AQUIS RESORT AT THE GREAT BARRIER REEF PTY LTD

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 11

APPENDIX R

AIR AND GREENHOUSE

Aquis Resort

Yorkeys Knob, Cairns

Air Quality and Greenhouse Assessment Report

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25/09/13

Prepared for

Aquis Resort on the Great Barrier Reef, c/o Flanagan Consulting Group

ASK Consulting Engineers Pty Ltd

ABN: 55 622 586 522 - ACN: 128 491 967
PO Box 3901, South Brisbane. QLD. 4101.

P: 07-3255-3355 **F:** 07-3844-7180 **W:** www.askconsulting.com.au **E:** mail@askconsulting.com.au

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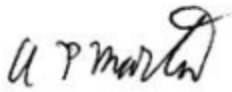
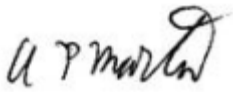
Author Signature		**Approver Signature**		
Name	Andrew Martin	Name	Andrew Martin	
Title	Air Quality Manager	Title	Air Quality Manager	

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1 Introduction

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by Flanagan Consulting Group to provide air quality and greenhouse consultancy services for the proposed new resort development located at Yorkeys Knob, a northern beach suburb of Cairns. A Stage 1 report (6925R01V01_draft) was issued to provide assistance to the team to understand the values, threats, constraints and opportunities associated with the air quality and greenhouse aspects of the project. This Stage 2 report discusses impacts, mitigation and management, and incorporates all details of the Stage 1 report.

The proposed development could include a range of uses and activities, including:

- Serviced apartments.
- Hotel suites
- Managed villas
- Rugby stadium and convention centre
- 18 Hole golf course
- Water park.

Following Stage 1 assessments, a staff accommodation building was removed from the design and other uses have been moved to minimise impacts. Of particular relevance to air quality, buffer zones have been incorporated into the south-western edge of the site to manage the impacts of spray drift.

The purpose of this report is as follows:

Stage 1:

- Discuss the existing air quality.
- Identify sensitive receptors.
- Review appropriate air quality criteria for the project.
- Describe the air emissions from operation of the project.
- Provide an overview of the background air emission sources potentially impacting on the project.
- Identify greenhouse gas emissions from baseline sugar cane farming.
- Identify greenhouse gas emissions from the operation of the project.
- Provide an overview of opportunities and constraints for the development based on current design expectations.

Stage 2:

- Assess baseline impacts of existing sources on the proposal and the existing air quality.
- Describe air emissions from construction of the project.
- Assess impacts of construction on ambient air quality.
- Assess impacts of operation on ambient air quality including the cumulative impact. This addresses both human health impacts and amenity impacts.
- Make recommendations for conditions, mitigation, management actions and monitoring.
- Estimate greenhouse gas emissions from existing activities.
- Compile greenhouse gas inventory for construction.
- Compile greenhouse gas inventory for operation.
- Discuss the relative scale and implications of these emissions compared to state and national emissions.
- Make recommendations for the Sustainability Strategy on mitigation of emissions and sequestering.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

2 Study Area Description

2.1 Location

The project is located adjacent Yorkeys Knob Road on the southern entrance to Yorkeys Knob, a northern beach suburb of Cairns. The site location is shown in **Figure 2.1**.

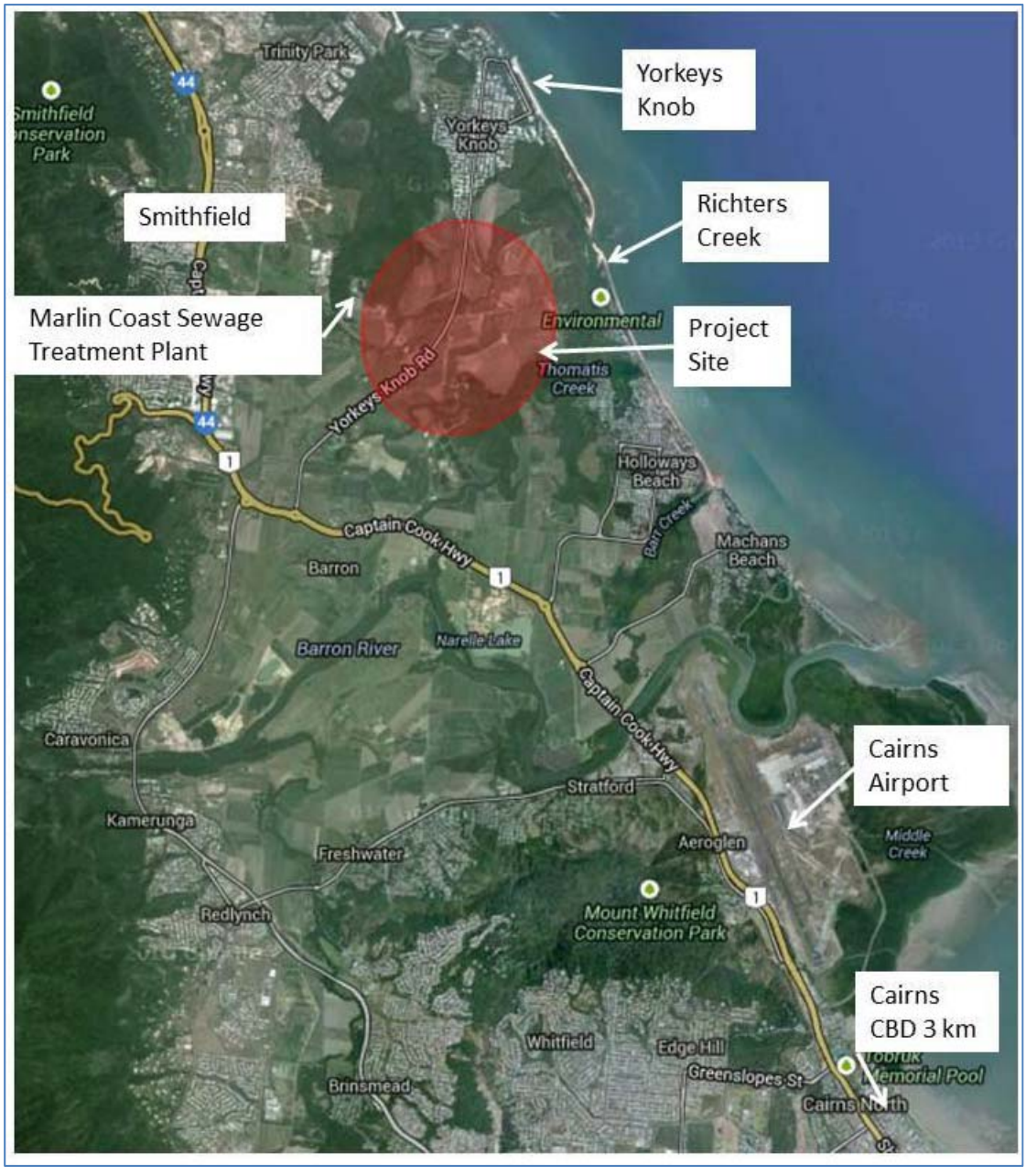


Figure 2.1 Site Location

The site occupies 340.6 ha with approximately 80% of it cleared of natural vegetation. 53% is currently used for growing sugar cane. Some remnant vegetation remains near the boundaries and along some degraded drainage lines. There are some existing residences located on the project site.

The proposed development is surrounded by the following land uses, as shown in **Figure 2.2**:

- Residential area of Yorkeys Knob and wetlands to the north.
- Wetlands, Richter Creek entrance and coastline to the east.
- Wetlands, Richter Creek and residential area of Holloways Beach to the south-east.
- Wetlands, Richter Creek and prawn farm to the south.
- Cattana Wetlands, Marlin Coast Sewage Treatment Plant, transfer station and depot to the west.

Figure 2.2 Project Location

2.2 Zoning

The site is located within the Barron-Smithfield District under CairnsPlan 2009. The site is included in the Rural 1 Planning Area. District Information for the Barron-Smithfield Planning Area identifies that"*Yorkeys Knob is intended to provide opportunities for convention, residential living, medium density residential living and for tourist accommodation in proximity to the waterfront.*"

The proposed use was not contemplated by the current zoning scheme and a Material Change of Use will be required as part of the approvals process.

2.3 Sensitive Receivers

Sensitive land uses are defined by in Schedule 1 of Department of Environment and Resource Management (2010).

The nearest affected sensitive receivers are shown in **Figure 2.3** and described in **Table 2.1**. In addition to those listed, aircraft pilots could be potentially affected if high concentrations of airborne dust reached flight paths causing vision to be limited.

Table 2.1 Location of Nearest Sensitive Receivers

ID	Name	Type	Coordinates (GDA 55)	
			Easting (m)	Northing (m)
A	Yorkeys Knob State School	School	363850	8140388
B	21 Clinton Street	Residence	363672	8140222
C	410 Varley Street	Residence	363563	8139827
D	1/369 Varley Street	Residence	363444	8140024
E	1 Samuel Street	Residence	362396	8139946
F	Smithfield Estate	Residence	362453	8138169
G	22 Cattana Road	Residence	363128	8138499
H	233 Yorkeys Knob Road	Residence	362813	8138080
I [1]	184 Yorkeys Knob Road	Residence	362593	8137835
J	154 Yorkeys Knob Road	Residence	361945	8137490
K	4 Robinson Road	Residence	363228	8137016
L	47 Walker Road	Residence	364966	8138265
M	72 Boronia Crescent	Residence	365126	8138813
N	30 Acacia Street	Residence	365162	8138969
O	Poinsettia Street Environmental Centre	Business & residential	363850	8140388
Ponds	Prawn Farm	Aquaculture	363384	8137741

Notes: 1. Residences in the vicinity of 184 Yorkeys Knob Road are now within the project boundary and considered part of the project.

2.4 Meteorology

Prevailing wind conditions vary with the seasons (wet and dry in Northern Australia) as shown in **Figure 2.4** to**Figure 2.7**. In the dry season, the dominant winds are from the south in the morning and from the south-east during the afternoon. In the wet season, daytime winds arise from south, south-east, east, north-east and north.

The mean annual rainfall measured at Cairns Airport is 2013 mm, varying from 451 mm in February to 27 mm in August (Bureau of Meteorology, 2013).

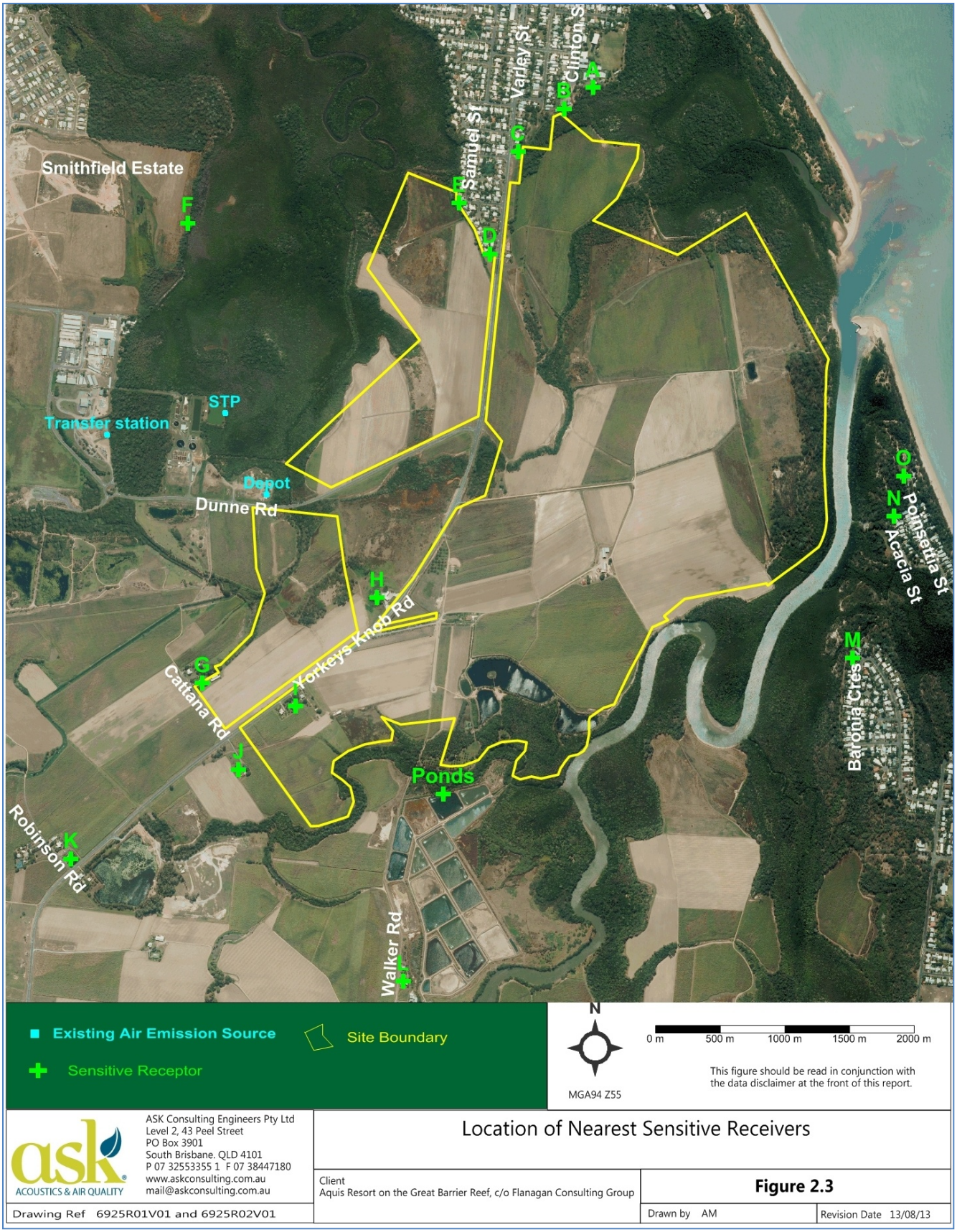
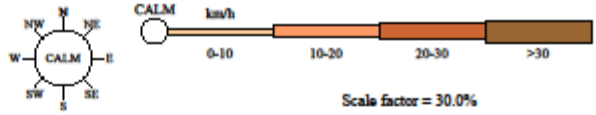


Figure 2.3 Location of Nearest Sensitive Receivers

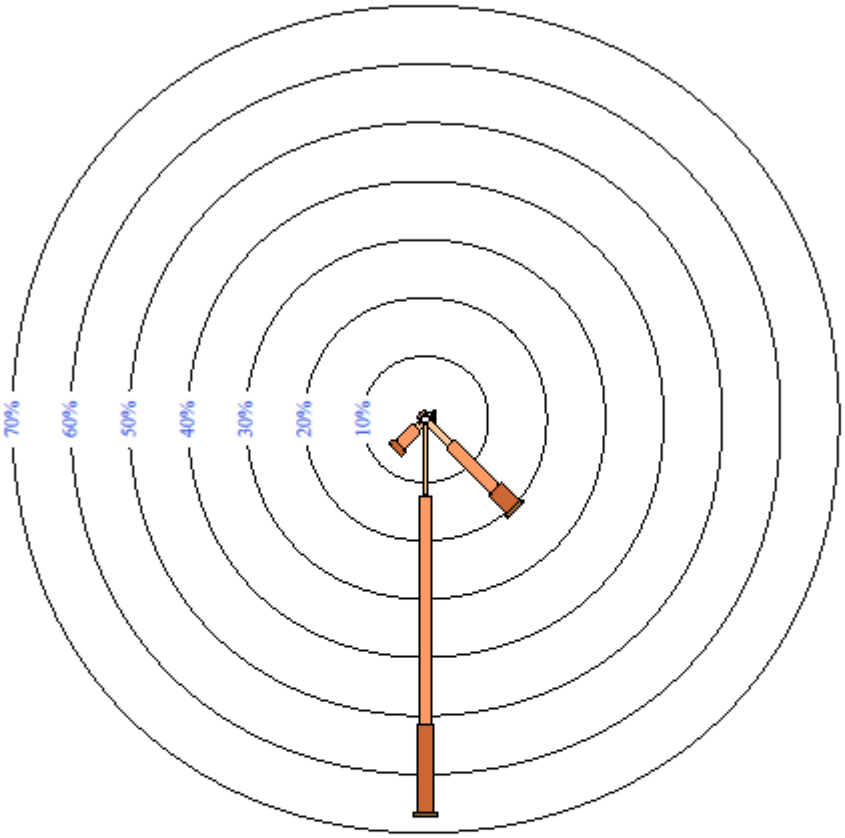
WIND FREQUENCY ANALYSIS (in km/h)
CAIRNS AERO STATION NUMBER 031011
Latitude: -16.87 ° Longitude: 145.75 °



Scale factor = 30.0%

9 am May to Sep
9658 Total Observations (1941 to 2004)

Calm 3%

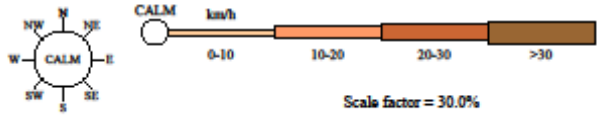


Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

[Page 1]

Figure 2.4 Dry Season Morning Wind Rose

WIND FREQUENCY ANALYSIS (in km/h)
CAIRNS AERO STATION NUMBER 031011
Latitude: -16.87 ° Longitude: 145.75 °



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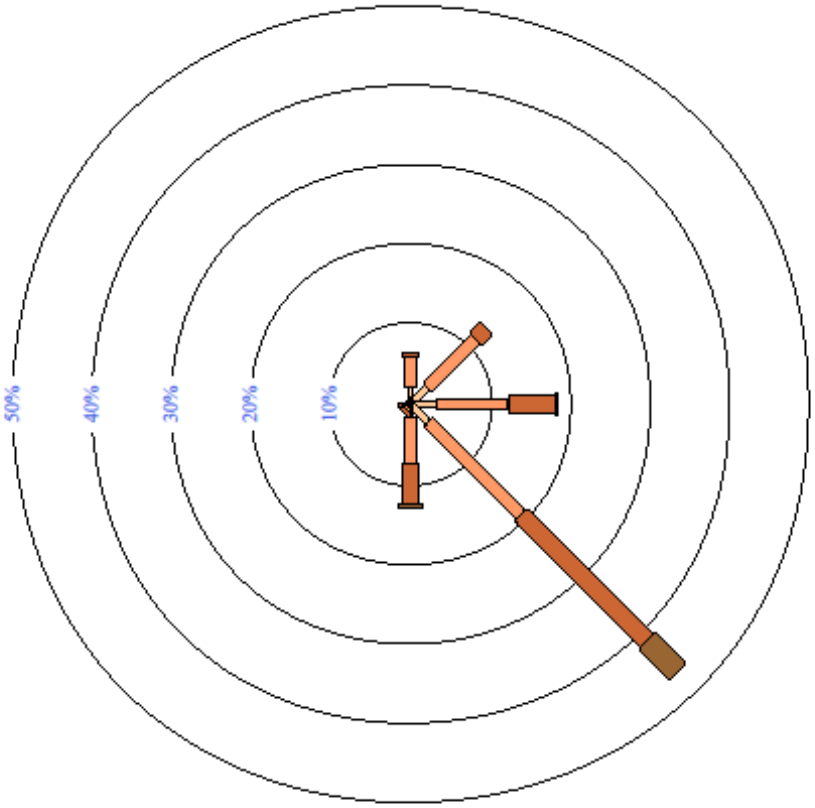
Calm 1%



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Australian Government
Bureau of Meteorology

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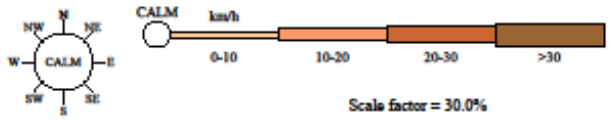
Figure 2.5 Dry Season Afternoon Wind Rose

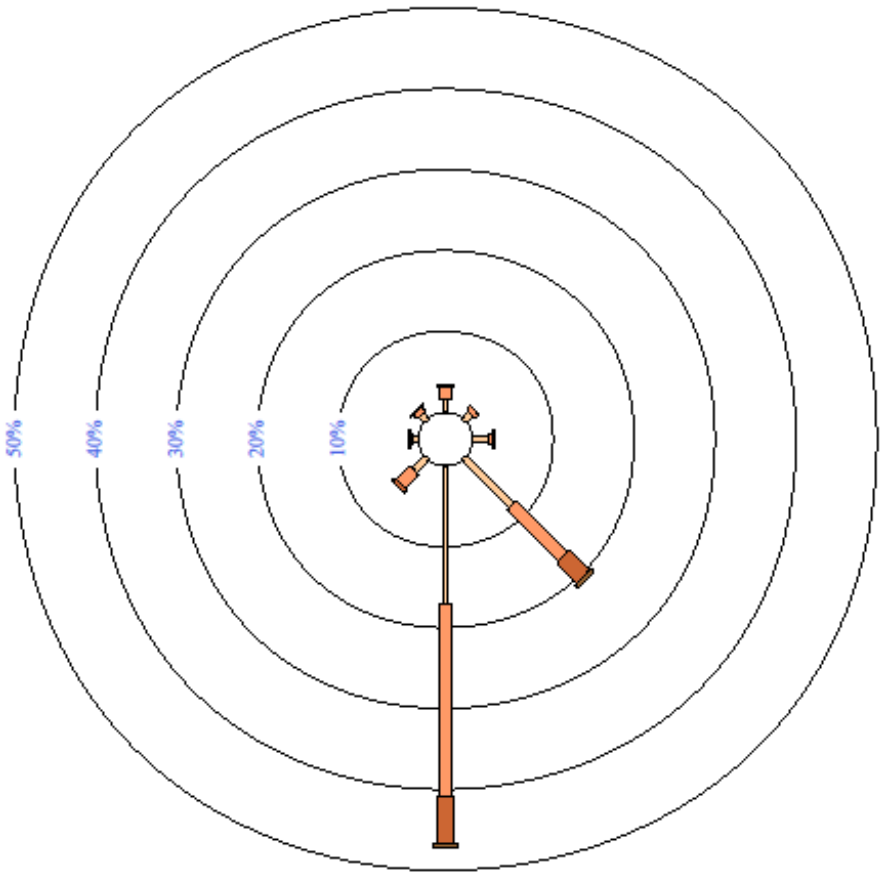
WIND FREQUENCY ANALYSIS (in km/h)
CAIRNS AERO STATION NUMBER 031011
Latitude: -16.87 ° Longitude: 145.75 °



Scale factor = 30.0%

9 am Oct to Apr
13257 Total Observations (1941 to 2004)

Calm 16%



Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

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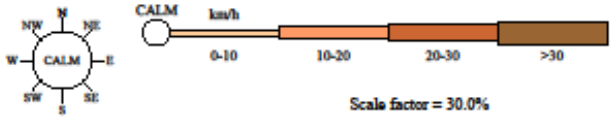
Figure 2.6 Wet Season Morning Wind Rose

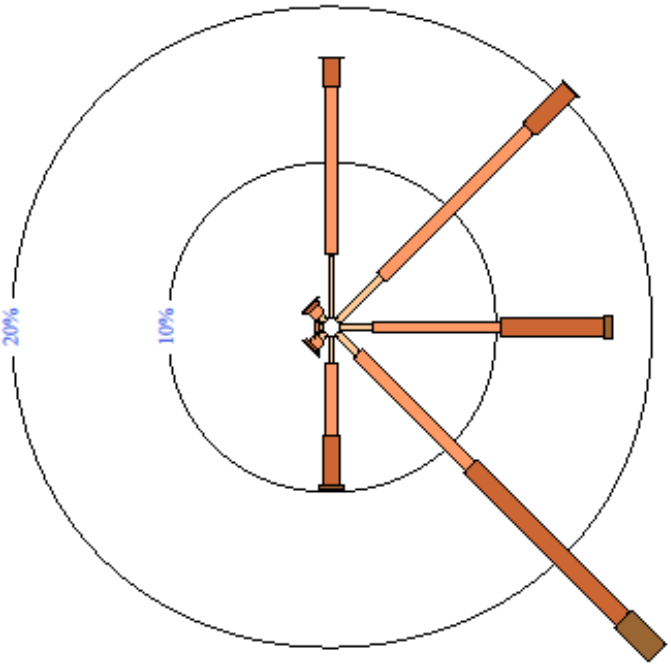
WIND FREQUENCY ANALYSIS (in km/h)
CAIRNS AERO STATION NUMBER 031011
Latitude: -16.87 ° Longitude: 145.75 °



Scale factor = 30.0%

3 pm Oct to Apr
13236 Total Observations (1941 to 2004)

Calm 3%



Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

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Figure 2.7 Wet Season Afternoon Wind Rose

3 Proposed Development

3.1 Overview

The development proposed in the Initial Advice Statement was modified based on the findings of the Stage 1 assessment. The modifications included reduction in the number of islands, a vegetated buffer along the south-west boundary, relocation of the stadium, convention centre and water park, and deletion of staff accommodation.

The new concept plan is for a resort consisting of a range of accommodation and ancillary facilities catering for short stay tourists including:

- Around 3,750 hotel rooms within a series of 18 storey (maximum) towers on the northern island (Items I to IX on Concept Land Use Plan).
- 1450 serviced apartments within a series of 10 storey (maximum) towers on the southern island (Items A and B on Concept Land Use Plan).
- 13,500 m^2 of high-end retail shopping restaurants, bars and food and beverage outlets on northern island.
- An international class casino on the northern island.
- One of the world's largest aquariums on the northern island.
- 2 x 2,500 seat theatres on the northern island.
- 13 ha reef lagoon as a central feature.
- A 50 ha Lake surrounding the northern and southern islands.
- An18 hole championship golf course including driving range and club house (Item 3 on Concept Land Use Plan).
- A 25,000 seat rectangular sports stadium catering for Rugby/Soccer (Item 2 on Concept Land Use Plan).
- A 45,000m^2 convention and exhibition centre (Items A and B on Concept Land Use Plan).
- A Tennis Centre (Item 4 on Concept Land Use Plan).
- A cultural heritage centre located within hotel complex on northern island.
- A 13 ha Water Park (Item 1 on Concept Land Use Plan).
- Ancillary facilities including access roads, water supply mains, sewage pump stations and electrical, communications services infrastructure, administration and maintenance facilities (generally as shown for Item 6 on Concept Land Use Plan) plus water quality improvement devices (Item 7) and carpark/silt disposal area (Item 5).
- Upgrade of external trunk services and associated infrastructure including water supply, sewerage, electrical and communications to cater for anticipated demands from the development.
- Upgrade of external local and state controlled road networks to cater for the anticipated traffic generation and transport needs. Two accesses proposed as shown generally on Concept Land Use Plan
- The proposal does not include any permanent residential elements.

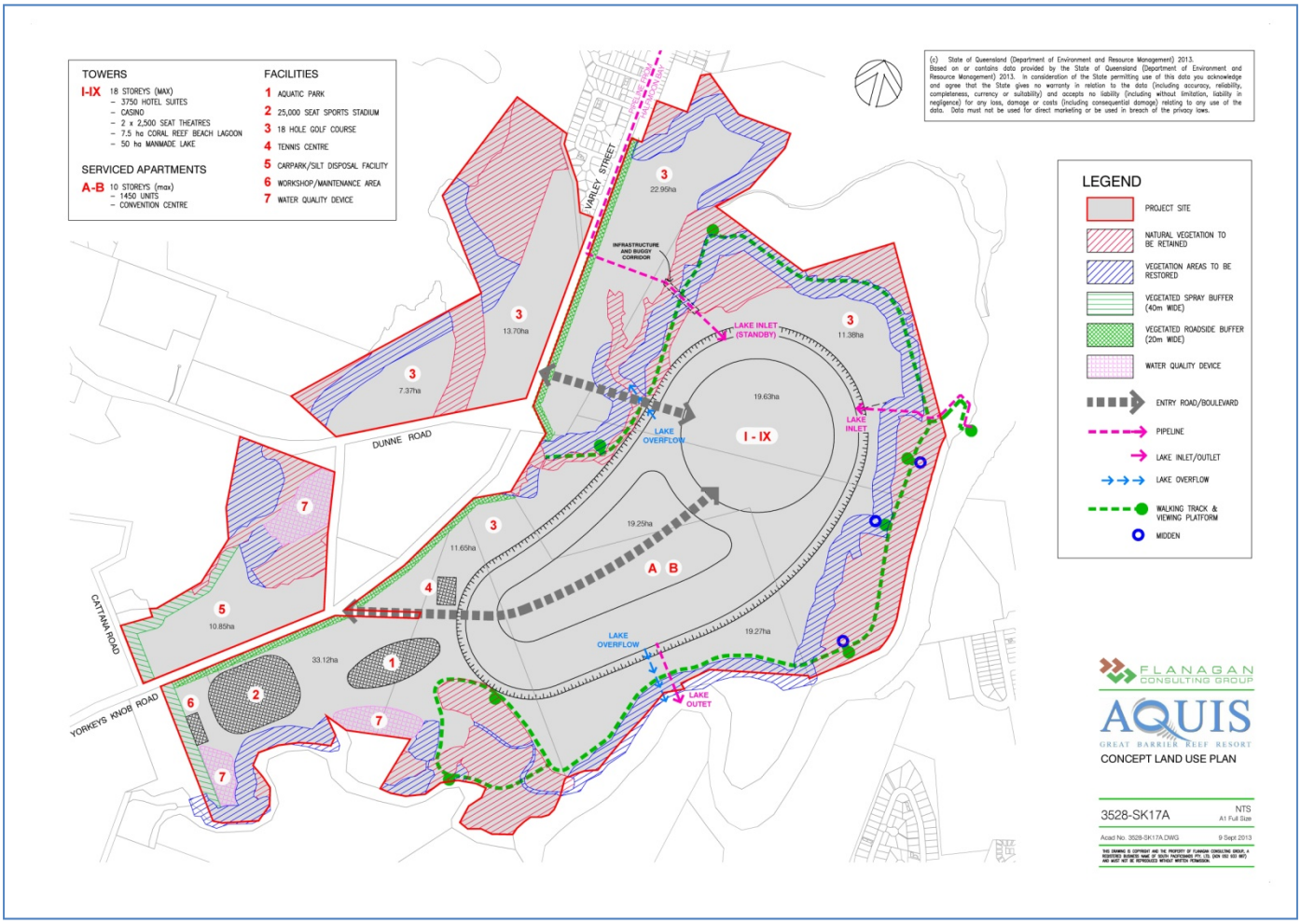

Figure 3.1 Concept Land Use Plan

3.2 Construction

Construction work will include, but not be limited to:

- Site preparation including site clearance,
- Establishment of a number of temporary administration buildings and worker facilities
- A number of laydown areas, installation of temporary and permanent fencing,
- Installation of erosion controls,
- Installation of drainage and water, stormwater and wastewater management controls and construction of site access
- Civil works including bulk earthworks, soil treatment, construction of cuts and embankments,
- Construction of temporary haul roads, bridge and watercourse crossing
- Development of borrow areas
- Temporary concrete batching plant

4 Criteria

4.1 Dust Deposition

Whilst there are no quantitative limits specified in legislation, there are guidelines designed to avoid nuisance caused by dust deposition fallout onto near horizontal surfaces.

The Department of Environment and Heritage Protection (EHP) normally includes, in license conditions, the guideline that insoluble deposited matter should not exceed 120 mg/m^2/day (3.6 g/m^2/month). This is in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (Department of Minerals and Energy, 1995). It should be noted that this value is a guideline for the level that may cause nuisance at a sensitive receptor such as a residence or sensitive commercial land use. It is not normally necessary to achieve this level at the boundary, but boundary measurement can assist in the assessment of whether there is risk of nuisance occurring or not.

4.2 Suspended Contaminants

The relevant air quality criteria are those specified in the Queensland *Environmental Protection (Air) Policy 2008* (EPP(Air)) as summarised in **Table 4.1**. The odour criterion is specified in the Queensland odour guidelines (Environmental Protection Agency 2004). Note that the EPP(Air) has incorporated the goals nominated within the *National Environmental Protection (Ambient Air Quality) Measure* (NEPM).

Note that the NEPM standard for $PM_{2.5}$ is a threshold above which reporting is required.

Table 4.1 Air Quality Criteria (EPP Air except as noted)

Air Quality Indicator	Value	Criteria (µg/m^3)	Period
TSP	health & wellbeing	90	1 year
PM_{10}	health & wellbeing	50 [1]	24 hours
$PM_{2.5}$	health & wellbeing	25 8	24 hours 1 year
Benzene	health & wellbeing	10	1 year
Benzo(a)pyrene (for PAHs)	health & wellbeing	0.0003	1 year
Carbon monoxide	health & wellbeing	11,000 [2]	8 hours
Cumene	aesthetic environment	21	1 hour
Cyclohexane	health & wellbeing	19,000	1 hour
Ethylbenzene	health & wellbeing	8,000	1 hour
n-Hexane	health & wellbeing	3,200	1 hour
Nitrogen dioxide	health & wellbeing health & wellbeing ecosystems	250 [2] 62 33	1 hour 1 year 1 year
Toluene	health & wellbeing health & wellbeing aesthetic environment	4100 410 1.1	24 hours 1 year 30 minutes
Xylene	health & wellbeing	1200 950	24 hours 1 year
Odour from ground-level sources	aesthetic environment	2.5 ou	99.5 percentile 1-hour

Notes:

1. The intent of the five allowable exceedances in the NEPM is to cater for regional events. However EHP has permitted these exceedances to be used in assessment of the impact of major developments.
2. Allowance is made to exclude 1 day but this should only be during identified bushfires.

4.3 Greenhouse Gas Emissions

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

The NGER Technical Guidelines provide additional guidance and commentary to assist in estimating greenhouse gas emissions for reporting under the NGER system. The emission factors used in these guidelines are consistent with those specified in the National Greenhouse Accounts Factors (Department of Climate Change and Energy Efficiency 2012b)

The NGER 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 NGER Regulations.

The NGER Determination provides methods, and criteria for methods, for the estimation and measurement of the following items arising from the operation of facilities:

- Greenhouse gas emissions.
- The production of energy.
- The consumption of energy.

Greenhouse gas emissions are defined in Section 2.23 of 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 is given in Section 1.3 (4) of the NGER Determination by the following categories:

(a) fuel combustion, which deals with emissions released from fuel combustion; and

(b) fugitive emissions from fuels, which deal with emissions mainly released from the extraction, production, processing and distribution of fossil fuels; and

(c) industrial processes emissions, which deal with emissions released from the consumption of carbonates and the use of fuels as feedstock or as carbon reductants, and the emission of synthetic gases in particular cases; and

(d) waste emissions, which deal with emissions mainly released from the decomposition of organic material in landfill or wastewater handling facilities.

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

Scope 3 emissions are those produced during the off-site processing or consumption of products. It is not compulsory to report these under NGER.

5 Existing Air Quality

5.1 Overview of Existing Sources

The neighbourhood of the project site has the existing sources of air emissions listed in **Table 5.1** and shown in **Figure 2.3**:

Table 5.1 Existing Sources of Air Emissions

Source	Pollutants
Marlin Coast Sewage Treatment Plant (STP)	Odour
Sugar cane farms	Pesticide and fertiliser application, PM_{10}
Sugar cane farm firing	PM_{10} with smaller quantities of NO_x
Sugar cane farms	Carbon dioxide (CO_2) and methane (CH_4) greenhouse gases
Material depot (to east of STP)	Dust, TSP, PM_{10}
Smithfield Estate	Dust
Aircraft fuel dumping	VOCs and odour
Road traffic	Nitrogen oxides (NO_x), carbon monoxide (CO) and particulates represented by those less than 10 microns (PM_{10})
Controlled forest burns	PM_{10}, NO_x
Waste transfer station	PM_{10}, odour

Most of these are common emission sources that can be managed by adequate buffer zones.

5.2 Marlin Coast Sewage Treatment Plant

Sewage treatment plants emit odorous sulphur compounds in varying concentrations depending on design and management. Odour is typically detectable in the vicinity of these plants. However a buffer zone of a few hundred metres normally suffices for smaller operations.

5.3 Sugar Cane Farm Chemical Application

The existing cane farms in the area, apply fertiliser, herbicide, fungicide and insecticide to crops. Typical application rates are provided in **Table 5.2.**

Table 5.2 Typical Application Rates of Pesticides

	Active Ingredient	Concentration (g/l)	Application Rate (l/ha)
Herbicide			
Roundup	Glyphosate	470	2 to 6
StompXtra	Pendimethalin	155	3
Shirquat	Paraquat	250	0.75
Soccer	Metribuzin	700	1.5
Barrage	Diuron Hexazinone	468 132	2.2
Agroxone	MCPA	750	0.4 to 1
Starane	24D Picloram	33 75	0.4
Tordon75D			0.4
Fungicide			
Throttle	Hydrocarbon	426	0.12

	Active Ingredient	Concentration (g/l)	Application Rate (l/ha)
Insecticide			
Telstar	Bifenthrin	250	0.15

Notes: 1. This information was sourced from the share farmer who manages the parcel.

5.4 Sugar Cane Farm Firing

The old method of burning cane before every harvest is no longer practiced in the region. Based on communication with the share farmer, it is understood that:

- The local farms use the "green trash blanket" method that retains the harvest waste as a layer on the ground and avoids burning every year.
- Burning is undertaken when the "flack" is replanted [approximately every four to six years] and the frequency of burns limited to minimise impacts on nearby residents.

Dust from a train was observed by ASK staff during harvesting. However this is an infrequent event not likely to cause long-term nuisance.

5.5 Sugar Cane Farm Greenhouse Gas Emissions

An analysis of farm records reveals that the average area under cane over the period 2007 to 2012 was 187 ha with an annual production of 13,300 tonnes. This equates to approximately 71 t/ha (D Rivett pers. comm. 25 August 2013). This is consistent with the average yield for Wet Tropics sugar cane of 80 t/ha reported by Renouf and Wegener (2007). Data from the existing famer, listed in **Table 5.3,** indicates that the typical area harvested every year is 186.6 ha.

Table 5.3 Average Farm and Production Details (2007 to 2012)

Farm	Area Cut (ha)	Tonnes harvested (t)
297	20.2	1535.8
620	117.3	8575.3
621	49.0	3195.2
Total	**186.6**	**13306.3**

Notes: 1. Source is Salmec Harvesting (M Savina pers. comm.. 23 August 2013).

Running the FullCAM model (Department of Climate Change and Energy Efficiency 2012a) for a year gives an increase in carbon mass on site of approximately 962 tonnes, equivalent to approximately 3527 tonnes of CO_2 sequestered. This does not account for emissions from the sugar mill, which are scope 3 emissions under NGER, but are expected to be a similar quantity. At the mill, some carbon would be lost back to atmosphere via bagasse waste material, but bagasse could potentially be used to generate net electricity. Ultimately the carbon in sugar is also likely to be released back to the atmosphere as CO_2 so the net greenhouse gas emissions of the sugar cane growing are expected to be minor if any.

5.6 Material Depot

During the ASK site inspection, this depot contained concrete pipes and stockpiled materials appearing to be fill, gravel and road base. Part of the proposed development site is across Dunne Road from this depot.

5.7 Smithfield Estate

A major residential development is being constructed in multiple stages to the north-west of the Aquis site. The distance between these is more than 700 metres. Earthworks and bare ground are sources of particulates, although a water spray truck observed on site would reduce emissions.

5.8 Aircraft Fuel Dumping

During emergencies including diverted flights, aircraft may dump excess fuel or burn it in the exhaust.

Emission concentrations in the air could be derived using a mass balance calculation based on the following parameters:

- Maximum valve flow rate (or quantity dumped over a specified time)
- Air speed
- Estimated cross-section area of turbulence behind plane

The emission concentrations for individual species could be calculated using the composition data in **Table 5.4**.

Table 5.4 Composition of jet kerosene fuel

Content	Proportion (%) from Table 2 of DEWHA (2012)
benzene	0.37
cumene	2.8
cyclohexane	1.2
ethylbenzene	0.52
n-hexane	4.7
PAH	0.99
toluene	0.18
xylene	1.9

According to Cairns Airport Ltd (CAPL), this is a rare occurrence and if undertaken would be done over water. The limitations of this activity are specified by Civil Aviation Safety Regulations (1998) as:

- The minimum release height to be 6000 feet agl (~2000 metres).
- The vapour zone extends a half nautical mile on each side, 2000 feet below, and is to be kept clear of other aircraft until 5 minutes after dumping completed.

The release of fuel 2000 metres above ground and dispersed over considerable distance, is only likely to reach the ground level in trace amounts below odour detection thresholds and health criteria.

5.9 Road Traffic

Traffic volumes recorded in 2008 along Yorkeys Knob Road have a daily average of between 5000 and 6000 vehicles. Even allowing for anticipated increases in recent years, this quantity of traffic will not have any adverse air quality impacts in open air.

5.10 Controlled Forest Burns

During the site inspection by ASK, controlled burns were underway in the Mount Whitfield Conservation Park approximately 5 kilometres to the south of the project site. Odour from smoke was noticed whilst driving past the Park but was not noticed further north.

There is potential during calm conditions for smoke to accumulate. However the proximity of the site to the coast, combined with the prevalence of southerly and south-easterly winds during the dry season, make the likelihood of such events at the project site low.

5.11 Waste Transfer Station

According to the Disposal Fees Notice at the gate, waste processed at the station includes:

- general domestic waste
- domestic and commercial green waste
- domestic building waste
- household hazardous waste
- white goods and metals
- tyres
- recyclable paper, cardboard, plastic and metal

Of these green waste, if stored on site could emit odour. General vehicle movements and material handling will emit dust.

5.12 Summary of Existing Air Emissions

The sources are likelihood of adverse impacts on the local air quality are summarised in **Table 5.5**.

Table 5.5 Summary of Air Quality Issues Considered

Source	Key Pollutant	Likelihood of Criteria Exceedence
Marlin Coast Sewage Treatment Plant (STP)	Odour	Low
Sugar cane farms	Chemical spray	Low
Sugar cane firing	Particulates	Moderate
Material depot	Dust	Low
Smithfield Estate	Dust	Low to moderate
Jet fuel dumping	VOCs and odour	Very low
Road traffic	Particulates and combustion gases	Very low
Controlled forest burns	Particulates	Low
Waste transfer station	Dust and odour	Low

5.13 Summary of Existing Ambient Air Quality

There are no government air monitoring stations in the Cairns airshed with the nearest being at Townsville.

Concentrations of PM_{10} and $PM_{2.5}$ in the region may occasionally exceed goals due to controlled forest and sugar cane fires. Although there are likely to be fires at some locations every year, rainfall is high and recirculation patterns are not expected to be common. Therefore exceedances of goals are not expected to be of high frequency.

Combustion gases and VOCs are not expected to exceed criteria as traffic volumes are low compared to city, there are no large industrial facilities in the region, and meteorological dispersion at the site is high due to the sea breeze compared to other parts of the airshed.

Dust fallout and odour are highly site specific. Sugar cane farming is likely to have the largest impact on the site but is not considered likely to exceed criteria. The sewage treatment plant is the only known source of odour but has a 500 metre buffer from the site.

6 Inventory of Project Sources

6.1 Air Quality Pollutant Emission Sources during Construction

6.1.1 Earth-Moving Activities

It is estimated that 2 million cubic metres of earth will be excavated mostly from the eastern area proposed to be lake. Approximately half of this is to be used as fill on site, with the remainder becoming spoil. These earth-moving activities will generate dust.

At the main excavation site for the proposed lake, the presence of vegetation along the creeks between the site and sensitive receptors will enhance deposition of dust and reduce suspended particulates. Provided dust emissions are kept to a minimum by water-spraying working areas during dry weather, the particulate concentrations reaching sensitive receptors should be well within health criteria. Similarly dust deposition beyond the vegetated areas should be well within the nuisance guideline.

Generation of dust clouds sufficient to limit visibility of airline pilots or vehicles on Yorkeys Knob Road is considered unlikely. Particularly poor site management might lead to dust clouds crossing the road, but it is highly unlikely these would limit the vision of pilots. Application of water sprays should prevent visible dust crossing the site boundaries.

The proposed site of the stadium is also considered suitably sheltered from residences with the possible exception of receptor H on **Figure 2.3**, which is approximately 200 metres from the proposed edge of the stadium. Appropriate monitoring should be undertaken at this receptor to record dust deposition.

The edge of the proposed site of the aquatic park is approximately 350 metres from receptor J. This may be another useful location for dust deposition monitoring.

The golf course is proposed for the vicinity of receptors G, H and J. A 40 metre buffer zone is proposed on the boundary near receptor G. Appropriate water spraying during earth-moving should prevent impacts at these receptors.

Development on the northern end of the site near Yorkey's Knob township has not yet been identified but may include facilities such as the cultural centre. Any earthworks near residences not sheltered by vegetation, such as receptor D, would need to be carefully managed. Earthworks likely to take more than three months would need to be monitored with a dust deposition gauge.

6.1.2 Excavated Earth

Excavated earth from low-lying coastal ground may emit odour typically associated with decomposition of biological material in exposed swamp ground. The process of treating acid sulphate soils with lime will help to reduce this odour, provided treatment areas are not located close to residences or Yorkeys Knob Road.

6.1.3 Mobile Plant Exhausts

Mobile plant will exhaust combustion gases and particulates. As discussed in **Section 6.1.1** there are reasonable buffer distances to residents. The number and size of vehicles is not considered likely to be significantly different to other construction projects. For these reasons and considering the anticipated low background concentrations of gases and particulates, emissions are not likely to contribute to exceedances of criteria.

6.1.4 Drilling

Drilling (for piles) will generate dust. However this activity is likely to be necessary only near the site of the proposed lake. Vegetation and distance to residences should adequately reduce the amount of particulates emitted from drill rigs. As good management practice, water sprays should be used for any dry drilling.

6.1.5 Wind

Strong wind will generate dust from exposed surfaces during dry weather. This should be mitigated by application of water sprays during dry weather to surfaces that are both un-vegetated and unsealed. The potential for nuisance to occur will accumulate over time, and the likelihood of complaints may accelerate over time. This should be avoided by rapid treatment of surfaces by re-vegetation or sealing.

6.1.6 Concrete Batching Plant

The proposed concrete batching plant will emit dust and suspended particulates from cement, sand and gravel. This will require an adequate buffer distance to residences taking into account any vegetation. Wind breaks around storage bunkers and water sprays will also help to minimise dust emissions.

6.2 Air Quality Pollutant Emission Sources during Operation

Table 6.1 Inventory of Air Emissions Sources Associated with Operation of the Proposed Development

Proposed source	Parameters	Pollutants
Golf course spraying	Treated water Pesticides	odour [1] chemicals
Motor vehicles on roads	Exhaust emissions	NO_x, CO, PM_{10}
Sewage pump stations	Emission from ventilation stack	odour
Restaurants	Cooking	odour

Notes: 1. Odour should not be produced if Class A recycled water is used,

It is proposed that Class A recycled water be purchased from the nearby Marlin Coast Sewage Treatment Plant and be used to spray on the golf course. Class A treatment requires no detectible levels of pathogens. It is anticipated that this water will not produce odour.

Pesticides, both insecticides and herbicides, may be applied to the golf course during establishment and operation. These may potentially impact on residences and aquaculture ponds.

Motor vehicles traffic is not expected to reach volumes that would cause exceedances of criteria as the area is well ventilated in the absence of street canyons.

Ventilation stacks for sewage pump stations should not be located near existing residences (ie near receptors C, D & E) in Yorkeys Knob township or receptors G and I.

Odour from restaurant cooking is considered unlikely to cause nuisance provided exhaust stacks emit three metres above roof if within 10 metres of residences.

6.3 Greenhouse Gas Emissions Sources During Construction And Operation

The potentially significant sources of greenhouse gases during construction and operation of the development are listed in **Table 6.2**.

Table 6.2 Inventory of Greenhouse Gas Sources Associated with Construction and Operation of the Proposed Development

Potential source	Parameters	Pollutants
Vegetation clearing and disposal	Scope 1 greenhouse gases	CO_2, CH_4
Construction mobile plant	Scope 1 greenhouse gases	CO_2
Motor vehicles on roads	Scope 2 greenhouse gases	CO_2
Material consumption production	Scope 2 greenhouse gases	CO_2
Grid power consumption	Scope 2 greenhouse gases	CO_2
Additional aircraft required to deliver customers	Scope 2 greenhouse gases	CO_2

6.3.1 Vegetation Clearing

The majority of the site is cleared of vegetation for the purpose of sugar cane farming. There is to be no clearing of remnant vegetation.

6.3.2 Construction Mobile Plant

Based on a typical daytime earth-moving operation, a fleet of vehicles including excavator, three haul trucks, two dozers, two loaders, a water cart and two graders may consume approximately 250,000 litres of diesel per year.

6.3.3 Staff Motor Vehicles

Although public transport, cycling and walking is encouraged, motor vehicles may be used by staff travelling to and from the resort. The worst case is 1800 return trips per day from Cairns a distance of approximately 17 kilometres each way. Based on a fuel consumption rate of 11 litres per 100 kilometres, this gives a total fuel consumption of approximately 6700 litres of petrol per year.

6.3.4 Material consumption

The only material likely to be associated with substantial greenhouse gas emissions during its manufacture is concrete. The quantity of concrete required for construction of the resort has not yet been calculated.

To provide an indication of potential concrete needs other facilities have been reviewed with details provided in **Table 6.3**. The Aquis Resort with 18 storey hotel, multiple 10 storey apartment towers, sports stadium, convention centre and casino, and aquarium is expected to require more concrete than any of these. It may require of the order of 100,000 cubic metres of concrete. Assuming a clinker to cement ratio of 78%, and that 10 kilograms of cement make 0.028 cubic metres of

concrete, then 7.8 kilograms of clinker is consumed to make 0.028 cubic metres of concrete. Thus this project may consume approximately 28,000 tonnes or 20,000 cubic metres of clinker.

Table 6.3 Concrete Consumption of Other Facilities

Facility	Description	Concrete Consumption (m^3)	Source
Halycon Hills	Resort with villas, marina, pools,	24,700	http://www.bandbw.co.uk/newsletters/Newsletter-Issue-11-Nov-11.pdf
Bahrain Grand Prix track	-	70,000	http://www.bahraingp.com/AboutBIC/OurTracks/Pages/Grand-.aspx
CBX Tower	36 floor office tower	32,000	http://issuu.com/fgamimarlik/docs/nemetschek_engineering_user_contest_2005
Plazzo Versace D1 Tower	85 level Hotel Tower	70,000	http://www.pamposh.net/hotels-spa-centres.html
Ritz Carlton, Dubai	Two 17 floor towers	65,000	http://www.pamposh.net/hotels-spa-centres.html
Ibis Novotel, Dubai	Two 11 floor towers	20,000	http://www.pamposh.net/hotels-spa-centres.html
Wafi Hotel	240 room hotel and retail	29,000	http://www.pamposh.net/hotels-spa-centres.html
Viceroy Resorts, Anguilla	31 villas, hotel and 4 service buildings	38,000	http://www.pamposh.net/hotels-spa-centres.html

6.3.5 Grid power

The total energy demand for the full operating development is in excess of 25 mega Watts (GHD 2013). During normal power supply, no power generation is proposed on site. However, some may be offset by the use of natural gas and solar hot water systems. It is also recommended that solar panels be used to generate electricity on site. GHD (2013) estimated that solar panels on the rooves of the casino, apartments and stadium could yield approximately 5 mega Watts.

6.3.6 Aircraft

For the purpose of estimating greenhouse gas emissions from additional aircraft, it can be assumed that there will be 1200 people per day arriving at Cairns airport. A typical flight origin may be from Beijing, which is approximately 7000 kilometres each way or 14000 kilometres two way. Typical fuel efficiency rates for international flights from Australia are approximately 39 litres per 100 RTKs (tonnes of payload x kilometres) (Qantas 2011). Assuming the average person carries a weight of 0.1 tonnes including luggage gives a daily fuel consumption increase of 1200 x 0.1 x 14000 x 39 / 100 = 655,200 litres.

6.3.7 Liquid Fuel Emissions

Greenhouse emission factors for liquid fuel consumption are shown in **Table 6.4**.

Table 6.4 Liquid Fuel Greenhouse Gas Emission Factors

Fuel Type	Energy Content (GJ/kL) [1]	Scope 1 Emission Factor (kg CO_2-e/GJ) [1, 2]	GHG Emission Factor (tonnes eCO_2/ kL) [3]
Diesel	38.6	69.5	2.68
Petrol	34.2	67.1	2.29
Aircraft fuel (Avgas)	33.1	66.7	2.21

Notes: 1. Source: Table 3 in DCCEE 2012b.

2. Emission factors include contributions from CO_2, CH_4 and N_2O.

3. GHG Emission Factor is the Energy Content multiplied by Scope 1 Emission Factor.

6.3.8 Summary of Greenhouse Gas Emissions

Estimated quantities of greenhouse gases released by the project are provided in **Table 6.5**

Table 6.5 Estimated Annual Greenhouse Gas Emission Inventory

Source	Material Quantity	Emission Factor [1]	Emission Rate CO_2-e (kt)
Scope 1 Construction mobile plant	250,000 litres diesel	2.68 t $CO_{2\text{-}e}$/kL	0.7
Scope 2 Concrete consumption production	28,000 tonnes clinker	0.544 t $CO_{2\text{-}e}$/ t clinker	15.2
Scope 2 Motor vehicles on roads	6,700 litres petrol	2.29 t $CO_{2\text{-}e}$/kL	0.02
Total Construction	-	-	**17.4**
Scope 2 Motor vehicles on roads	6,700 litres petrol	2.29 t $CO_{2\text{-}e}$/kL	0.02
Scope 2 Grid power consumption	25 MW x 8760 hours	0.86 t $CO_{2\text{-}e}$ /MWh	188.3
Scope 2 Additional aircraft required to deliver customers	655,200 litres avgas	2.21 t $CO_{2\text{-}e}$/kL	1.5
Total Operation	-	-	**189.8**

Notes: 1. Emission factors are from **Table 6.4** and DCCEE (2012b).

The total greenhouse gas emissions in 2011-2012 from corporations that had to report to NGER was 435.9 Megatonnes CO_2-e (Clean Energy Regulator 2012). Based on the total emissions for 2011-2012, emissions from the construction and annual operation of the resort would be respectively 0.004% and 0.042% of Australian NGER emissions.

7 Constraints

7.1 Industry Buffer Zones

Department of Environment and Resource Management (2010) define the following buffer distances within which planning investigations are required:

- medium impact industry–250 metres
- high impact industry–500 metres

These industry categories are defined as (Department of Infrastructure and Planning 2010):

- medium impact industry is Premises used for industrial activities that have offsite air, noise and odour emissions. Despite mitigation measures these activities would still have noticeable impacts on non-industrial uses. The primary emitting aspects of the use are indoors.
- high impact industry is Premises used for industrial activities that have *significant* offsite impacts on non-industrial uses including air, noise or odour emissions that are not easily controlled. These uses may operate outdoors.

Table 7.1 Air Emissions Sources (Existing and Proposed) and Applicable Buffer Zones

Source	Category	Recommended buffer zone (m) [1]
Marlin Coast Sewage Treatment Plant (STP)	High impact from odour	500
Sugar cane farms	Medium impact from occasional burns and spraying	250
Materials Depot	Medium impact from minor emissions of dust	250
Forest Burns	Medium impact from occasional burns managed by closing air intakes	250
Waste transfer station	Medium impact from minor dust and odour	250
Concrete batching plant	Medium impact from dust	250
Golf course spraying	Medium impact from spraying	250

Notes: 1. These buffer zones assume no other mitigation measures such as vegetation are in place.

The only buffer zone that impinges significantly onto the proposed site is that for sugar cane farms. This is illustrated in **Figure 7.1.** No new high density residential accommodation should be planned for the site to the west of the orange line, which is approximately 250 metres from the sugar cane farms. The 40 metre vegetated buffer will be adequate to protect the project site from sugar cane spray drift, and to protect the existing residences from golf course spray drift. However the larger buffer is recommended to reduce impacts of the occasional cane firing on project residences.

A smaller buffer is recommended around site sewage pump stations to protect residences from odour. Given the well-ventilated nature of the site, a vegetated buffer of 10 metres or an open buffer of 40 metres would suffice.

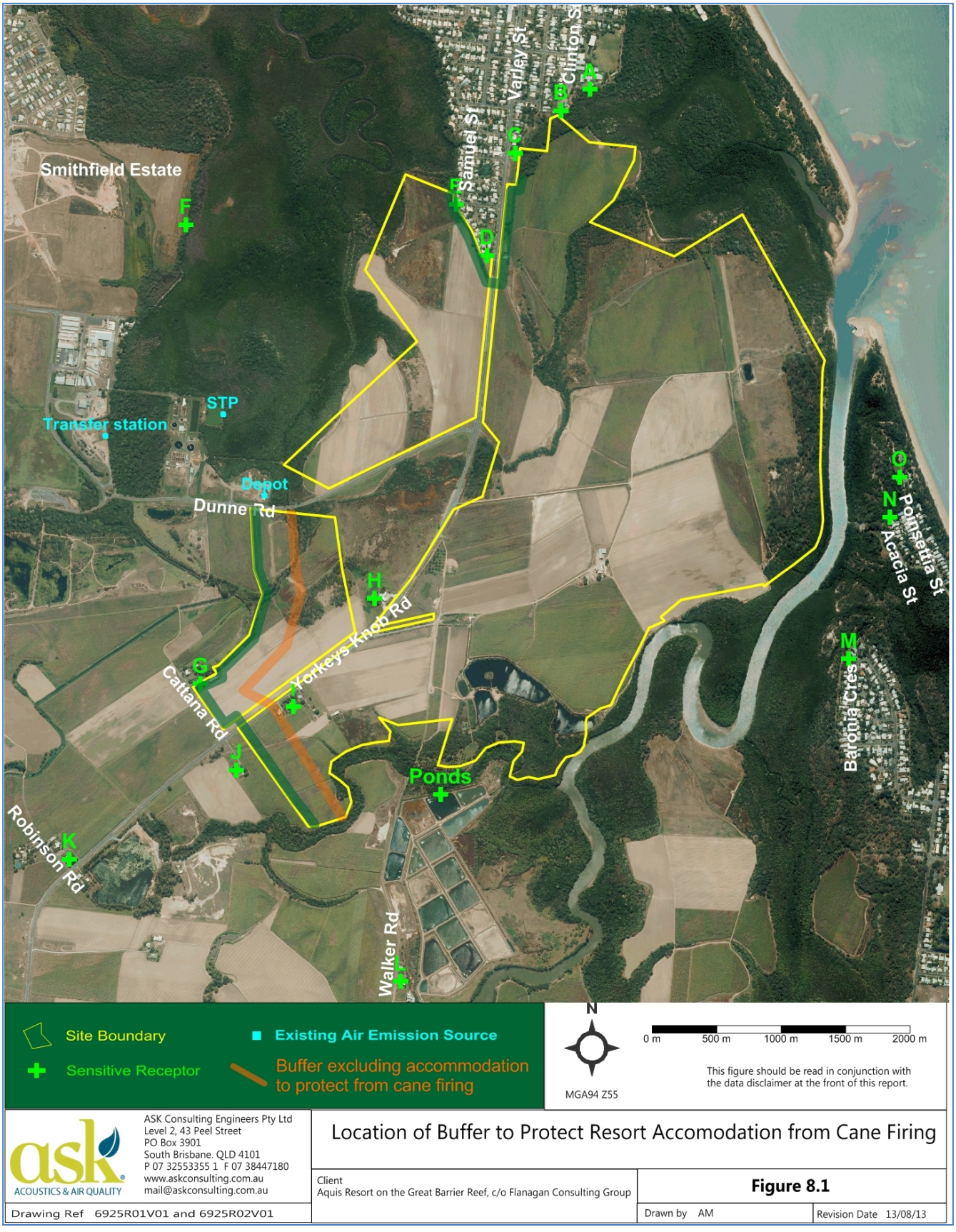

Figure 7.1 Buffer Zone to Protect Development from Background Air Emissions

7.2 Spray Drift Mitigation Guidelines

7.2.1 Queensland Planning Guideline 1997

Planning Guidelines: Separating Agricultural and Residential Land Uses, by the Queensland Department of Natural Resources, has the primary purpose to separate good quality agricultural land zoned as rural from land for residential uses. The recommended minimum buffers are 300 metres over open ground and 40 metres through vegetation. In addition some of the relevant and applicable design features from the Guideline are noted:

- Spacings of 4 to 5 metres between trees may be suitable.
- Long, thin rough foliage from base to crown is most suitable.
- Porosity of the barrier should be maintained at approximately 50% to prevent forcing air over the buffer.
- Height of buffer trees should be 1.5 times the target vegetation height.

7.2.2 CSIRO 2002

Similarly, *Spray Drift Management: Principles, Strategies and Supporting Information*, by the CSIRO Primary Industries Standing Committee Report 82, mainly addresses large scale farms with aerial or boom spraying operations. However, there are some buffer design recommendations from this document that may be relevant:

- 50% porous barrier will minimise disturbance of air flow.
- Mixed plantings avoid [large] gaps in the lower canopy.
- Thin, rough foliage should extend from the base to the crown.
- Small and / or hairy leaves will maximise droplet capture.
- Tree height should be at least double the **release** height of the spray.
- The vegetative buffer should be as close as practical to the spray zone.

7.2.3 USDA 2008

Conservation Buffers: Design Guidelines for Buffers, Corridors and Greenways, by the US Dept of Agriculture National Agroforestry Centre, addresses a wide range of potential land use conflicts. However, the focus of the spray drift discussion is on protection of flora and fauna rather than humans. The recommended buffer widths for protection from ground spraying, range upward from approximately 15 feet (5 metres). Other recommendations from this document which may also be relevant:

- Use vegetation with fine, needle like leaves.
- Provide 40 to 50 % density.
- The buffer should be at least two times taller than the crop.
- Use a mixture of plant forms to ensure no gaps.
- Locate as close as possible to the spray.

7.2.4 *Role of Hedgerows in Intercepting Spray Drift*

Lazzaro, Otto & Zanin (2008) report measurement of a tracer from a tractor. A key finding was that "with an optical porosity of 74-75%, the aerial drift caused by common broadcast air-assisted sprayers becomes negligible at a distance of 6 – 7 metres".

It is also worth noting the following citation from Lazzaro et al:

"Guidelines for planting vegetated buffer zones for drift reduction are provided in Queensland, Australia, and suggest buffer widths of around 20 metres. However, these are almost impossible to

achieve in many cropping systems in the world." Voller 1999 *Growing Trees on Cotton Farms, RIRDC publication 1440-6845 no 99-65., Kingston ACT, Australia*.

7.2.5 Discussion of Spray Drift Mitigation

Height is more important than width, and should be 1.5 to 2 times the height of the crop i.e. assuming the crop is 4 metres high, buffer trees should be at least 6 to 8 metres. The buffer trees should extend beyond the length of the target crop to prevent spray drifting around the ends.

Spacings between trees will depend on species chosen but should be as close as practical that allows air to flow freely between leaves. Species should have long and thin, or hairy leaves.

As discussed in **Section 7.2.1**, an appropriate buffer zone to protect residences and sensitive flora/fauna from chemical spray drift (from the golf course or remaining sugar cane farms) is 300 metres over open ground or 40 metres through vegetation.

The existing residences at receptor G are already exposed to chemical spray drift from the sugar cane farms and it is unlikely that impacts from the golf course would be any worse. Similarly if the golf course were to be constructed on the northern end of the site, this would be on land already occupied by existing cane farms.

The prawn aquaculture ponds to the south of the site are also currently in the near vicinity of sugar cane farms. The separation from the site provides an adequate buffer distance including vegetation. It is anticipated that no spray drift from the proposed golf course would reach the ponds provided the existing vegetation buffer is maintained.

8 Opportunities

8.1 Air Quality

The proposed development will instigate removal of the sugar cane farm from near the southern extent of the Yorkeys Knob township. This will remove the impact of sugar cane firing.

8.2 Vegetation Buffers

A 40 metre vegetation buffer is proposed along the site boundary from Dunne Rd down to the waterway along the southern boundary of the site (northern tributary of Richters Creek). This will provide the following benefits:

- It will create a buffer from the golf course (if constructed on this portion) to protect receptor G from spray.
- It will create a buffer from the existing cane farm to protect any accommodation or residences on the proposed site from spray and dust, and reduce the impact of smoke.
- It will also provide ecological and aesthetic benefits.

8.3 Greenhouse Gases

Among the issues to be incorporated into a Sustainability Strategy proposed for the site (Environment North 2013) will be minimisation of greenhouse gas emissions and maximising greenhouse offsets. The following measures are recommended to be part of the strategy:

Design:

- Plant native vegetation on site to act as a greenhouse gas sink. The best location for this would be that described in Section 8.2 having an area of approximately 6 hectares. An additional location would be along the boundary adjacent to Yorkey's Knob township having and area of approximately 4 hectares. Guidance for types of vegetation suitable for air quality buffers are provided in Section 6.1. Running the FullCAM model (Department of Climate Change and Energy Efficiency 2012a) for the first year of growth following planting gives an increase in carbon mass on site of approximately 6188 tonnes, equivalent to approximately 22,690 tonnes of CO_2 sequestered.
- Appropriate design of water management systems to minimise consumption and pumping can have substantial savings in energy consumption as can use of variable speed drives on large pumps.
- Design buildings to 5 star standards for energy conservation.
- Maximise use of natural lighting and ventilation in design of buildings.

Construction:

- As far as practical, obtain construction materials and ongoing consumable from local suppliers to reduce fuel consumption.
- Where practically available, use maximum size of earth-moving equipment to minimise trip numbers.
- Install light and motion sensors to switch on lighting. Use energy efficient light bulbs. Ensure outdoor lighting is not operated during daylight hours. This has potential for substantial reductions in electricity demand.
- Minimise generation of waste during construction and operation.
- Install solar hot water.
- Cover available roof space with solar power panels.
- Install a reticulated gas network to supply energy efficient cooking and boosters for water heating, although solar water heating is also recommended. This combination is estimated to reduce grid electricity consumption by 4 mega Watts (GHD 2013).

- Install centralised chilled water generators for air-conditioning as per the recommendation of GHD (2013).
- Purchase energy efficient appliances.
- Purchase water efficient appliances.
- Install programmable thermostats.

Operation:

- Maintain equipment to retain energy efficiency. This has potential for reductions in electricity demand.
- Where suitable, use local personnel to reduce transport emissions. This has potential for reductions in transport fuel consumption.
- Training should be provided to all staff in energy management specific to their roles.
- Purchase grid electricity from renewable sources such as wind or solar.
- Energy audits are to provide a breakdown of energy use by activity, profiles of energy load across key plant items, analysis of energy efficiency initiatives, trending of energy usage over time, and addressing energy usage in procedures.
- Obtain certification as a sustainable tourism facility from a third party such as Green Globe (http://greenglobe.com/).
- Track carbon footprint and other environmental practices using a system such as Green Hotels Global.

9 Summary of Impacts

The potential impacts of the proposed development are summarised in **Table 9.1**. Nuisance dust from earth-moving, uncovered ground and the concrete batching plant require buffers and/or appropriate management practices. Odour from excavated earth, sewage pumping stations and restaurants require appropriate buffers. The only source potentially posing a direct human health risk is chemical spray from the golf course, which can be managed with a vegetation buffer, and is not likely to differ substantially from the existing spraying of sugar cane. Other emissions do not require any specific mitigation measures.

Table 9.1 Summary of Potential Air Quality Impacts Considered

Pollutant & Source	Relevant Sensitive Receptors	Likelihood of Criteria Exceedence
Dust from earth-moving	H, J, G, D	Low to moderate
Odour from excavated earth	Residences or Yorkeys Knob Road	Low
Mobile plant exhausts	H, J, G, D	Very low
Dust from drilling	H	Very low
Dust from wind over uncovered ground	H, J, G, D	Low to moderate
Dust from concrete batching plant	Residences	Low to moderate
Odour from effluent watering of golf course	H, J, G	Very low
Chemical spray from golf course	H, J, G, ponds	Low
Particulates and combustion gases from increased traffic on roads	Residences	Very low
Odour from sewage pump stations	Residences	Low
Restaurants	Residences	Low

10 Mitigation, Recommendations & Conclusion

The planning and design of the resort should take into account the following constraints and opportunities detailed in this report.

10.1 Constraints:

- Ventilation stacks for sewage pump stations should not be located within 40 metres of residences, or 10 metres if the buffer zone is vegetated.
- Restaurant exhaust stacks should have three metre stacks if located within 10 metres of residences.
- The concrete batching plant should be located at least 250 metres from residences.
- High density accommodation is not to be developed within 250 metres of the south-eastern boundary of the site to minimsie smoke from the occasional cane-firing.

- Existing vegetation buffers inside the southern boundary of the site to the north of the aquaculture ponds should be maintained.

10.2 Opportunities:

- The sugar cane farm to the south of Yorkeys Knob township is being replaced with a golf course, a lower impact land use, and on the eastern side of Varley St, a vegetation buffer.
- The 40 metre vegetation buffer proposed for the south-western boundary of the site will prevent issues arising from spray drift provided it meets spray drift guidelines.
- A Sustainability Strategy is to be developed and implemented to minimise greenhouse gas emissions among other goals. A list of recommended actions is provided in **Section 8.3**.

10.3 Other Management Actions

- Water sprays should be used during all earth-moving activities during dry weather and for dry ground drilling.
- Wind breaks and water sprays should be used at the concrete batching plant.
- Open ground should be vegetated or sealed as soon as practical.
- Dust deposition monitoring should be undertaken when earth-moving activities are in the proximity of receptors H, J and D.

10.4 Conclusion

The existing air quality is likely to be well within health and amenity criteria for most of the time. The only potential exception is concentrations of PM_{10} and $PM_{2.5}$ during sugar cane firing, which may occur every four to six years. The accommodation sites proposed for the development have a substantial buffer to the remaining sugar cane plantation including vegetation buffers, so this potential impacts is considered to be well managed within the project proposal.

The main potential impacts on air quality at sensitive receptors during construction activities include dust from earth-moving, uncovered ground and concrete batching. These should be carefully managed with buffers, water sprays, wind breaks, revegetation and monitoring throughout the construction phase. Other construction impacts such as odour are unlikely and it is expected they will be well managed by buffer distances.

There are few potential impacts on air quality at sensitive receptors during operation. These include odour and chemical spray drift, which are unlikely and it is expected they will be well managed by buffer distances.

The Project is estimated to contribute 17 kilotonnes of CO2-e per annum during construction and 190 kilotonnes of CO2-e per annum during operation. This operation exceeds the 25 kilotonne threshold requiring Aquis to report to the NGER system.

Emissions from the operation resort will be approximately 0.04% of Australian NGER emissions. This represents a small contribution to Australia's emission inventory. All practical measures to reduce these emissions should be implemented.

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Appendix A Glossary

Parameter or Term	Description
CO	Carbon monoxide
Dust fallout	Dust that has fallen out of the air onto a horizontal surface
EHP	Queensland Department of Environment and Heritage Protection
EPP (Air)	Queensland Environmental Protection (Air) Policy 2008
g/m^2/month	Grams per square metre per month
m/s	Metres per second
mg/m^2/day	Milligrams per square metre per day
NEPM	National Environmental Protection (Ambient Air Quality) Measure
NOx	Oxides of nitrogen including nitric oxide and nitrogen dioxide
NO_2	Nitrogen dioxide
PAHs	Polycyclic aromatic hydrocarbons
$PM_{2.5}$	Particulates suspended in air with aerodynamic diameter less than 2.5 microns
PM_{10}	Particulates suspended in air with aerodynamic diameter less than 10 microns
TSP	Total particulates suspended in air
µg/m^3	Micrograms per cubic metre
VOCs	Volatile organic compounds