulk soil samples were collected for geotechnical assessment. Additional samples were collected at 0.25 metre intervals for preliminary acid sulfate soil (ASS) assessment as recommended in SPP 2/02 Guideline. Sampling was supported by a visual assessment of accessible areas.

Investigations into the groundwater resources within the Quaternary sand deposits, which included the drilling and installation of monitoring bores to the full depth of the sand deposits, as well as sampling and water quality testing, are described in **Appendix Z (i)**, **Appendix Z (ii)**, and **Appendix Z (v).**

### (b) Interpretation of Geology

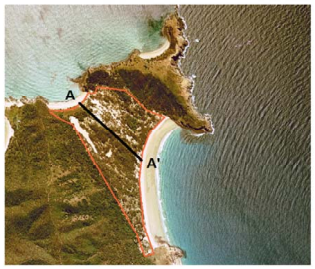
Surface geology encountered consisted primarily of sand with localised outcrops of quartzose sandstone rock (**Appendix Z (iii)**. The subsurface conditions encountered within the central area of the Island, proposed for golf course development, comprised a large deposit of sand that was more extensive than that described in the published geology (DNRMW, 2006). Sands encountered in the central area of the Island were considered to be a mixture of dune sands and colluvium.

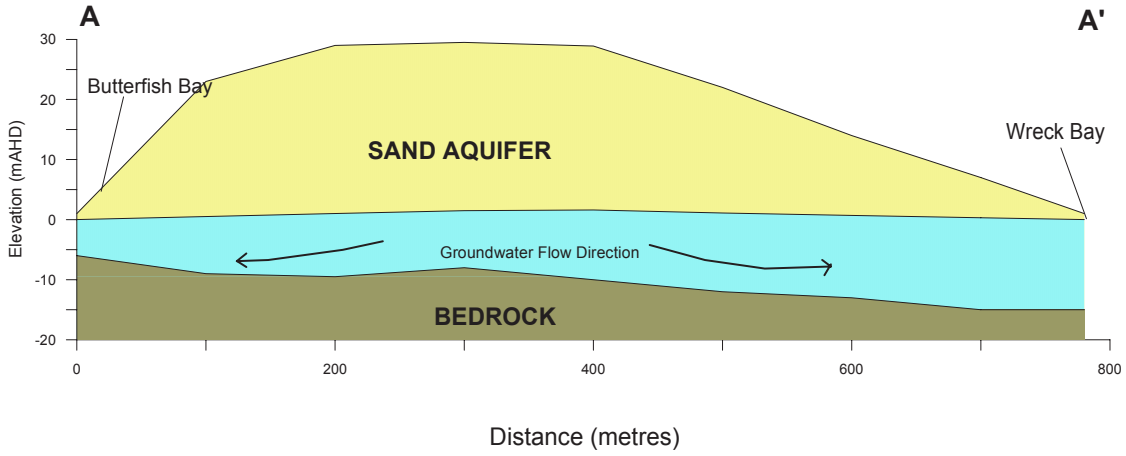
Drilling of groundwater bores within the Project area (**Appendix Z (i)**, **Appendix Z (ii)**, and **Appendix Z (v)**) identified the following underlying geology:

#### (b) (i) *North-east Dune Sand Deposit*

This deposit is comprised of fine to medium grained sand which ranged in thickness from 7.5 metres to greater than 21.5 metres depth. The sand was underlain by residual sandy clay and weathered rock belonging to the Shoalwater Formation. The sand extended from Wreck Beach to Butterfish Bay and a cross section showing the interpreted geology is provided in **Figure 3.8**.

## Figure 3.8 NORTH-EAST AQUIFER - CROSS SECTION A

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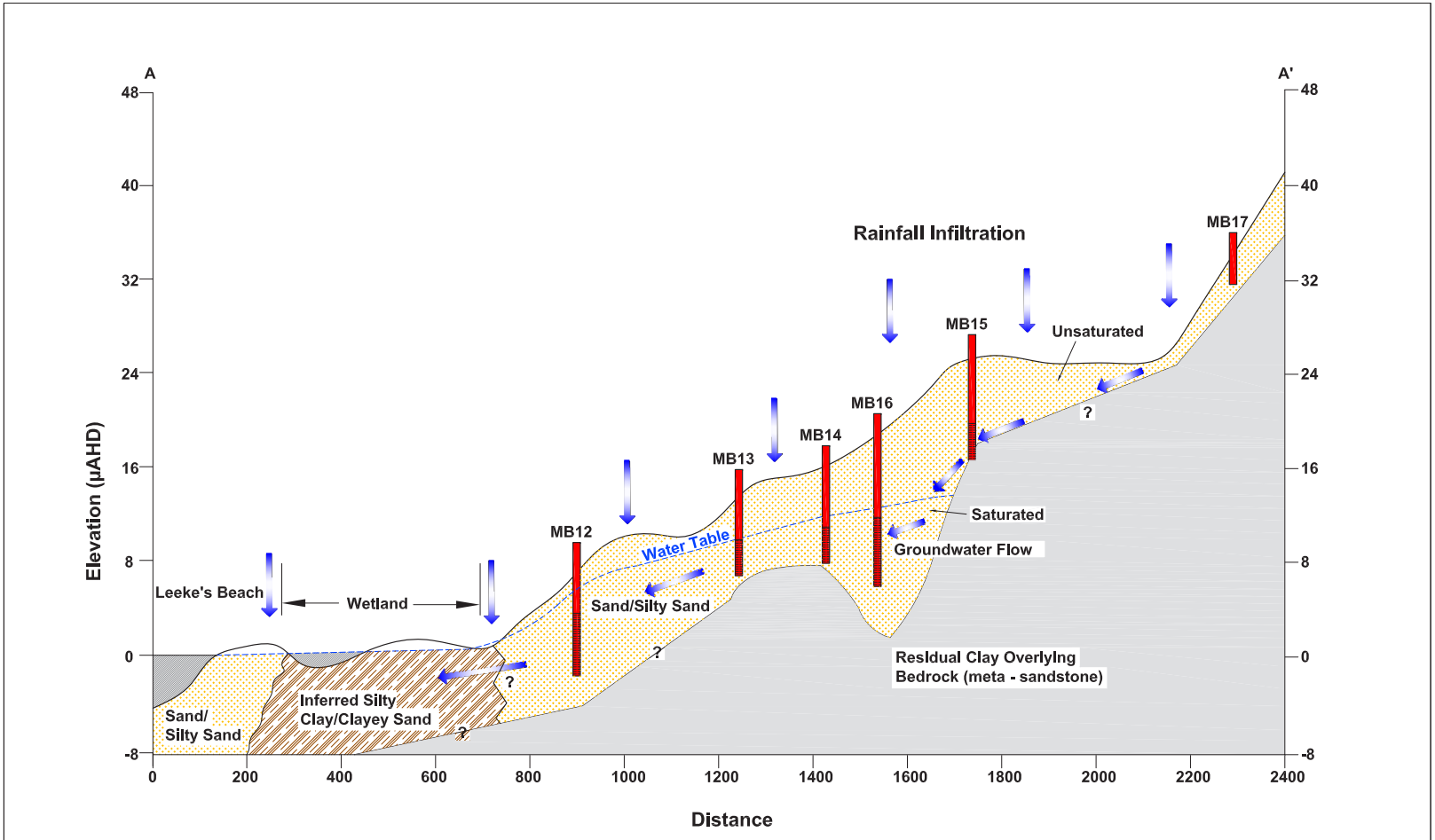
| Douglas Partners Geotechnics · Environment · Groundwater | Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin | Campbelltown, Townsville, Cairns, Wollongong, Wyong | |
| TITLE: | Northeast Aquifer - Cross Section A<br>Groundwater Supply Investigation<br>Great Keppel Island | | |
| CLIENT: OZTON PTY LTD | | | OFFICE: BRISBANE |
| DRAWN BY: | MFW | PROJECT NO: 33796 | DRAWING NO: 6 |
| APPROVED: | | DATE: Feb 2007 | |

**(b) (ii)** *Central Dune Sand deposit (Located Between Leeke's Beach and Clam Bay)*

Comprised a relatively poorly-sorted fine to medium grained sand and silty sand in some areas. The sand deposit varies from 2.5 metres near Clam Bay to greater than 17 metres near Leeke's Beach. The sand is underlain by residual silty clay/clayey sand, which overlies the metamorphic quartzose and lithic sandstones of the Carboniferous Shoalwater Formation. The dune sand deposit is bounded to the north, east and south by outcrops of the Shoalwater Formation. A cross section showing the interpreted geology is provided in **Figure 3.9**.

**Figure 3.9 CONCEPTUAL HYDROLOGICAL MODEL CROSS-SECTION ADDITIONAL GROUNDWATER INVESTIGATION CENTRAL DUNE SAND DEPOSIT**

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| Douglas Partners Geotechnics / Environment / Groundwater | CLIENT: GKI Resort Pty Ltd | | TITLE: Conceptual Hydrological Model Cross-Section<br>Additional Groundwater Investigation<br>Central Dune Sand Deposit, Great Keppel Island | PROJECT No: 74586.01 |
| | OFFICE: Brisbane | DRAWN BY: JT | | DRAWING No: 5 |
| | SCALE: As shown | DATE: 1 September 2011 | | REVISION: 1 |

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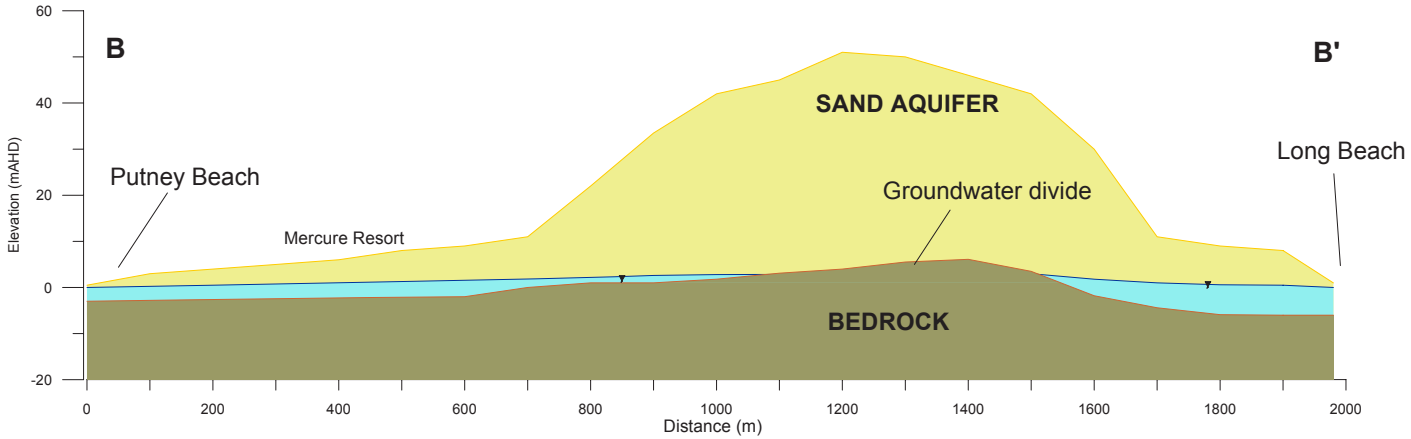
**(b) (iii)** *South-western Dune Sand Deposit*

This deposit is comprised of relatively well sorted fine to medium grained sand, which ranged in thickness generally from six metres to 17 metres depth. The sand was underlain by residual sandy clay/clayey sand and weathered rock belonging to the Shoalwater Formation. The sand extended from Fisherman's Beach to Long Beach and a cross section showing the interpreted geology is provided in **Figure 3.10**. The Shoalwater Formation underlying the sand was found to be shallow beneath the southern end of the air strip and divided the Quaternary sand deposit into two distinct aquifers, the Long Beach aquifer and the Resort Aquifer.

Douglas Partners interpretation of the surface geology based on the published maps and onsite investigations is summarised in **Figure 3.11**.

**Figure 3.10 SOUTH-WEST AQUIFER - CROSS SECTION B**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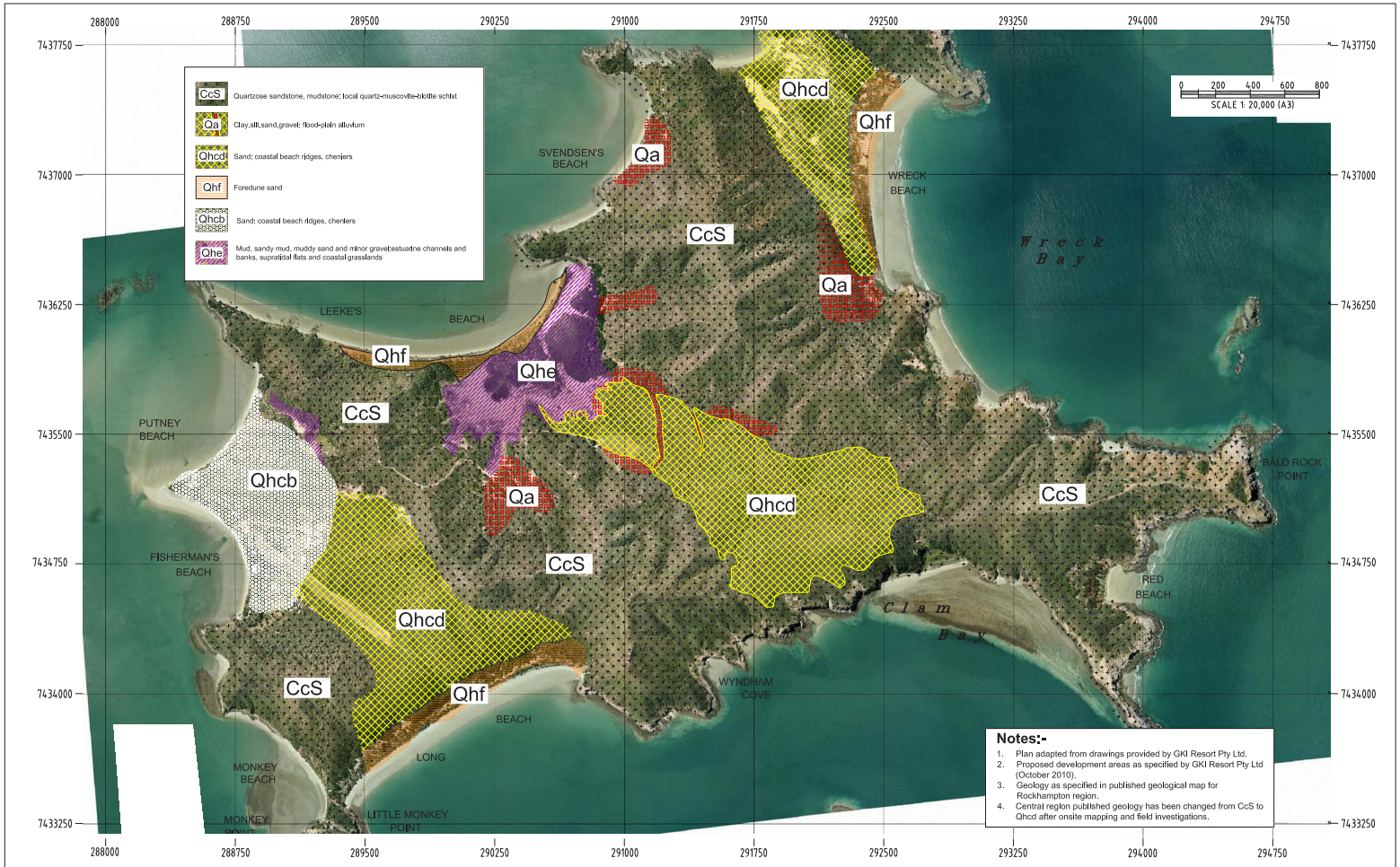
| Douglas Partners Geotechnics · Environment · Groundwater | | Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin | Campbelltown, Townsville, Cairns, Wollongong, Wyong |
| TITLE: | South-west Aquifer - Cross Section B<br>Groundwater Supply Investigation<br>Great Keppel Island | | |
| CLIENT: | OZTON PTY LTD | | OFFICE: BRISBANE |
| DRAWN BY: | MFW | PROJECT NO: 33976 | DRAWING NO: 9 |
| APPROVED: | | DATE: Feb 2007 | |

## Figure 3.11 REVISED GEOLOGICAL MAP PRELIMINARY GEOTECHNICAL ASSESSMENT



**(c) Geotechnical Properties**

A preliminary assessment of subsurface soil conditions at the proposed development sites identified sand and localised outcrops of quartzose sandstone rock in broad agreement with the published geological maps (**Appendix Z (iii)**). Testing of the surface soils found them to have a medium potential for erosion and to be generally suitable for re-use as bulk and structural filling. Re-use will be contingent upon control of field procedures in accordance with standard practices for engineering works and earthworks design.

Rock outcrops comprising low strength (and stronger) quartzose sandstone were observed within the former quarry, along the track between the quarry and Long Beach, as well as along the access road to the lookout (**Appendix Z (iii)**). Rock outcrops generally formed the surface of the access road down the eastern side of the lookout ridgeline. Bedding was thinly laminated and generally aligned on a bearing of 320°, and dipping into the face at approximately eight to 10° with a dip direction of 50°.

### 3.2.5.3 Soils

Max Winders (2006) extrapolated the likely soil and land resources from published geological mapping (refer Geology section), land zone descriptions in regional ecosystem mapping, and land resources maps. An assessment of the probable land resource area, soils, and potential rural land uses for various parts of the Island was made based on land zones, geology and associated ecosystems. It was concluded that "land not required for development, recreation, aesthetic or conservation purposes would only have grazing potential" (Max Winders, 2006: 5) and no parts of the Island would be regarded as "good quality agricultural land" under Queensland's State Planning Policy (SPP 1/92, 1992).

An assessment of predominant soil types by Douglas Partners Pty Ltd found that soil strata comprised very loose fine to medium grained sand in all locations assessed.

Emerson class testing indicated that fine granular sandy soils prevalent near the soil surface have a medium potential for erosion. If disturbed, eroded soils would influence the quality of stormwater leaving any area disturbed by the Project and a medium potential for environmental harm exists (**Appendix Z (iii)**). Soil disturbance could lead to the mobilisation of sands and may result in increased turbidity of stormwater leaving disturbed areas. A detailed erosion hazard assessment would be required once the extent of the development and the actual disturbance areas has been confirmed.

### (a) Acid Sulfate Soils

An initial desktop review of the proposed development areas was conducted to identify any ASS risk areas and to provide an assessment of the presence or otherwise of ASS (Douglas Partners Pty Ltd 2011b). The desktop review was based on the topography and with reference to QASSIT (1998), SPP 2/02 (2002), its accompanying SPP Guideline 2/02, and QASSMAC (1999). No previous ASS investigations are known to have been carried out on the Island and no documented information was available with regard to the ASS conditions.

SPP Guideline 2/02 (2002: 3) stipulates that disturbance of land with a surface elevation at or below five metres AHD via excavation of at least 100 cubic metres, or filling of at least 500 cubic metres, triggers an ASS assessment. An ASS assessment would also be triggered where the surface elevation is between five metres AHD and 20 metres AHD and an excavation of at least 100 cubic metres is to occur below five metres AHD.

The proposed GKI Revitalisation Plan does not include any deep excavations (i.e., from 20 metres AHD to depths less than five metres AHD) and only minimal excavation is proposed below five metres AHD. Therefore, only areas identified as having an elevation of less than five metres AHD were considered as potential ASS risk areas for the Project. ASS risk areas were identified only east of Fisherman's Beach and within the footprint of the proposed marina development (Drawing 2, **Appendix Z (iv)**).

The proposed golf course area has a topographic elevation ranging from approximately 12 metres AHD in the north-west to 65 metres AHD in the south-east near Clam Bay. As this area lies well above the ASS trigger elevation of five metres AHD and the golf course development is not intended to include deep excavations (more than five metres), it was considered by Douglas Partners that an ASS investigation under SPP Guideline 2/02 (2002) was not required for this area (**Appendix Z (iv)**).

Portions of the proposed marina development area with a surface elevation less than five metres AHD consist primarily of rock outcrops and beach sand. Although this was identified as a potential ASS risk area, observations noted during the site inspection confirmed the geology and that it did not indicate a potential for ASS (**Appendix Z (iv)**). It was considered highly unlikely that ASS would be present in this vicinity and soil sampling and laboratory testing was not warranted.

Approximately 12.145 hectares of land east of Fisherman's Beach lies at elevations less than five metres AHD (Drawing 2, **Appendix Z (iv)**). At the time of the preliminary assessment (November 2010), it was expected that the requirement for extensive demolition and construction of new resort buildings would result in soil disturbance in low-lying areas that would trigger an ASS assessment under SPP 2/02 (2002) (**Appendix Z (iv)**). Therefore, the preliminary assessment was focussed on the area east of Fisherman's Beach with an elevation less than five metres AHD.

Field screening and chemical laboratory tests for ASS were carried out with reference to SPP Guideline 2/02 (2002), QASSIT (1998), Dear et al (2002), and Ahern et al (2004). Assessment of screening test results and their indications of actual or potential ASS was based on QASSIT (1998).

Field pH (pHF) and field peroxide (pHFOX) test results indicated that actual ASS was not present and the presence of potential ASS was considered unlikely (**Appendix Z (iv)**). Chromium suite laboratory analysis was conducted on selected samples to confirm this and negligible amounts of sulfides were identified. Although results indicated that some naturally acidic material was present in one location (HA 13, 0.25 metres depth), it was not considered to be an indication of ASS.

Douglas Partners (**Appendix Z (iv)**) concluded that as no indications of actual or potential ASS were identified, ASS management is not necessary within the Project areas assessed.

### (b) Erosion Potential

Erosion processes, such as those caused by wind, water flow, and raindrop impact, have the potential to accentuate the mobilisation of soils in disturbed areas during development/ construction of the Project. If left unmanaged during soil disturbance, these processes could impact existing environmental values both on- and off-site via sheet erosion, bank destabilisation, wash-out of access tracks, and the sedimentation of local waterways. Exposed areas would be susceptible to erosion and would be expected to include:

- beach-front areas;
- areas with little or no vegetation;
- stream banks and waterway crossings;
- access roads and tracks; and
- areas undergoing revegetation.

Removal of vegetation during construction works is likely to result in the loosening of soil. This would in turn facilitate mobilisation of the soils via wind and/or water and could potentially cause a loss of topsoil and off-site impacts, such as the sedimentation of nearby waterways.

Potential receptors of eroded materials and sediments would be the local waterways/ creeks, wetland and beaches. As the local beaches and wetland are comprised of dune sand, receipt of additional sand via mobilised soils is expected to result in deposition and is therefore not considered to pose an unacceptable risk. However, increased quantities of sand in waterways may lead to a slight decrease in waterway quality.

Erosion risk from wind is considered to be low in vegetated areas. However, removal of vegetation for construction and development purposes would lead to the exposure of soils and could facilitate erosion by wind and cause excessive dust. As the majority of the proposed development areas are located close to exposed beaches (Fisherman's Beach, Putney Beach) it could be expected that some wind erosion may occur during development works.

Douglas Partners Pty Ltd (**Appendix Z (iii)**) concluded that a medium risk of erosion exists for fine granular sandy soils prevalent near the soil surface in the areas of the proposed development included in their assessment. This was a generalised assessment based on the soil type, Emerson Class testing of soil samples, and Brisbane City Council (2006).

Erosion risk from water flow and raindrop impact would vary depending on local site conditions and the expected rainfall. According to Douglas Partners (Table 1, **Appendix Z(iii)**), average monthly rainfall ranges from 31 millimetres to 176 millimetres with the majority of rainfall expected from December to March. As the majority of rainfall could be expected to infiltrate through the sandy soils and recharge groundwater aquifers rather than generate runoff, erosion risk for the proposed development areas could be expected to vary as follows (IECA 2008: Table 4.4.2, adapted for increased infiltration):

- Very Low risk: in the months with rainfall less than 45 millimetres (July to October);
- Low risk: when rainfall is between 45 millimetres and 100 millimetres (April to June, November); and
- Moderate risk: in months with average rainfall between 100 millimetres and 225 millimetres (December to March).

An initial estimate of the maximum expected erosion rate was calculated using RUSLE and values listed in IECA (2008) to allow design of appropriate erosion and sediment control measures. For estimation purposes, it was assumed that the majority of soil disturbance and clearing would occur in the central area of the Island. Estimates indicate that the maximum expected erosion rate for an assumed slope gradient of 20 percent would vary between approximately four tonnes per hectare per year and 40 tonnes per hectare per year dependent on the extent and type of vegetation cover maintained.

Accurate calculation of expected soil erosion rates and a detailed erosion hazard assessment would be required for each area of development once the extent of soil disturbance in each area has been confirmed. This should be included in detailed Erosion and Sediment Plans (ESCPs) for each area of disturbance and should be implemented as part of an EMP for each development precinct.

Based on recommendations in IECA (2008), the predominantly sandy soils present, and best management practice drainage controls, Type 3 (or better) erosion management techniques and sediment control measures should be employed to minimise environmental risk. These will be dependent on the extent and location of disturbed areas and should be detailed in a series of ESCPs for each phase of works for each disturbed area.

### 3.2.5.4 Mitigation Measures

#### (a) Erosion

Implementation and maintenance of best practice management erosion and sediment control techniques during the construction phase would serve to mitigate potential impacts of wind and water/rainfall erosion and/or sedimentation to local waterways. ESCPs including supporting specifications should be developed for each area of soil disturbance in accordance with current best practice environmental management, i.e., IECA (2008) and EPA (2008). These should be implemented prior to and during the construction phase. Measures will require ongoing maintenance throughout the construction phase and modification may be necessary as additional areas of disturbance are progressively disturbed and stabilised. ESCPs must remain in place until stable land conditions are achieved.

ESCPs should include the specification, location, construction and maintenance requirements for best practice erosion and sediment control management techniques. A combination of drainage, erosion control, and sediment management techniques should be implemented as appropriate to the specific area of disturbance including, but not limited to, the following:

- maintenance of vegetation cover;
- dust control e.g., via maintaining wind breaks and moist soil conditions, revegetation etc.;
- diversion of water around soil disturbance and stockpiles;
- subdivision of disturbance areas into manageable drainage areas;
- construction of stabilised drainage structures such as grassed swales and purpose built outlet structures;
- control of water flow velocity;
- control of drainage on unsealed roads/access tracks;
- soil stabilisation and protection e.g., via mulching, application of erosion control blankets, mats and/or mesh, revegetation, application of turf etc.;
- implementation of minimum Type 3 sediment traps (IECA 2008: p. 4.27); and
- stockpile management and protection, where appropriate.

Regular monitoring of erosion and the effectiveness of the implemented control measures is recommended to aid in the identification of erosion problems. A daily inspection of control measures should be undertaken if works are to be carried out during the months of high erosion risk (December to March). Weekly inspections should be sufficient at all other times.

**(b) Acid Sulfate Soils**

As no ASS action criteria were triggered during the assessment, ASS management measures are not considered necessary within the proposed project areas assessed by Douglas Partners (**Appendix Z (iv)**). The potential for acid generation by disturbance of ASS during earthworks and construction is therefore considered to be negligible. Samples will be taken and analysed, however from each work area prior to earth disturbing activities to ensure ASS are not present, and if detected, appropriate mitigation measures will be implemented.

## 3.2.6 Land Contamination

### 3.2.6.1 Description of Environmental Values

A preliminary review was undertaken by CQG Consulting to identify the potential for existing land contamination on the Island that may have resulted from historic activities.

This investigation included a search of DEHP's (formerly EPA) Environmental Management Register (EMR) and Contaminated Land Register (CLR), interviews with Island residents, a review of historical aerial photographs and on-ground surveys targeting historic and current land uses. The assessment was conducted in line with EPA's *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998)* and the *National Environment Protection (Assessment of Site Contamination) Measure (1999)*. The scope of works for this element of the EIS was preliminary only and did not include any soil or water sampling.

**(a) Sites Listed on the EMR or CLR**

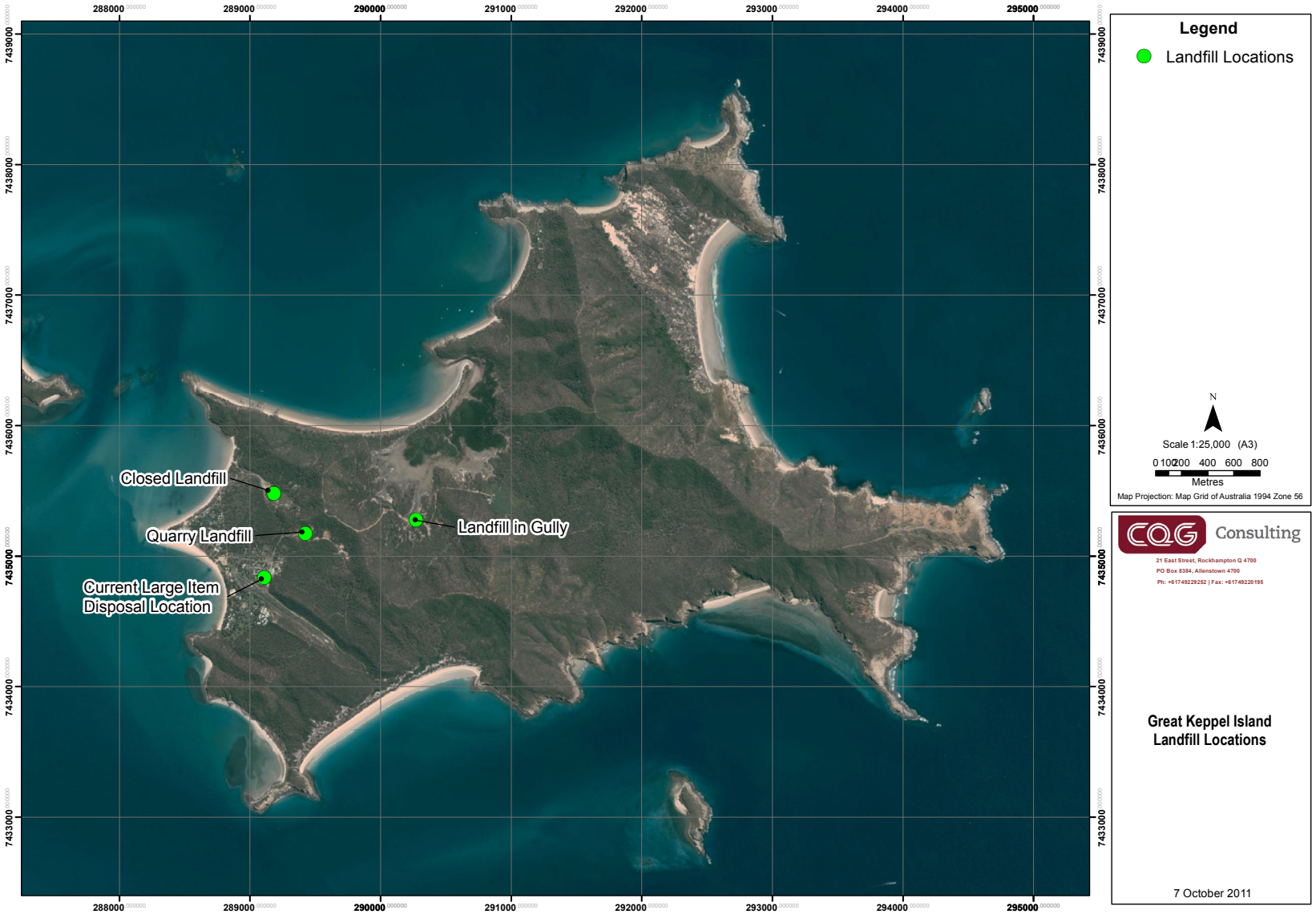
A search of the State Govenrment's EMR and CLR did not report any registered lots on the Island. There however are sites on the Island that should be listed on the register due to historic notifiable activities including landfilling and petroleum storage.

**(b) Potentially Contaminated Sites not on the Registers**

A site inspection was conducted by a land contamination specialist in December 2010 on foot across the area of land within the proposed development footprint and of known suspected contaminated sites on the Island. Several locations on the Island were observed that have been used for historic dumping of wastes (**Figure 3.12**), including:

- domestic landfill, reportedly closed in 1996, covers an area of approximately 13,000 square metres, (owned and managed by Rockhampton Regional Council) located above Putney Creek (Lot 2 on CP900494) (refer **Photograph 3.2**);
- quarry landfill (green waste only), currently used by Island residents, extent unknown, inspection identified several non-green waste items at the quarry landfill, including items that may be asbestos-containing materials (refer **Photograph 3.3** and **3.4**); and
- large goods dump within the former resort grounds (disused whitegoods and other sizable items).

## Figure 3.12 GKI LANDFILL LOCATIONS



**Photograph 3.2 CLOSED COUNCIL LANDFILL ABOVE PUTNEY CREEK**

**Photograph 3.3 GREEN WASTE LANDFILL**

**Photograph 3.4 ASBESTOS AT GREEN WASTE LANDFILL**

**Photograph 3.5 RUBBISH IN LEEKE'S CREEK**

Other potential land contamination areas on the Island (excluding residential and commercial blocks) were also observed including workshops and fuel and chemical storages associated with the former resort and the old sheep station near Leeke's Homestead. Rubbish materials were observed in Leeke's Creek (refer **Photograph 3.5**) during the site inspection. There are also anecdotal reports of fishermen, historically and currently, cleaning their vessels within Leeke's Creek and of chemical drums being buried some years ago within Leeke's Creek, both which could potentially cause contamination. However, neither were confirmed during the site inspections.

Uncontrolled release of sewage from vessels mooring around the Island for a number of years and the discharge of sewage from the former resort have most probably caused contamination of marine sediments adjacent to the Island. The current practice of uncontrolled unloading of fuel containers and rubbish bins onto and off the ferry by local residents on Fisherman's Beach may have resulted in some contamination in the past due to leaking or spilt containers.

#### 3.2.6.2 Potential Impacts and Mitigation Measures

Contamination impacts on ecological receptors vary depending on the type and quantity of the contaminant and the sensitivity of the receptors. The existing probable contaminated sites have the potential to cause downstream contamination due to the lack of containment. Appropriate management practices will be implemented as part of the EMP to avoid uncontrolled disturbances of contamination identified during earthworks and to avoid any future land contamination. An experienced land contamination specialist will conduct an investigation of known potentially contaminated areas within any proposed development areas prior to construction commencing to identify the type of contaminant present and the horizontal and vertical delineation to enable appropriate remediation/removal of contaminated material for offsite treatment or disposal.

Management of the closed landfill on Lot 2 of CP900494 rests with Rockhampton Regional Council.

Potential future land contamination on the Island could result if appropriate mitigation measures are not implemented, including but not limited to appropriate storage, transport, handling and use of hydrocarbons and chemicals including pesticides and herbicides. These risks will be addressed in the Hydrocarbon and Chemical Management Plan to be prepared as part of the Construction and Operational Management Plans. Potential contamination of marine sediments could occur in the future if there are spills when materials are being unloaded from barge delivery vessels, if marine vessel owners don't follow rules within the marina to use the pump out facility, or the wastewater treatment system fails, releasing nutrients. These scenarios are unlikely due to the safe-guard practices proposed to be implemented at all stages during the Project.

A Waste Management Plan (WMP) will be prepared for all phases of the Project development to inform appropriate waste management strategies for both the construction and operation of the Resort. The implementation of the WMP will, as far as practicable, mitigate potential impacts on environmental values from waste contamination. Identification of asbestos - containing materials will take place prior to demolition works occurring. Management strategies will be implemented to ensure appropriate handling and disposal. The WMP will include the requirements for vessels within the marina to use the sewerage pump out and waste collection facilities. As described in previous sections of the EIS, the Proponent has committed to installing a tertiary wastewater treatment system and to reuse all wastewaters onsite through various measures, including irrigation of a proposed golf course to avoid discharging any wastewater contaminants into the marine environment.

A Dredge Management Plan (DMP) will be prepared prior to the commencement of the dredging activities for the proposed marina. The DMP will outline how the dredged material will be used within the construction of the marina, how future maintenance dredged material will be used for sand replenishment on Putney Beach. Reuse plans will consider the quality of the material to ensure appropriate handling and placement. The DMP will need to be assessed and approved by GBRMPA. As noted in the EMP if any contamination occurs during the life of the Project, the proponent will be responsible to ensure an immediate clean up response.

Following decommissioning of the former resort (including the existing wastewater treatment infrastructure and potential in-situ asbestos materials) a full land contamination assessment would need to be conducted to classify the type and level of any contamination to facilitate appropriate remediation if necessary.

In summary, there are locations on the Island which are likely to have some level of contamination due to historic land use practices. Those within the proposal footprint will be investigated further and remediated as required. Future proposed activities are unlikely to cause significant contamination if the mitigation measures proposed in the EMP are implemented. The Proponent will adopt appropriate practices to endeavour to avoid future contamination of soils or sediments on the Island and identify, remediate and manage existing and potential land contamination (including post decommissioning) within the Project footprint.