Great Keppel Island Resort

Central Queensland

Air Quality and Greenhouse Gas Assessment

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Prepared for

Great Keppel Island Resort Pty Ltd

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Executive Summary

GKI Resort Pty Ltd proposes to revitalise the Great Keppel Island resort including providing new accommodation, marina, retail outlets, restaurants, golf course and support facilities. Great Keppel Island is located approximately 12km east of Yeppoon on the Central Queensland coast within the Great Barrier Reef World Heritage Area.

The report has addressed the current climatic conditions and existing air quality environment within the region. An assessment of air quality emission during both construction and operation of the proposed development.

During construction of the development the worst case scenario air quality impacts are expected to be due to the dust emissions occurring during the runway relocation earthworks. The predicted dust impacts of all of the modelled health and wellbeing dust descriptors meet the nominated criteria, assuming the haul routes are watered when required.

During the operation of the development the main air quality impacts associated with the development were identified as pollutant impacts of fuel storage, odour impacts from the proposed solid waste facility and odour impacts from the waste water treatment.

To reduce air pollutant impacts of fuel storage associated with the development the recommended buffer distance between the fuel storage and residential receivers is 300m. The recommended buffer distance may be reduced with appropriate selection of fuel storage volume and equipment selection.

The assessment of the potential odour impacts of the solid waste facility found that a recommended buffer distance of up to 200m between any composting activities and residential receivers is required. Enclosing and controlling emissions of a solid waste facility may provide reductions to the recommended buffer distance.

The details of the treatment plant type and size are not yet known. An assessment of potential odour impacts and recommended buffer distances of different treatment plants and sizes was undertaken. The recommended buffer distances vary between 50m and 700m for the approximate number of 3000 equivalent persons. The recommended buffer distances to mitigate against odour impacts of waste water treatment plants can be reduced if an enclosed package plant similar to a sequencing batch reactor is selected. Recommended buffer distances could be reduced to a little as 20m depending on plant size and configuration.

An assessment of Greenhouse gas emissions has been conducted. The project is expected to generate annual maximum scope 1 emissions of 1.25 kt CO_2-e and 10.8 kt CO_2-e scope 2 emissions. Part of the greenhouse gas abatement strategy for the development is to install approximately 24,000 Photovoltaic solar panels which are estimated to provide approximately 12.7 kt CO_2-e of annual carbon offset to the development and therefore create a carbon positive development.

To assess the risk posed to the air quality environment by activities undertaken as part of the proposed project a risk assessment has been undertaken. This risk assessment addresses the potential impacts for each phase of the project and their consequences described in the above sections along with proposed mitigation measures to address each identified risk. The risk assessment matrix and potential impacts and mitigation strategies are included in Appendix C.

1 Introduction

GKI Resort Pty Ltd proposes to revitalise the Great Keppel Island resort including providing new accommodation, marina, retail outlets, restaurants, golf course and support facilities. Great Keppel Island is located approximately 12km east of Yeppoon on the Central Queensland coast within the Great Barrier Reef World Heritage Area.

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by GKI Resort Pty Ltd to provide an air quality assessment for the proposed resort development on Great Keppel Island. This air quality report is to form part of the Environmental Impact Study (EIS) for the project.

The principle air quality aspects of the development relate to construction activities, the industrial compound, resort activities (e.g. golf course), and vehicle movements.

The purpose of this report is as follows:

- Outline the relevant project air quality criteria
- Present a summary of the existing climate and meteorological conditions
- Present a summary of the existing ambient air quality for the region
- Predict and assess the air quality emissions from the development
- Estimate the air quality impacts onto the development
- Describe mitigation and management requirements

2 Study Area Description

The proposed development is to be located Great Keppel Island, which is located 12km east of Yeppoon on the Central Queensland coast. The site location is shown in Figure 2.1 (source: Google Earth Pro).

A plan showing the names of the beaches around the Island, and the proposed resort plan, is included in Appendix A.

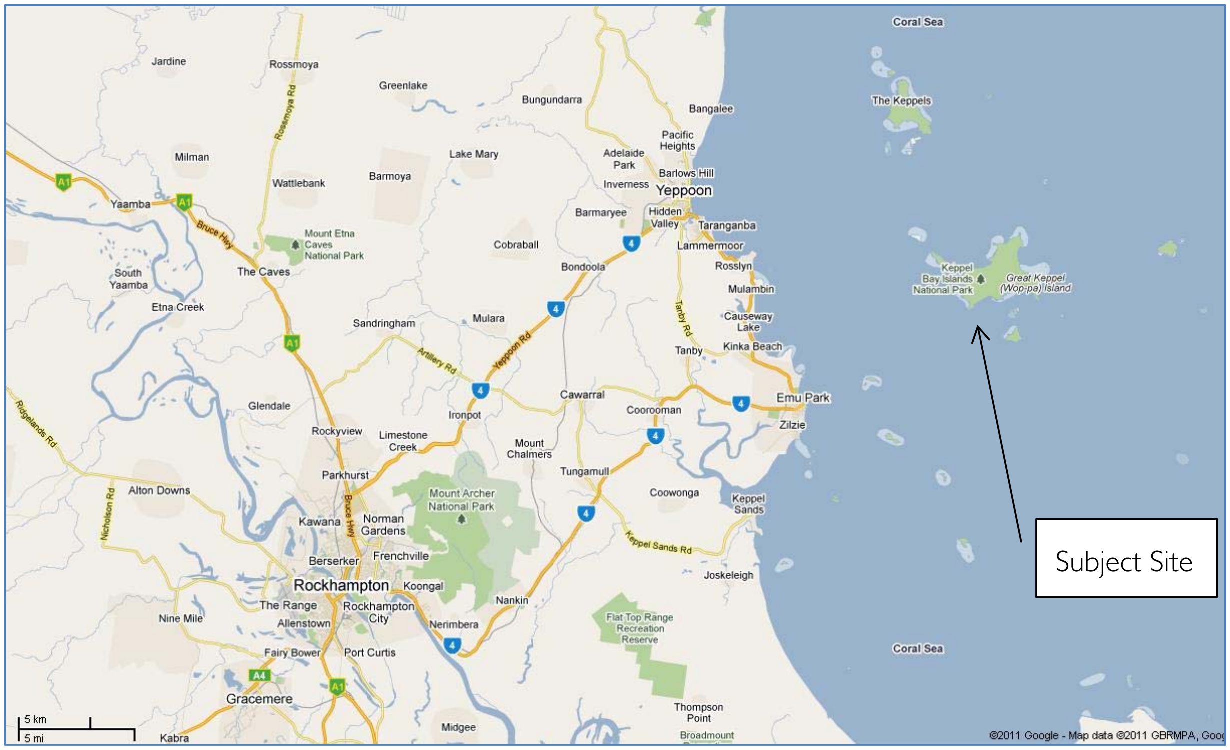

Figure 2.1 Location of Great Keppel Island (North to Top of Page)

Great Keppel Island currently includes a number of existing uses, which are shown on Figure 2.2 and listed as follows:

- Approximately 20 private detached dwellings, including private generators for power.
- Holiday Village, including backpacker facilities.
- Runway for light aircraft.
- Non-operational 'old' Great Keppel resort.
- Svendsens Beach Retreat.

Figure 2.2 Aerial Photo Showing Existing Uses on Island

The majority of existing dwellings are located around Fishermans Beach (refer **Figure 2.2**), on the west side of the Island. Aerial photos of these residences are shown in **Figures 2.3**, **2.4** and **2.5**. A photo of the Holiday Village backpacker accommodation is shown in **Figure 2.6**. A photo of the Svendsens Beach Restreat is shown in **Figure 2.7**.

A photo of the old resort staff accommodation and adjoining services area is shown in **Figure 2.8**.

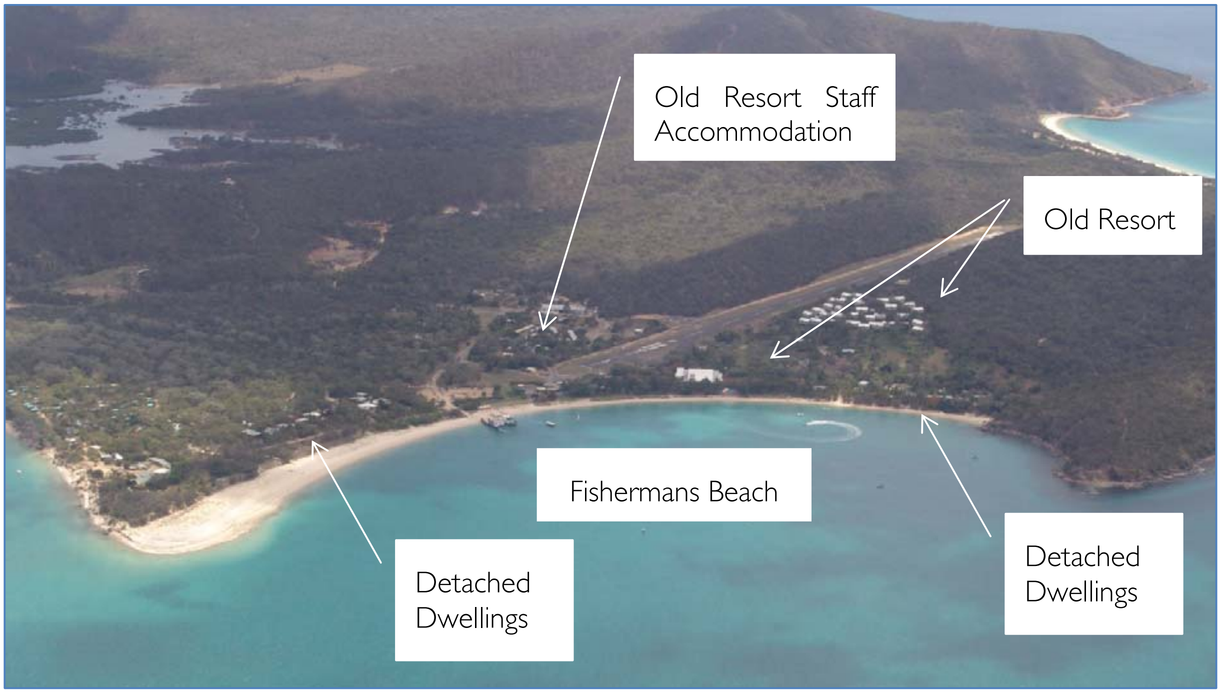

Figure 2.3 Photo of Fishermans Beach Looking East

Figure 2.4 Photo of Northern End of Fishermans Beach and Putney Beach Looking North

Figure 2.5 Photo of Southern End of Fishermans Beach Looking North-East

Figure 2.6 Holiday Village Backpacker Accommodation Looking South

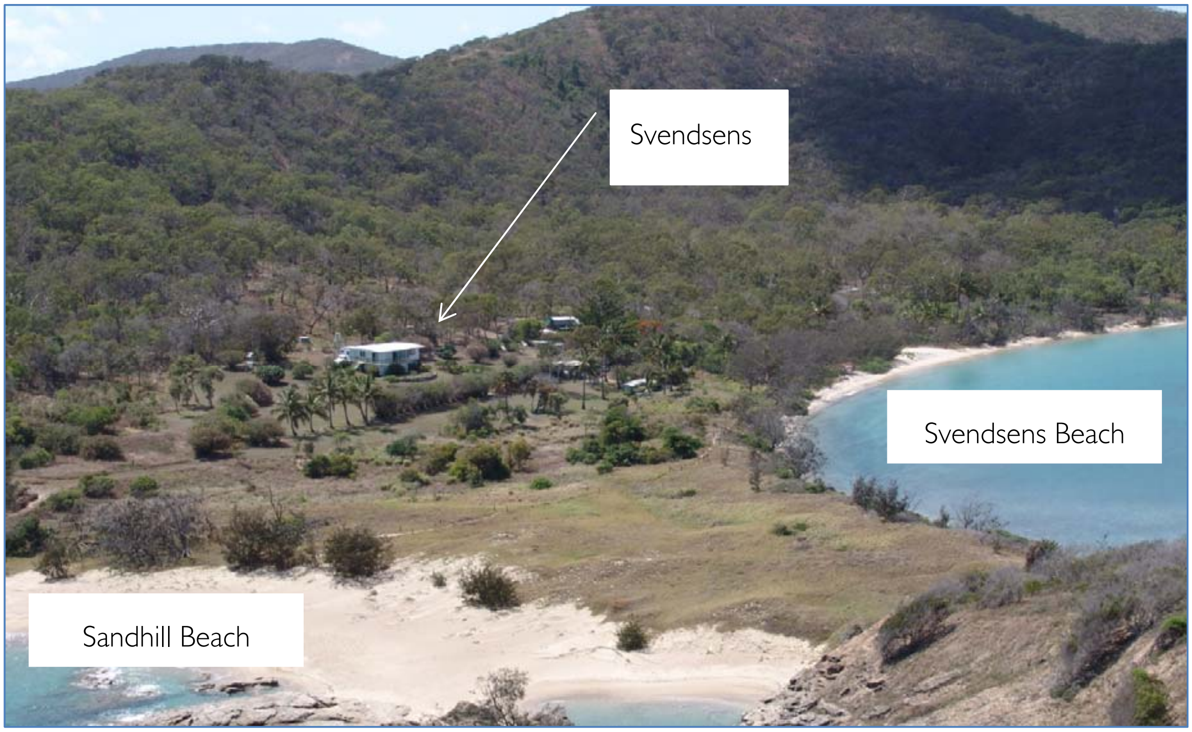

Figure 2.7 Svendsens Beach Retreat Looking East

Figure 2.8 Old Resort Staff Accommodation and Services Area Looking East

3 Proposed Development

3.1 Overview

The proposed development is located in areas of Great Keppel Island that are leased by the proponent, including Lot 21 SP 192569, which covers a total area of 875 hectares out of an overall Island area of 1478 hectares.

The major components of the action are expected to include

- 750 eco-tourism villas.
- 300 eco-tourism apartments.
- A 250 suite hotel facility at Fisherman's Beach (Including day spa and swimming pools).
- New marina at Putney Beach comprising 250 berths. emergency services facilities, ferry terminal yacht club, and dry dock storage, including associated dredging activities.
- Retail area with a mix of cafes, restaurants and clothing shops around the marina.
- An 18 hole golf course and golf club (Including golf pro shop cafe, restaurant swimming pool, convenience store, day spa tennis courts and gymnasium facility).
- Sporting oval/park.
- New relocated runway.
- Associated service facilities and utilities (waste collection area fire-fighting and emergency services hub, fuel solar, wastewater treatment plant).
- Wastewater treatment plant and constructed wetlands.
- Scientific research centre.
- Installation of sub-marine connection of power, water telecommunications and possibly wastewater and gas between the Island and mainland.
- Restoration work to the historic Leeke's homestead.
- Creation of 545 hectares of environmental protection areas including marked walking tracks, compost toilets and picnic facilities.

The resort will be powered by a combination of solar energy and electricity supplied from the mainland via a proposed sea-cable. Water supply will be provided by rainwater tanks at all villas and throughout the resort, and supplemented by a mainland water connection. Transportation between the resort precincts is proposed to be undertaken via pedestrian access bicycles and electric carts. Other transport between the various resort precincts will be provided by regulated resort mini-bus services.

The proposed development plan is included in Appendix A.

The construction is proposed to commence in 2012 subject to all necessary approvals. The construction period is expected to take between 10 and 15 years. Construction will be staged with Stage 1 expected to comprise decommissioning of existing infrastructure, construction of the new hotel at Fishermans Beach, the marina, refurbishment of the historical Leeke's Homestead, creation of environment protection areas and associated infrastructure.

3.2 Emissions

The proposed development has the potential to create air quality impacts on nearby residences due to the following sources:

- Emissions during construction:
  - Decommissioning and breaking down existing infrastructure.
  - Earthworks during construction.
  - Exhaust emissions from construction equipment.
  - Wind erosion during clearing activities.
- Emissions during operation:
  - Waste water treatment facility odour.
  - Solid Waste Management facility.
  - Exhaust emissions from aircraft, boats and vehicles and on the island.
  - Building exhaust vents from commercial kitchen etc.
  - Waste storage area.

The nearest affected sensitive receivers are described as follows (refer Figure 2.2):

- Approximately 20 existing private detached dwellings (refer Figures 2.3, 2.4 and 2.5).
- Holiday Village, including backpacker accommodation (Refer Figure 2.6).
- Svendsens Beach Retreat (Refer Figure 2.7).

If predicted air quality concentrations due to these sources are compliant at the receivers listed above, and impacts on marine life are acceptably managed then it is considered that all emission levels are compliant.

4 Air Quality Criteria

4.1 Overview

Air quality criteria for the project will need to address a number of potential air quality impacts on existing and future residential receivers.

The assessment will be undertaken in accordance with relevant legislation and criteria including:

- The Queensland State Government Coordinator General Terms of Reference for the Environmental Impact Statement, dated April 2011.
- Department of Sustainability, Environment, Water, Population & Communities (SEWPAC) guidelines for the EIS, dated 21/02/11. These guidelines have been partly developed by Great Barrier Reef Marine Park Authority (GBRMPA), and acknowledge that the island is located within Great Barrier Reef World Heritage Area, the Great Barrier Reef National Heritage place, and the Great Barrier Reef Marine Park.
- Department of Environment and Resource Management (DERM)
  - Environmental Protection Act.
  - Environmental Protection Policy (Air).
  - Odour Impact Assessment from Developments Guideline
- National Environment Protection Council
  - National Environment Protection (Ambient Air Quality) Measure

4.2 Terms of Reference

The Queensland State Government Coordinator General Terms of Reference for the Environmental Impact Statement includes the following sections on Air Quality and Greenhouse Gas Emissions:

"3.6 Air Quality

3.6.1 Description of environmental values

This section of the EIS should describe the existing air quality that may be affected by the project in the context of environmental values as defined by the EP Act and Environmental Protection (Air) Policy 2008.

A discussion of the existing air shed environment both local and regional should be provided, including:

- *background levels and sources of particulates, gaseous and odorous compounds and any major constituent*
- *pollutants, including greenhouse gases which may be affected by the project*
- *baseline monitoring results including sensitive receptors*
- *data on local meteorology and ambient levels of pollutants to provide a baseline for later studies or for the modelling of air quality environmental harms.*

Parameters should include air temperature, wind speed and direction, atmospheric stability, mixing depth and other parameters necessary for input to the models.

3.6.2 Potential impacts and mitigation measures

The following air quality issues and their mitigation should be considered:

- *an inventory of air emissions from the project expected during construction and operational activities*
- *identify 'worst case' emissions that may occur during operation. If these emissions are significantly higher than those for normal operations, it will be necessary to evaluate the worst-case impact as a separate exercise to determine whether the planned buffer distance between the facility and neighbouring sensitive receptors will be adequate*
- *ground level predictions should be made at any residential, industrial and agricultural developments believed to be sensitive to the effects of predicted emissions*
- *dust generation from construction activities especially in areas where construction activities are adjacent existing road networks or are in close proximity to sensitive receivers*
- *climatic patterns that could affect dust generation and movement*
- *vehicle emissions and dust generation along major haulage routes both internal and external to the project site*
- *human health risk associated with emissions from the facility of all hazardous or toxic pollutants should be assessed*
- *impacts on terrestrial flora and fauna.*

Potential air quality impacts from emissions must be discussed with reference to the National Environmental Protection Measures (NEPM) for ambient air quality (1998) and the Environmental Protection (Air) Policy 1997.

3.7 Greenhouse gas emissions

3.7.1 Description of environmental situation

This section of the EIS should provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO2 equivalent' terms for the following categories:

- *Scope 1 emissions, where 'Scope 1 emissions' means direct emissions of greenhouse gases from sources within the boundary of the facility and as a result of the facility's activities*
- *Scope 2 emissions, where 'Scope 2 emissions' means emissions of greenhouse gases from the production of electricity, heat or steam that the facility will consume, but that are physically produced by another facility*
- *briefly describe method(s) by which estimates were made.*

The Department of Climate Change's National Greenhouse Accounts (NGA) Factors can be used as a reference source for emission estimates and supplemented by other sources where practicable and appropriate. As a requirement of the NGA Factors, estimates should include the loss of carbon sink capacity of vegetation due to clearing and impoundment.

3.7.2 Potential impacts and mitigation measures

This section of the EIS should discuss the potential for greenhouse gas abatement measures. This may include:

a description of the proposed measures (alternatives and preferred) to avoid and/or minimise direct greenhouse gas emissions

an assessment of how the preferred measures minimise emissions and achieve energy efficiency

a description of any opportunities for further offsetting greenhouse gas emissions through indirect means including sequestration and carbon trading."

4.3 Australian Government Guidelines for the EIS

The Department of Sustainability, Environment, Water, Population & Communities has finalised the guidelines for the EIS in a document dated 21/02/11 (reference: 2010/5521). In the guidelines it is noted that they have been revised since a draft was released for public comment on 4 October 2010, and that the revisions take account of comments from the Client, the public, Great Barrier Reef Marine Park Authority, and relevant areas of the department including subsequent discussions by assessment officers.

In terms of Air Quality, in Section 5.9.5 of the guidelines it is stated that the assessment must address the *"Impacts of the proposal on air quality (any information on greenhouse gas emissions should be presented consistent with the Australian Government's standard National Carbon Accounting Toolbox)"*

4.4 Environmental Protection Act

In Queensland, the environment is protected under the *Environmental Protection Act 1994*. The object of the Act is to protect Queensland's environment while allowing for development that improves the total quality of life using, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

The Act states a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm. This is termed the 'general environmental duty'. Environmental harm is defined as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Environmental nuisance for this report is unreasonable interference or likely interference with an environmental value caused by air pollution.

This act refers to the Environmental Protection Policies as being subordinate legislation to the Act.

4.5 Environmental Protection (Air) Policy

In respect of the air environment, the object of the Act is achieved by the Environmental Protection (Air) Policy 2008 (EPP (Air)). This policy identifies environmental values to be enhanced or protected, states air quality quality objectives, and provides a framework for making decisions about the air environment.

The environmental values to be enhanced or protected by the EPP (Air) are as follows:

a) *the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and*
b) *the qualities of the air environment that are conducive to human health and wellbeing; and*
c) *the qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property; and*
d) *the qualities of the air environment that are conducive to protecting agricultural use of the environment.*

Schedule 1 of the EPP(Air) contains air quality objectives of the environmental values described above. It is the intent of EPP (Air) that the air quality objectives be achieved progressively over the long term.

4.6 National Environmental Protection Measure

The EPP(Air) has incorporated goals nominated within the National Environmental Protection Measure (NEPM). The NEPM ambient air quality guideline was released in 1998 and amended in 2003. NEPM standards are intended as goals for regional averages across large populations (>20,000 people). The NEPM advisory reporting standards were not intended to be used for peak sites impacted by individual sources *(Ambient Air Quality NEPM Review Discussion Paper, 2007)* and have therefore been not been addressed in this air quality assessment. The NEPM standards are currently under review and any developments in the NEPM standards should be monitored throughout the life of this project.

4.7 Odour Impact Assessment from Developments Guideline

The DERM odour guideline "Guideline for Odour Impact Assessment from Developments" July 2004 identifies the following guideline values for odour emissions:

- 0.5 OU, 1-hour average, 99.5th percentile for tall stacks;
- 2.5 OU, 1-hour average, 99.5th percentile for ground-level sources and down-washed plumes from short stacks; and
- for facilities that do not operate continuously, the 99.5th percentile must be applied to the actual hours of operation

As described in the Guideline for Odour Impact Assessment from Developments the DERM hourly 99.5th percentile peak concentration is corrected to represent peak odour concentrations by using odour peak to mean ratios on the default annoyance threshold of 5 OU.

4.8 Other Guidelines

Dust deposition is not addressed as an air quality objective in any of the above policies or guidelines, however it is often used as an air quality descriptor for nuisance dust. For many industrial, construction activities involving earthworks and mines, DERM applies dust deposition limits as a licensing condition. The licensing condition commonly applied by DERM for dust deposition is based on DERM's guideline "Preparing an Environmental Management Overview Strategy (EMOS) for Nonstandard Mining Projects". The dust deposition limit for nuisance dust as described in DERM's EMOS guidelines, measureable at any sensitive or commercial place, is as follows:

> *"Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulates - Deposited matter - Gravimetric method of 1991"*

4.9 Summary of Air Quality Goals

The Environmental Protection (Air) Policy 2008 (EPP(Air)), Queensland EPA's guideline for Odour Impact Assessment from Developments (EPA, 2004) and DERM common license conditions have been summarised in Table 4.1 with the relevant air quality indicators shown. All design ground level concentrations are intended for health and wellbeing values, unless otherwise noted.

Table 4.1 Summary of Air Quality Goals

Air Quality Indicator	Units	Design Ground Level Concentration	Averaging Period	Source
Particulate PM_{10}	$\mu g/m^3$	50*	24 hours	EPP(Air)
Particulate $PM_{2.5}$	$\mu g/m^3$	25	24 hours	EPP(Air)
		8	Annual	EPP(Air)
Total Suspended Particulate (TSP)	$\mu g/m^3$	90	Annual	EPP(Air)
Nitrogen Dioxide (NO_2)	ppm ($\mu g/m^3$)	0.12 (250)	1 hour	EPP(Air)
	ppm ($\mu g/m^3$)	0.03 (62)	Annual	EPP(Air)
	ppm ($\mu g/m^3$)	0.016 (33)	Annual	EPP(Air)**
Ozone	ppm ($\mu g/m^3$)	0.10 (210)	1 hour	EPP(Air)
	ppm ($\mu g/m^3$)	0.08 (160)	4 hour	EPP(Air)
ozone (measured as accumulated exposure over a threshold of 40 ppb during daylight hours)	ppm-hr	10	6 months	EPP(Air)
Sulfur Dioxide	ppm ($\mu g/m^3$)	0.20 (570)	1 hour	EPP(Air)
	ppm ($\mu g/m^3$)	0.08 (230)	1 day	EPP(Air)
	ppm ($\mu g/m^3$)	0.02 (57)	Annual	EPP(Air)
	ppm ($\mu g/m^3$)	0.0075 (22)	Annual	EPP(Air)***

Air Quality Indicator	Units	Design Ground Level Concentration	Averaging Period	Source
Odour	OU	2.5	1 hour*	DERM
Dust Deposition	$mg/m^2/day$	120	30 days	DERM

Notes - * 5 allowable exceedances per year, ** Environmental value is health and biodiversity of ecosystems, *** Environmental value is health and biodiversity of ecosystems (for forests and natural vegetation).

5 Existing Environment

5.1 Climate and Meteorology

Great Keppel Island is located approximately 12km east of the Yeppoon Coast. Yeppoon and the surrounding region have a subtropical climate. The Bureau of Meteorology (BoM) does not have a weather station on Great Keppel Island and the nearest BoM weather station is located on the Esplanade in Yeppoon. Figure 5.1 shows a summary of 1993 to 2011 rainfall and temperature data from the Yeppoon weather station. As shown in Figure 5.1 Yeppoon experiences wet summers with daily maximum and minimum temperatures around 30°C and 23°C respectively. Winters are generally a dry period with daily maximum and minimum temperatures around 22°C and 12°C respectively. The period between November and April is commonly influenced by storms and cyclonic events.

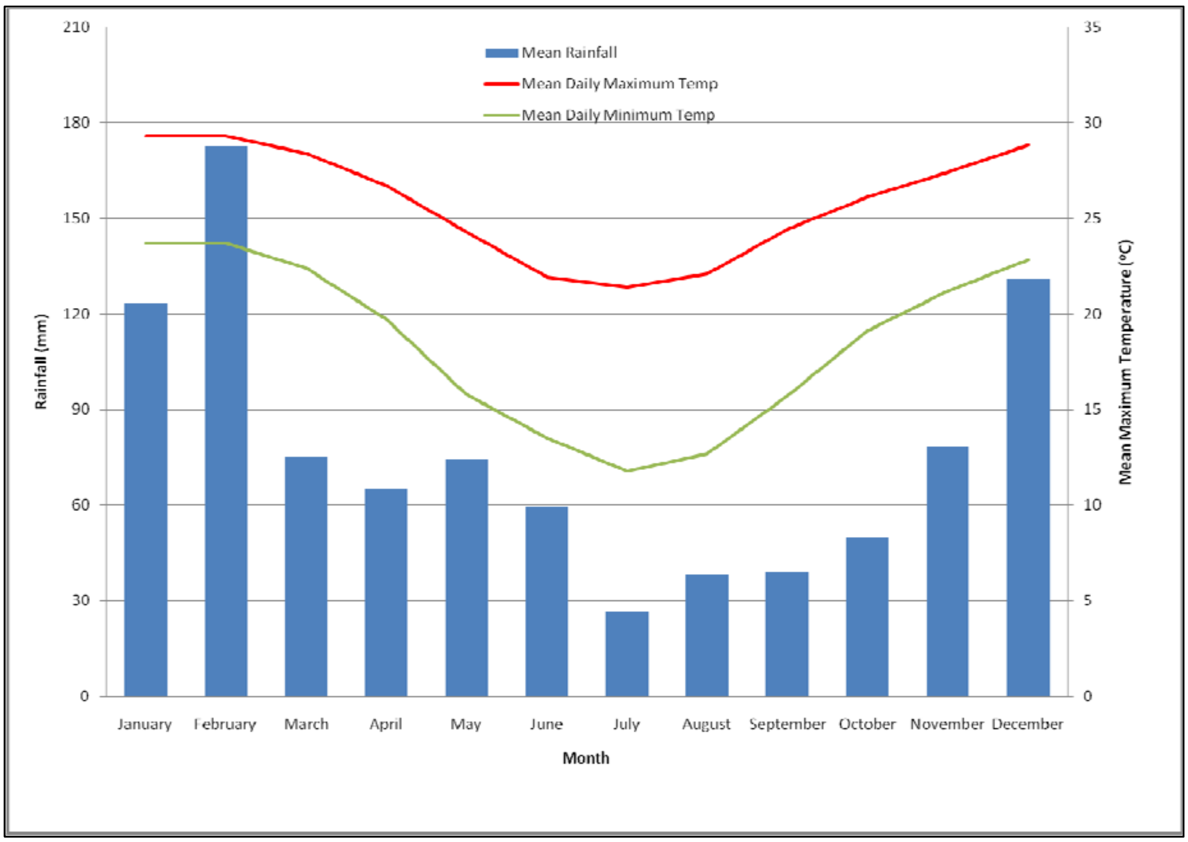

Figure 5.1 Summary of Yeppoon Climate

To give an indication of wind conditions for the region surrounding Great Keppel Island, wind data was sourced from the nearest mainland weather station, the Yeppoon Esplanade weather station, and the nearest island weather station, Rundle Island, located approximately 50km southeast of Great Keppel Island. Annual wind roses and wind speed and direction distribution graphs for the Yeppoon and Rundle Island weather stations are provided in Figures 5.2 to Figure 5.5. Seasonal wind roses for the Yeppoon and Rundle Island weather stations are provided in Appendix B.

Plume dispersion is affected by atmospheric stability. Plumes are more readily dispersed during unstable atmospheric conditions, such as on a hot summer's day, than during stable atmospheric conditions, such as on a cool winter's night. The Pasquill-Gillford-Turner stability classifications categorize very unstable conditions as Stability Class A, with very stable conditions denoted as Stability Class F. Neutral conditions, such as those that typically occur during cloudy conditions, are denoted as Stability Class D.

DERM has produced meteorological data files showing atmospheric stability for the air quality dispersion modelling program AUSPLUME for two nearby regions. The nearest regional DERM meteorological data file is for the Rockhampton region located inland approximately 45km southwest. The second nearest regional DERM meteorological data file is for the Gladstone region located on the coast approximately 80km south. Wind speed and direction distribution graphs and Pasquill-Gillford-Turner stability class distributions for the Rockhampton and Gladstone DERM meteorological data files are provided in Figure 5.6 to Figure 5.9.

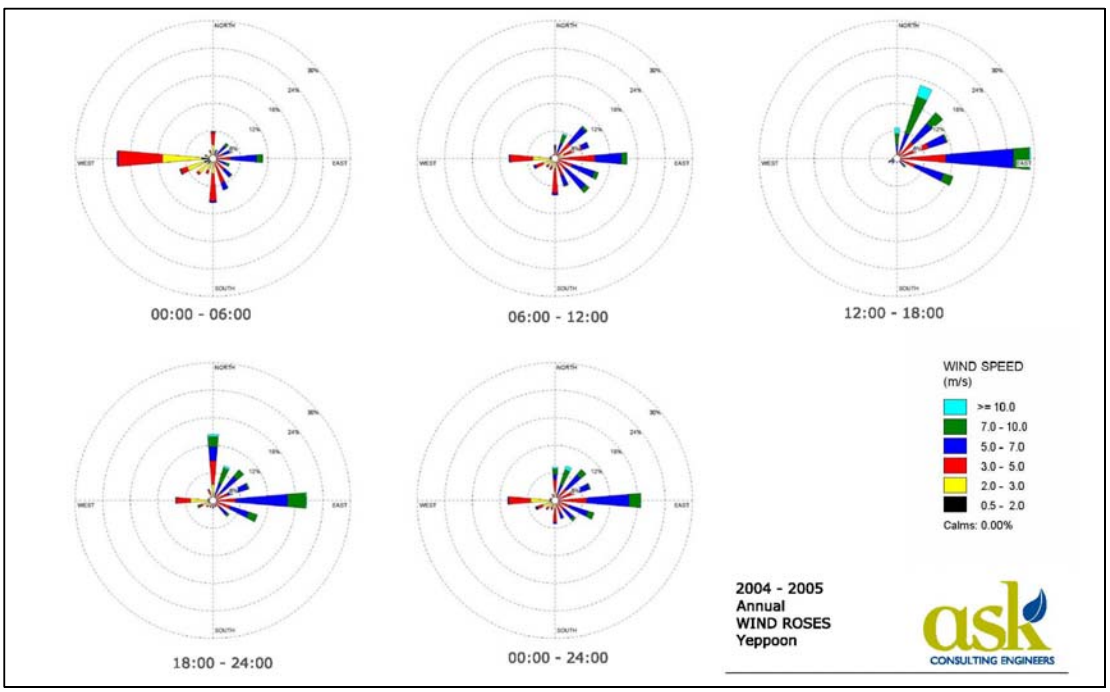

Figure 5.2 Annual Wind Roses for Yeppoon

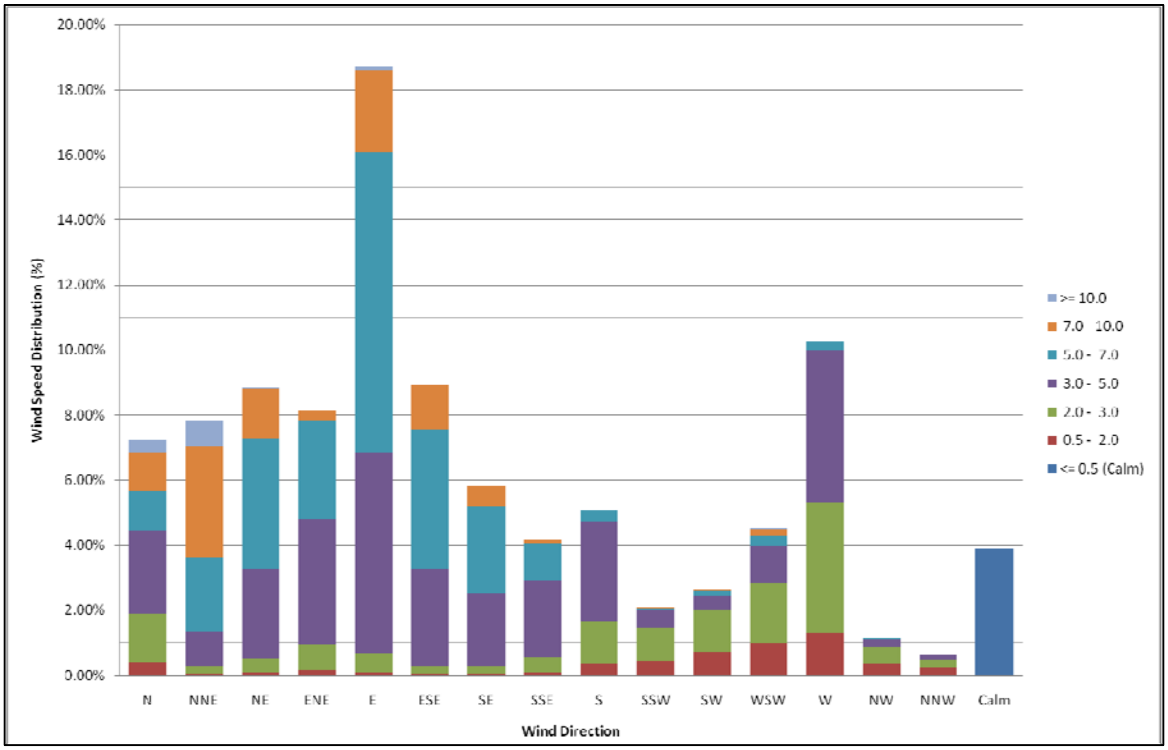

Figure 5.3 Wind Speed and Direction Distribution for Yeppoon

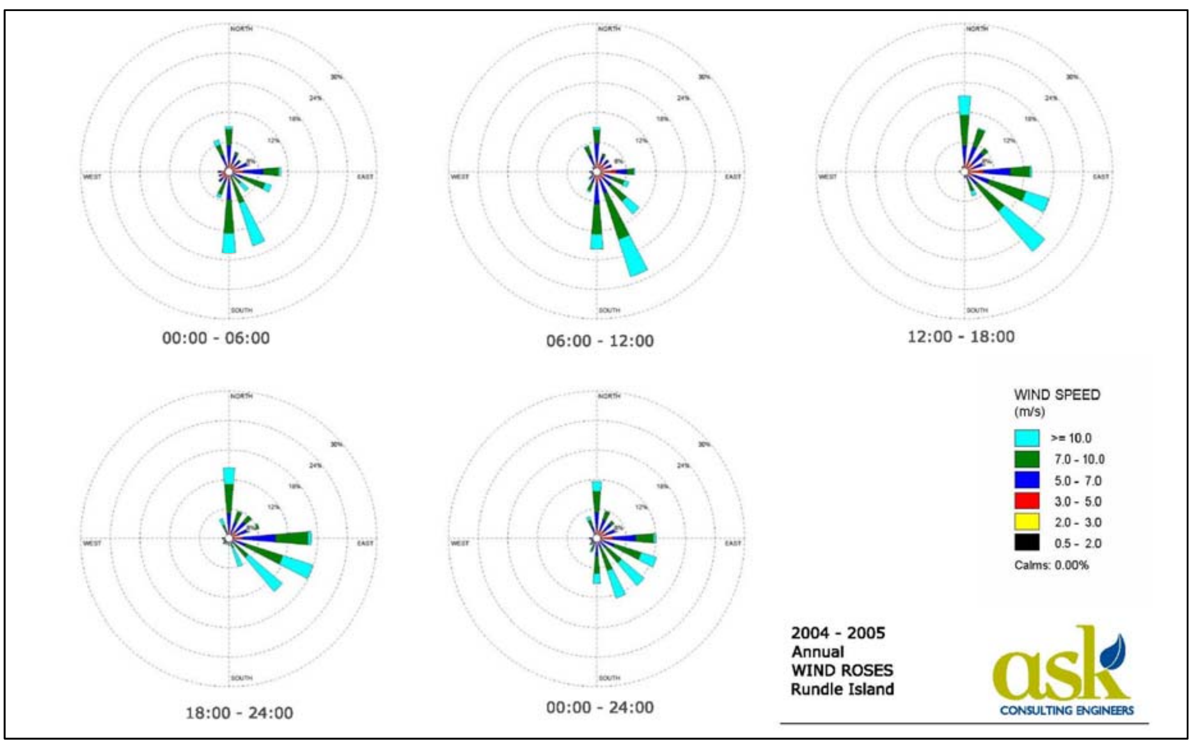

Figure 5.4 Annual Wind Roses for Rundle Island

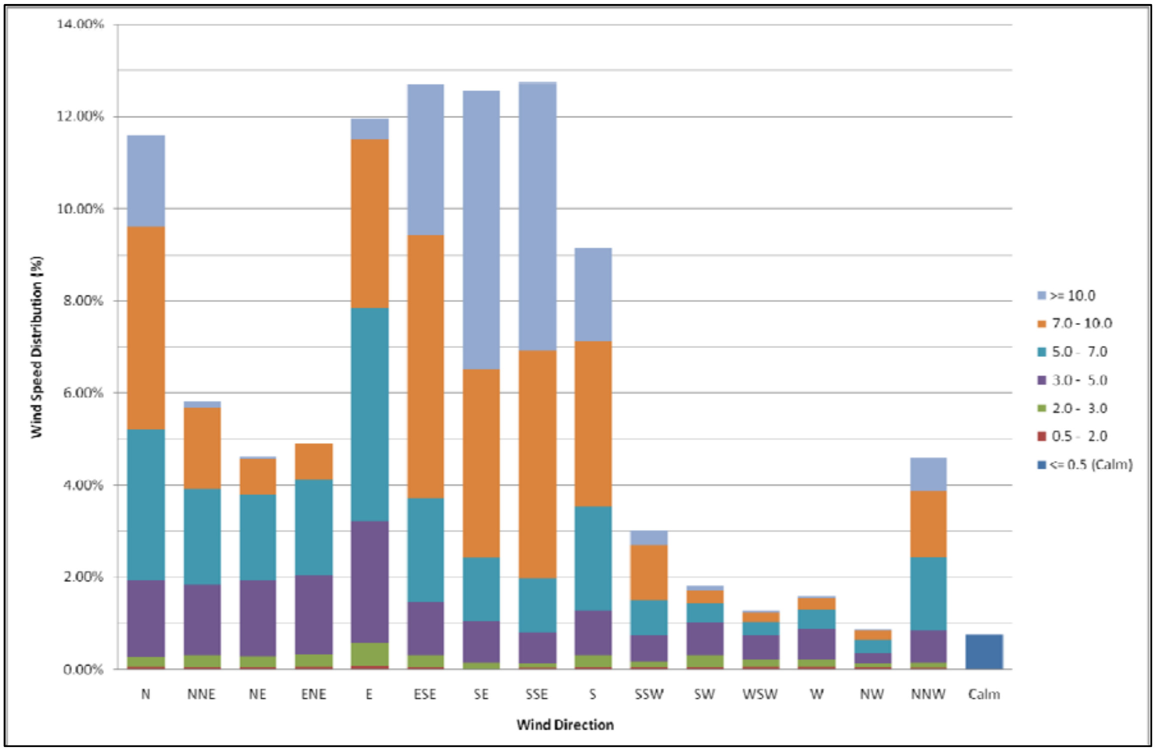

Figure 5.5 Wind Speed and Direction Distribution for Rundle Island

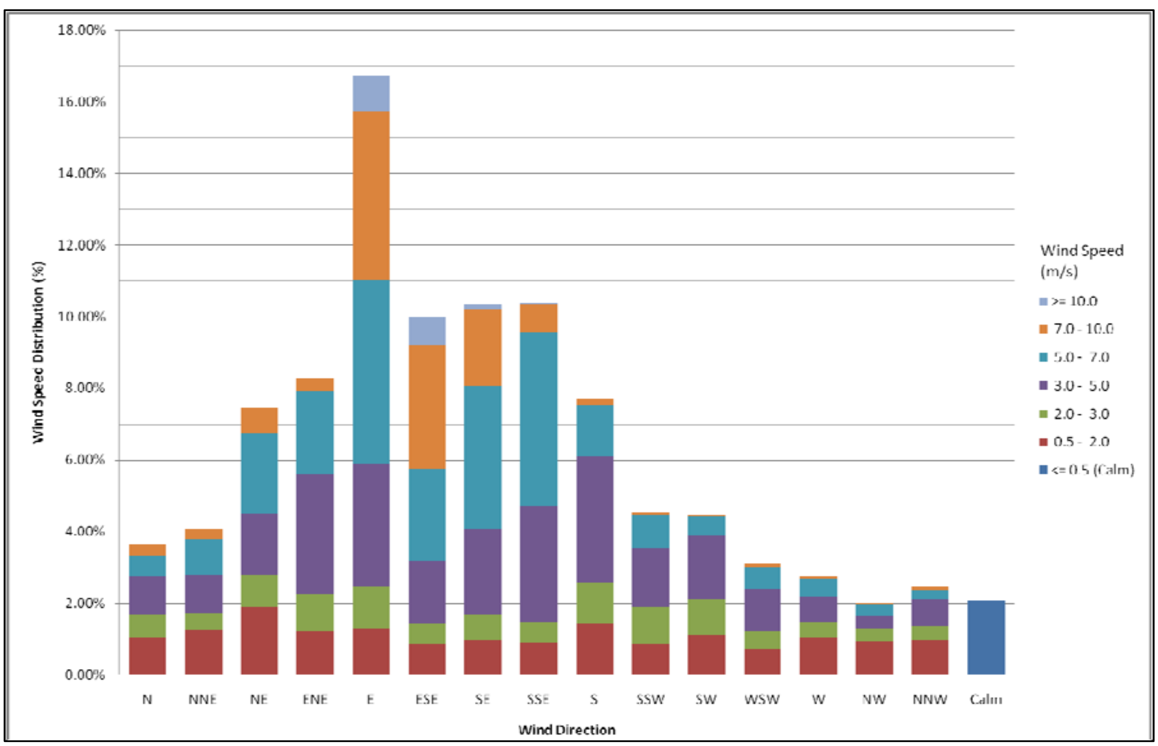

Figure 5.6 Wind Speed and Direction Distribution for Gladstone DERM

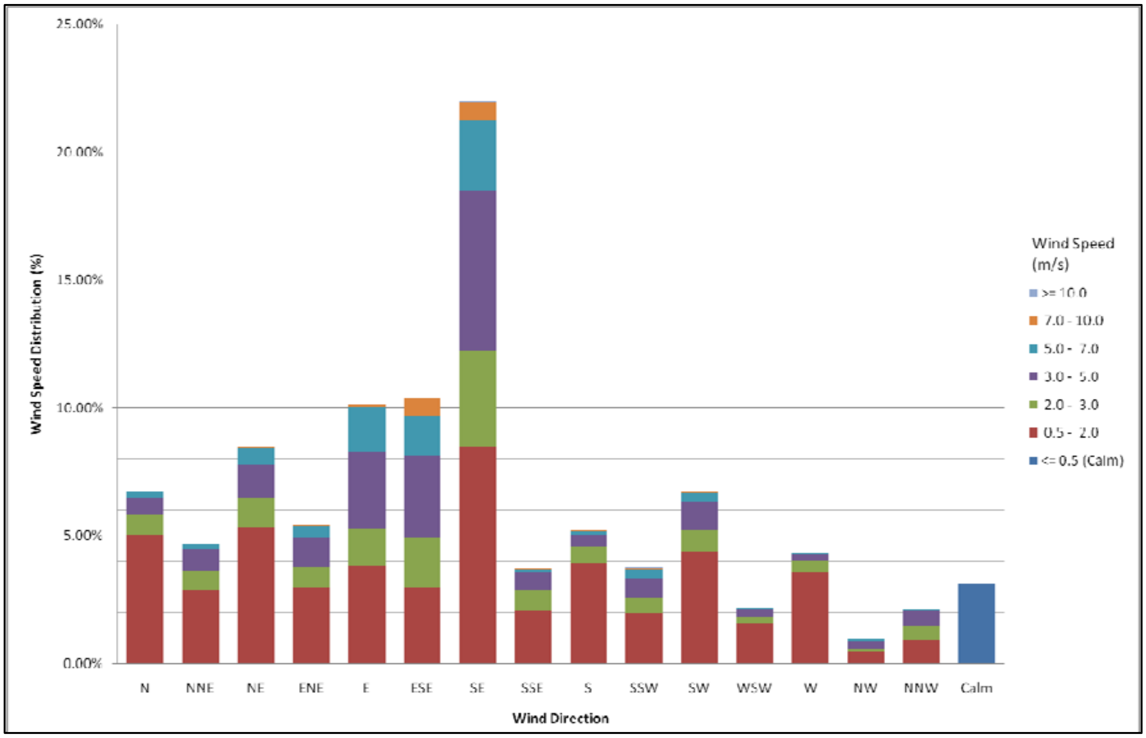

Figure 5.7 Wind Speed and Direction Distribution for Rockhampton DERM

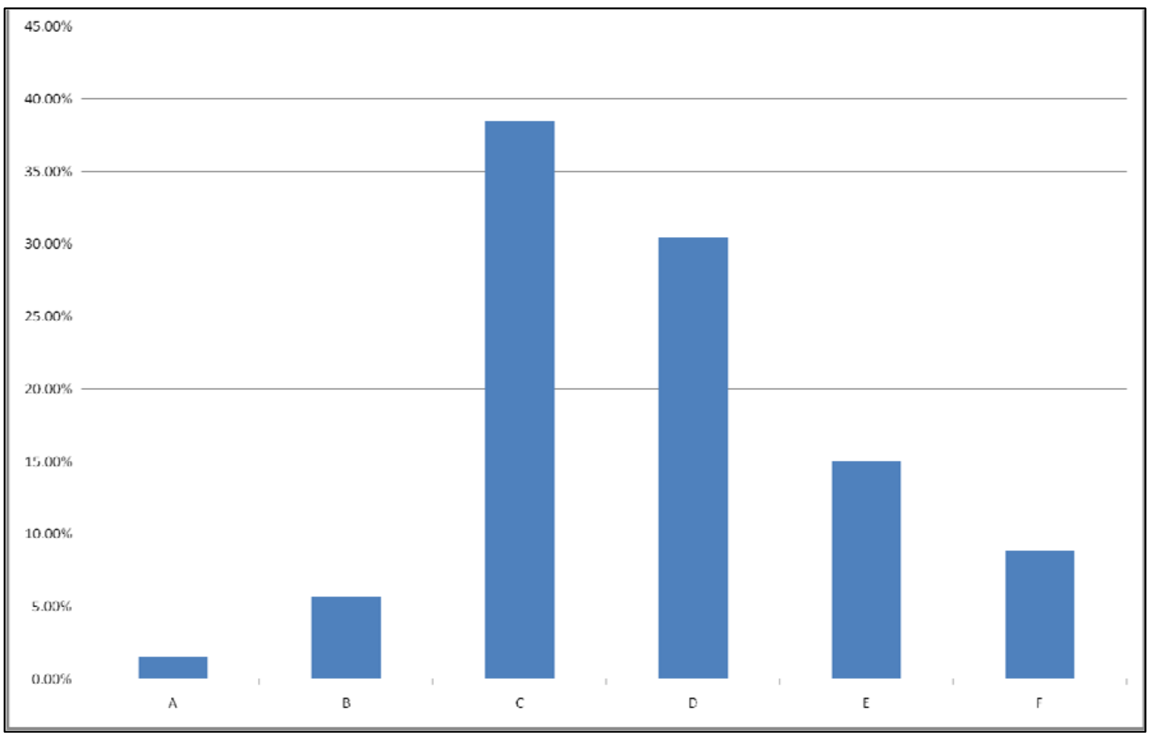

Figure 5.8 Annual Frequency Distribution Stability Class for Gladstone DERM

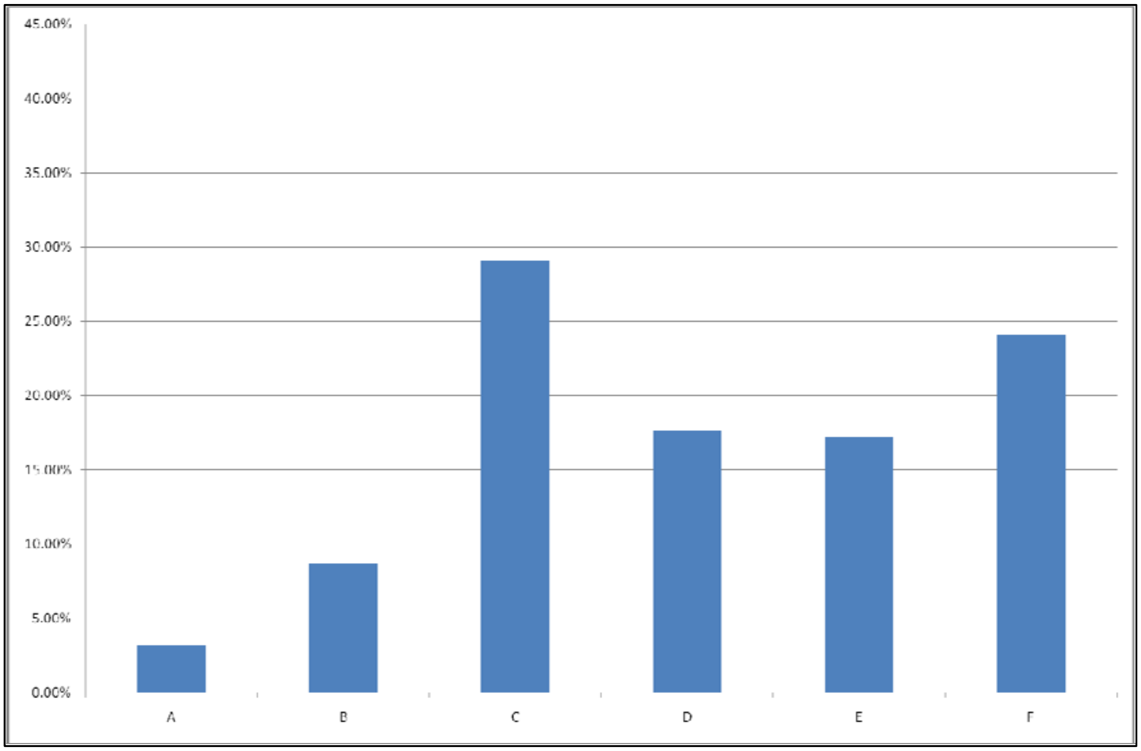

Figure 5.9 Annual Frequency Distribution Stability Class for Rockhampton DERM

Annual wind rose diagrams based on the BoM weather stations are presented in Appendix B.

Wind roses for Yeppoon indicate the following:

- Highest speeds are normally associated with winds from the east after midday.
- Between midnight and 6am the wind speed tends to decrease resulting in a large percentage winds from the west with a low average speed.
- In summer and spring, winds are predominantly from the northeastern quadrant and have a high average speed.
- In autumn, winds are predominantly from the southeastern quadrant and have a high average speed.
- In winter, winds are predominantly from the west and have a low average speed.

Wind roses for Rundle Island indicate the following:

- Winds are commonly over 7m/s.
- Low wind speeds are not common on Rundle Island.
- In summer, winds are predominantly from the north and south-eastern quadrant and have a high average speed.
- In autumn and winter, winds are predominantly from the southeastern quadrant and have a high average speed.

- In spring, winds are predominantly from the northeastern quadrant and have a high average speed.

Wind roses data for the BoM Yeppoon and Rundle Island weather stations are somewhat different. Rundle Island wind roses indicate wind conditions which are commonly observed off the Capricornia coastline. The Rundle Island wind roses show high average wind speeds which frequently result in good air dispersion. The high average speed wind from the southeastern quadrant and the low average wind speed from the west shown in the Yeppoon wind roses indicate a combination of common coastal and inland wind conditions. The Yeppoon wind conditions show that the region has relatively good air dispersion characteristics during the second half of the day however the low wind speeds from the west between midnight and 6am show potential for poor air dispersion during that time period.

From Figure 5.8 it can be seen that for Gladstone the stability classes C (slightly unstable) and D (neutral) are dominant with frequencies of 38% and 30%. Slightly stable and stable conditions being Classes E and F result in 15% and 9% of the distribution respectively while unstable Classes A and B results in the remainder of the distribution for the year (totally 8%).

From Figure 5.9 it can be seen that for Rockhampton the stability class C (slightly unstable) is dominant with a frequency of 29%. Neutral, slightly stable and stable conditions being Classes D, E and F result in 18, 17% and 24% of the distribution respectively while unstable Classes A and B results in the remainder of the distribution for the year (totally 12%).

With the increased frequency of stable (class F) conditions the Rockhampton stability class distribution shows a higher probability of inversion conditions resulting in low atmospheric dispersion. The Gladstone wind speed and direction distributions shown in Figure 5.6 are similar to the Yeppoon and Rundle Island wind speed and direction distributions shown in Figure 5.3 and Figure 5.5, rather than the Rockhampton wind speed and direction distributions shown in Figure 5.7. The Gladstone stability class distribution shows lower frequency of stable (class F) conditions and therefore a lower number of strong inversion conditions.

5.2 Ambient Air Quality

Air pollution monitoring data for the study area is not available. Great Keppel Island does not currently have any significant air pollution sources. The ambient air quality for the subject site and surrounds would be influenced by the use of local and regional transport corridors, marine environment, bushfires and controlled burning.

It is expected that the air quality at and around the subject site would be generally good, with acceptable levels of pollutants for the majority of the time. The nearest region with major air pollutant sources is the Gladstone region located approximately 80km south.

In order to assess the Great Keppel Island Resort construction and operational air quality impacts, background pollutant levels have been estimated. Due to the lack of local monitoring data, background pollutant levels were based on available measured results obtained by DERM in Gladstone. These background pollutant levels are considered to be a conservative by high estimation of the background air quality in the study area due to the increase number of major air pollutant sources within the Gladstone Region when compared to the subject site. In Queensland the background concentration is generally taken as the 95th percentile of the measured data.

'The 95th percentile of ambient measured data from "Ambient air quality in Queensland 2004 annual summary and trend report" and "Ambient air quality in Queensland 2005 annual summary and trend report" was used to estimate background pollutant concentrations. A summary of the background concentrations for these pollutants is presented in Table 5.1.

The existing odour environment is currently influenced by potential odour emissions from the existing WWTP and intermittent localised odour from fertilizing and irrigation of the golf course and private properties. Odour from the golf course activities is intermittent and the odour sources at the existing WWTP will no longer be present. Therefore the existing background odour concentration is taken to be negligible.

Table 5.1 DERM Air Quality Background Concentrations (95th Percentile)

Pollutant	Units	Targinie (Stupkin Lane)		South Gladstone		Averaging Period	EPP Air Goal
		2004	2005	2004	2005		
Particulate PM_{10}	$\mu g/m^3$	30.0	25.6	25.6	26.5	24-hour	50
Ozone	ppm	0.022	0.023	-	-	1 hour	0.10
	ppm	0.021	0.022	-	-	4 hour	0.08
Nitrogen dioxide (NO_2)	ppm	0.017	0.018	0.014	0.013	1 hour	0.12
Sulfur dioxide	ppm	0.005	0.005	0.003	0.002	24-hour	0.02 (0.0075*)
		0.009	0.010	0.005	0.001	3-hour	0.08
		0.010	0.010	0.005	0.001	1-hour	0.20

Note: *Environmental value is health and biodiversity of ecosystems (for forests and natural vegetation).

6 Air Quality Assessment

During both construction and operation of the proposed the development potential air quality impacts are likely. This section discusses the sources of potential air quality impacts and the "in principle" mitigation measures for both construction and operation of the proposed the development. Currently some aspects of the development have not yet undergone detailed design and consequently cannot be quantifiably assessed. Where detailed design is unavailable an assessment of air quality emissions typical of this type of development has been undertaken. For air quality assessment the proposed criteria and environmental values being protected is discussed in Section 4.

6.1 Construction Air Quality Impacts and Mitigation

Potential air quality impacts during construction of the development include exhaust fumes from construction equipment and airborne particulates generated by construction activities.

The main pollutants of concern present in exhaust fumes from construction equipment are carbon monoxide, sulfur dioxide, particulates and nitrogen dioxide. Exhaust fume emissions from construction equipment tends to be intermittent, localised and during the daytime period. As discussed in Section 5 the existing environment provides strong dispersion conditions during the day and as such exhaust fumes from construction equipment are not expected to result in significant air quality impacts.

Airborne particulate emissions from construction activities are primarily from activities associated with the bulk earthworks for site preparations. Activities with potential to contribute to particulate emissions during bulk earth works may include the following:

- Site clearance and removal of topsoil.
- Earthworks required for the construction of the runway (including excavators, bulldozer and dump truck movements).
- Wind erosion from exposed soil and stock piles.
- Wheel generated dust by vehicles on unpaved surfaces.
- Concrete crushing activities.

Particulate emissions from the above activities will occur at intermitted times across different parts of the development. To minimise dust emissions from the above activities where possible the following dust mitigation strategies should be implemented:

- Minimise vehicle/equipment traffic on unsealed areas.
- Establishment of vegetation. Progressive rehabilitation where practicable will minimise the area of exposed unvegetated soil that forms a wind-dependent dust source.
- Limit drop height when loading hauls trucks.
- Limit speed of vehicles/equipment on unsealed areas.
- Limit double handling of soil.
- Use of water sprays on stockpiles and access roads to limit dust emissions.
- Where practicable, erect physical barriers and or wind breaks around stockpiles.
- Locate equipment outside appropriate buffer distances to sensitive receivers.

During the construction of the development, the primary particulate emissions are most likely to be associated with the decommissioning and relocation of the runway. The runway construction activities are expected to consist of the majority of earthworks required for the construction of the development and represent worst case emissions for construction. Particulate concentrations and deposition rates originating from typical earthworks activities related to the relocation of a runway have been predicted in the surrounding area. Particulate impact predictions are based on the following methodology:

- Dust emissions estimates were based on accepted methods and data consolidated by the National Pollutant Inventory (NPI) and the Environmental Protection Agency of The United States of America (USEPA).
- DERM issued meteorological data file for Gladstone, as described in Section 5.
- Prediction of dust concentrations and depositions with AUSPLUME dispersion model developed by the Victorian EPA.
- Predicted levels are compared against criteria presented in Section 4.

Currently the construction equipment fleet is unknown. Emission estimates are based on a typical earthworks fleet with approximately 30,000 truck movements and associated activities in the proposed 18 month construction stage. The only emission control technology included in the assessment is watering of haul routes.

The predicted regional results of the AUSPLUME dispersion modelling for the project are presented as dust contour plots (Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4 and Figure 6.5). The dust contours show the predicted dust concentrations due to typical earthworks activities similar to those expected to occur during construction of the runway relocation. The predicted dust contours do not include the assumed background levels. The figures are described as follows:

- Figure 6.1 and Figure 6.2 show the 24-hour maximum $PM_{2.5}$ concentrations and annual average $PM_{2.5}$ concentrations for the maximum production case.
- Figure 6.3 shows the 6th highest 24-hour PM_{10} concentrations for the maximum production case.
- Figure 6.4 shows the annual average TSP concentrations for the maximum production case.
- Figure 6.5 shows the annual average dust deposition for the maximum production case.

The annual average concentrations are the average of 8,760 one hour predicted concentrations, while the 24 hour concentration is the 24-hour midnight to midnight concentration.

During the multiple construction phases a mobile concrete batching plant may also be used. Concrete batching plants have potential to cause significant dust emissions. The proposed buffer distance required between the concrete batching plant and sensitive receivers is 100m, as recommended by the Victorian EPA (EPA Victoria 1990).

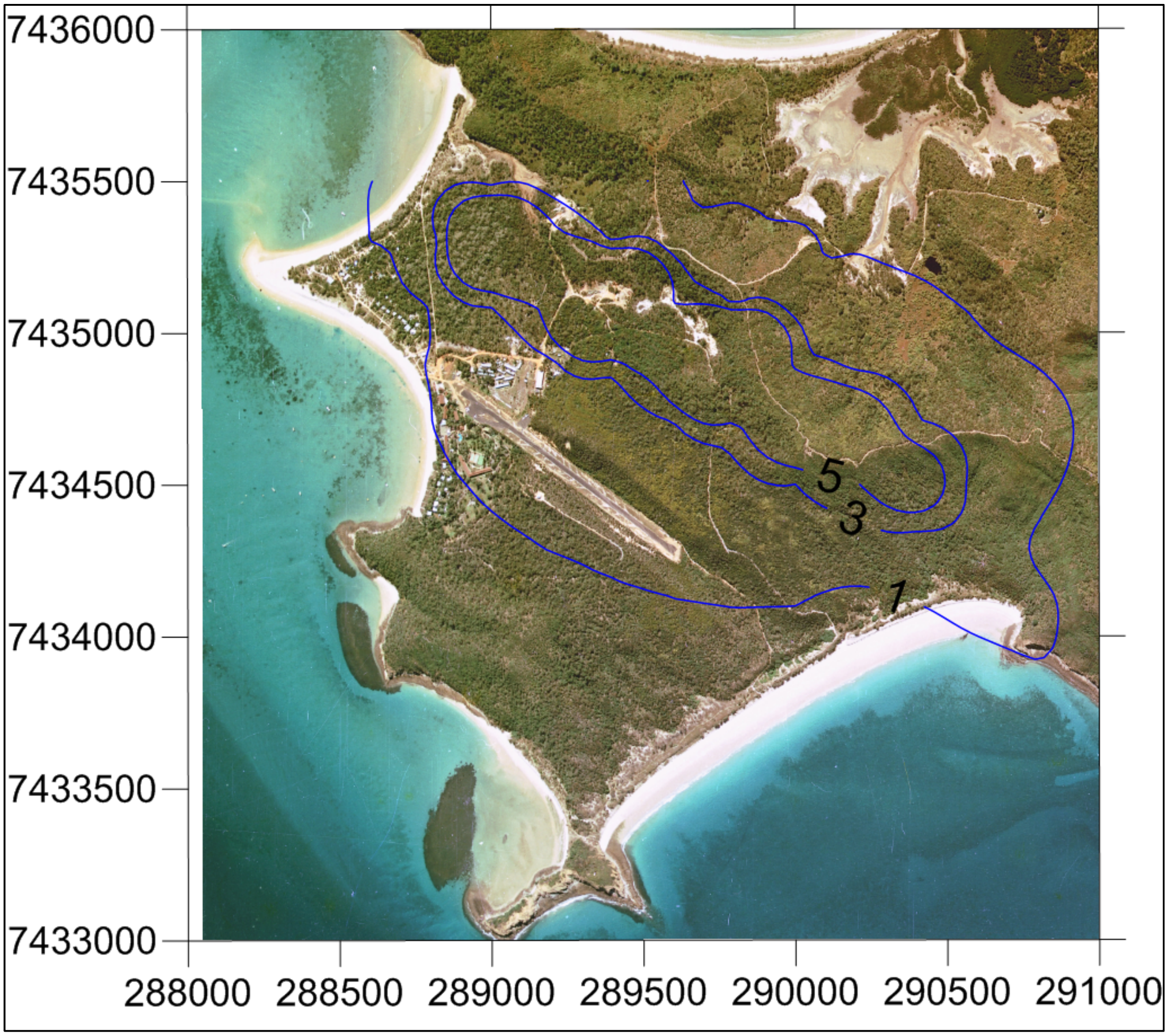

Figure 6.1 Predicted Typical $PM_{2.5}$ 24 hour Average Dust Emissions (µg/m^3)

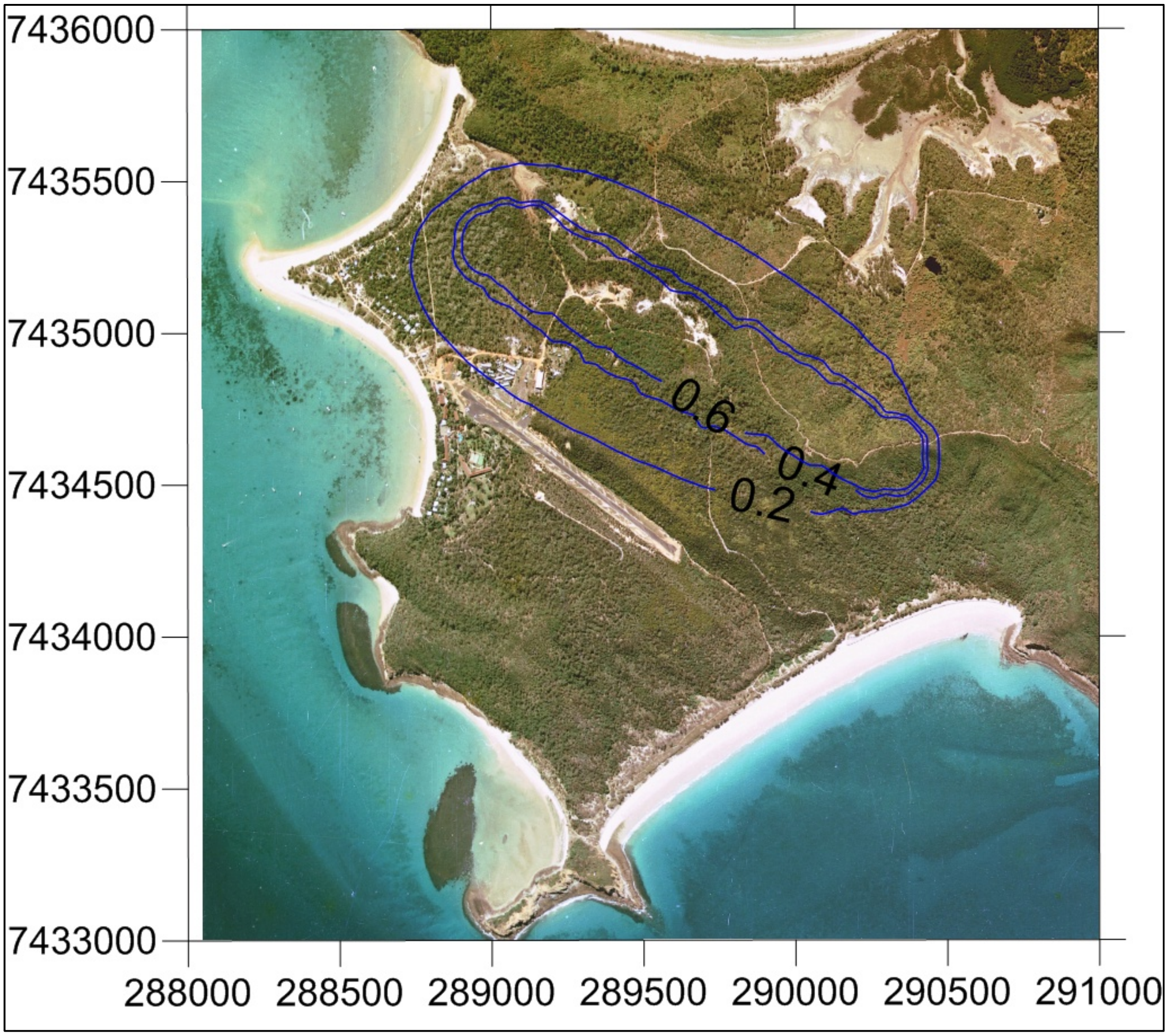

Figure 6.2 Predicted Typical $PM_{2.5}$ Annual Average Dust Emissions (µg/m^3)

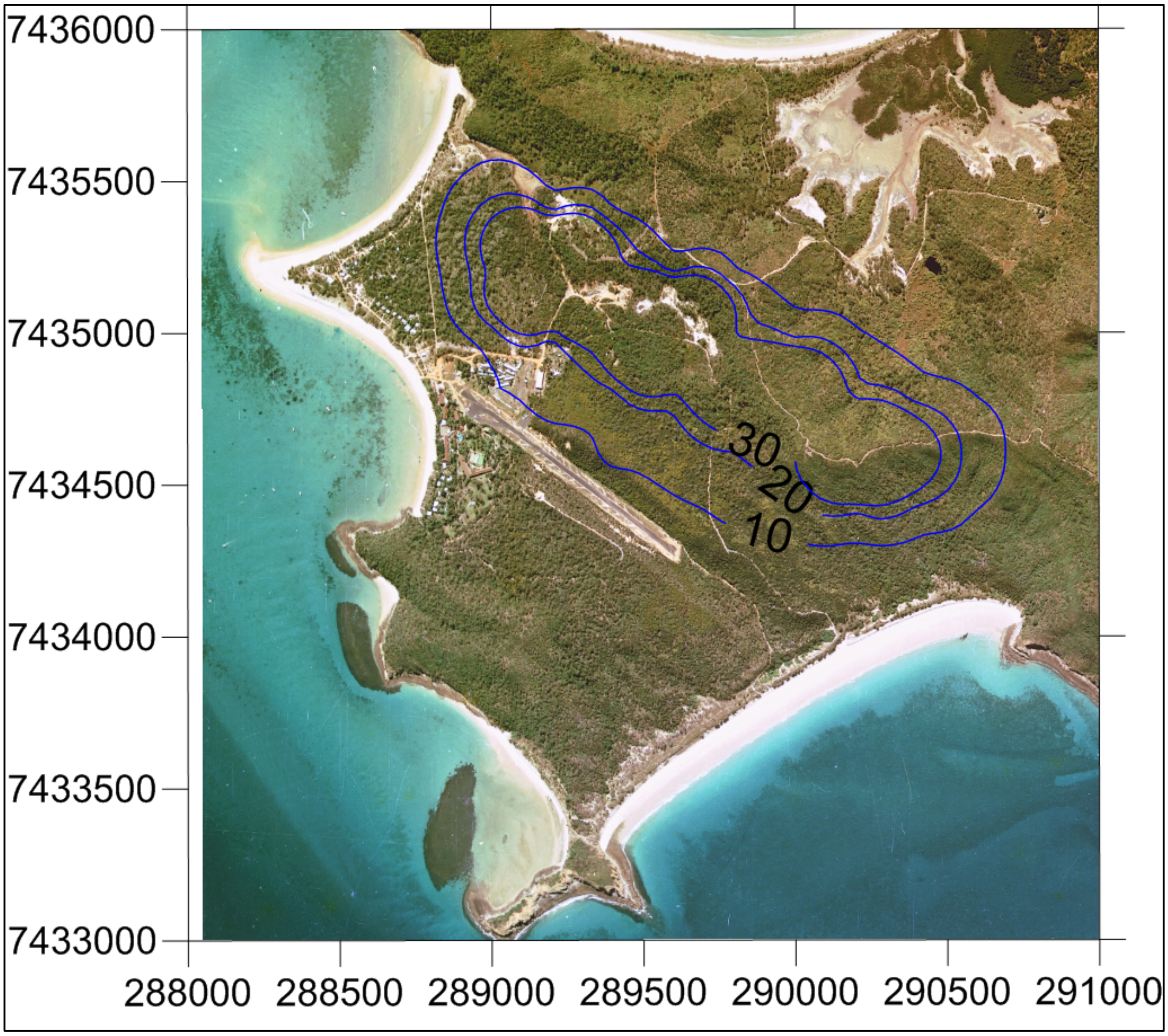

Figure 6.3 Predicted Typical PM_{10} 24hour Average Dust Emissions (µg/m³)

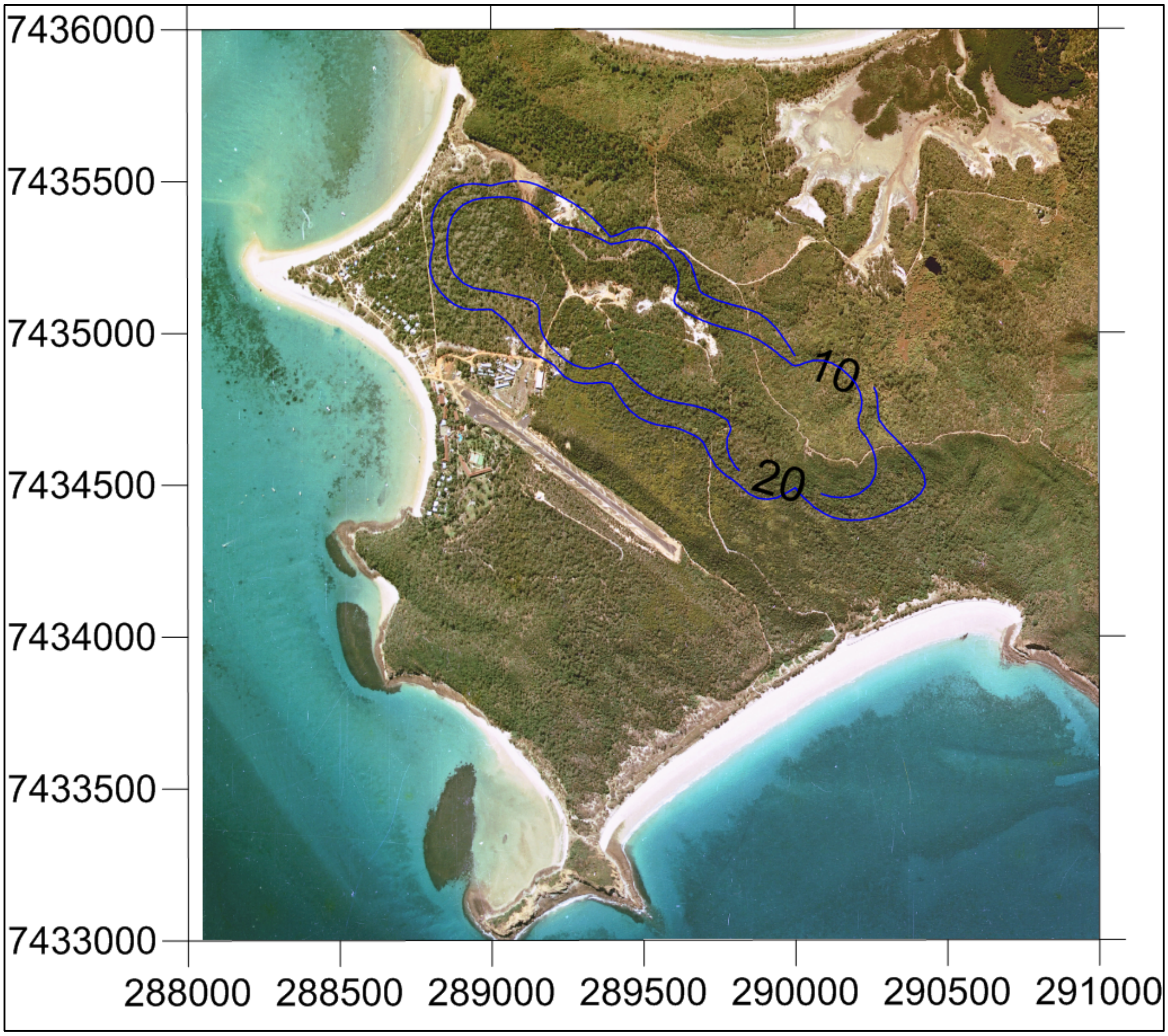

Figure 6.4 Predicted Typical TSP Annual Average Dust Emissions (µg/m^3)

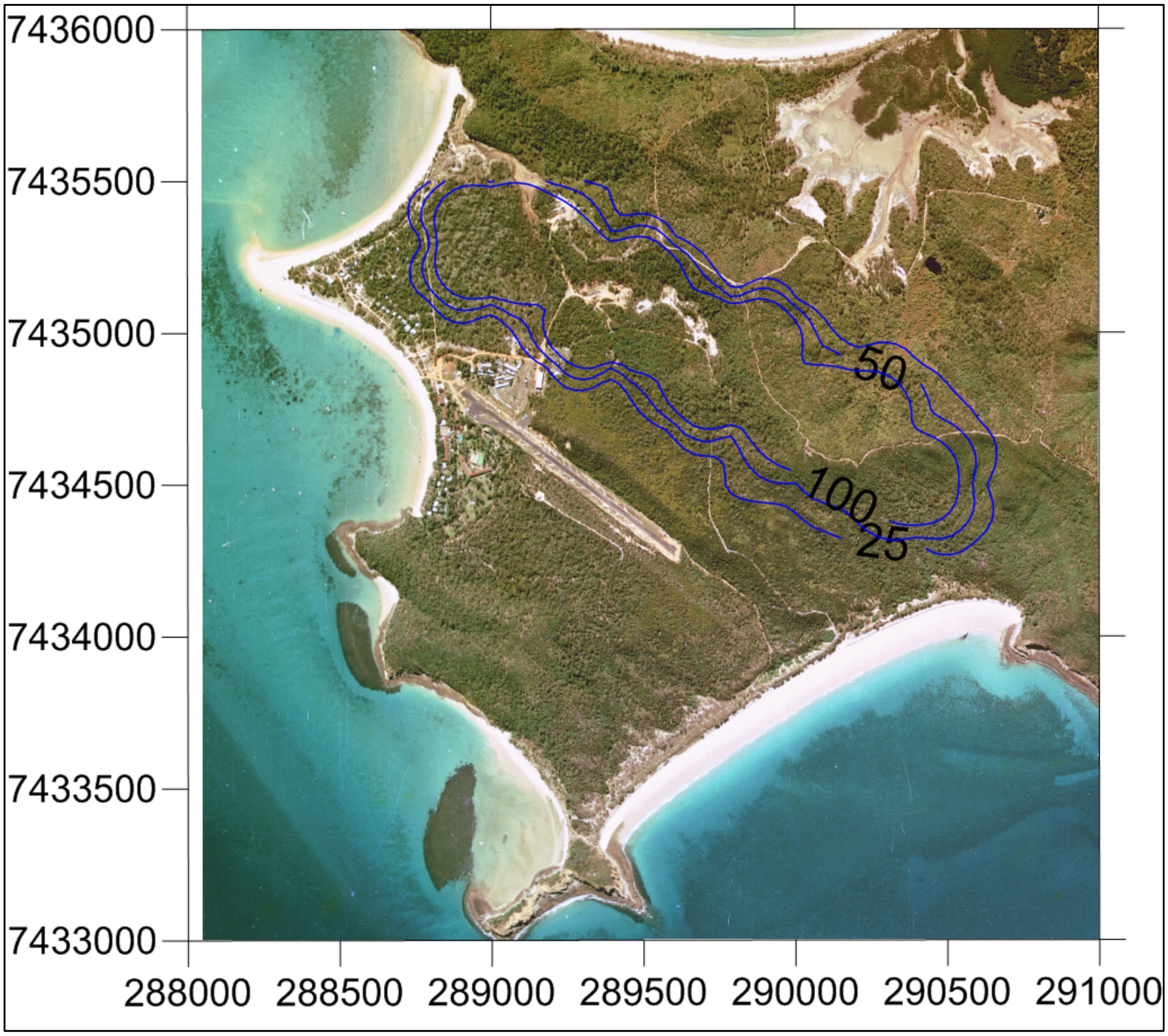

Figure 6.5 Predicted Typical Deposition Annual Average Dust Emissions (mg/m^2/month)

The predicted dust emissions from activities associated with typical earth work activities during the worst case scenario of the construction period of the development, shown in Figures 6.1 to 6.5, meet the proposed criteria described in Section 4.

6.2 Operational Air Quality Impacts and Mitigation

Potential air quality impacts during operation of the development are expected to be minor and include:

- Exhaust fumes from private vehicles, boats, aircraft and commercial vehicle operation and fuel storage.
- Odour impacts from solid waste management facility
- Odour impacts from kitchen facilities.
- Odour impacts from the proposed waste water treatment plant.

Similar to construction exhaust fume emissions during operation the potential exhaust fume emissions from vehicles tends to be intermittent and localised. As discussed in Section 5 the existing environment provides strong dispersion conditions during the day and as such exhaust fumes from vehicles is not expected to result in significant air quality impacts.

At this stage details on potential for storage of aviation fuel are unavailable. When detailed design of the runway supporting facilities is undertaken, air quality impacts from aviation fuel storage should be considered when selecting the storage and refuelling location. Recommended buffer distances for fuel storage can be up to 300m (EPA Victoria 1990) from residential receivers.

Emissions from kitchen exhausts are expected to be minor, localised and intermitted. For commercial kitchen facilities the implementation of standard practice ventilation systems and grease traps are expected to be sufficient to minimise odour emissions and thus kitchen exhaust emissions can be considered as an insignificant air quality emission.

Current plans are for the solid waste from the development to be removed from the Island to go a land fill on the mainland. A composting facility maybe included in the development for composting putrescible waste. Composting facilities have potential to cause odour nuisances if they are not properly designed, maintained and operated. Recommended buffer distances for composting centres can be up to 200m (EPA Victoria 1990) from residential receivers. Recommended buffer distances can be reduced on a case by case basis by enclosing the facility and controlling emissions.

The detailed design of the wastewater treatment plant including plant type and location are yet to be finalised. Odour emissions from wastewater treatment plants can cause annoyance. Criteria for quantifying odour annoyance are discussed in Section 4. Buffer distances for different plant types and capacity, as recommended by the Victorian EPA, are provided in Table 6.1. If the wastewater treatment plant is to be located within the recommended buffer distances then an odour assessment may be required.

Table 6.1 Recommended Buffer distances for Wastewater Treatment Plants (Vic EPA, 1990)

Type of Installation		Plant Treatment Capacity (Equivalent Persons)			
		<1000	<5000	<20000	<50000
Mechanical/Biological Wastewater Plants		100m	200m	300m	400m
Aerobic Pondage Systems		150m	350m	700m	1000m
Facultative Ponds		300m	700m	1400m	2200m
Disposal Areas for Secondary Treated Effluent	By Spray Irrigation	200m*	200m*	200m*	200m*
	By Flood Irrigation	50m*	50m*	50m*	50m*

* Based on secondary treated effluent. If effluent is treated to tertiary standards then the estimated buffer distances are expected to be reduced substantially.

Enclosed wastewater treatment package plants, such as sequencing batch reactors, may require buffer distances less than those outlined in Table 6.1 and in some cases a little as 20m.

7 Greenhouse Gas Assessment

7.1 GHG Regulatory Requirements

The National Greenhouse and Energy Reporting Act 2007, the Regulations under that Act and the National Greenhouse and Energy Reporting (Measurement) Determination 2008 establish the legislative framework for a national greenhouse and energy reporting system.

These Technical Guidelines embody the latest methods for estimating emissions and are based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008 as amended ('the Determination') by the National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2009 (No. 1). Technical Guidelines provide additional guidance and commentary to assist in estimating greenhouse gas emissions for reporting under the NGER system.

The objectives for the NGER system are set out in the National Greenhouse and Energy Reporting Act 2007 (the Act) and include:

- Informing government policy formulation and the Australian public.
- Meeting Australia's international reporting obligations.
- Assisting Commonwealth, State and Territory government programs and activities.
- Underpinning the introduction of an emissions trading scheme in the future.
- Avoiding duplication of similar reporting requirements in the States and Territories.

The Act makes reporting mandatory for corporations whose energy production, energy use, or greenhouse gas emissions meet certain specified thresholds. These thresholds are detailed in the Regulations and reproduced in the National Greenhouse and Energy Reporting Guidelines, prepared by the Department of Climate Change. Section 7.1.1 summarises the reporting thresholds.

The Determination was made under subsection 10 (3) of the Act and provides methods, and criteria for methods, for the estimation and measurement of the following items arising from the operation of facilities:

1. Greenhouse gas emissions.
2. The production of energy.
3. The consumption of energy.

Greenhouse gas emissions are defined in the NGER Regulation as:

> *(2) Emissions of greenhouse gas, in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of 1 of the following:*
>
> > *(a) an activity, or series of activities (including ancillary activities) that constitute the facility (scope 1 emissions);*
> >
> > *(b) 1 or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility (scope 2 emissions).*

Coverage of Scope 1 emission sources in the Determination is given by the following categories:

- Fuel combustion, which deals with emissions released from fuel combustion.
- Fugitive emissions from fuels, which deal with emissions mainly released from the extraction, production, processing and distribution of fossil fuels.
- Industrial processes emissions, which deal with emissions released from the consumption of carbonates and the use of fuels as feedstocks or as carbon reductants, and the emission of synthetic gases in particular cases.
- Waste emissions, which deal with emissions mainly released from the decomposition of organic material in landfill or wastewater handling facilities.

The most important source of Scope 1 emissions is from fuel combustion, which accounts for over 60 per cent of the emissions reported in the national greenhouse gas inventory.

Scope 2 emissions are generally emissions that results from activities that generate power offsite for consumption onsite. The largest contributor to scope 2 emissions is consumption of electricity.

7.1.1 Reporting Thresholds

The National Greenhouse and Energy Reporting Act 2007 sets thresholds for reporting for the operation of a facility or corporations. Section 13 of the NGER Act is as follows:

13 Thresholds

(1) A controlling corporation's group meets a threshold for a financial year if in that year:

(a) the total amount of greenhouse gases emitted from the operation of facilities under the operational control of entities that are members of the group has a carbon dioxide equivalence of:

(i) if the financial year starts on 1 July 2008—125 kilotonnes or more; or

(ii) if the financial year starts on 1 July 2009—87.5 kilotonnes or more; or

(iii) if the year is a later financial year—50 kilotonnes or more; or

(b) the total amount of energy produced from the operation of facilities under the operational control of entities that are members of the group is:

(i) if the financial year starts on 1 July 2008—500 terajoules or more; or

(ii) if the financial year starts on 1 July 2009—350 terajoules or more; or

(iii) if the year is a later financial year—200 terajoules or more; or

(c) the total amount of energy consumed from the operation of facilities under the operational control of entities that are members of the group is:

(i) if the financial year starts on 1 July 2008—500 terajoules or more; or

(ii) if the financial year starts on 1 July 2009—350 terajoules or more; or

(iii) if the year is a later financial year—200 terajoules or more; or

(d) an entity that is a member of the group has operational control of a facility the operation of which during the year causes:

(i) emission of greenhouse gases that have a carbon dioxide equivalence of 25 kilotonnes or more; or

(ii) production of energy of 100 terajoules or more; or

(iii) consumption of energy of 100 terajoules or more.

The thresholds can also be summarised as shown in Figure 7.1.

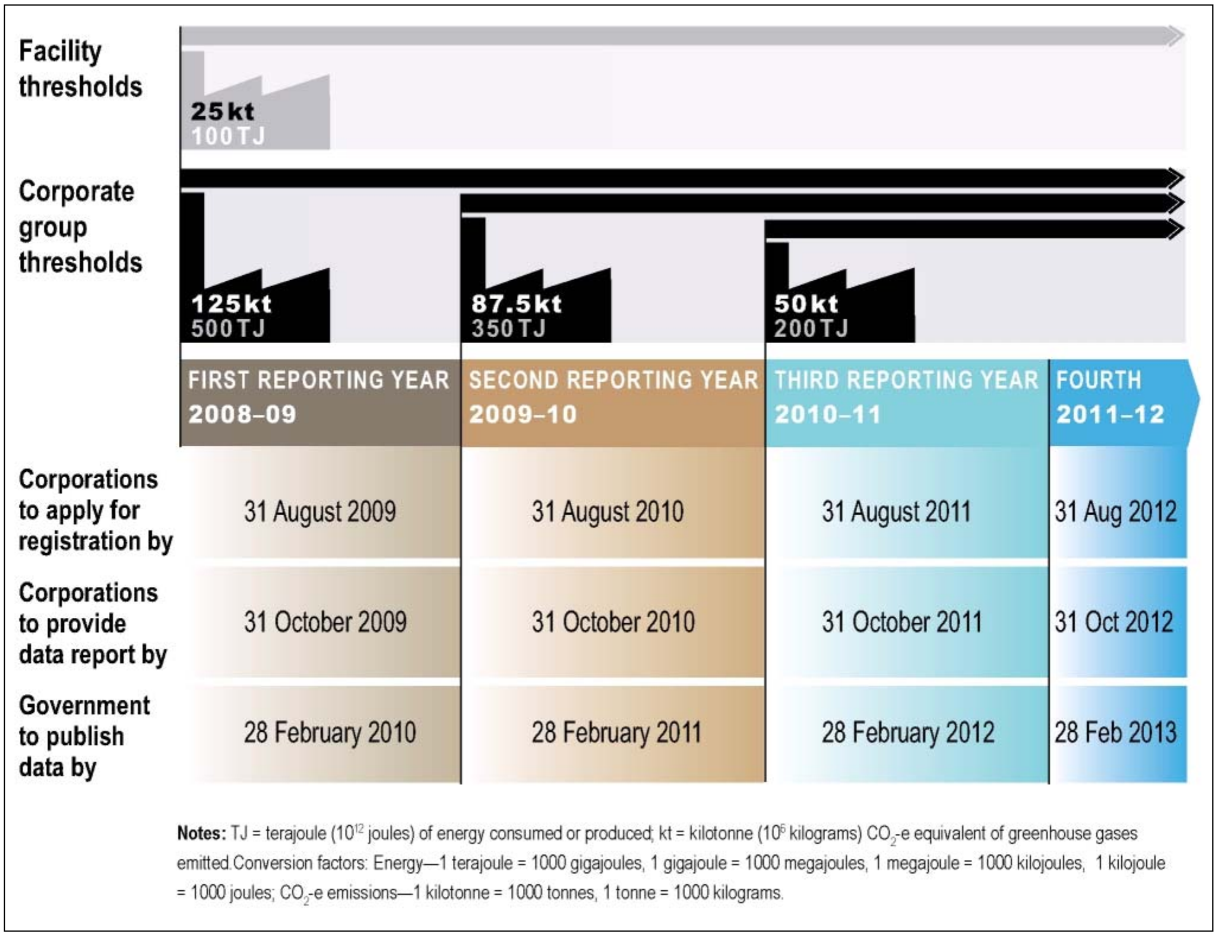

Figure 7.1 The National Greenhouse and Energy Reporting Thresholds (DCC ,2008b)

7.1.2 Greenhouse Gases Included

Consistent with the Kyoto Protocol and the National Greenhouse and Energy Reporting Regulations 2008 (NGER Regulation)(DCC, 2008a), minimisation of greenhouse gas emissions has concentrated on six key greenhouse gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Specified Hydrofluorocarbons (HFC's)
- Specified Perfluorocarbons (PFC's)
- Sulphur hexafluoride (SF_6)

These gases differ in their capacity to trap heat and contribute to the greenhouse effect. The capacity of each gas to contribute to global warming is referred to as its global warming potential (GWP) relative to that of carbon dioxide. The GWP's of the six Kyoto greenhouse gases are provided in Table 7.1.

Table 7.1 Global Warming Potential of Greenhouse Gases

Greenhouse Gas	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFC's)	140 -11,700
Perfluorocarbons (PFC's)	6,500 – 9,200
Sulphur hexafluoride (SF_6)	23,900

Because of the variation in GWP between different gases, the emission factors used to calculate greenhouse gas emissions from the Project are stated in terms of carbon dioxide equivalents (CO2-e) and consider the various GWP's of the different greenhouse gases.

An assessment of the greenhouse gas emissions associated with the project was conducted and involved:

- Identification of the likely sources of greenhouse gas emissions.
- Estimating the likely quantities of greenhouse gases from these sources.
- Nominating emission factors for the GHG sources.
- Identification of possible emission abatement measures.

Emissions of greenhouse gases were calculated in accordance with methods provided by the Australian Department of Climate Change formerly Australian Greenhouse Office (AGO). GHG emission estimates are based on the following:

- Operational data.
- GHG emission factors nominated in National Greenhouse and Energy Reporting System Measurement Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia, June 2009 (DCC, 2009a).

7.2 Emission Sources

The following greenhouse gas emission sources were included in the assessment:

- Scope 1 emissions:
    - Fuel consumption by construction equipment
    - Fuel consumption of stationary sources (pumps, generators and lights)
    - Deposition of solid waste to landfill
    - Processing of waste water
- Scope 2 emissions:
    - Electricity purchased from the grid

7.2.1 Liquid Fuel Emissions

Diesel fuel will be used by construction equipment during construction. Light vehicles and backup generators will also consume diesel during operation. Emission factors for liquid fuel consumption are shown in Table 7.2.

Table 7.2 Liquid Fuel Emission Factors

Fuel Type	Energy Content (GJ/kL)	Scope 1 Emission Factor (kg CO2-e/GJ)
Diesel (stationary)	38.6	69.5
Diesel (mobile)	38.6	69.9
Petroleum based oils (other than petroleum based oil used as fuel)	38.8	27.9
Petroleum based greases	38.8	27.9
Gasoline (other than for use as fuel in an aircraft)	34.2	67.1

Estimates of mobile diesel use are based on the same construction fleet as estimated in the particulate emission estimates. Based on emission factors shown in Table 7.2 and the estimated construction fleet the construction of the development would produce 0.22 kt CO_2-e due to construction equipment.

Estimates of stationary diesel use are based on the ARUP Renewable Energy Analysis report that identifies diesel usage during operation of the development at 8,376 L/year. Based on emission factors shown in Table 7.2 the operation of the development will produce 0.02 kt CO_2-e annually.

7.2.2 Solid Waste Disposal Emissions

The municipal waste (putrescibles and plastic) associated with the project would also be disposed of at an offsite waste handling facility. Emission factors per tonne of waste to the onsite landfill are presented in Table 7.3 and are based on the formulae contained in Division 5.2.2 Method 1 — emissions of methane released from landfills.

Table 7.3 Waste Emission Factors

Waste Type	Scope 1 Emission Factor (t CO2-e/t)
Industrial/Municipal Solid Waste	0.389

Current domestic waste estimations, as described in the Waste management Report by Opus, for the operation of the development are up to 1.2 tonnes per day. Based on emission factors shown in Table 7.3 the development will produce 170.4 t CO_2-e annually due to solid waste disposal.

7.2.3 Onsite Wastewater Treatment Emissions

Waste water from the development is to be treated onsite. Emission estimates are based on a facility which services 2845 equivalent persons (EP). Emission factors are presented in **Table 7.4.** As no detailed facility data is present, formulae contained in Appendix 4 National Greenhouse Accounts (NGA) Factors November 2008 (AGO, 2008c) were used to estimate the emissions.

Table 7.4 Onsite Wastewater Treatment Emission Factors

Wastewater Type	Scope 1 Emission Factor (t CO2-e/EP)
Domestic	0.264

Based on emission factors shown in **Table 7.4** the development will produce 0.75 kt CO_2-e annually from the wastewater facility.

7.2.4 Consumption of Electricity

Consumption of purchased electricity is to occur in order to power the development. ASK has been provided with information regarding the consumption of purchased electricity, being 11,430,000 kWh.

Emission factors associated with consumption of purchased electricity are shown in **Table 7.5**.

Table 7.5 Consumption of Purchased Electricity Emission Factors

State, Territory or grid description	Scope 2 Emission factor (kg CO2-e/kWh)
Queensland	0.89

Based on emission factors shown in **Table 7.5** the development will produce 10.2 kt CO_2-e annually.

7.2.5 Land Use Change

The land use change, including clearing, due to the development has potential to reduce the carbon sink capacity of the vegetation on Great Keppel Island. According to Table 1 of the Unidel Biodiversity Offset Strategy Report 2011 between 89.95 ha and 146.5 ha of land may be cleared during the construction of the development. Using a conservative scenario within the Australian Government FullCAM Carbon Accounting Model the estimated total carbon sink loss due to land clearing is approximately between 14.8 and 24.2 kt of CO_2-e. Table 5 of ehe Unidel Biodiversity Offset Strategy Report 2011 describes proposed revegetation offset area of 586hs. Over the life of the development the potential to reduction in carbon sink capacity due to land clearing is expected to be at a minimum offset by proposed revegetation areas.

7.2.6 GHG & Energy Summary

The project is expected to generate annual maximum scope 1 emissions of 1.25 kt CO_2-e and 10.8 kt CO_2-e scope 2 emissions. The annual maximum emissions represent a contribution of less than 0.0066% to the reported QLD greenhouse gas emissions in 2007 (DCC, 2009b) and less than 0.0022% of Australia's reported greenhouse emissions in 2008 (DCC, 2009c).

The effects of global warming and associated climate change are the cumulative effect of many thousands of such sources and it is the cumulative effects that ultimately bring about climate change.

7.2.7 GHG Abatement

To ensure that the emissions of greenhouse gas emissions are minimised, the following management measures should be considered:

- The inventory of emissions developed for this assessment should be regularly updated and maintained as reporting is likely to be required as an individual facility or as part of a corporate group.
- Adoption of the proposed abatement measures from the ARUP Renewable Energy Analysis report. The proposed abatement is estimated to provide approximately 12.7 kt CO_2-e of annual carbon offset through the installation of approximately 24,000 Photovoltaic solar panels.
- Revegetate as much as practically possible of the land cleared for the development.
- During procurement of both diesel and electric powered equipment, the efficiency of such equipment should be considered.
- Equipment should be maintained, to retain high levels of energy efficiency.
- An internal review should be conducted annually to ensure that the development is using best practice techniques in order to minimise energy use.

8 Recommendations & Conclusion

An air quality assessment has been conducted for the proposed resort development at Great Keppel Island. The report has addressed the current climatic conditions and existing air quality environment within the region. An assessment of air quality emission during both construction and operation of the proposed development.

During construction of the development the worst case scenario air quality impacts are expected to be due to the dust emissions occurring during the runway relocation earthworks. The predicted dust impacts of all of the modelled health and wellbeing dust descriptors meet the nominated criteria, assuming the haul routes are watered when required.

During the operation of the development the main air quality impacts associated with the development were identified as pollutant impacts of fuel storage, odour impacts from the proposed solid waste facility and odour impacts from the waste water treatment.

To reduce air pollutant impacts of fuel storage associated with the development the recommended buffer distance between the fuel storage and residential receivers is 300m. The recommended buffer distance may be reduced with appropriate selection of fuel storage volume and equipment selection.

The assessment of the potential odour impacts of the solid waste facility found that a recommended buffer distance of up to 200m between any composting activities and residential receivers is required. Enclosing and controlling emissions of a solid waste facility may provide reductions to the recommended buffer distance.

The details of the treatment plant type and size are not yet known. An assessment of potential odour impacts and recommended buffer distances of different treatment plants and sizes was undertaken. The recommended buffer distances vary between 50m and 700m for the approximate number of 3000 equivalent persons. The recommended buffer distances to mitigate against odour impacts of waste water treatment plants can be reduced if an enclosed package plant similar to a sequencing batch reactor is selected. Recommended buffer distances could be reduced to a little as 20m depending on plant size and configuration.

An assessment of Greenhouse gas emissions has been conducted. The project is expected to generate annual maximum scope 1 emissions of 1.17 kt CO_2-e and 10.2 kt CO_2-e scope 2 emissions. Part of the greenhouse gas abatement strategy for the development is to install approximately 24,000 Photovoltaic solar panels which are estimated to provide approximately 12.7 kt CO_2-e of annual carbon offset to the development and therefore create a carbon positive development.

To assess the risk posed to the air quality environment by activities undertaken as part of the proposed project a risk assessment has been undertaken. This risk assessment addresses the potential impacts for each phase of the project and their consequences described in the above sections along with proposed mitigation measures to address each identified risk. The risk assessment matrix and potential impacts and mitigation strategies are included in Appendix C.

Please contact the undersigned with any queries on 07 3255 3355.

Yours faithfully

ASK Consulting Engineers

Dave Claughton

Environmental Engineer

9 References

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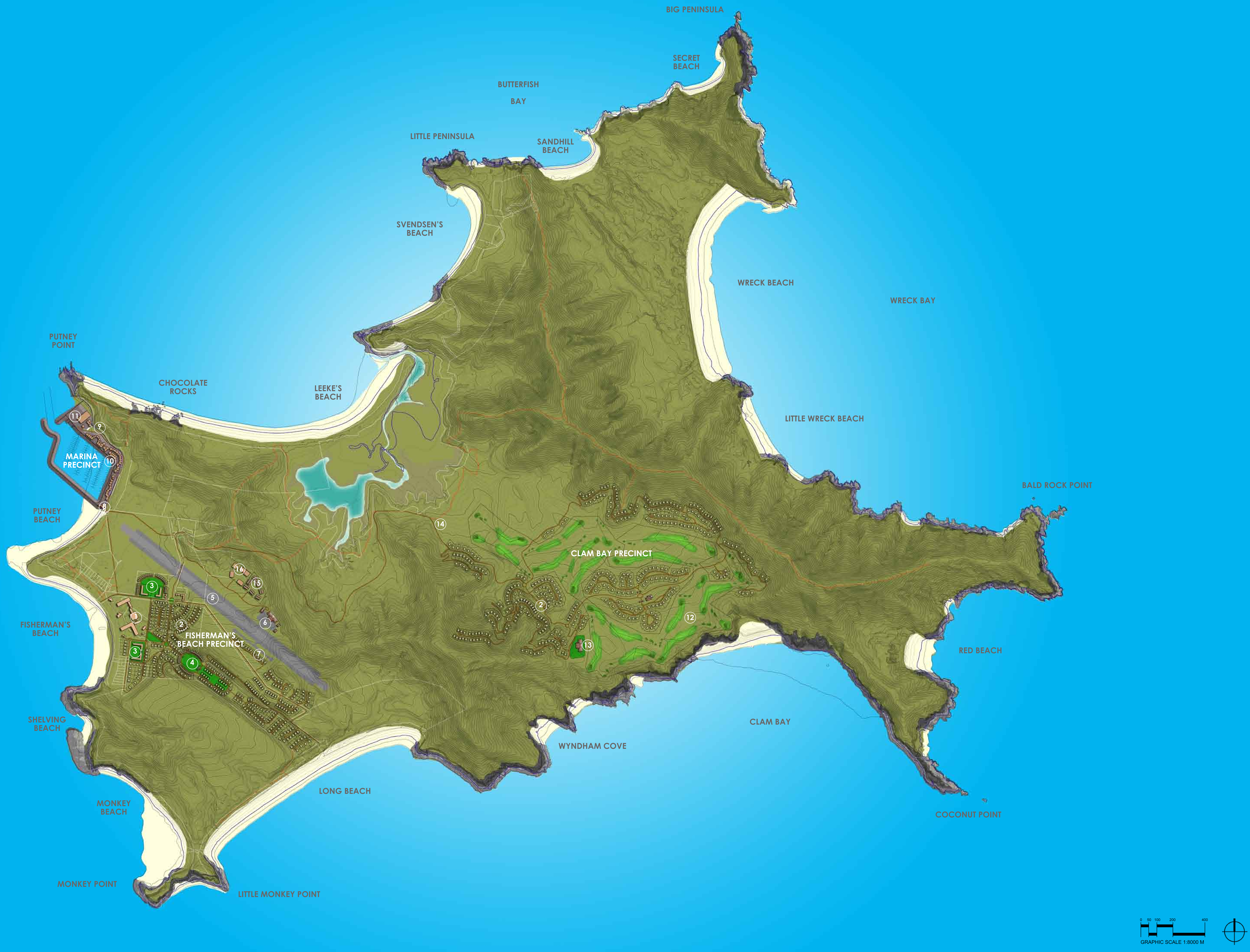
Appendix A – Proposed Development Plan

1. FISHERMAN'S BEACH HOTEL & SPA
2. ECO - TOURISM VILLAS
3. ECO - TOURISM APARTMENTS
4. PARK
5. RUNWAY
6. AIRPORT TERMINAL
7. RUNWAY VILLAS
8. FERRY TERMINAL
9. RESEARCH & HISTORIC CENTRE
10. RETAIL SHOPS & TOURISM APARTMENTS
11. BARGE TERMINAL
12. GOLF COURSE
13. GOLF RESORT FACILITY
14. LEEKE'S HOMESTEAD
15. STAFF ACCOMODATION
16. INDUSTRIAL COMPOUND

PUBLIC ACCESS TRACKS



GREAT KEPPEL ISLAND RESORT ~ REVITALISATION PLAN

REVITALISATION PLAN 2011

PROJECT #: 093024
08 JULY 2011

GREG NORMAN GOLF COURSE DESIGN

WATG

Appendix B – Wind Roses

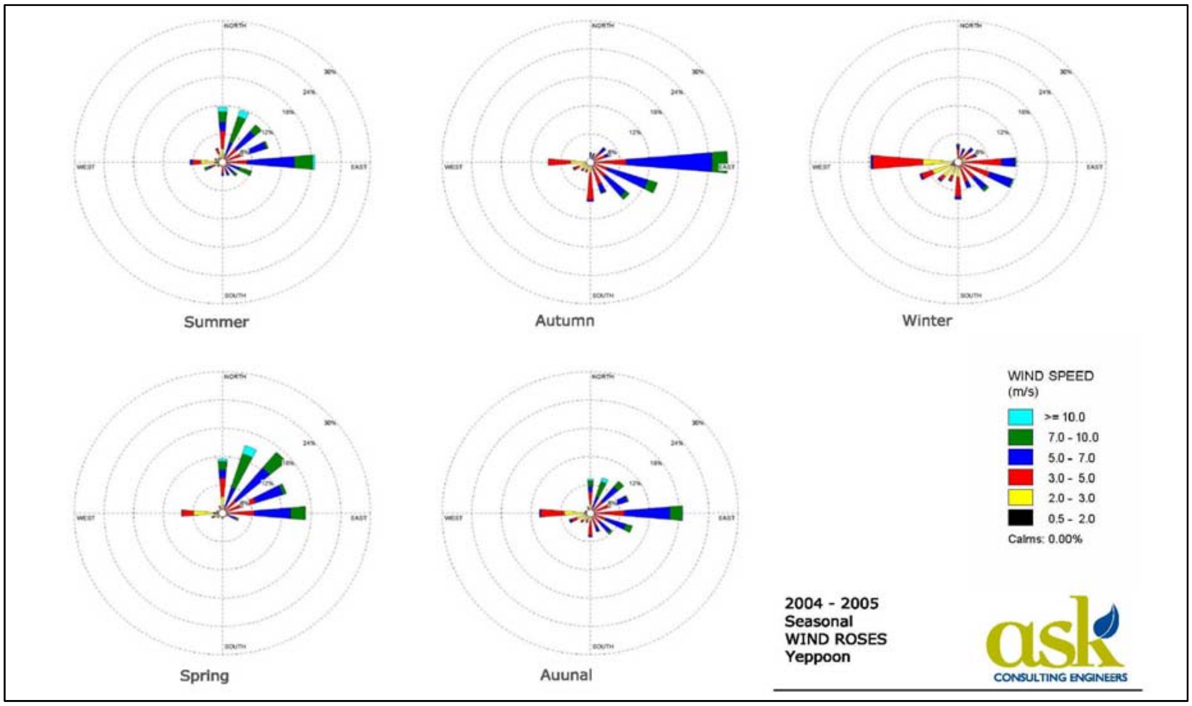


Figure B.1 – Seasonal Wind Roses for Yeppoon

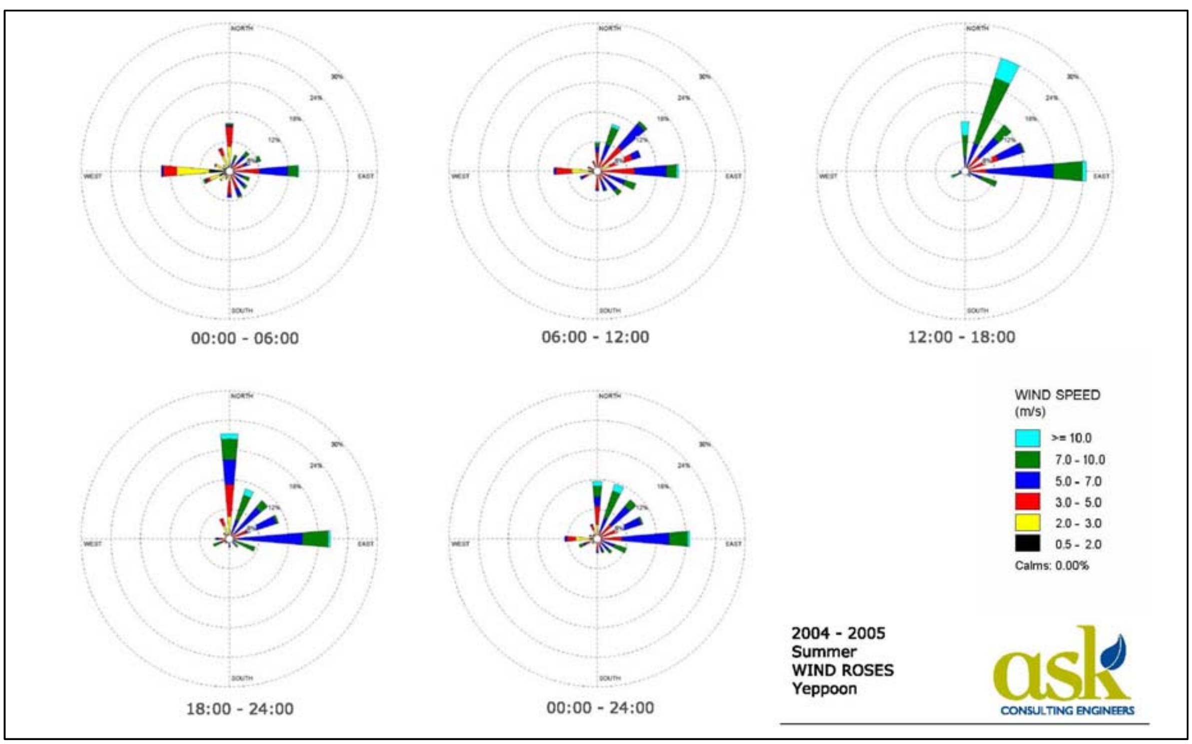


Figure B.2 – Summer Wind Roses for Yeppoon

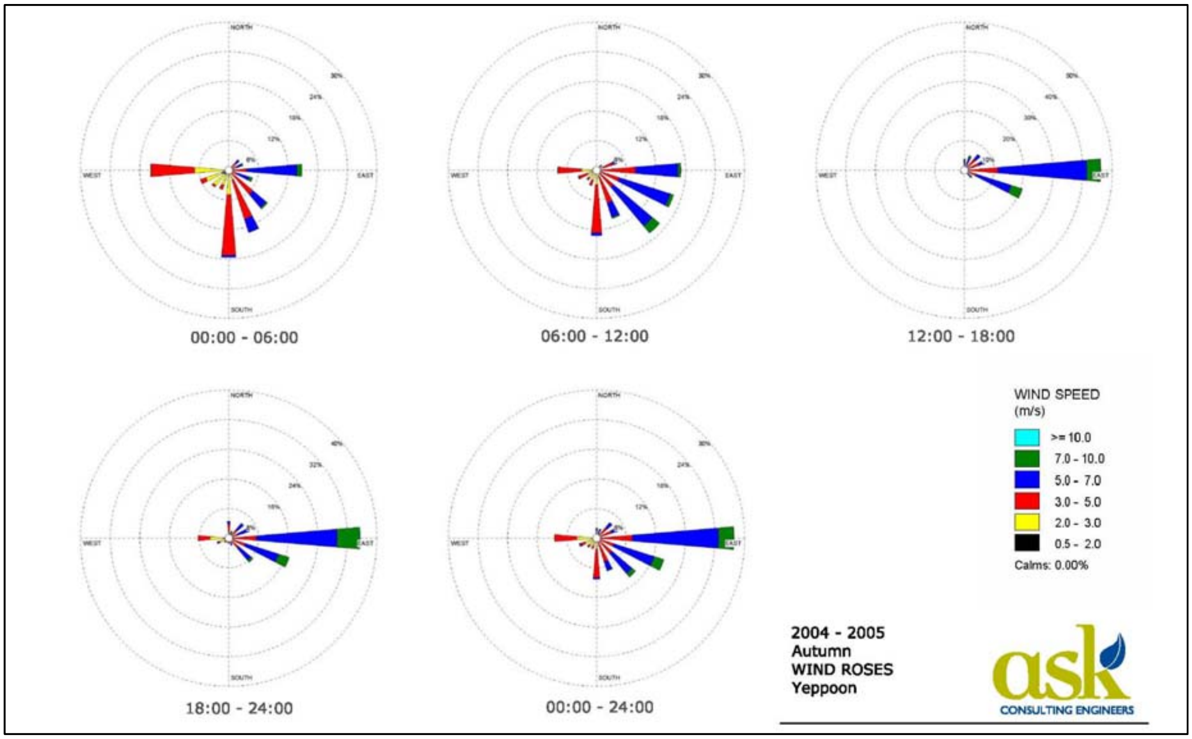


Figure B.3 – Autumn Wind Roses for Yeppoon

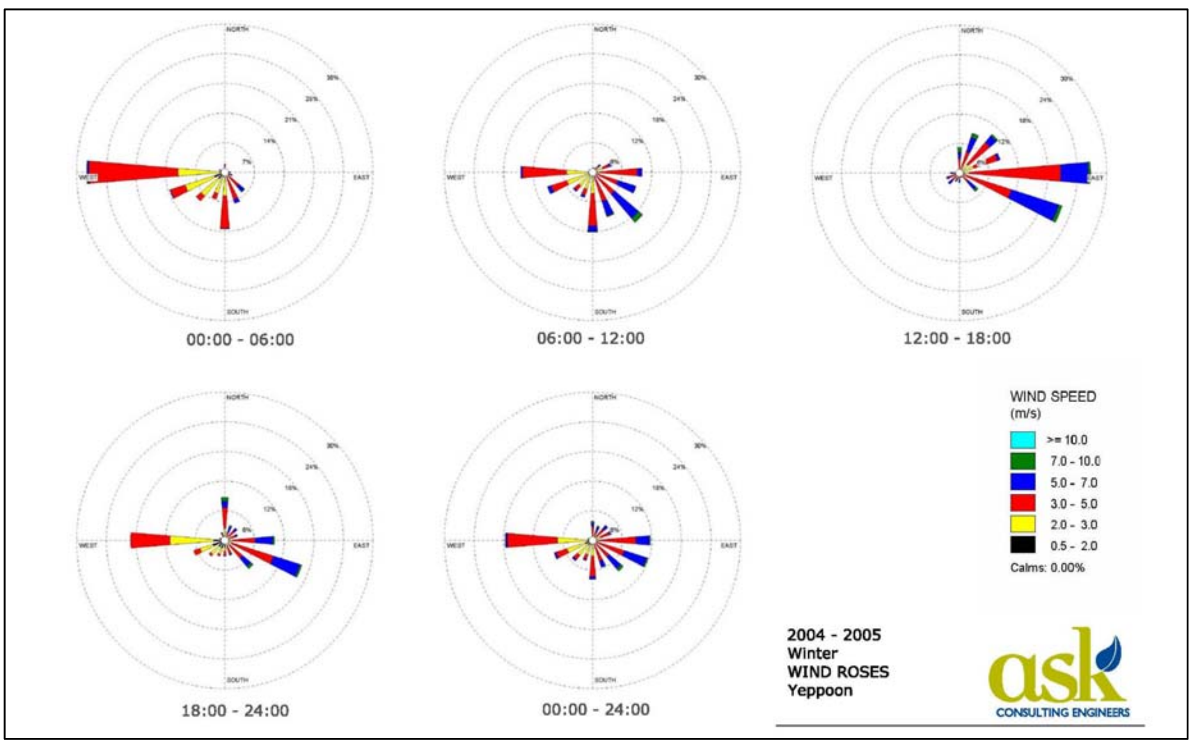


Figure B.4 – Winter Wind Roses for Yeppoon

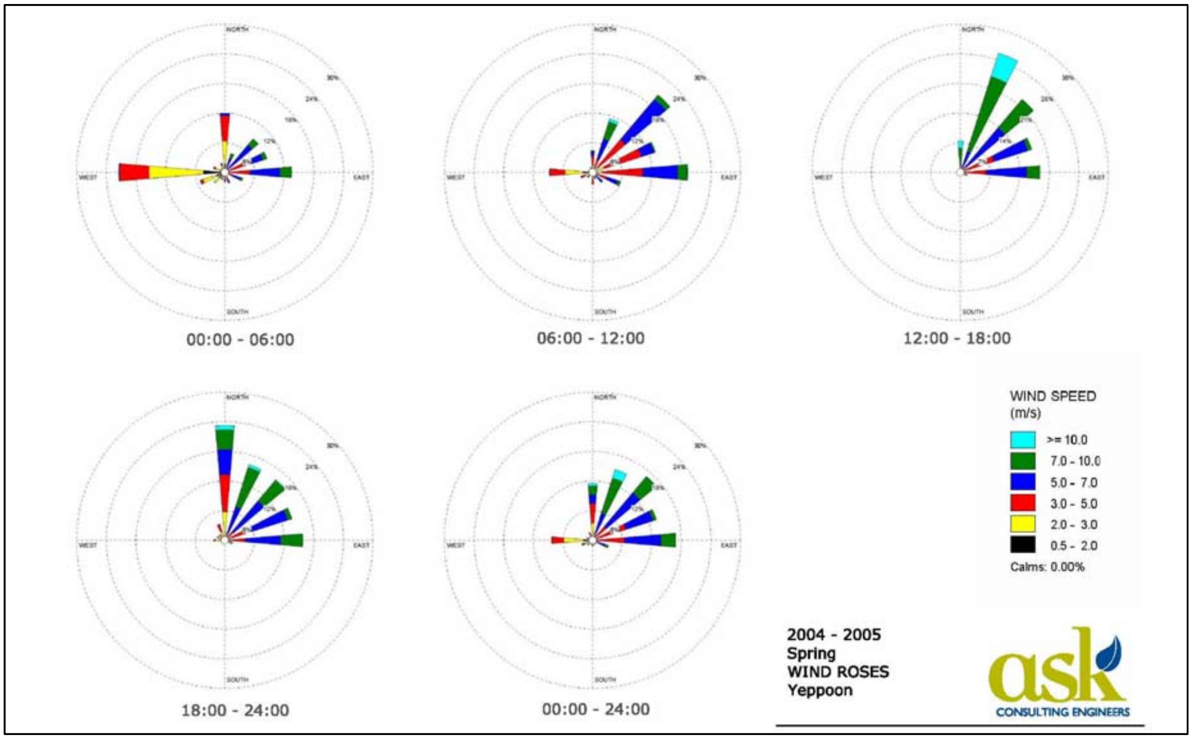


Figure B.5 – Spring Wind Roses for Yeppoon

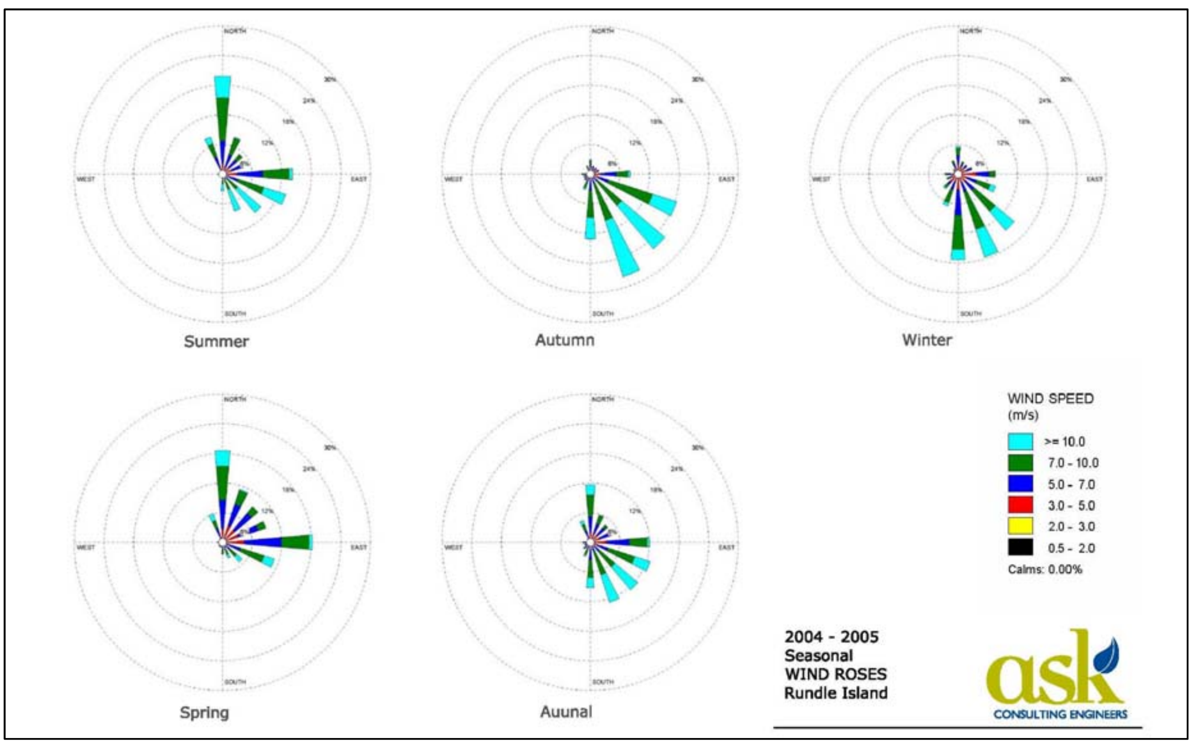


Figure B.6 – Seasonal Wind Roses for Rundle Island

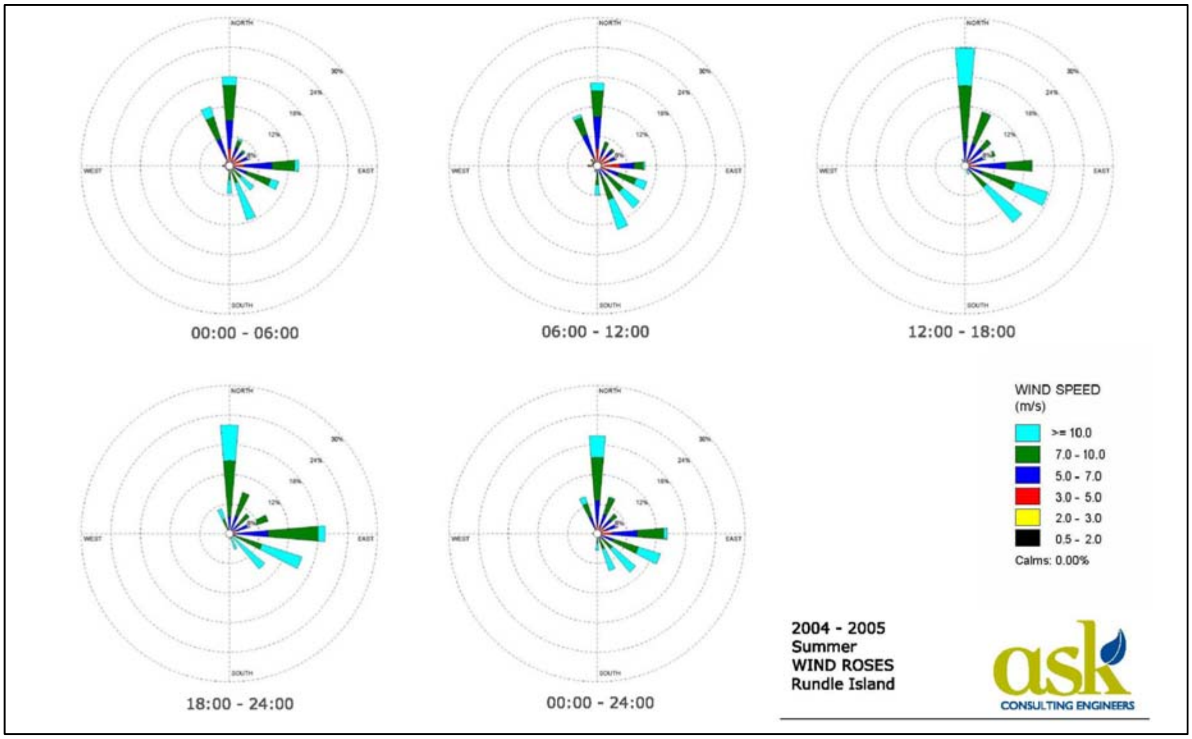


Figure B.7 – Summer Wind Roses for Rundle Island

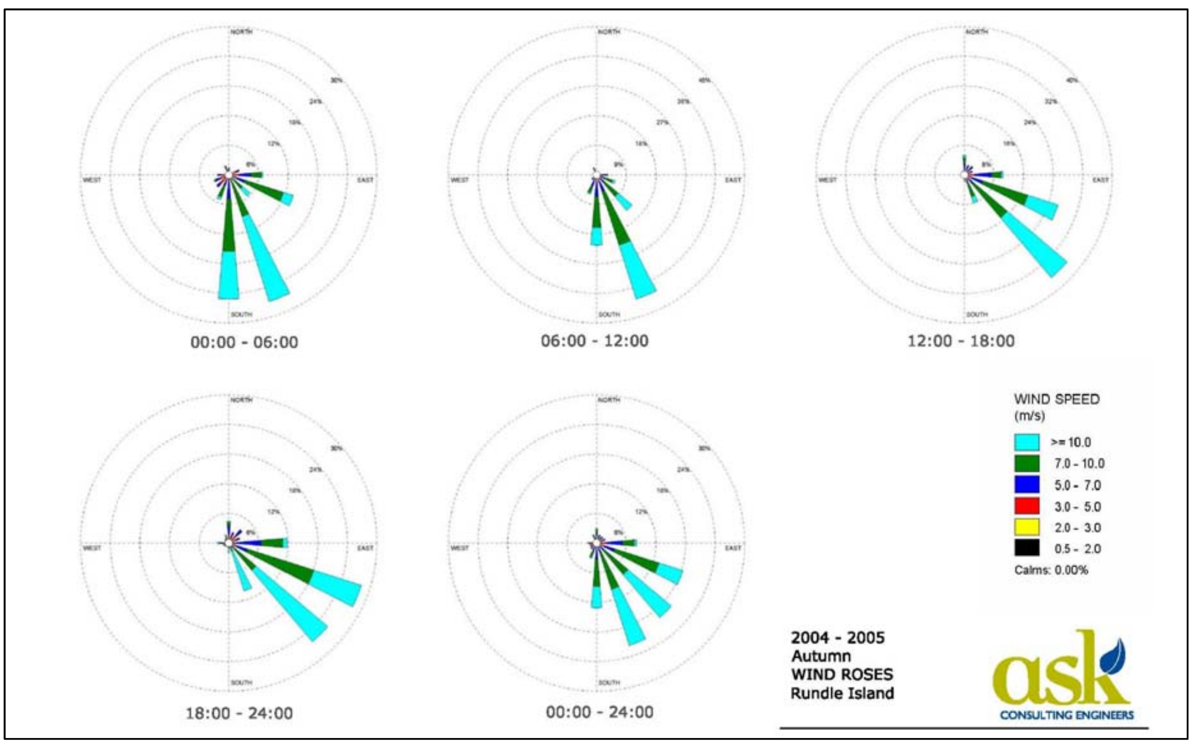


Figure B.8 – Autumn Wind Roses for Rundle Island

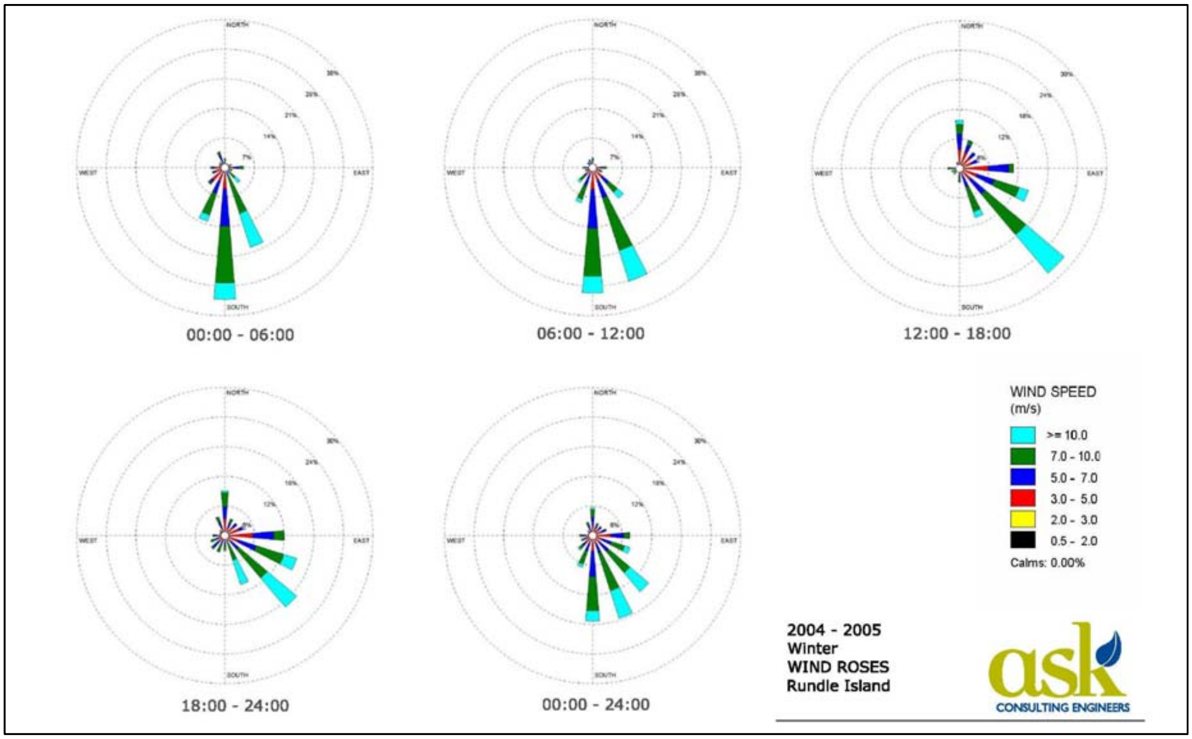


Figure B.9 – Winter Wind Roses for Rundle Island

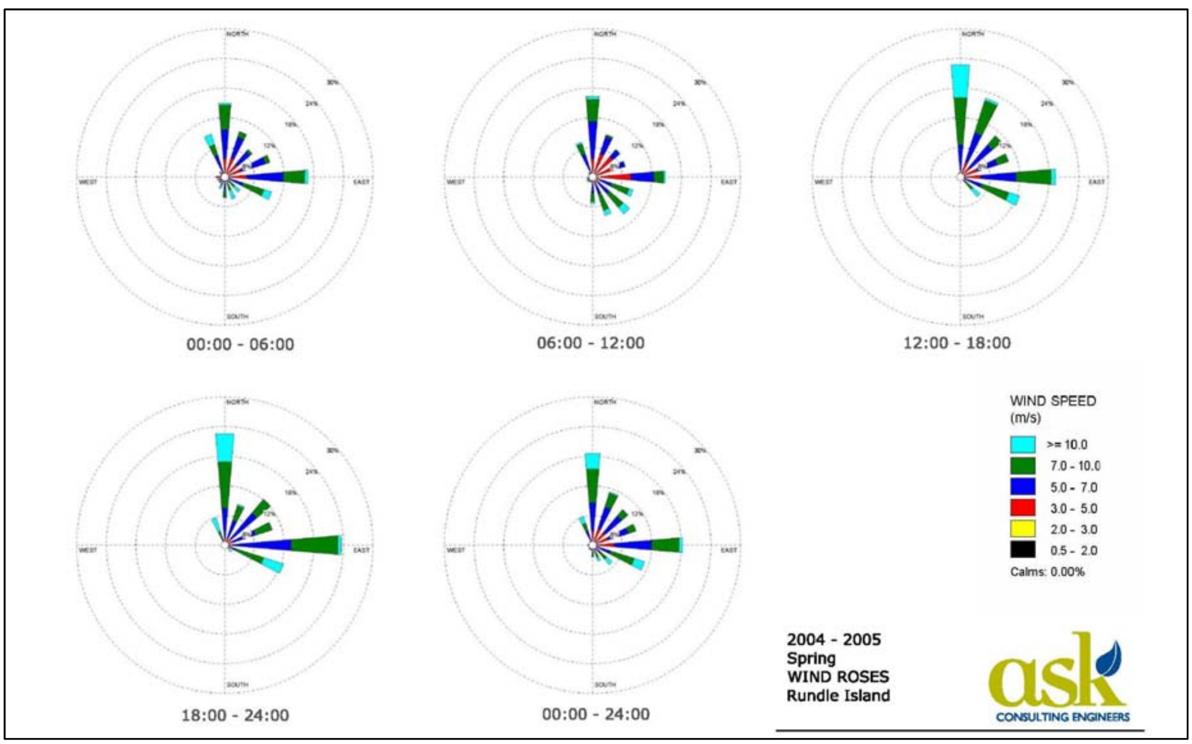


Figure B.10 – Spring Wind Roses for Rundle Island

Appendix C – Risk Matrix

Table C.1 Risk Assessment Matrix

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

Table C.2 Risk Assessment

Activity Description	Potential Impacts and Their Consequences	Preliminary Risk Assessment (C,L) Score	Additional Control Strategy	Residual Risk with Control Strategies Adopted (C,L) Score
Construction	Excessive dust from construction at existing residences and proposed accommodation.	(3,4) High	Haul routes to be watered	(2,2) Low
Fuel storage	Excessive air pollutants from fuel storage at proposed staff accommodation.	(3,4) High	Buffer distance to be at least 300m, subject to review of volume and equipment	(2,2) Low
Solid Waste Facility	Excessive odour from solid waste facility at proposed staff accommodation.	(3,3) Medium	Buffer distance to be at least 200m, subject to review of design.	(2,2) Low
Wastewater Treatment Facility	Excessive odour from wastewater treatment facility at proposed staff accommodation.	(3,4) High	Chose design to suit available buffer distance	(2,2) Low
Land Clearing	Potential reduction of carbon sink capacity due to proposed land clearing	(3,4) High	Implement proposed offset revegetation.	(2,2) Low
GHG emissions	Proposed development is predicted to both directly and indirectly contribute to GHG emissions.	(4,4) High	Installation of proposed photovoltaic solar panels to at a minimum offset GHG emissions.	(2,1) Low

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