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David Perkins

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Cardno (Qld) Pty Ltd
ABN 57 051 074 992

Level 11
515 St Paul's Terrace
Fortitude Valley QLD 4006
Australia

Phone: +61 7 3369 9822
Fax: +61 7 3369 9722
www.cardno.com

www.cardno.com/cardnohrp

Queensland Major Projects Section
Environment Assessment Branch
Department of the Environment
GPO Box 787
CANBERRA ACT 2601

Email: leigh.barker2@environment.gov.au

Dear Leigh

TURTLE STREET BEACH RESORT, CURTIS ISLAND (EPBC 2015/7585) – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Please find the following response to the Department's request for additional information regarding the referral for the Turtle Street Beach Resort, Curtis Island and dated 6 November 2015.

1.0 SURVEYS OF LISTED THREATENED AND LISTED MIGRATORY BIRD SPECIES

Logic Environmental was engaged by QRE Pty Ltd to carry out surveys to indicate the presence of listed threatened and listed migratory bird species, including the Eastern Curlew and the Curlew Sandpiper.

Survey Points

Shorebird surveys were undertaken in February 2016. Six sites were identified to provide a species count, evidence of presence of relevant shorebird species and available habitat for these species (refer to **Attachment A**). These sites were identified as the preferred survey sites in an original briefing provided to the Department on 9 December 2015 in order to address key likely shorebird areas. Site inspections indicated that it was not possible to get any closer to the airstrip location.

Mr Andrew Thorrold from Logic Environmental, the environmental scientist who undertook the survey work, has advised that based on the site observations he considers the locations to be appropriate and sufficient to provide an accurate and comprehensive record of the level of shore bird activity taking place on the site including areas within potential take-off and landing areas for the airstrip.

Flight Movements
Planes will land from the north and can take off to the north. Helicopters will approach from and take off to the north. The helicopter landing area is to the centre and top left of the runway. Flight paths are to limit overflying of potential shore bird areas (i.e. generally mangrove/mud flat/intertidal areas associated with the upper reaches of Graham Creek). We note that the surveys indicated these areas (and the site as a whole) to be fairly depauperate when considering shore bird abundance and diversity. That is, no large gathering of shore birds is anticipated in these areas, based on current findings.

Survey Report Findings

The report is contained as **Attachment A** to this response document. The report concludes:

> *"The site (as a whole) displayed limited diversity/abundance of shore bird species. A total of 6 species were observed. The highlighted species, the Eastern Curlew (Numenius madagascariensis) and the Curlew Sandpiper (Calidris furruginea) were not observed. Of the species observed, the Beach Stone Curlew is federally listed as a marine species (EPBC Act) and in Queensland as vulnerable (NC Act) and the Bar Tailed Godwit is listed as migratory.*
>
> *Various habitat observations were made during the course of the field surveys; these observations highlighted a range of habitat features generally considered suitable for a range of shore bird species. At this stage, it is unknown as to why shorebird species diversity/abundance levels were observed as being so low. There is some potential that diversity/abundance levels may display as higher at different times of the year, dependant on specific migratory patterns of birds in the area. It is also possible that shorebirds in fact prefer other areas on Curtis Island or in the general vicinity.*
> *.....*
>
> *Whilst this report does not aim to provide in depth discussion on the proposed resort development and any potential environmental impacts associated, we do consider any impact on shore bird species/communities and their habitat will be minimal. We understand that all clearing activities on the site have been completed and that no direct impact on any areas of habitat/potential habitat will occur.*
>
> *We suggest, however, that a specifically designed management plan/strategy be employed during the operational phase of the resort to limit potential disturbance to shore birds, particularly in areas directly adjacent the resort and other areas of concentrated activity."*

The issue of a management plan/strategy to limit potential disturbance to shore birds is discussed further in this response under **Section 5.0**.

2.0 SURVEYS OF SPECIFIC SPECIES

Attachment A provides the results of flora field surveys. The report concludes:

> *"Given the extent of survey effort employed (in this and previous studies), we consider it accurate to conclude that the site does not support the highlighted rare/threatened flora species (i.e. Samadera bidwillii, Cupaniopsis shirleyana, Cycas ophiolitica and Cycas megacarpa). Whilst certain site characteristics and the site's general location may suggest their potential existence, evidence at hand does suggest otherwise."*

3.0 HOBBLE GULLY DAM AND PROPOSED WATER TREATMENT PLANT

Attachment B provides a report prepared by Bligh Tanner Consulting Engineers titled *"Turtle Street Beach Resort: Integrated Water Management Design Report December 2010."* In summary, the main water supply will be from Hobble Gully Dam located in the infrastructure and access corridor. A small package water treatment plant is proposed to be located in the resort infrastructure area (refer to **Attachment C** and the response in **Section 5.0**) to treat the raw water from the dam to a potable standard.

The water treatment system to produce high quality potable water for the resort will include:

- Inlet screening;

- Media filtration with addition of a coagulant or flocculent to improve filter efficiency;
- Membrane ultra-filtration to achieve very high suspended solids reduction;
- Ozonation for colour removal and disinfection;
- Activated carbon filter to remove residual organics and colour;
- Residual chlorine dosing; and
- Controlled by a registered operator.

The water treatment plant and transfer main will be sized to meet the demands of the development based on 100 percent occupancy, however, the extraction rates will depend on the actual demands of the development and the extent of supplementation with recycled water.

Potable water supply demands will be significantly reduced with the mandatory implementation of AAA water saving devices and providing Class A+ recycled water for unrestricted non-potable use such as toilet flushing, cold water supply for washing machines, garden watering and hosing purposes. It is expected that the water demands would be reduced by 57% compared to traditional water supply solutions. Raw dam water and recycled water will be used to irrigate landscaped areas within the site.

It is not considered that the Hobble Gully Dam or water treatment plant will have any environmental implications on matters of environmental significance.

4.0 LOCATIONS OF THE PROPOSED SEWAGE TREATMENT PLANT AND WATER TREATMENT PLANT

Attachment C provides the location of the proposed sewerage treatment plant and water treatment plant. Both facilities are to be located at the infrastructure compound to the west of the resort node.

The waste water treatment system will have the following features:

- A tertiary wastewater treatment plant will be constructed for treatment of wastewaters generated within the development and is to be licensed for operation in accordance with environmental regulations.
- Wastewater will be collected in a system of gravity mains and pumping stations to the central plant;
- Wastewater will be treated to a quality suitable for reuse for irrigation of the designated irrigation area as approved in the operational works permit plans and other landscaped areas throughout the resort node;
- The wastewater treatment plant will be sized for the peak population in the resort;
- Treatment processes provided will be capable of producing high quality recycled water suitable of use for irrigation;
- The plant will include:
    - Screening and grit removal to remove gross / heavy solids upstream of the plant;
    - A Biological secondary treatment process to break down organic matter and to reduce nutrient concentrations;
    - Extended aeration activated sludge;
    - Membrane bioreactor process;
    - Trickling filter process;
    - Filtration to reduce turbidity prior to disinfection;
    - Disinfection using UV irradiation or chlorination; and
    - Controlled by a registered operator.

Environmental Regulation Compliance

The *Environmental Protection Act 1994* provides for the granting of environmental authorities for wastewater treatment activities referred to as Environmentally Relevant Activity ERA 63. The *Environmental Protection Regulation 2008* includes the requirements for protection of receiving environments for activities relating to wastewater treatment works. The *Model Operating Conditions for ERA 63 – Wastewater Treatment* published by DEHP in 2014 provides a framework of conditions to apply for applications for wastewater treatment works within Queensland.

The wastewater treatment plant will require approval for operation as described by Schedule 2, Part 13, 63 Wastewater Treatment of the *Environmental Protection Regulation* 2008 with a threshold of 100 -1,500 EP.

Compliance with the relevant model operating conditions is deemed to satisfy the requirements of the *Environmental Protection Act 1994* and the *Environmental Protection Regulation* 2008. The Turtle Street Beach Resort wastewater treatment plant will comply with the relevant conditions within the *Model Operating Conditions* as described in Table 1.

Table 1 Compliance with Model Operating Conditions for ERA 63 – Wastewater Treatment

Condition Requirement	Demonstration of Compliance
General	
Adequate sizing and operation of the wastewater treatment plant	The wastewater treatment plant is sized to treat the anticipated flows from the development at 100 percent occupancy. The wastewater treatment plant will be sized to cater for three times the average dry weather flows to enable wet weather flows to be treated to the required standard. An offline storage will be provided to store flows unable to be fed through the plant due to extreme wet weather events or plant failure. The storage will have capacity for four hours of peak flows. Operational and maintenance procedures will ensure activities are carried out in a way which does not cause environmental harm.
Activities and all operational and management actions are undertaken in a way which does not cause or threaten to cause environmental harm.	All actions taken and equipment used will be carried out in a way to minimise risk to the environment. Wastewater treatment is achieved with membranes and technologies are to be selected aimed at minimising the need for chemical use within the plant. Any chemicals that are required will be transported and stored in accordance with regulatory requirements and standards with appropriate bunding.
Recording and reporting	Records will be maintained of daily inflows, outflows, effluent quality monitoring results, discharges and any complaints received. Annual reports will be prepared and submitted to the regulator. The regulator will be notified promptly of any breaches of the Environmental Authority. A sampling and monitoring program will be prepared that will provide for the transfer of the necessary samples to the mainland for analysis by a NATA accredited laboratory.

Condition Requirement	Demonstration of Compliance
Environmental Monitoring Program	An Environmental Monitoring Program will be prepared to monitor the environmental impact of wastewater treatment activities
Air	
Contaminants released to air as a result of the activity do not cause environmental nuisance.	Odour control measures will be implemented to ensure odours do not cause nuisance to resort guests or staff. These measures may include odour treatment units and enclosure of processes likely to emit odours.
Land	
Discharge of waters to land must comply with water quality and volume release limits of the Environmental Authority	The wastewater treatment plant will be designed, constructed, operated and maintained to produce a consistent Class A+ recycled water. The recycled water will be monitored to ensure the required water quality prior to irrigation. Application rates will be based on modelling which considers local climate conditions, soil and vegetation types, irrigation water quality, land area and wet weather storage availability. Adequate buffers will be maintained around irrigation areas to maintain public and environmental health and safety.

5.0 OPERATIONAL PROCEDURES TO MINIMISE THE RISK OF DISTURBANCE AND FATALITIES TO LISTED THREATENED BIRDS AND LISTED MIGRATORY BIRDS RESULTING FROM AIRCRAFT

We have reviewed the results of the Logic Environmental survey work and the GBRMPA publication *Guidelines for Managing Visitation to Seabird Breeding Islands 1997*.

It does not appear that the guidelines provide directly applicable guidance for the control/mitigation measures for the proposed airstrip having regard to:

- the low number of birds observed and the location of the observations;
- the fact that Curtis Island is not mentioned in the guidelines (and the GBR islands that are mentioned are physically much smaller, with much higher densities of birds);
- the distances between the airstrip and potential habitat; and
- the low number of proposed daily flights being:
    - Plane - 8 movements per day on average
    - Helicopter - 4 movements/day on average

  [A take-off is a movement, as is a landing].

It is considered however that Chapter 5 of the guidelines provides useful control/mitigation measures for resorts which are appropriate to be implemented by the project:

> ***"Control/Mitigation Measures for Resorts***
> *The measures which might be taken to avoid or mitigate the impacts of resort construction on seabird breeding include:*
> - *preparation of education/awareness programs for workers on the site;*
> - *inclusion of environmental protection clauses and codes of behaviour in contracts of contractors and subcontractors on the site;*
> - *marking the boundaries beyond which personnel and machinery may not move;*
> - *requiring maximum noise reduction on equipment operated on the site;*
> - *prohibiting the use of explosives;*
> - *planning with architects and site managers the location and nature of lighting used on the site;*
> - *including satisfactory arrangements for spoil disposal in construction plans;*
> - *requiring inspection and, if necessary, steam cleaning of equipment and materials brought onto the site; and*
> - *requiring catering waste to be stored in covered bins and ultimately to be buried, incinerated or removed from the site.*
>
> *Appropriate measures during resort operation include:*
> - *use of signs, brochures, videos and other awareness tools to make guests aware of appropriate codes of behaviour;*
> - *developing appropriate codes of behaviour for staff;*
> - *requiring catering waste to be stored in covered bins and ultimately to be buried, incinerated or removed from the site;*
> - *development of a list of acceptable plants for use in landscaping and rehabilitation; and*
> - *prohibition enforced through employment contracts on the private introduction of plants or animals to the island."*

In order to address the above, it is proposed that a specifically targeted Shore Bird Management Plan be formulated for the resort to effectively manage any risk that might exist.

6.0 DESIGNATED WATER ACTIVITY AREAS

The proponent seeks to remove marine tourism activities from the EPBC Act referral. Section 156A of the EPBC Act allows a variation of the referred action if the following information is provided:

(a) details of the proposed variation to the action;

(b) the reasons for the proposed variation;

(c) how the impacts of the proposed variation on matters of national environmental significance compare with those of the original proposal.

In relation to the above, we confirm that the proposed variation to the EPBC Act referral is the removal of marine tourism activities on the basis that a separate GBRMPA permit will be made at the time when the proposed extent of water activities have been resolved. The GBRMPA's assessment of the application for a permit will assess the acceptability of any potential impacts. The removal of this aspect from the referral will not have any impact on matters of national environmental significance compared to that included in the original proposal.

7.0 VALIDITY OF CURRENT APPROVALS

We confirm that the proponent has the following current approvals:

- Operational Works Approval – Roadworks, Stormwater, Water Infrastructure, Drainage Works, Earthworks, Sewerage Infrastructure and Landscaping from Gladstone Regional Council (OPW/436/2013) – due to lapse 26 July 2017 (refer to **Attachment D**); and
- Town Planning Consent Order – The Town Planning Consent Permit is due to lapse on 26 July 2017 (DA/99/2009) (refer to **Attachment D**).

The proponent has met with Gladstone Regional Council on 16 February 2016 to discuss extension of the currency period for these permits and it is anticipated that those requests will be lodged with Council in the next few weeks.

8.0 PROJECT SCOPE AND DESCRIPTION OF ALL COMPONENTS OF THE PROPOSED ACTION

The site comprises 713 hectares of leasehold land (Lot 8 CP860464, Lot 11 CP860464 and an area of Esplanade of approximately 250m^2 for barge landing and access at Hobble Gully), with the resort itself concentrated on a very small portion of this total site area, about 20 hectares.

The proposed Turtle Street Beach Resort includes 177 villas and units (297 rooms), resort amenities (beach centre, pools and tennis courts) and a central facility with a reception, conference facilities, shop, bar and restaurant.

9.0 TURTLES

In May 2014 Pendoley Environmental Pty Ltd prepared the *Gladstone Region 2013/2014 Marine Turtle Hatchling Orientation Monitoring Program* report for Gladstone Ports Corporation (refer to **Attachment E**). Significantly, the report in Appendix 1 records the communications between the proponent and the Department of Environment and Heritage Protection. It is noted that on 18 November 2013 Dr Col Limpus (Chief Scientist, Threatened Species Unit, Department of Environment and Heritage Protection) advised the proponent's consultant in relation to known or potential nesting/hatching sites of any species along Gladstone-Yeppoon coastline that:

> *"The principle* (sic) *nesting beaches in the Port Curtis - Port Alma area are*
>
> *1. Peak Island, ~15km off the coast from Yeppoon*
>
> *2. South End Curtis Island, a 5km long beach*
>
> *3. Settlement Bay at the southern end of Facing Island - has small numbers of nesting flatbacks (10s of females annually) - the best concentration for Facing Island.*
>
> ***There are no other beaches in the Gladstone area with predictably nightly nesting of flatback turtles during the mid nesting season".***

We note that South End is a lineal distance of 12 kilometres south from Black Head (the resort node) (refer to **Figure 1**).

The stated advice of Dr Limpus is consistent with observations from the site's caretaker who for forty-four years did not observed turtles nesting at or adjacent to the Turtle Street Beach Resort site. Notwithstanding this, the development has been designed to incorporate measures to ensure that there is minimal impact on turtle populations in accordance with the 1996

Commonwealth approval (refer to **Attachment F**) and conditions of lease. Similar requirements are contained in the current Town Planning Consent Permit. Specifically all development is setback from the foreshore and lighting has been designed by Greenleaf (refer to **Attachment G**) to ensure that it meets the condition of lease (condition 13) which states:

> *"The lessee must at all times take the necessary precautions to ensure that all lights on or above the leased land are shielded to prevent glare or reflection which may interfere with safe navigation of surrounding waterways or with reasonable enjoyment of neighbouring properties or nesting sites for turtles"*:

The proposed lighting design by Greenleaf to achieve the above condition include:

- Lights will be low mounted;
- Low wattage lamps are to be used to avoid visibility from the beach/ocean;
- Lowest illumination level possible while still meeting *Australian Standard AS1158;*
- Lamps and light fittings to be directional with full cut of optics to avoid light spill; and
- Orientation of all lights away from the beach/ocean.

Figure 1. Location of resort node relatiatve to South End (Source: Google Maps, 2016).

CONCLUSION

The proposed Turtle Street Beach Resort project has been subject to rigorous State and Local Government assessment processes which commenced in 1989. Since this time the proponent has been involved in a complex approvals and negotiation process with Commonwealth, State and Local Government agencies which has resulted numerous site investigations and a Development Permit (Operational Works) and Planning and Environment Court Consent Order for the proposed tourist resort. Through this process the design of the resort has been refined to become lower in scale and intensity and approximately 32,890 hectares of the original Monte Christo holding has been dedicated to the State for National Park and Conservation Park, and for a Vegetation Off-Set Area (18,950ha) resulting in significant environmental benefits.

The proponent submits that the based on the original referral and proposed proposal and subject to a condition requiring the proposed Shore Bird Management Plan, the proposal will not have a significant impact on matters of national environmental significance (given the site selection, sensitive design, investigations and comprehensive approval framework in place governing the development of the site) and as such should not be declared a controlled action under the EPBC Act.

Should you require any further details or clarification on any of these matters please contact David Perkins on 07 3310 2354 or david.perkins@cardno.com.au.

Yours faithfully

David Perkins

Senior Principal
Cardno HRP

Attachment A: Field Survey (Logic Environmental, April 2016)

ABN 73 437 852 252

Brisbane – 61 Lugg Street Bardon QLD 4161
Sunshine Coast – 3/13 Kerryl Street Kunda Park QLD 4556
Phone – 07 33921951 Fax – 07 5335 1619 Email – admin@logicenviro.com.au

Ref: L010126BS

6 April 2016

QRE Pty Ltd

PO Box 1108

Caloundra Qld 4551

Via Email: qre@sbcglobal.net

Attention: Tim Reigel

RESPONSE TO RFI – EPBC REF 2015/7585
FIELD SURVEYS
TURTLE STREET BEACH RSORT
CURTIS ISLAND, QLD

1.0 INTRODUCTION

Logic Environmental was commissioned by QRE Pty Ltd to prepare this report. The report has been compiled generally to convey results obtained during surveys conducted at the subject site in response to a request for further information (RFI) from the Department of the Environment (DoE). Specifically, the report and site surveys were aimed at addressing matters relating to;

- listed threatened and listed migratory bird species; and
- specific rare/threatened flora species.

Relevant site surveys (for migratory birds) and this report have been conducted/prepared in general accordance with the documents; '*Survey Guidelines for Australia's Threatened Birds (DoE)'* and the *'Background Paper to EPBC Act Policy Statement 3.21 - Significant Impact Guidelines for 36 Migratory Shorebird Species'*. Flora surveys were undertaken generally utilising recognised industry best practice methodology.

The report generally aims to convey results of field surveys conducted in February 2016 only, rather than provide in depth discussion on the site, associated ecology and reasoning to explain results. We understand significant other information on the site/proposal has been provided.

1.1 Site Description

The site as a whole is located on the eastern side of Curtis Island, in the Central Queensland region, directly offshore from the city of Gladstone. The proposed development involves a resort with various accomodation types, a central facility and associated infrastructure, including an airstrip.The specific survey sites identified for this assessment vary from an area of beach to mudflats, salt pans and tidal mangrove areas. Refer Section 3.2 for further details on each survey site.

2.0 SCOPE OF SURVEY

Six sites were identified within the subject site and surveyed using techniques and survey design generally outlined in the SGATB. Surveys were conducted at the various locations during February 2016 to provide a species count, evidence of presence of relevant shorebird species, available habitat for

these species and to determine the presence of a range of flora species. Further:

- Shorebird surveys and habitat assessment were targeted toward threatened and listed migratory bird species outlined within the RFI and associated correspondence. In particular, the species *Numenius madagascariensis* (Eastern Curlew) and *Calidris furruginea* (Curlew Sandpiper) were targeted. Surveys included intertidal point surveys foraging/traverse on foot and shorebird roost surveys by small vessel traverse along mangrove edges (at high tide) to facilitate flushing of target species; and
- Flora observation survey was undertaken across the subject site. Targeted flora species included the following;
  - *Samadera bidwillii;*
  - *Cupaniopsis shirleyana;*
  - *Cycas ophiolitica;* and
  - *Cycas megacarpa.*

3.0 METHODOLOGY

3.1 Shorebird Survey

Various methods were employed to collect data to satisfy the different aspects of the RFI. Table 3.1 below outlines the methodology, timing and survey effort employed to collect data on shorebirds at each survey location. Refer Figure 1 in Appendix A for survey locations. The survey team was lead by Andrew Thorrold, an Ecologist with 15 years experience in the field and six years consecutive experience working on Curtis Island and the subject site. Tide heights experienced throughout the survey period ranged from a low of 1.01m to a high of 4.19m.

Table 3.1 Dates, methodology and effort at each site surveyed at the Turtle Street Beach Resort.

Survey Location	Dates	Methodology	Survey Effort (Total Hrs)
1	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Foraging surveys (high and low tide) - 6hrs Opportunistic observations throughout the survey period. This survey point was observed every day due to being used for access to other survey locations and was used as a staging point. - 15hrs
2	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time	Foraging surveys (high and low tide) - 6hrs Opportunistic Observations - 1hr

Survey Location	Dates	Methodology	Survey Effort (Total Hrs)
		prior to and post surveys.	
3	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Foraging surveys (high and low tide) - 6hrs Opportunistic Observations - 1hr
4	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Foraging surveys (high and low tide) - 6hrs Opportunistic Observations - 1hr
5	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Foraging surveys (high and low tide) - 6hrs Opportunistic Observations - 1hr
6	2/2/2016 3/2/2016 4/2/2016 17/2/2016 18/2/2016 19/2/2016	Intertidal Point (Foraging) Survey • Sampling during high and low tides for shorebirds and habitat that may support target species. • Each site was traversed by two observers at both high and low tide within 2hrs either side of the tide, for a total of 30 minutes at each site, totaling one (1) man hour, • All observed species were identified, counted and recorded. • Relevant habitat observations recorded • All Evidence of Presence was recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Foraging surveys (high and low tide) - 6hrs Opportunistic Observations - 1hr
7	3/2/2016	Shorebird Roost Survey	Vessel man hrs - 1hrs

Survey Location	Dates	Methodology	Survey Effort (Total Hrs)
	18/2/2016	• Sampling at high tide for shorebirds via traverse by small vessel along the mangrove edge, flushing birds from roosting areas, generally for a 30 minute period either side of the high tide. • All observed species were identified, counted and recorded. Opportunistic Observations • Observations were recorded during site setup time prior to and post surveys.	Opportunistic Observations - 1hr

3.2 Habitat Observations

During the course of the shorebird surveys, observations on the available habitat were recorded. Habitat characteristics observed generally included the following;

- Site hydrology;
- Dominant landform type;
- Dominant terrestrial and aquatic vegetation types;
- Intertidal substrate characteristics; and
- Invasive species.

3.3 Flora Survey

Flora surveys were conducted throughout the proposal site and opportunistically at the numbered shore bird sites (i.e. sites 1 - 7), generally by traversing the areas and searching for the nominated species of concern. The flora survey effort was performed in addition to previous (extensive) flora surveys conducted over the site. Particular attention was paid to a small area of previously identified 'beach scrub', located close to shore bird survey site 1. This area was thought most likely to contain the targeted species of concern.

4.0 SURVEY OUTCOMES

4.1 Shorebird Survey

The resort site and associated areas surveyed had a very small number of individuals recorded, representing six species in total. These were limited to the Beach Stone-curlew (*Esacus magnirostris)*, Masked Lapwing (*Vanellus miles*), Black-winged Stilt (*Himantopus himantopus*), Bar-tailed Godwit (*Limosa lapponica*),White Faced Heron (*Egretta novaehollandiae*) and Pied Oyster Catcher (*Haematopus longirostris*).

Maximum species count for survey sites one to six are shown in the table below;

Common Name	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
Beach Stone-curlew	2					
Masked Lapwing		1			1	
Black Winged Stilt						1

Common Name	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
Bar-tailed Godwit					1	
White Faced Heron				1		1
Pied Oyster Catcher	2					

The maximum number of Shorebirds recorded at the survey locations was four individuals present at site 1. Survey site 3 recorded 0 birds, sites 5, 6, 2 and 4 each recorded one individual. All sites showed a lack of evidence of presence (droppings, calls, footprints, obvious roosts) of the targeted shorebird species.

4.2 Habitat Assessment

Habitat assessment was conducted at each site simultaneously with the shorebird counts. General details for each site are as follows. Refer Figure 1 in Appendix A for site locations and Site Photographs in Appendix B for further details. The site as a whole was observed as containing a range of habitat that was thought to be generally suitable as habitat for a range of shorebird species, generally with minimal levels of disturbance.

Site 1

This site generally represented a tidal sand flat/beach area adjacent a rocky headland and a small estuary mouth/area of mangroves.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Open beach (oceanic influence) - Mouth of small estuary	- Beach/sand flats	- Mangroves associated with small estuary - Fringing eucalypt woodland	- Sand	- Minimal to none	Good

Site 2

This site represented a tidal salt pan with some adjacent mangroves and eucalypt woodland. Some small areas of salt couch (*Sporobulous virginicus)* were also observed.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- minimal standing water observed	- intertidal clay/sand/salt flats	- Mangroves associated with small estuary - fringing eucalypt woodland - some areas of salt couch	- Clay material	- Minimal to none	Good

Site 3

This site represented an intertidal zone with surrounding mangrove vegetation, in the upper reaches of tidal influence. The site is directly adjacent (East of) the proposed run way for the development.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Tidal upper estuary	- Underlying rock	- Mangroves associated with small estuary - fringing eucalypt woodland	- Clay material	- Minimal to none	Good

Site 4

This site represented an intertidal zone with surrounding mangrove vegetation.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Tidal upper estuary	- Mud/clay flats - underlying rock	- Mangroves associated with small estuary - fringing eucalypt woodland	- Clay material	- Minimal to none	Good

Site 5

This site represented an intertidal zone with surrounding mangrove vegetation and significant areas of salt couch (*Sporobulous virginicus)* flats.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Tidal estuary	- Mud/clay flats	- Mangroves associated with estuary - Salt couch - fringing eucalypt woodland	- Clay material	- Minimal to none	Good

Site 6

This site represented an intertidal zone with surrounding mangrove vegetation and significant areas of salt couch (*Sporobulous virginicus)* flats.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Tidal estuary	- Mud/clay flats	- Mangroves associated with estuary - Salt couch - fringing eucalypts	- Clay material	- Minimal to none	Good

Site 7

This site represented a mangrove community with areas of mud flat (at low tide). Note, this was the only survey site where a boat was able to be employed into the survey effort.

Parameter	Hydrology	Dominant Land Form	Dominant terrestrial/aquatic vegetation	Intertidal Substrate Characteristics	Invasive Species	Overall Assumed Suitability as Shore Bird Habitat
Observations	- Tidal estuary	- Mud/clay flats	- Mangroves associated with estuary - fringing eucalypt woodland	- Clay/estuarine mud material	- Minimal to none	Good

4.3 Flora Survey

None of the species highlighted in the DoE RFI were observed within the site during the field surveys. It should be noted also that extensive flora surveys were completed for the site in 2015 by Logic Environmental (refer previously submitted documentation). The information below provides further discussion on the highlighted species and their likelihood to occur on the subject site.

Cupaniopsis shirleyana (Wedge-leaf Tuckeroo) – COMMENTS:

- *Cupaniopsis shirleyana* generally occurs in specific vineforest habitats - from simple microphyll closed forests to tall closed forest, often with Hoop Pine. The small areas supporting vineforest, vineforest species, and specific regional ecosystems near the 'resort area' were well surveyed for this plant during 2015.
- The majority of the property is comprised of Land Zone 11 (with scattered areas of LZs 2, 3 and 12; the three dominant LZs on which the plant could occur).
- Overall there is limited supporting habitat on site.
- The plant is recorded from Mt Larcom (probably on LZ12) and Turkey Beach – near Rodds Bay, Sth Gladstone (probably on LZ 2).
- There are no records mapped for Curtis Island, see. The Australian Virtual Herbarium website, the southern section of the island is mapped, only, as a 'likely' distribution area.
- However 'Curtis Island' is referenced as the northern limit of the plant's distribution on the Commonwealth Govt's 'Conservation Advice' for the species.

NOTES:

- Wedge-leaf Tuckeroo occurs in a number of small populations throughout its range, in dry rainforest and scrubby urbanised areas on moderate to very steep slopes, scree slope gullies and rocky stream channels at elevations of 60–550 m above sea level (Thomas & McDonald, 1989).
- Sites where the species has been found are mostly simple microphyll closed forests to tall closed forest, often with Hoop Pine (*Araucaria cunninghamii*) emergent (SPRAT Profile, 2015).
- The Wedge-leaf Tuckeroo is predominately found on dark brown sandy loams and sandy clay loams (pH 5-7.5) and rocky scree slopes (SPRAT Profile 2015). Generally, these soils have formed from volcanic parent materials (mainly granites and granodiorites, basalt and andesitic flows, and pyroclastics (Barry & Thomas 1994).

Above notes from - SPRAT Profile (2015). Commonwealth of Australia.

Samadera bidwillii (Quassia) - COMMENTS:

- Similar habitat that supports this species occurs on site – i.e. near 'temporary and permanent watercourses' in rainforest or on rainforest margins, open forest and woodland.

The watercourses and surrounding habitat areas near the 'resort area' were well surveyed for this plant.

- In 2001 the plant was 'confirmed' at 40 sites (see Notes below).
- It is recorded from the Mt Larcom area.
- There are no records mapped for Curtis Island, see The Australian Virtual Herbarium website, part of the island is mapped, only, as a 'likely' distribution area.
- There is no mention in the Commonwealth Gov't (2015) notification for occurrences of this plant on Curtis Island.

NOTES:

- Quassia commonly occurs in lowland rainforest or on rainforest margins (Hewson 1985), but it can also be found in other forest types, such as open forest and woodland (QDNR 2001). Quassia is commonly found in areas adjacent to both temporary and permanent watercourses (Belleng Pty Ltd 2004) in locations up to 510 m altitude. The species occurs on lithosols, skeletal soils, loam soils, sands, silts and sands with clay subsoils (Stanley & Ross 1983).
- Of the 40 sites on which Quassia occurs (where the species is confirmed), nine are within state forest, one within a military reserve, and one within a protected area (Stanley & Ross 1983; R. Melzer 1995, pers. comm., cited in QDNR 2001). The remaining sites are on freehold land or roadsides (Queensland Herbarium 2000).

Cycas ophiolitica – COMMENTS:

- The resort area is not within known distributional range – it is currently only known from the brigalow belt.
- The species is known to occur in certain Regional Ecosystems none of which were located on site.
- There are no records mapped for Curtis Island; refer The Australian Virtual Herbarium website. The island is mapped, only, as a 'likely' distribution area.

NOTES:

- *C. ophiolitica* is endemic to central Queensland where the known populations are concentrated in two areas, from Marlborough in the north, to the Fitzroy River near Rockhampton in the south, in woodland or open woodland dominated by eucalypts.
- It occurs within an altitudinal range of 80-400m, often on serpentinite substrates (with *Corymbia dallachiana, C. erythrophloia, C. xanthope, Eucalyptus fibrosa*), but also on mudstone (with *Corymbia dallachiana, C. erythrophloia* and *Eucalyptus crebra*) and on alluvial loams (with *Corymbia intermedia, Eucalyptus drepanophylla* and *E. tereticornis*).
- Above notes from - Queensland Herbarium. 2007. National Multi-species Recovery Plan for the cycads, *Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamiapauli-guilielmian Macrozamia platyrhachis,* Report to Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service, Brisbane.

Cycas megacarpa (Tree zamia) - COMMENTS:

- Tree Zamia is recorded from the Mt Larcom area, in open eucalypt forest on mid/upper and top of slope.
- Tree Zamia is known to occur in quite a number of REs and mosaics over its range; several of these occur in the resort area. Likely REs and surrounding areas near the 'resort area' were well surveyed for this plant.
- There are no records mapped for Curtis Island, see The Australian Virtual Herbarium website. The island is mapped, only, as a 'likely' distribution area.

NOTES:

- *C. megacarpa* occurs within an altitudinal range of 40–680m, in woodland or open woodland dominated by eucalypts, particularly *Corymbia citriodora* and *Eucalyptus crebra*, but also *Corymbia erythrophloia*, *E. melanophloia* and *Lophostemon confertus*. The substrate is usually rocky and derived from acid volcanics, ironstone or mudstone, rarely from alluvium.

5.0 CONCLUSIONS

The site (as a whole) displayed limited diversity/abundance of shore bird species. A total of 6 species were observed. The highlighted species, the Eastern Curlew (*Numenius madagascariensis)* and the Curlew Sandpiper (*Calidris furruginea*) were not observed. Of the species observed, the Beach Stone Curlew is federally listed as a marine species (EPBC Act) and in Queensland as vulnerable (NC Act) and the Bar Tailed Godwit is listed as migratory.

Various habitat observations were made during the course of the field surveys; these observations highlighted a range of habitat features generally considered suitable for a range of shore bird species. At this stage, it is unknown as to why shorebird species diversity/abundance levels were observed as being so low. There is some potential that diversity/abundance levels may display as higher at different times of the year, dependant on specific migratory patterns of birds in the area. It is also possible that shorebirds infact prefer other areas on Curtis Island or in the general vicinity.

Given the extent of survey effort employed (in this and previous studies), we consider it accurate to conclude that the site does not support the highlighted rare/threatened flora species (i.e. *Samadera bidwillii, Cupaniopsis shirleyana, Cycas ophiolitica* and *Cycas megacarpa).* Whilst certain site characteristics and the site's general location may suggest their potential existence, evidence at hand does suggest otherwise.

Whilst this report does not aim to provide in depth discussion on the proposed resort development and any potential environmental impacts associated, we do consider any impact on shore bird species/communities and their habitat will be minimal. We understand that all clearing activities on the site have been completed and that no direct impact on any areas of habitat/potential habitat will occur. We suggest, however, that a specifically designed management plan/strategy be employed during the operational phase of the resort to limit potential disturbance to shore birds, particularly in areas directly adjacent the resort and other areas of concentrated activity.

6.0 CLOSURE

If you have any further queries, please contact the undersigned.

Yours faithfully,

Andrew Thorrold
BAppSci (Hons) MEIANZ MAILDM
Director

logic ENVIRONMENTAL

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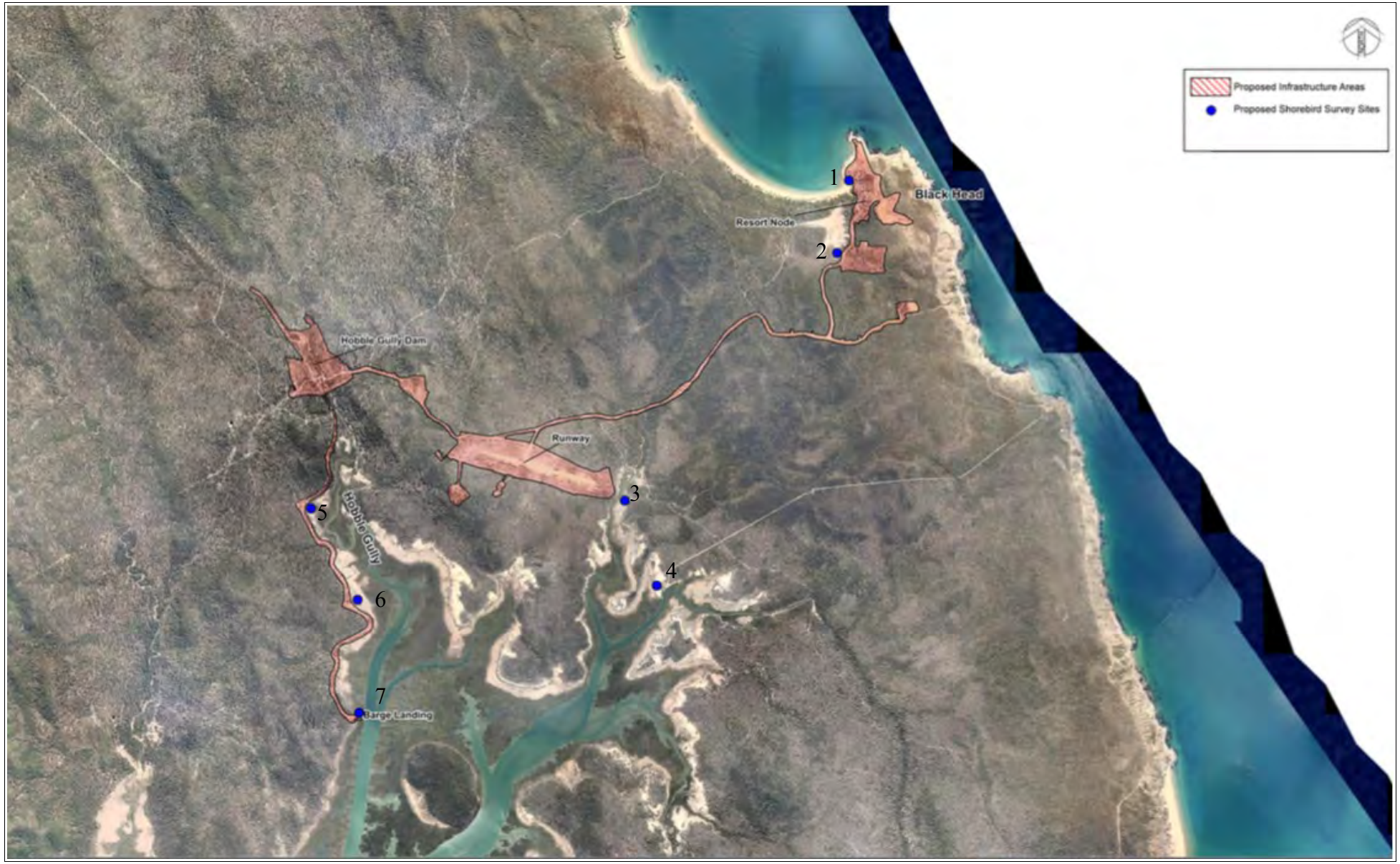
APPENDIX A:
FIGURES AND DIAGRAMS

Figure 1 – Shorebird Survey Sites



APPENDIX B:
SITE PHOTOGRAPHS

Site 1

Site 2

Site 3

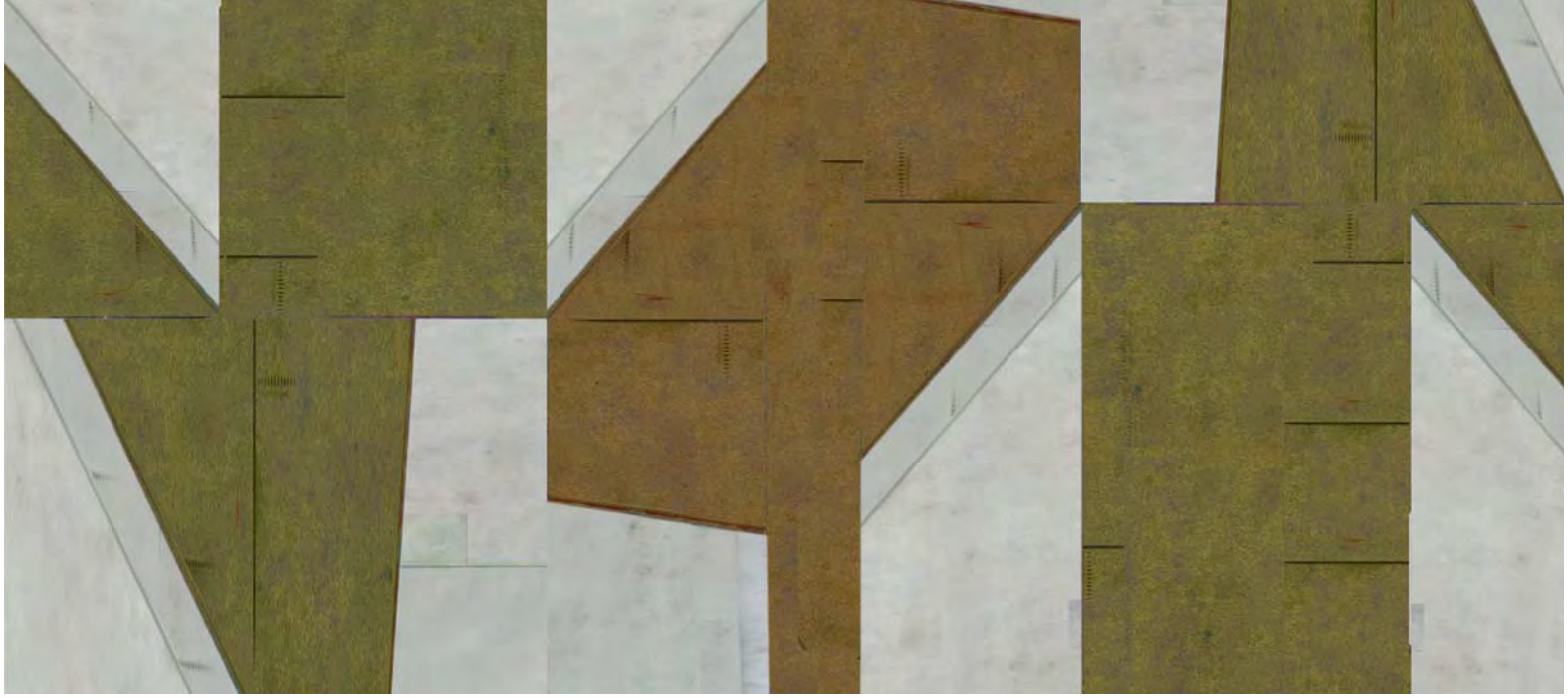
Site 4

Site 5

Site 6

Site 7

Attachment B: Turtle Street Beach Resort: Integrated Water Management Design Report (Bligh Tanner, December 2010)



Turtle Street Beach Resort: Integrated Water Management Design Report

December 2010

BLIGH TANNER
CONSULTING ENGINEERS

SUSTAINABLE LAND DEVELOPMENT

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ABN 32 061 537 666
LEVEL 9, 269 WICKHAM STREET
PO BOX 612
FORTITUDE VALLEY
QUEENSLAND 4006 AUSTRALIA
TELEPHONE +61 7 3251 8555
FACSIMILE +61 7 3251 8599
blightanner@blightanner.com.au
www.blightanner.com.au

Document: Turtle Street Beach Resort Integrated Water Management Design Report
Bligh Tanner Job Number: 2008.274.1
Project Engineer: David Hamlyn-Harris
Client: Queensland Resort Enterprises Pty Ltd
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Version	Author	Reviewed	Approved	Date
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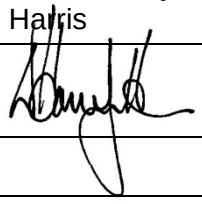
2	David Hamlyn-Harris	David Hamlyn-Harris		22 December 2010

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Attachments

Attachment A – Water Management Schematic

1 INTRODUCTION

1.1 Background

Queensland Resort Enterprises Pty Ltd is proposing the development of the Turtle Street Beach Resort at Black Head on Curtis Island. The site is located off the central Queensland coast near Gladstone and is currently accessible by boat only (refer to Figure 1).

In 2008, Bligh Tanner Pty Ltd was engaged to undertake a preliminary assessment of Water Management Options for the resort to provide initial estimates of population and demand and to provide initial evaluation of the water sources to the site and wastewater management options (Bligh Tanner 2009).

This document has been prepared as the basis for the design of the Integrated Water Management Systems for the Turtle Street Beach Resort.

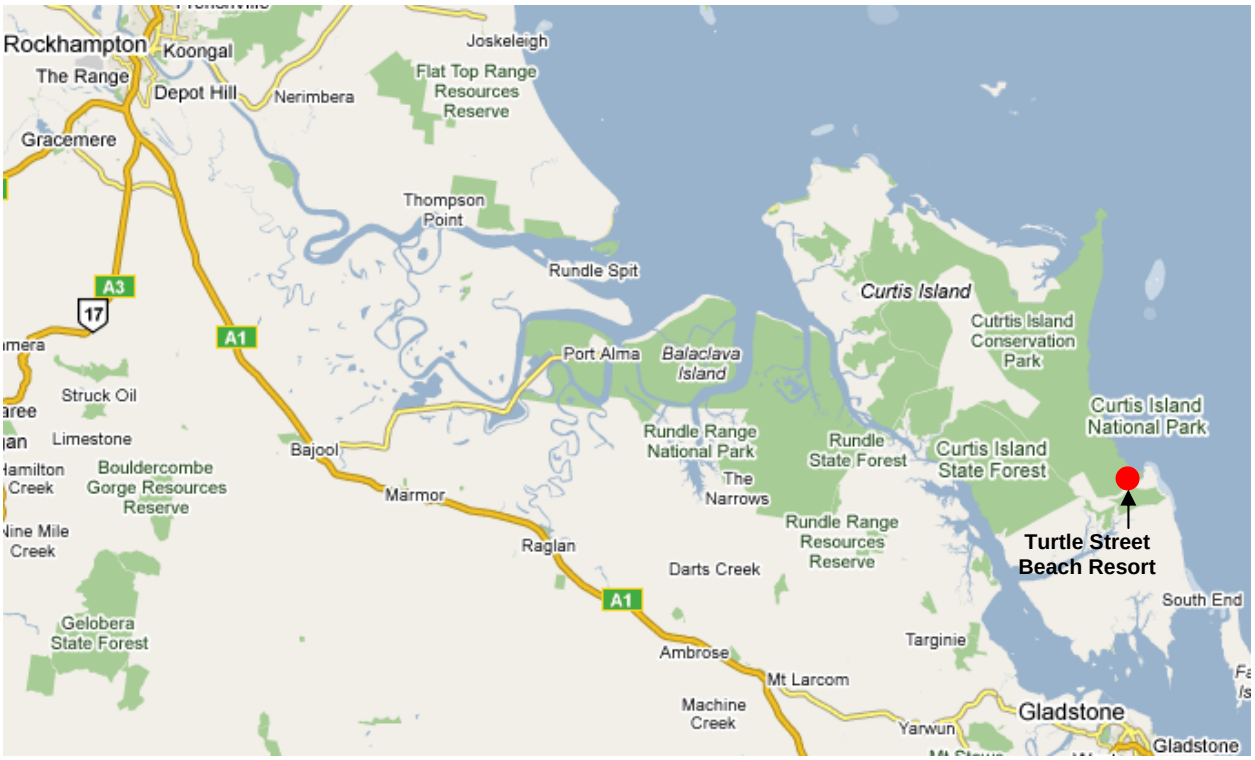


Figure 1 Locality plan

1.2 Objectives

The specific objectives of this report are to:

- Provide the basis for the design of water management systems, ie potable water, wastewater and recycled water for the development;
- Identify water uses and provide preliminary estimates of water demands and wastewater flows within the development;
- Identify water quality requirements for the intended use;
- Confirm the water sources that will be used;
- Present preliminary water balance modelling to illustrate the anticipated reliability of proposed sources to supply the water demands of the development; and
- Present the overall water balance for the development.

1.3 Previous Studies

In 2002 Mc William Consulting Engineers completed an Infrastructure Report (McWilliams 2002) and a number of concept drawings for the proposed works. Where relevant, the findings of this earlier work have been incorporated into this report.

Bligh Tanner completed the report, *Turtle Street Beach Resort: Preliminary Water Management Report*, in April 2009. This Design Report is based on the Preliminary |Water Management Report.

2 DEVELOPMENT DETAILS

2.1 Development Description

The site Master Plan is provided in Figure 2. The resort site is expected to be developed as follows:

Table 1 Development Details

Facility	Stage 1	Stage 2	Stage 3
Guest Accommodation: - 3 Bedroom Villas Type A - 3 Bedroom Villas Type B - 3 Bedroom Villas Type C - 2 Bedroom Units - King and Queen Units - Luxury Apartments	 24 bedrooms - - 40 bedrooms 68 bedrooms -	 - - - 20 bedrooms 32 bedrooms 26 bedrooms	 42 bedrooms 36 bedrooms 9 bedrooms - - -
Manager's Residence	1	-	-
Main Staff Accommodation	6 staff	-	-
Additional Staff Accommodation	10 staff	-	-
Restaurants	Main Restaurant A la carte Restaurant	-	Villa Facility Restaurant
Bar	Main Bar Sky Bar	-	-
Pools	510 m^2	-	150 m^2
Reception and Office	1	-	-
Villa Facilities	-	-	Day Spa

The landscaped areas within the development that have been identified (in consultation with the Project Principal) for irrigation are summarised below. The estimated areas are considered to be conservatively sized and will yield conservative estimates of irrigation water demand.

Table 2 Landscaped Areas to be Irrigated

Land Use	Area (ha)
R resort area landscaping	5.0
Recreational Lake landscaping	1.0
Access road planting	0.5
Open space in the horse paddock.	5.2
Total	**11.7**

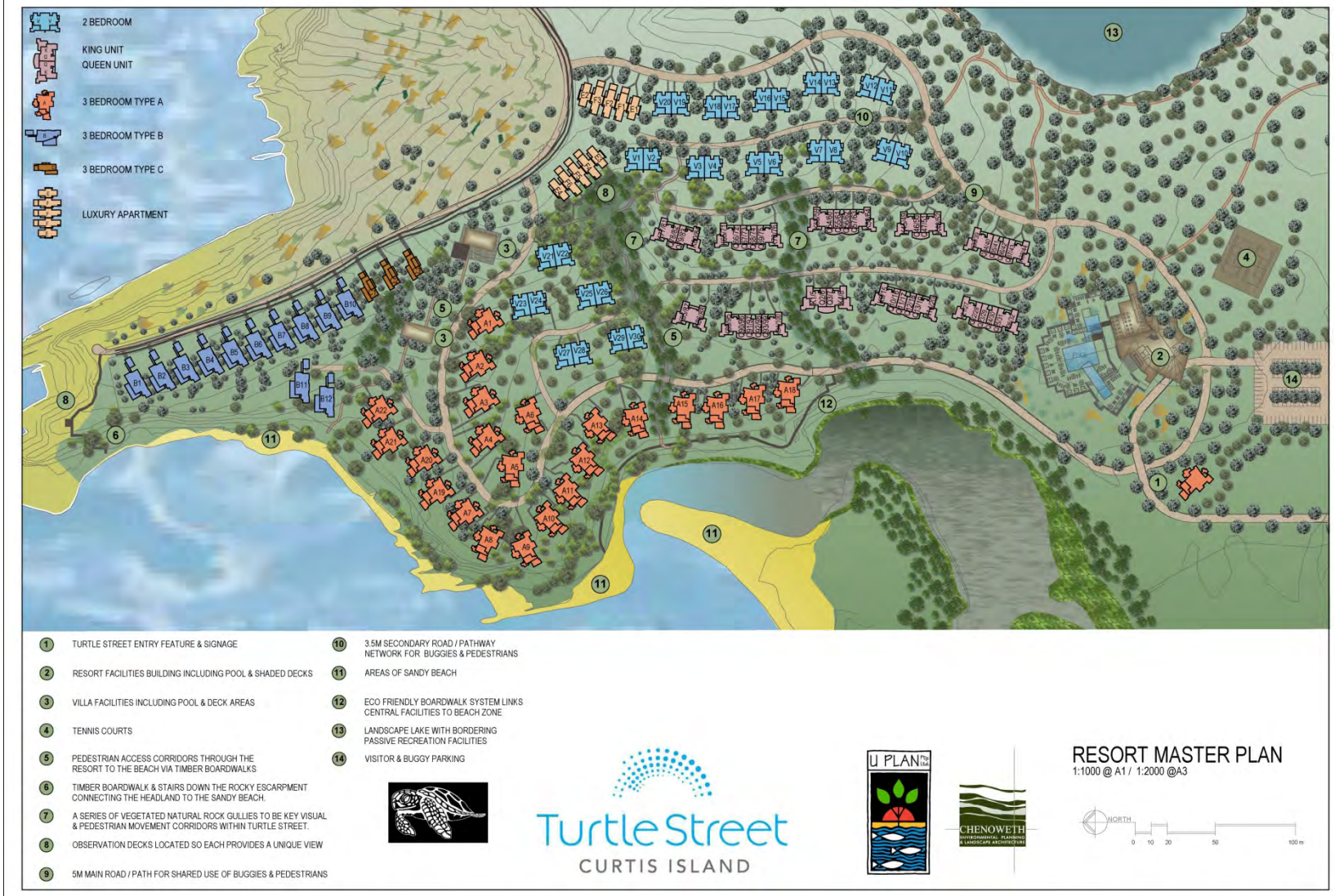


Figure 2 Turtle St Beach Resort Master Plan

2.2 Population Estimates

Estimates of average and peak resort guest population are shown in Table 3 and Table 4.

Table 3 Estimated Maximum Population – Guests Only

Accommodation	No. of Units	Effective No. of Bedrooms	Occupancy	Maximum People/unit	Maximum No. of People
3 Bedroom Villas	37	111	100%	6.3	233
2 Bedroom Units	30	60		4.2	126
King/Queen Units	100	100		2.1	210
Luxury Apartments	10	26		2.1	55
Total	**177**	**297**		**-**	**624**

Table 4 Estimated Average Population – Guests Only

Accommodation	No. of Units	Effective no of Bedrooms	Occupancy	Average People/unit	Average no. of People
3 Bedroom Villas	37	111	60%	3.8	140
2 Bedroom Units	30	60		2.5	76
King/Queen Units	100	100		1.3	126
Luxury Apartments	10	26		1.3	33
Total	**177**	**297**		**-**	**375**

For the purpose of water and wastewater flow estimates a number of assumptions regarding the site population have been made:

- The estimated maximum guest population is 624 people based on:
  - 297 bedrooms @ 2.1[1] people per bedroom = 624 people;
- The estimated average guest population is 375 people based on:
  - 60% population occupancy on average;
  - 297 bedrooms @ 2.1 people per bedroom with 60% occupancy = 375 people;
- The estimated staff population is expected to be:
  - 16 staff living on site permanently;
  - An average of 17 additional staff from the mainland;
  - Up to 30 additional staff in peak periods.

The seasonal variation in population adopted for analysis is illustrated in Figure 3. This indicates monthly average population varying from 290 up to 450 people.

[1] Allows 5% for use of sofa beds.

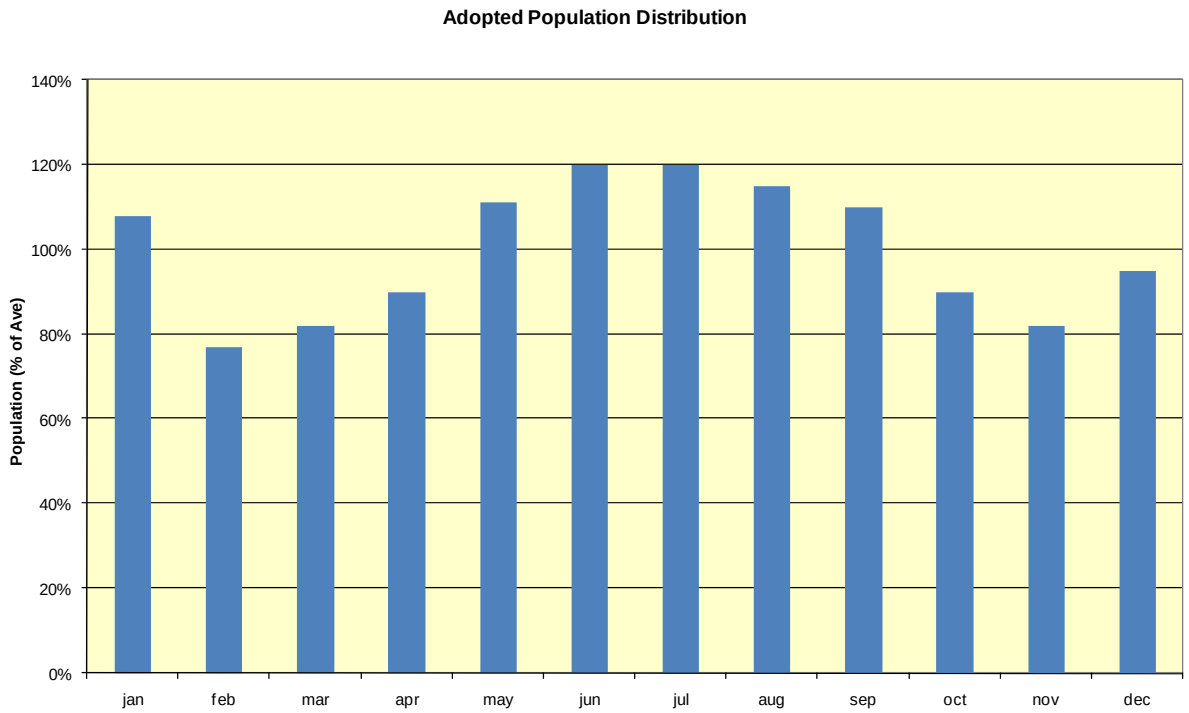


Figure 3 Adopted Seasonal Population Distribution

3 WATER USES AND DEMANDS

3.1 General

Water demand estimates have been prepared to provide design information as follows:

- The maximum daily water volume that must be supplied;
- The seasonal variations in water demand and the annual average demand;
- A breakdown in demand between the various uses to determine what water must be supplied from potable water and what uses could accept water of a lower quality;
- An estimate of the volume of wastewater that will be produced. The maximum flow will determine the wastewater treatment plant capacity required and the average flow and seasonal variations will determine the storage and irrigation areas required for disposal.

3.2 Water Uses

Water uses within the resort may include all of the following:

- Internal domestic uses within the accommodation units (including cooking, bathing, toilet flushing and laundry);
- Internal uses within the various guest facilities (including restaurants, bars, day spa);
- External uses such as building or car washing;
- Swimming pool backwashing and top-up;
- Landscape irrigation:
  - Within the resort area;
  - Along the access road;
  - Adjacent to the small recreational dam;
  - The Horse Paddock;
- Top-up of the recreational dam;
- Fire-fighting;
- Construction water, including earthworks, concrete batching and dust suppression.

3.3 Preliminary Water Demand Estimates

3.3.1 Assumptions

The assumptions made in developing water demand estimates are as follows:

- Resident internal water demand: 166 L/capita/day including planning factor of 20% (138 L/capita/day excluding planning factor);
- Demand for other uses such as Day Spa, restaurant, bar and community facilities are shown in Table 5;
- Average irrigation demand of 2.3 mm/day distributed seasonally based on crop factors and net rainfall;
- None of the accommodation units will have a swimming pool with residents to use the communal pool facilities;
- 59 units are expected to have spa baths or garden baths;
- The combined swimming pool and spa pool surface area is approximately 510m^2 in Stage 1 and 150 m^2 in Stage 3;
- Pool losses are based on daily evaporation data. Peak resort occupancy is assumed to coincide with the 98%ile pool evaporation rate. Evaporation losses are calculated based on an average net evaporation rate of 4.5 mm/day and a peak evaporation rate of 9.0 mm/day (Based on Department of Natural Resources data);

- Pool backwash calculations are based on a recommended pool turnover rate of 6 hours (Queensland Health Swimming and Spa Pool Water Quality and Operational Guidelines) and a backwash rate of 0.05% of the filter throughput;
- All residential demands include a planning factor of 20%; and
- Unit demand rates excluding the planning factor are distributed as shown in Table 5.

Table 5 Breakdown of Unit Demand Rates (excluding planning factor of 20%)

Use	User	Kitchen	Bath-room	Toilet	Laundry (HW)[2]	Laundry (CW)[3]	Total Internal
Resort	Guest/ Live in Employee	24.0	16.0	19.0	19.8	59.3	**138**
Central Facility	Visitor	0.5	22.5	3.0	0.0	0.0	**26**
Day Spa	Visitor	0.5	40.5	6.0	2.5	10.0	**60**
Restaurant/ Bar	Day Employee	10.0	3.0	12.0	0.0	0.0	**25**
	Restaurant Customer	5.0	3.0	9.0	1.5	6.0	**25**
	Bar Customer	0.0	3.0	9.0	0.5	2.0	**15**

3.3.2 General

The estimated peak and average residential water demands are given in Table 6 below.

Table 6 Water Demands for Guest Accommodation and Facilities

Water Use[4]	Average Water Demand		Peak Water Demand
	kL/d	ML/yr	kL/d
Stage 1:			
3 Bedroom Villas	5.0	1.8	8.3
2 Bedroom Units	8.3	3.0	13.9
King/Queen Units	14.2	5.2	23.6
Managers Residence	0.3	0.1	0.3
Staff Accommodation	2.7	1.0	2.7
Resort Restaurant/bar	9.2	3.4	15.3
Day Visitors and Staff	3.6	1.3	7.1
Swimming Pool	4.7	1.7	7.5
Spa baths/ Garden baths	1.8	0.7	5.4
Sub-total	**49.7**	**18.2**	**84.1**
Stage 2:			
2 Bedroom Units	4.2	1.5	7.0
King/Queen Units	6.7	2.4	11.1
Luxury Apartments	5.4	2.0	9.0
Sub-total	**16.3**	**5.9**	**27.1**

[2] HW = Hot Water.
[3] CW = Cold water.
[4] Staff water demands included under relevant area of employment.

Water Use[4]	Average Water Demand		Peak Water Demand
	kL/d	ML/yr	kL/d
Stage 3:			
3 Bedroom Villas	18.2	6.6	30.2
Day Spa	2.3	0.8	3.9
Villa Facility Restaurant	1.8	0.7	2.9
Villa Facility Swimming Pool	1.4	0.5	2.2
Spa baths/ Garden baths	1.7	0.6	5.2
Sub-total	**25.4**	**9.3**	**44.5**
TOTAL	**91.4**	**33.4**	**155.7**

The estimated peak and average water demands for the small dam and for landscape irrigation are given in Table 7.

The overall water demands are summarised in Table 8.

Table 7 Water Demands for Irrigation

Irrigation Area Options	Area (ha)	Average Water Demand		Peak Water Demand
		kL/d	ML/yr	kL/d
Resort area landscaping	5.0	115	42.0	350
Recreational Lake landscaping	1.0	23.0	8.4	70
Access road planting	0.5	11.5	4.2	35
Open space in the horse paddock.	5.2	120	43.7	364
Total	**11.7**	**270**	**98.2**	**819**

Table 8 Summary of Water Demand Estimates

Option	Peak Demand (kL/day)		
	Guest Accommodation & Facilities[5]	Irrigation[6]	Total
Peak Day	156	819	975
Average Day	91.4 (33.4 ML/yr)	270 (98.2 ML/yr)	361 (132 ML/yr)

The estimated peak daily demand is up to 975 kL/day for all uses assuming that the resort is at maximum occupancy. Water and wastewater infrastructure will need to be able to deliver water at this rate, however, because the resort is expected to be full for only relatively short periods at any one time, the peak demands will not need to be sustained for long.

The estimated average demand is 361 kL/day for all uses. This is equivalent to 37% of the peak highlighting the significance of taking into account the seasonal variations in resort occupancy and the seasonal variations in water demand for landscape irrigation.

The demand data highlights the dominance of irrigation uses on water demands.

[5] Potable water quality required for these uses.
[6] Irrigation does not require potable water quality, ie could be supplied by either raw dam water or recycled water.

3.4 Wastewater Flows

Wastewater flows are assumed to be equivalent to the total internal water usage, ie water used in kitchens, bathrooms, toilets and laundry. Estimated wastewater flows are provided below.

Table 9 Wastewater Flows

Condition	Wastewater Flow (kL/day)	Total (ML/year)
Peak Flow	149	-
Average Flow	88	32.1

4 WATER QUALITY REQUIREMENTS FOR IDENTIFIED USES

4.1 Minimum Water Quality Requirements

The minimum water quality requirements for the various water uses are indicated below.

Table 10 Water Quality Requirements for Proposed Uses

Use	Quality Required	Proposed Sources
Internal domestic uses within the accommodation units:		
• cooking, bathing and laundry (hot water)	Potable Water [7]	Treated dam water
• toilet flushing and laundry (cold water)	Recycled Water [8] Class A+ or better	Treated dam water
Internal uses within guest facilities (restaurants, bars, day spa):		
• cooking, bathing and laundry (hot water)	Potable Water	Treated dam water
• toilet flushing and laundry (cold water)	Recycled Water Class A+ or better	Treated dam water
External uses such as building or car washing	Recycled Water Class A+ or better	Treated dam water
Swimming pool backwashing and top-up	Potable Water	Treated dam water
Landscape irrigation:		
• Spray irrigation; unrestricted access	Recycled Water Class A or better	Treated dam water; Class A recycled water; Class A+ recycled water
• Spray irrigation; restricted access	Recycled Water Class B/C or better	Treated dam water; Untreated dam water; Class B recycled water
• Subsurface irrigation; unrestricted access	Recycled Water Class B/C or better	Treated dam water; Class B recycled water
Top-up of the recreational dam	Raw dam water	Untreated dam water
Fire-fighting	Recycled Water Class A+ or better	Treated dam water; Class A recycled water; Class A+ recycled water
Construction water:		
• Earthworks	Recycled Water Class B or better	Untreated dam water
• Concrete batching	Recycled Water Class A+ or better	Treated dam water; Untreated dam water
• Dust suppression	Recycled Water Class A+ or better	Untreated dam water

[7] Potable water must meet the requirements of the Australian Drinking Water Guidelines (2004).
[8] Recycled water quality requirements are included in the Water Quality Guidelines for Recycled Water Schemes (NRW 2008), the Public Health Amendment Regulation 2008 and the Australian Guidelines for Water Recycling (NRMMC, EPHC & AHMC 2006).

4.2 Potable Water Treatment Requirements

The water quality from the Hobble Gully Dam is expected to be relatively good though existing dams in the catchment exhibit a brown tannin colour due to decaying vegetation.

The water treatment system to produce high quality potable water for the resort is expected to include:

- Inlet screening;
- Media filtration possibly with addition of a coagulant or flocculent to improve filter efficiency;
- Membrane ultra-filtration to achieve very high suspended solids reduction;
- Ozonation for colour removal and disinfection;
- Possibly an activated carbon filter to remove residual organics and colour;
- Residual chlorine dosing.

As not all uses will require this quality water it may be possible to reduce treatment costs by separating potable and non-potable streams.

5 WATER SUPPLY SYSTEM

5.1 Water Management Strategy

A range of water supply options were considered in the Preliminary Water Management Report (Bligh Tanner 2009).

Turtle Street Beach Resort is remote from any reticulated water supply and will therefore need to be self-sufficient with respect to water supply. The proposed strategy for providing a secure water supply to the resort is as follows:

- Minimise water demand through adoption of a broad range of water conservation measures;
- Provide a treated potable water supply from the proposed Hobble Gully Dam;
- Use raw dam water and recycled water to irrigate landscaped areas within the site (refer to Section 7.2).

The proposed water management strategy is illustrated in the schematic in Attachment A.

The main elements of the strategy are as follows:

- The primary potable water source to the resort will be the Hobble Gully Dam;
- Untreated water will be pumped to the resort facilities area for treatment and distribution within the development;
- Treated water will be used for domestic potable uses and pool top up/backwash;
- Untreated dam water and recycled wastewater will be used for irrigation of landscaped areas within the resort;
- The total area of landscaping identified for irrigation is 11.7 ha;
- Fire-fighting water will be supplied from the potable water supply;
- Service reservoirs will be provided at the high point of the site to provide constant pressure into the distribution system;
- Provision will be made for water to be added to the recreational lake from the Hobble Gully Dam from time-to-time, however, this use has not been taken into account in the water balance calculations and will only occur subject to water availability at the time.

5.2 Hobble Gully Dam

Details of the proposed dam (taken from McWilliam Drawing No. C.05) are as follows:

- Embankment length – 280 m
- Maximum embankment height – 4.5 m
- Top of embankment – RL 8.5 mAHD
- Full supply level - RL 7.5 mAHD
- Maximum water depth at the dam – 5 m
- Catchment area – 1,119 ha
- Inundation area 12.4 ha
- Full volume – 194 ML

6 WASTEWATER MANAGEMENT

6.1 Wastewater Management Strategy

A range of wastewater management systems were considered in the Preliminary Water Management Report (Bligh Tanner 2009).

The main elements of the strategy are as follows:

- A central wastewater treatment plant will be provided in the resort facilities area;
- Wastewater will be collected in a system of gravity mains and pumping stations to the central plant;
- Wastewater will be treated to a quality suitable for reuse for irrigation of the Horse Paddock and other landscaped areas. The available irrigation area and wet weather storage volume will need to be large enough to ensure near full beneficial reuse (defined as 98% beneficial reuse). As discussed in Section 7.2 recycled water will need to be supplied to all identified irrigation areas to ensure that near-full beneficial reuse is achieved;
- Treated recycled water will be stored in wet weather storage tanks adjacent to the plant and distributed to reuse areas as required;
- The total area of landscaping identified for irrigation is 11.7 ha;
- The recycled water supply will be backed-up with raw water from the Hobble Gully Dam;
- Recycled water and raw dam water will be distributed to irrigation areas using a separate (3rd pipe) distribution system.

6.2 Wastewater Treatment

The wastewater treatment plant will need to be sized for the peak population in the resort. The wastewater will be similar quality to normal domestic sewage and the treatment processes provided will need to be capable of producing high quality recycled water suitable of use for irrigation. The plant is likely to include:

- Screening and (possibly) grit removal to remove gross / heavy solids upstream of the plant;
- Some form of biological secondary treatment process to break down organic matter and to reduce nutrient concentrations. Possible plant configurations include:
    - Extended aeration activated sludge (many different configurations available);
    - Membrane bioreactor process;
    - Trickling filter type processes, eg the Orenco Advantex® textile filter system;
    - Other specialist design, for example the Biolytix system;
- Filtration to reduce turbidity prior to disinfection;
- Disinfection using UV irradiation or chlorination.

6.3 Recycled Water Supply

The recycled water system is expected to include:

- Covered storage tank to balance seasonal supply and demand variations;
- Irrigation distribution pumps and distribution pipelines;
- Irrigation systems, either above-ground sprinklers or subsurface;
- Control systems to ensure that irrigation only occurs when it is not raining and there is a demand, including weather station, soil moisture sensors and irrigation sequencing controls.

Details of the recycled water balance, including minimum irrigation areas and storage volumes required, are provided in Section 7.2.

6.4 Regulatory Requirements

The quality of recycled water and the extent to which it can be used are determined by a number of guidelines and Acts. A brief overview of the relevant legislation and the implications for end use are provided below.

Environmental Protection Act and Regulations
The wastewater treatment plant would cater for a flow greater than 21 equivalent persons and therefore constitutes an Environmentally Relevant Activity under the Environmental Protection Regulation 1998 and would need a Development Permit from the Department of Environment and Resource Management (DERM). The DERM approval will include a range of conditions including minimum water quality and annual reporting. The plant would need to be operated by a registered operator (DERM Registration).

Water Supply (Safety and Reliability) Act 2008
The *Water Supply (Safety and Reliability) Act 2008* commenced on 1 July 2008. It is administered by the Department of Natural Resources and Water (NRW) and the Chief Executive of the NRW is the regulator under the Act. The *Act* also links to the *Public Health Act* via the Public Health Amendment Regulation 2008 providing minimum water quality requirements for recycled water.

A number of Guidelines have been prepared that define the detailed requirements under the Act:

- Recycled Water Management Plan and Validation Guidelines – November 2008, NRW;
- Recycled Water Management Plan Exemption Guidelines – November 2008, NRW;
- Water Quality Guidelines for Recycled Water Schemes – November 2008, NRW.

Because of the nature of this development (as a resort) it may not be necessary to comply with all requirements of this Act, or prepare a Recycled Water Management Plan, however it would be advisable to comply with the general requirements of the Act and guidelines particularly with respect to water quality, monitoring and control.

Australian Guidelines for Water Recycling
To the extent that the guidelines are not amended by the requirements of the new *Water Supply (Safety and Reliability) Act* the recycled water supply would be designed to meet the water quality requirements of the Australian Guidelines for Water Recycling (NRMMC, EPHC & AHMC 2006) and the Queensland Water Recycling Guidelines (EPA 2005)[9]. The water recycling guidelines adopt a risk-based approach to the design of water recycling systems, i.e. the minimum treatment processes and water quality to be determined based on an assessment of the risks associated with the water source and use.

Plumbing and Drainage
All plumbing and drainage would need to comply with AS/NZS 3500 (Set):2003 – Plumbing and Drainage.

[9] The NRW Guidelines replace Parts 4, 5 and 6 of the Queensland Water Recycling Guidelines (EPA 2005).

7 WATER BALANCE RESULTS

7.1 Hobble Gully Dam

A daily rainwater balance model has been developed for the proposed dam. The water balance assessed the variation in stored water volume and dam water level over time. The basic methodology included:

- Daily rainfall and evaporation data for the period November 1978 to October 2008 obtained from the Bureau of Meteorology's SILO database; the average annual rainfall to the area over this period is 844 mm/year;
- Volumetric runoff from the catchment was estimated to be 20% on average[10] (lower for low intensity rainfall events and higher for high intensity events);
- Daily water demands were input as follows:
  - Resort guest and facility demand from Table 6 varied seasonally as per Figure 3;
  - Irrigation demand taken from the recycled water balance (Section 7.2);
- The model calculates catchment runoff, evaporation losses, volume in storage, water level and overflows etc on a daily basis continuously over the 30 year analysis period;
- The model assumes that there is no leakage from the dam;
- The following output curves were generated:
  - Dam storage volume over time for the various demand scenarios - Figure 4;
  - A percentile analysis of dam storage - Figure 5. This shows the percentage of time that the dam is below a given storage level.

The model was run for a number of supply scenarios as detailed in Table 11.

Table 11 Summary of Water Balance Modelling

Scenario	Water Demand (ML/yr)		Water Supply (ML/yr)	
	Domestic	Irrigation	Hobble Gully Dam	Recycled Water
1. Base Case – all supply from Hobble Gully Dam	33.4	98.2	132	-
2. Recycled water used for irrigation	33.4	98.2	100	31.5
3. Potable water supply only	33.4	-	33.4	-
4. Recycled water use only	-	98.2	-	31.5

[10] Source: Draft Stormwater Harvesting Guidelines, Bligh Tanner, March 2009.

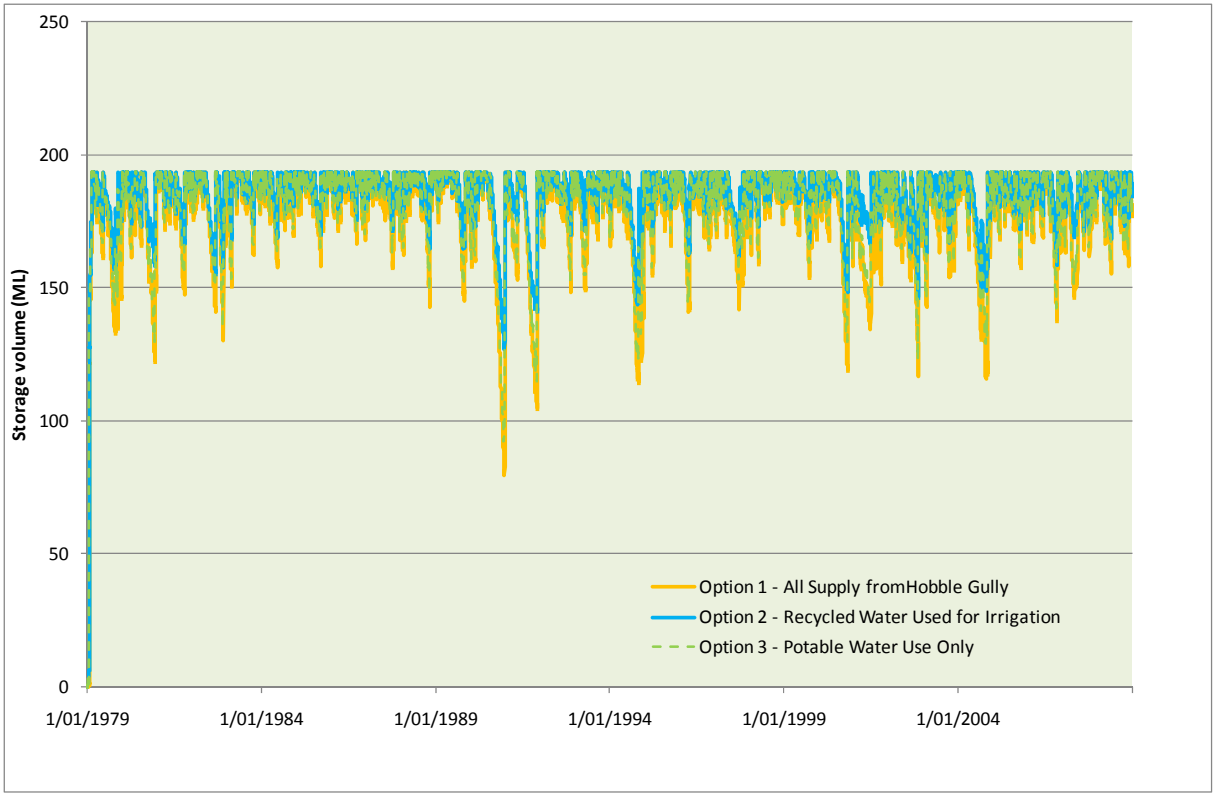


Figure 4 Hobble Gully Dam – Water Storage Variation Over Time

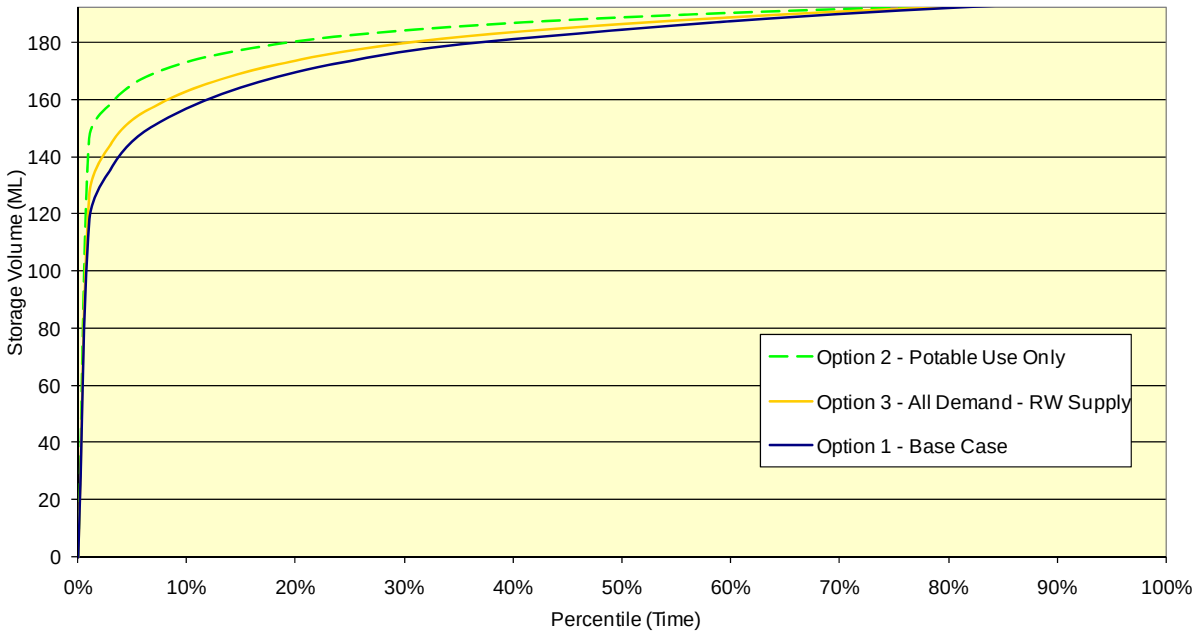


Figure 5 Hobble Gully Dam – Water Storage Percentile Analysis

For the proposed 194 ML dam, the model indicates that:

- Under the maximum demand Base Case (Option 1) the dam can meet all demand for 100% of the time and would be expected to be over half full for 99% of the time;

- As other non-potable demands are removed the dam becomes progressively more reliable, ie:
    - With all demands supplied from the dam the dam level never goes below 41%;
    - With recycled water used for irrigation (Option 2) – the dam never goes below 48% full;
    - Potable uses supplied only (Option 3) – the dam never goes below 66% full.

7.2 Recycled Water

A preliminary daily water balance model has also been developed to assess the area required for irrigation of the treated water from the wastewater treatment plant and the relationship between irrigated area, volume of storage available and the percentage of recycled water beneficially reused[11]. The results of the model are illustrated in Figure 6.

The results indicate that:

- At 2.3 mm/day the theoretical area required for irrigation of all the recycled water from the site is approximately 3.8 ha;
- However, because of the seasonal variations in demand and supply this is difficult to achieve in practice without excessively large balancing storage volumes. The practical option for effectively full (98%[12]) reuse is:
    - Irrigation of all landscaped areas with recycled water with 380 kL of storage tank;
    - Irrigation of only the Horse Paddock (as previously proposed) could achieve 98% reuse but would require a storage volume of approximately 4,500 kL; this is not practical;
    - This increase in area required results because the average volume of water to be irrigated has increased by approximately 40% and the irrigated area within the Horse Paddock has been reduced by 35%;
    - This approach uses 98% of the water but meets only 30% of the theoretical water demand for the irrigated areas.

The key conclusion from this analysis are as follows:

- Recycled water needs to be supplied to the full 11.7 landscaped area to ensure full beneficial reuse (the Horse paddock is not large enough on its own to provide full recycled water use);
- A minimum effective wet weather storage volume of 380 kL is required;
- There is insufficient recycled water available to meet all the water requirements of the landscaped areas;
- The recycled water supply will need to be supplemented with water from Hobble Gully Dam;
- It is recommended that recycled water be used as the primary source of irrigation water with untreated raw dam water supplied into the recycled water storage to meet irrigation watering requirements;
- A separate non-potable water reticulation system will be required to supply recycled water and dam water to irrigation areas.

[11] Beneficial reuse is defined as irrigation up to, but not exceeding, the plant water needs based on evapo-transpiration.

[12] 98% reuse has been adopted as the practical maximum for “beneficial” reuse without providing excessively large storages. The 2% that cannot be beneficially reused would still be applied to the irrigation area as an “over-irrigation” during wet weather periods. Past experience has shown that DERM will accept 98% reuse as effectively “full” reuse for the purposes of providing ERA approvals.

It should be noted that these results are based on a preliminary assessment of irrigation water usage. A more detailed assessment using site soils information and the MEDLI model will be required as part of any application to DERM for ERA approval.

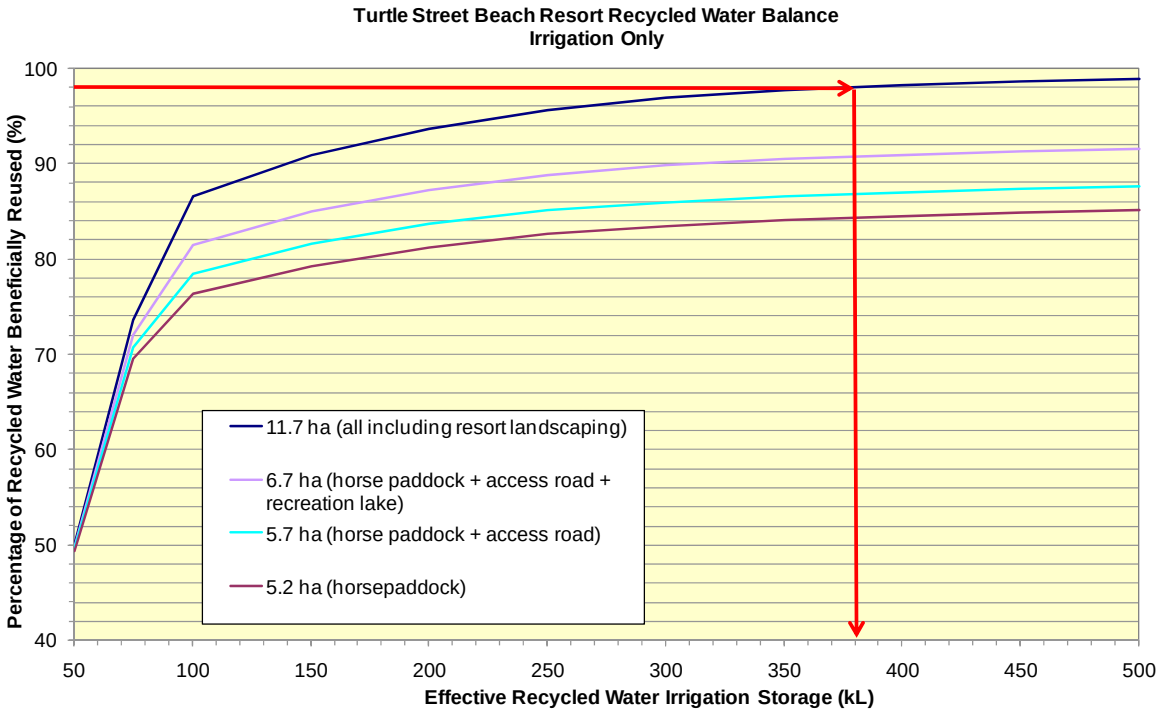


Figure 6 Recycled Water Balance Model Results

8 FIRE-FIGHTING

The resort will need to provide a minimum fire-fighting supply as follows:

- 15 L/s for a period of 2 hours, ie a total of 108 kL (NRM 1995).

At this stage it is anticipated that the fire-fighting system would be supplied from the potable water supply and would include as a minimum:

- 108 kL of fire storage either in a dedicated fire storage tank or within the larger water storage reservoir;
- An automatically started diesel fire pump to boost fire flows;
- Fire hydrants installed on the potable water distribution system.

9 REFERENCES

- Australian Drinking Water Guidelines (2004);
- Bligh Tanner 2009, Turtle Street Beach Resort; Preliminary Water Management Report, April 2009.
- EPA 2005, Queensland Water Recycling Guidelines, December 2005;
- McWilliams 2002, Curtis Island Beach Resort Development – Infrastructure Report, McWilliam Consulting Engineers, December 2002;
- NRM 1995, Planning Guidelines for Water Supply and Sewerage, Department of Natural Resources and Mines, March 1995;
- NRMMC, EPHC, AHMC (2006), Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1);
- NRW 2008a, Recycled Water Management Plan and Validation Guidelines – November 2008;
- NRW 2008b, Recycled Water Management Plan Exemption Guidelines – November 2008;
- NRW 2008c, Water Quality Guidelines for Recycled Water Schemes – November 2008;
- Queensland Health 2004, Qld health swimming and spa pool water quality and operational guidelines, Queensland Health, Brisbane

ATTACHMENTS

Attachment A – Water Management Schematic

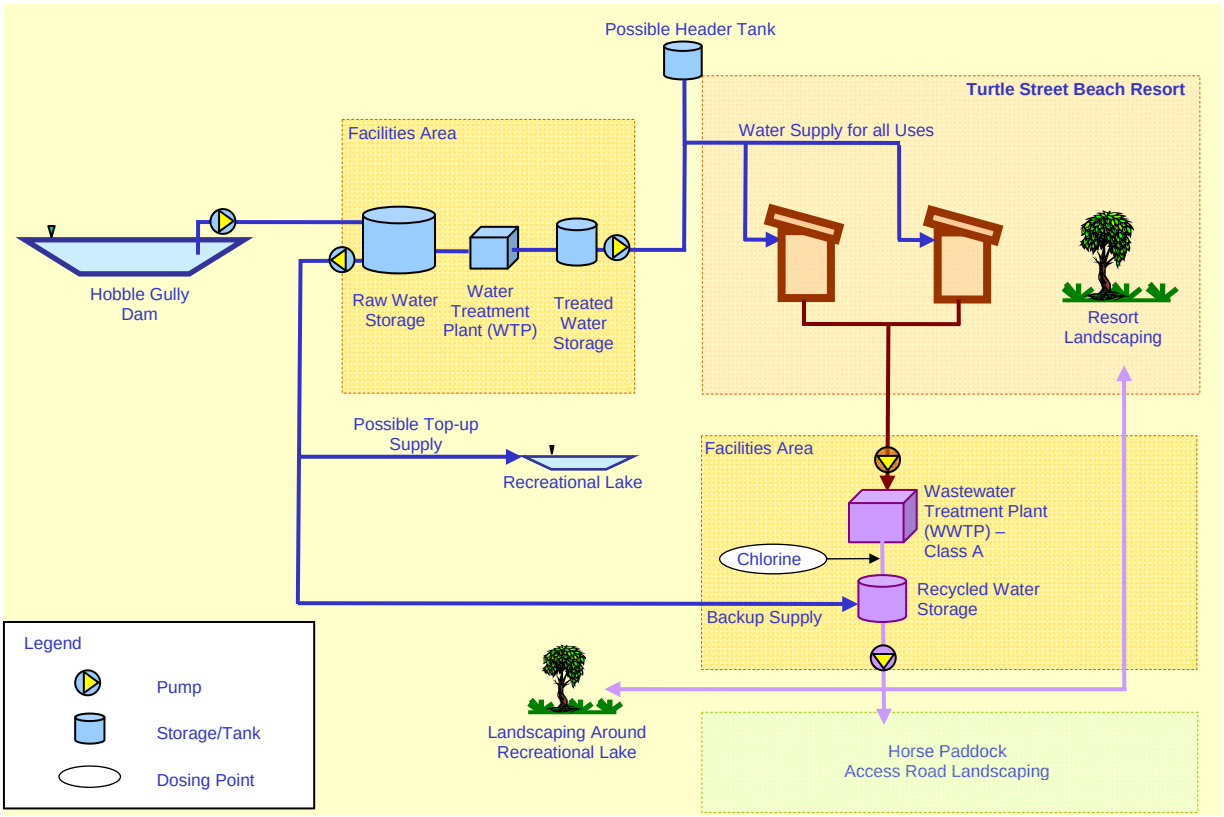


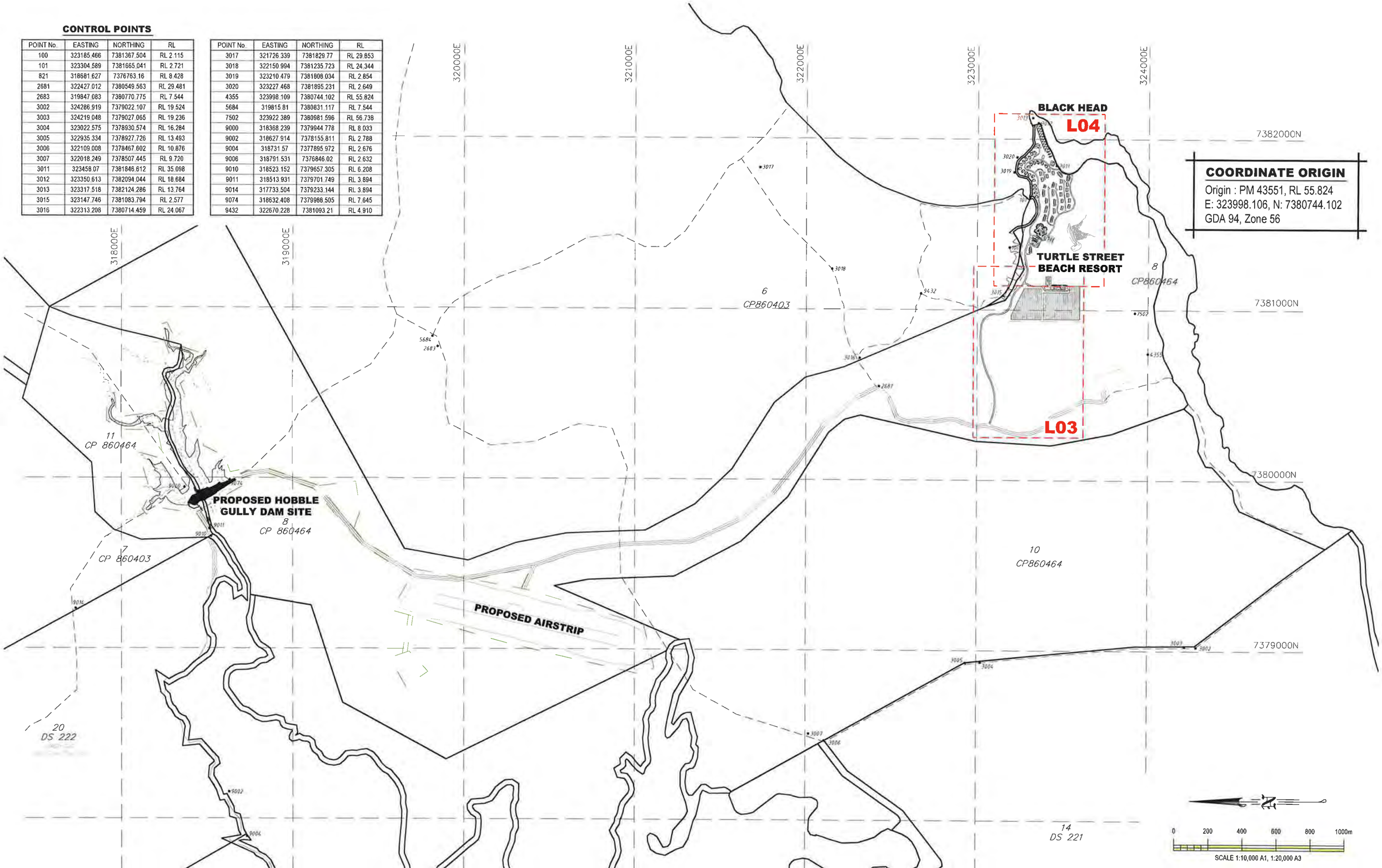
Figure 7 Water Management Schematic

Attachment C: Resort Layout Plan (Tate Professional Engineers, 2011)

CONTROL POINTS

POINT No.	EASTING	NORTHING	RL
100	323185.466	7381367.504	RL 2.115
101	323304.589	7381665.041	RL 2.721
821	318681.627	7376763.16	RL 8.428
2681	322427.012	7380549.563	RL 29.481
2683	319847.083	7380770.775	RL 7.544
3002	324286.919	7379022.107	RL 19.524
3003	324219.048	7379027.065	RL 19.236
3004	323022.575	7378930.574	RL 16.284
3005	322935.334	7378927.726	RL 13.493
3006	322109.008	7378467.602	RL 10.876
3007	322018.249	7378507.445	RL 9.720
3011	323458.07	7381846.612	RL 35.098
3012	323350.613	7382094.044	RL 18.684
3013	323317.518	7382124.286	RL 13.764
3015	323147.746	7381083.794	RL 2.577
3016	322313.208	7380714.459	RL 24.067

POINT No.	EASTING	NORTHING	RL
3017	321726.339	7381829.77	RL 29.853
3018	322150.994	7381235.723	RL 24.344
3019	323210.479	7381808.034	RL 2.854
3020	323227.468	7381895.231	RL 2.649
4355	323998.109	7380744.102	RL 55.824
5684	319815.81	7380831.117	RL 7.544
7502	323922.389	7380981.596	RL 56.738
9000	318368.239	7379944.778	RL 8.033
9002	318627.914	7378155.811	RL 2.788
9004	318731.57	7377895.972	RL 2.676
9006	318791.531	7376846.02	RL 2.632
9010	318523.152	7379657.305	RL 6.208
9011	318513.931	7379701.749	RL 3.894
9014	317733.504	7379233.144	RL 3.894
9074	318632.408	7379988.505	RL 7.645
9432	322670.228	7381093.21	RL 4.910



NOTE: ONLY DRAWINGS MARKED "FOR CONSTRUCTION" AND BEARING AN ORIGINAL SIGNATURE SHALL BE USED FOR CONSTRUCTION PURPOSES.

REV	DATE	DESCRIPTION	BY	CHKD

PRELIMINARY
NOT FOR CONSTRUCTION

DIRECTOR APPROVAL
RPEQ - 4665

Design: AL
Drawn: AL
Date: JULY 2011
Checked:
Datum AHD
A1 SHEET SIZE

TATE PROFESSIONAL ENGINEERS
TATE PROFESSIONAL ENGINEERS PTY LTD
A.B.N. 28 086 262 035
39-45 First Avenue, Mooloolaba
PO Box 1092, Mooloolaba, QLD, 4557
Tel (07) 5457 5300 Fax (07) 5477 6100
Email: engineers@tate.net.au
Web: http://www.tate.net.au

FILENAME C5668-11-L02.dwg - DATE 21/11/12 11:12am XREF's X-C5668-Overall Base 004-SITEPLAN SITEPLAN_WO-06

PROJECT:
TURTLE STREET BEACH RESORT
at CURTIS ISLAND, GLADSTONE
for QRE Pty Ltd

Council Ref:

Turtle Street
CURTIS ISLAND

DRAWING TITLE:
OVERALL LAYOUT PLAN

DRAWING No: C5668/11/L02
Revision
Sheet 2 of 5

REFER TO DRG No. L04 FOR CONTINUATION

INFRASTRUCTURE COMPOUND

ROAD 19

ROAD 21

ROAD 20

ROAD 18

PROPOSED SEWER & WATER STORAGE & TREAMENT AREA.

PROPOSED EFFLUENT IRRIGATION AREA.

APPROXIMATE EXTENT OF EXISTING CLEARED AREA.

APPROXIMATE EXTENT OF EXISTING CLEARED AREA.

ROAD 1

PROPOSED RESORT ACCESS ROAD (TO FUTURE DESIGN DETAILS)

TO SOUTHEND

TO HOBBLE GULLY BARGE

0 25 50 75 100 125m

SCALE 1:1250 A1, 1:2500 A3

NOTE: ONLY DRAWINGS MARKED "FOR CONSTRUCTION" AND BEARING AN ORIGINAL SIGNATURE SHALL BE USED FOR CONSTRUCTION PURPOSES.

REV	DATE	DESCRIPTION	BY	CHKD

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DIRECTOR APPROVAL
RPEQ - 4665

Design: AL
Drawn: AL
Date: JULY 2011
Checked:
Datum AHD
A1 SHEET SIZE

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PROFESSIONAL ENGINEERS

TATE PROFESSIONAL ENGINEERS PTY LTD
A.B.N. 28 086 262 035
39-45 First Avenue, Mooloolaba
PO Box 1092, Mooloolaba, QLD, 4557
Tel (07) 5457 5300 Fax (07) 5477 6100
Email: engineers@tate.net.au
Web: http://www.tate.net.au

FILENAME C5668-11-L03-L04.dwg - DATE 21/11/12 - 11:18am - XREF's X-C5668-Overall Base, 004-SITEPLAN_SITEPLAN_WO-05 X-TOPO CONTS 1500

PROJECT:
TURTLE STREET BEACH RESORT
at CURTIS ISLAND, GLADSTONE
for QRE Pty Ltd

Council Ref:

Turtle Street
CURTIS ISLAND

DRAWING TITLE:
RESORT LAYOUT PLAN
SHEET 1 OF 2

DRAWING No: C5668/11/L03

Revision

Sheet 3 of 5

PROPOSED HEADER TANKS.

APPROXIMATE EXTENT OF EXISTING CLEARED AREA.

PROPOSED NEW DAM.

PROPOSED TENNIS COURTS.

CENTRAL FACILITIES BUILDING

PROPOSED SEWER & WATER STORAGE & TREAMENT AREA.

ROAD 5
ROAD 10
ROAD 8
ROAD 6
ROAD 4
ROAD 12
RD 16
ROAD 14
ROAD 2
ROAD 3
ROAD 1
ROAD 21
ROAD 20

REFER TO DRG No. L03 FOR CONTINUATION

0 25 50 75 100 125m

SCALE 1:1250 A1, 1:2500 A3

NOTE: ONLY DRAWINGS MARKED "FOR CONSTRUCTION" AND BEARING AN ORIGINAL SIGNATURE SHALL BE USED FOR CONSTRUCTION PURPOSES.

REV	DATE	DESCRIPTION	BY	CHKD

PRELIMINARY
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DIRECTOR APPROVAL
RPEQ - 4665

Design: AL
Drawn: AL
Date: JULY 2011

Checked:

Datum AHD

A1 SHEET SIZE

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PROFESSIONAL ENGINEERS

TATE PROFESSIONAL ENGINEERS PTY LTD
A.B.N. 28 086 262 035
39-45 First Avenue, Mooloolaba
PO Box 1092, Mooloolaba, QLD, 4557
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Email: engineers@tate.net.au
Web: http://www.tate.net.au

FILENAME C5668-11 L03 L04.dwg DATE 21/11/12 - 11:16am XREFs X-C5668-Overall Base 004-SITEPLAN SITEPLAN_WD-05 X-TOPO CONTS 1500

PROJECT:
TURTLE STREET BEACH RESORT
at CURTIS ISLAND, GLADSTONE
for QRE Pty Ltd

Council Ref:

Turtle Street
CURTIS ISLAND

DRAWING TITLE:
RESORT LAYOUT PLAN
SHEET 2 OF 2

DRAWING No: C5668/11/L04

Revision

Sheet 4 of 5

Attachment D: Currency Period of Approvals

GLADSTONE REGIONAL COUNCIL

Gladstone Regional Council
PO Box 29, Gladstone Qld 4680
Phone (07) 4970 0700 Fax (07) 4975 8500
Email info@gladstonerc.qld.gov.au
Website www.gladstone.qld.gov.au

Please address all correspondence to The Chief Executive Officer

Contact Officer: Renqi Shen
Contact Phone Number.: 07 4977 6830
Our Ref: OPW/436/2013

12 June 2015

Q R E Pty Ltd
CARE Tate Professional Engineers Pty Ltd
PO Box 1092
MOOLOOLABA QLD 4557

Dear Sir/Madam

EXTENSION OF CURRENCY PERIOD
DEVELOPMENT APPLICATION NO. OPW/436/2013
OPERATIONAL WORKS APPLICATION - ROAD WORKS, STORMWATER, WATER INFRASTRUCTURE, DRAINAGE WORKS, EARTHWORKS, SEWERAGE INFRASTRUCTURE & LANDSCAPING - TURTLE STREET RESORT

DESCRIPTION: LOT 8 CP 860464, CURTIS, LOT 11 CP 860464, CURTIS, LOT TL 220087

I refer to your recent application received by this office on the 4 June 2015 for an extension of the currency period for the above application.

I wish to advise that Council agrees to an extension for a further *24 months* from the date of the current expiry date being *26 July 2015*. As such, the abovementioned operational works approval now lapses on the *26 July 2017* unless works have substantially commenced.

Please be advised that Council would be unlikely to support any further requests for an extension of the currency period beyond this date.

Please note that the currency period for the associated approval (DA/99/2009) has not automatically been extended as a result of this development extension approval. The Development Application is due to lapse on *26 July 2017*. Therefore it is recommended that you liaise with Council's Planning Department in regards to any further required extensions.

Should you have any queries in relation to this matter, please contact Council's Engineer - Development, Renqi Shen on **07 4977 6830**.

Yours Sincerely

EMMA HAMILTON
ACTING MANAGER TECHNICAL SERVICES

CC. David Douglas, QRE Pty Ltd

Attachment E: Gladstone Region 2013/2014 Marine Turtle Hatchling Orientation Monitoring Program, Pendoley Environmental (May 2014)

Note: REFER TO APPENDIX 1: MANAGEMENT OF CHANGE (SCOPE CA130031): RECORD OF COMMUNICATIONS BETWEEN DEHP, PENV AND GPC REGARDING DEVELOPMENT AND APPROVAL OF SURVEY DESIGN

GLADSTONE PORTS CORPORATION

GLADSTONE REGION 2013/2014 MARINE TURTLE HATCHLING ORIENTATION MONITORING PROGRAM

Prepared by

Pendoley Environmental Pty Ltd

For

Gladstone Ports Corporation

May 2014

PENDOLEY ENVIRONMENTAL

MARINE CONSERVATION ENVIRONMENTAL SERVICES

DOCUMENT CONTROL INFORMATION

TITLE: GLADSTONE REGION MARINE TURTLE HATCHLING ORIENTATION MONITORING PROGRAM 2014

Disclaimer and Limitation

Document History

Revision	Description	Date received	Date issued	Personnel
Draft	Report Draft		28/02/2014	Dr K. Pendoley/Dr C Bell
Rev IA	Technical/Editorial Review	28/02/2014	8/03/2014	Dr Brenda Landau
Rev IB	Internal Review	28/02/2014	13/03/2014	Tyrone Farrell
Rev IC	Peer Review	28/02/2014	17/03/2014	Professor B. Godley / Dr A Rees
Rev A	Client review	28/02/2014	18/03/2014	Mr Arvind Singh/ERMP
Rev B	Address comments (Editorial)	07/04/2014	09/04/2014	Kitty Drok
Rev B	Address comments	07/04/2014	07/05/2014	Dr Catherine Bell
Rev 0	Final report issued			

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Author(s):	Dr Kellie Pendoley/Dr Catherine Bell
Project manager:	Dr Catherine Bell
Name of organisation:	Pendoley Environmental Pty Ltd
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Client	Gladstone Port Corporation
Client representative:	Mr Arvind Singh
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EXECUTIVE SUMMARY

Flatback turtles (*Natator depressus*) are the dominant nesting marine turtle species in the Port Alma and Port Curtis regions. As many as 500 females nest annually on the beaches of Peak Island and South End Beach on Curtis Island reports between 10–100 females present at the nesting beach annually.

Hatchling sea-finding behaviour is primarily regulated by visual cues - hatchlings have a primary tendency to orient toward the brightest horizon, typically the ocean, as lit by astral light sources (the moon and/or stars), in contrast to the darker rear beach dune silhouette.

Artificial light has been shown to disrupt natural night horizons in proximity to nesting beaches (Limpus & Kamrowski 2013). Quantification of night sky horizons has shown that existing ambient night time dark sky horizons are considered highly modified by artificial light pollution (ERMP 2013, Kamrowski et al 2012). Pendoley Environmental (2012) detected and described specific light sources visible from nesting beach on Curtis and Facing Islands.

This survey was designed to allow for detection of potential variation in indices of hatchling orientation that may result from the influence of artificial lighting profiles associated with construction works and future operational lighting at the Curtis Island LNG gas plant. Modified survey design proposed six survey days on each of Curtis and Facing Islands and seven on Peak Island to capture primary nesting locations within the region. Adverse weather conditions limited access to sites and survey period at Facing Island was limited to five days and sampling at Peak Island did not take place.

A total of 28 turtle clutches, 27 flatback and one green (*Chelonia mydas*), were identified and assessed. Spatial distribution of samples was as follows: Curtis Island, flatback turtle n = 23, green turtle n = 1; Facing Island, flatback turtle n = 4.

The median spread angle of emerged clutches of flatback turtle hatchlings at Curtis Island (primary dune) in 2013/14 was 35° (interquartile range: 27 – 47°, n = 21). The median spread angle at Settlement Beach, Facing Island was 34° (interquartile range = 33° – 43°, n = 4). The mean spread angle at Curtis Island (swale) was 174° (range = 137° – 210°, n = 2).

The median offset angle of emerged clutches of flatback turtle hatchlings at Curtis Island (primary dune) in 2013/14 was 8° (interquartile range: 5° – 15°, n = 21). The median offset angle at Settlement Beach, Facing Island was 9° (interquartile range = 5° – 18°, n = 4). The mean spread angle at Curtis Island (swale) was 35° (range = 19° – 51°, n = 2).

The orientation of hatchlings emerging from the single green turtle clutch recorded in the primary dune area at Curtis Island was 23° (spread) and 3° (offset).

Specific outcomes

- Median spread angles among primary dune locations at Curtis and Facing Islands were considered to be similar, being 35° and 34° respectively.
- Spread angles of clutches located in the swale at Curtis Island was substantially greater than those located along the primary dune and facing the ocean.

- Median offset angles among primary dune locations at Curtis and Facing Islands were considered to be similar, being 8° and 9° respectively.
- Offset angles of clutches located in the swale at Curtis Island were substantially greater than those of clutches located along the primary dune and facing the ocean.
- Based on the limited survey data, flatback and green turtle hatchlings emerging from clutches located on the primary dune at both Curtis and Facing Islands orientated successfully toward the ocean without detectable disruption.
- Hatchlings emerging in the swale section of Curtis Island are likely to spend greater periods of time on the beach immediately following emergence, due to variation in topographical cues that confound sea-finding.
- It is not known whether variation among sites is statistically significant however the literature suggests frequent dis-or mis-orientation at this location due to limited access to typical sea-finding cues and this variation may not therefore be associated with altered night-sky horizons.
- Sample size was the primary constraint in data analysis and assessment of findings and it is recommended that survey duration in future sampling seasons is extended to account for low nesting density and inclement weather conditions.

Decision-making regarding these rookeries and management of artificial light sources associated with the Western Basin Dredging Project and facilities at the Curtis Island LNG plant must be evidence-based. Accumulation and analysis of robust multi-seasonal datasets regarding hatchling orientation and artificial light profiles will provide a sound scientific basis for decision-making and advice.

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1 INTRODUCTION

1.1 Background

Flatback turtles (*Natator depressus*) are the dominant nesting marine turtle species in the Port Alma and Port Curtis regions; on the east coast of Australia their range extends north from 19°–24° S. Low-density nesting occurs along the entire mainland coastline and on adjacent islands from Port Douglas to Bundaberg. Primary rookeries (turtle breeding colonies) of as many as 500 females nest annually on the beaches of Wild Duck, Avoid and Peak Islands (Limpus et al. 2002). South End Beach on Curtis Island is one of 30 rookeries reporting 10 – 100 females present at the nesting beach annually, and there are at least 50 additional, smaller rookeries reporting between 1–10 females present at the nesting habitat in each reproductive season (ERMP 2013).

1.1.1 Hatchling Orientation

Marine turtle hatchlings typically emerge from the buried nest at night (Miller 1997), *en masse*, with several smaller groups often making it to the surface either before or after the main cluster (Lohmann et al. 1997). Protracted emergences are not uncommon and have been documented in several species of marine turtle (see Koch et al. 2008 for review). The precise timing of emergence is controlled by the gradient of the sand temperature (Mrosovsky 1968; Glen et al. 2004) and social facilitation of other hatchlings within the clutch (Carr & Hirth 1961; Bustard 1967). Social facilitation describes an event where an individual performing an instinctive pattern of behaviour acts as a releaser for the same behaviour in others, and so initiates the same line of action in the whole group thus stimulating mass emergence which can occur at any time throughout the night (Lohmann et al. 1997).

Following emergence from the nest, hatchling sea-finding behaviour is primarily regulated by visual cues (Mrosovsky 1972) with some level of response to non-visual cues, particularly where no visual cues are present (Salmon et al. 1992; Limpus & Kamrowski 2013). There are three primary rules hatchlings use when sea-finding: first, they move toward brighter regions; second, they move away from high beach silhouettes (e.g. dunes); and third, when these two cues are inconsistent, they move in relation to elevation (i.e. downwards) and not brightness cues (Bartol & Musick 2003; Limpus & Kamrowski 2013).

Using these cues, and in the absence of interfering cues or hazards, hatchlings will generally take the most direct route toward the sea (Lohmann et al. 1997). Sea-finding is primarily directed by shape and/or elevation cues, made more or less prevalent in specific environments by levels of ambient light (Salmon & Witherington 1995), whether natural or anthropogenic (human influence). Where beach characteristics such as width and/or dune height vary, sea-finding behaviour may be naturally variable in response to these cues.

Light has multiple properties (intensity, wavelength, directivity and polarisation), all of which may impact sea-finding behaviour (Lohmann et al. 1997). Hatchlings have a primary tendency to orient toward the brightest horizon, typically the ocean, as lit by astral light sources (the moon and/or stars), in contrast to the darker rear beach dune silhouette. This contrast is particularly visible when observed from a hatchling's vantage point, i.e. ground level. Where beaches are wide and flat

orientation may be less accurate; on moonless (dark) nights or brightly lit beaches orientation has also been known to be impacted (Lohmann et al. 1997). Longer, more circuitous routes taken by either disoriented (wandering in random directions) or mis-oriented (wandering in the wrong direction) hatchlings may result in predation, dehydration and ultimately death (Salmon 2003).

A gap analysis submitted to GPC by the Ecosystem Research and Management Progam (ERMP) has described the current store of knowledge regarding these populations, their status and vulnerability to multiple and cumulative stressors, and also identified where data were lacking (ERMP, 2013). Additional and ongoing information is required to effectively monitor these populations and their response to increasing pressure caused by specific projects e.g. the Western Basin Dredging Project and importantly, cumulative effects from industrial and urban expansion in all forms.

Identified threats to marine turtle populations and individuals of all life-stages in this region include urban and coastal development along the mainland coast, in particular industrial development associated with the expansion of industry within the Port Alma and Port Curtis regions. Artificial light has been shown to disrupt natural night horizons in proximity to nesting beaches (Limpus & Kamrowski 2013) and the quantification of night sky horizons has shown that existing ambient night time dark sky horizons are considered highly modified by artificial light pollution (ERMP 2013, Kamrowski et al 2012).

1.2 Scope of Work and Objectives

The Gladstone Ports Corporation (GPC) Western Basin Dredging Project Hatchling Orientation Monitoring Program has been designed to specifically address parameters required by GPC Work Scope CA130031 relating to hatchling orientation on marine turtle nesting beaches in the Port Curtis and Port Alma regions.

Scope of Works CA130031 describes the requirement for data to be collected over:

- two nights at two locations on each of Curtis and Facing Islands in spatial and temporal alignment with deployment of equipment for collection of artificial light data in the previous (2011) monitoring season (Pendoley Environmental 2012);
- two nights at Peak Island;
- two nights at three locations on the Gladstone/Yeppoon coastline to be determined in consultation with the Queensland Department of Environment and Heritage Protection (DEHP) rangers responsible for managing local marine turtle populations; and
- use of best practice to analyse and interpret the collected data to identify potential areas of risk to marine turtles resulting from artificial light, for use in the ongoing assessment and management of the impacts on these species in the Port Curtis and Port Alma regions.

Survey design in the Scope was subsequently modified to ensure the greatest value could be extracted from field surveys. This was carried out in communication with, and following approval by the GPC. Details regarding the consultation and decision-making processes in the development of

the final survey design, collaborations entered into for data collection, and agreements for data sharing are provided in **Section 2.1** with supporting documentation in **Appendix 1.**

Quantification of survey effort (in terms of duration) is described (as per Scope CA130031; **Section 1.2**) as number of 'nights' of data collection. Surveys were however conducted during daylight hours and survey effort is, henceforth, described as 'number of survey days'.

2 METHODOLOGY

2.1 Development of Survey Design

2.1.1 Gladstone Port Region Hatchling Orientation Monitoring History

Hatchling orientation monitoring has been ongoing in the region since the 2011/12 reproductive season as part of a James Cook University (JCU) PhD project. These works have involved monitoring hatchling sea-finding ability on flatback turtle (*Natator depressus*) nesting beaches potentially exposed to the influencing variable of artificial light at Curtis and Peak Islands resulting from the current construction and ongoing operation of Liquefied Natural Gas (LNG) plants on Curtis Island.

Monitoring of artificial light profiles in the region was conducted by Pendoley Environmental in 2011 (Pendoley Environmental, 2012).

2.1.2 Consultation and Collaboration

2.1.2.1 Gladstone/Yeppoon Coastline

Through consultation with Dr Colin Limpus, of the Queensland Department of Environmental Protection and Heritage (DEHP) it was determined that there is little or no consistent nightly nesting on the mainland coast in the vicinity of Gladstone/Yeppoon (as per **Section 1.2**). Along this 80 km stretch of coastline the abundance of nesting females is low (C. Limpus pers. Comm., 18th November 2013) and data from this location would likely be sparse, resulting in an inadequate data set with regards to the robustness required for meaningful (statistical) analysis. The project scope did not allow for the additional survey time required to capture a robust sample size at this location. When the nesting population size was considered in conjunction with the distance of the area from the Gladstone/Yeppoon site, collection of these data was considered inefficient. In agreement with GPC this requirement was subsequently removed from the Scope (**Appendix 1**).

2.1.2.2 Peak Island

In terms of size, the nesting population at Peak Island is substantially larger than others in the region and in particular, to those described in Scope CA130031 for assessment within these surveys. It may, therefore, be under-represented by only two survey days. Dr Colin Limpus and colleagues/staff were scheduled to visit Peak Island for a period of two weeks in mid-February, during which time it was agreed he and his team would gather two weeks of hatchling orientation data on our behalf.

2.1.2.3 Data sharing

This collaboration substantially increased the data collection potential for all parties, and specifically GPC. By sharing resources and data, the program was able to expand the scheduled scope of the GPC program from two nights (or survey 'days') per location at Peak, Curtis and Facing Islands, to seven nights (or six survey days) at Curtis and Facing Islands and a *potential* maximum of 14 nights (or 13 survey days) at Peak Island.

It was agreed that data collected by GPC/PENV at Curtis Island and Facing Islands and by Queensland DEHP at Peak Island were to be shared equally by the two groups (GPC/PENV and Queensland DEHP) and used in public forms as deemed necessary, with appropriate acknowledgment of the source.

The 2013/14 Gladstone Ports Corporation Hatchling Orientation Monitoring Program therefore became a collaborative program between GPC/Pendoley Environmental (PENV), DEHP (Dr Colin Limpus) and JCU (PhD candidate, Ms R. Kamrowski).

2.2 Sampling Regimes

2.2.1 Spatial Distribution of Approach

In 2011, Pendoley Environmental deployed light monitoring equipment on Curtis and Facing Islands to gather information regarding artificial light profiles in the region (Pendoley Environmental 2012; **Figure 1**). Locations for survey of indices of hatchling orientation in 2014 were selected based on their temporal and spatial alignment with those sites, and in light of their known or potential capacity to host marine turtle nesting and therefore hatching (**Section 2.1**).

It was not possible to conduct the proposed surveys at Peak Island in 2013/14. Tropical Cyclone (TC) Dylan approached the area on 30th January 2014 and the Queensland Parks and Wildlife Services (QPWS) would not operate the transfer service due to safety concerns. This fieldtrip was rescheduled for early March, which is outside the biological window for these surveys, and therefore no data could be collected from this location.

Access to the camera deployment site north of Ocean Beach 1 on Facing Island (**Figure 1**) was considered unsafe due to tides and poor weather/cyclonic conditions associated with TC Dylan. Further, nesting density at this location was observed in 2011 to be low density and highly dispersed (K. Pendoley, pers. obs., November 2011) and it was not considered a primary monitoring site relative to other beaches identified to the south.

On Curtis Island the team surveyed South End Beach daily. On Facing Island the team surveyed Settlement Beach, Ocean Beach 1 and Ocean Beach 2 daily. The locations of surveyed nesting beaches are shown in **Figure 1**.

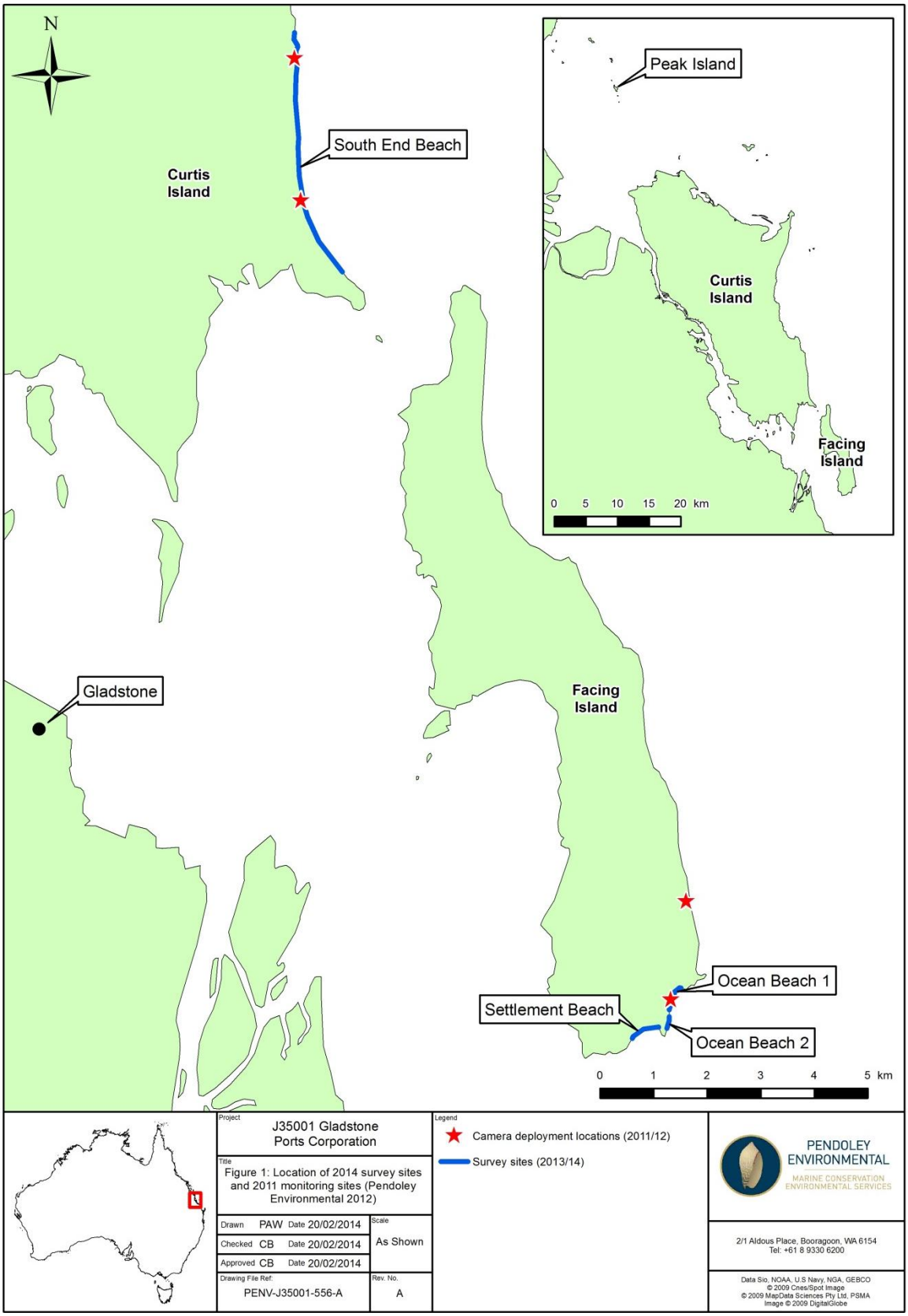
2.2.2 Temporal Distribution of Approach

The survey schedule is described in **Table 1.**

Table 1: Survey schedule.

DATE	DAY	SURVEY LOCATION	ACTIVITY
20/01/2014	---	TRANSFER TO GLADSTONE	
21/01/2014	1	Curtis Island	AM Ferry to Curtis, PM survey conducted
22/01/2014	2	Curtis Island	AM survey conducted
23/01/2014	3	Curtis Island	AM survey conducted
24/01/2014	4	Curtis Island	AM survey conducted
25/01/2014	5	Curtis Island	AM survey conducted
26/01/2014	6	Curtis Island	AM survey conducted*
27/01/2014	1	Curtis to Facing Island	AM Ferry to Facing Is, PM survey conducted *
28/01/2014	2	Facing Island	AM survey conducted
29/01/2014	3	Facing Island	AM survey conducted
30/01/2014	4	Facing Island	AM survey conducted
31/01/2014	5	Facing Island	*No survey due to weather (TC Dylan)
1/02/2014	6	Facing Island	AM survey conducted
2/02/2014	---	TRANSFER TO GLADSTONE	
2/02/2014	---	TRANSFER TO PEAK ISLAND	
3/02/2014	1	Peak Island	Cancelled due to adverse weather conditions
4/02/2104	2	Peak Island	Cancelled due to adverse weather conditions
5/02/2104	3	Peak Island	Cancelled due to adverse weather conditions
6/02/2104	4	Peak Island	Cancelled due to adverse weather conditions
7/02/2104	5	Peak Island	Cancelled due to adverse weather conditions
8/02/2104	6	Peak Island	Cancelled due to adverse weather conditions
9/02/2104	7	Peak Island	Cancelled due to adverse weather conditions

* On 26th and 27th January 2013, rain and winds 26 km/hr gusting to 39 km/hr erased any evidence of hatchling emergence.


N
South End Beach
Curtis Island
Peak Island
Curtis Island
Facing Island
0 5 10 15 20 km
Gladstone
Facing Island
Ocean Beach 1
Settlement Beach
Ocean Beach 2
0 1 2 3 4 5 km
Project
J35001 Gladstone Ports Corporation
Title
Figure 1: Location of 2014 survey sites and 2011 monitoring sites (Pendoley Environmental 2012)
Drawn PAW Date 20/02/2014
Checked CB Date 20/02/2014
Approved CB Date 20/02/2014
Scale
As Shown
Drawing File Ref.
PENV-J35001-556-A
Rev. No.
A
Legend
Camera deployment locations (2011/12)
Survey sites (2013/14)
PENDOLEY ENVIRONMENTAL
MARINE CONSERVATION ENVIRONMENTAL SERVICES
2/1 Aldous Place, Booragoon, WA 6154
Tel: +61 8 9330 6200
Data Sio, NOAA, U.S Navy, NGA, GEBCO
© 2009 Cnes/Spot Image
© 2009 MapData Sciences Pty Ltd, PSMA
Image © 2009 DigitalGlobe

2.3 Sampling Methodologies

2.3.1 Description of Approach

On Curtis Island one team member walked on top of the primary dune (A; **Figure 2**) as the other walked in the swale (the hollow between ridges, B; **Figure 2**) between the primary and the secondary dune (C; **Figure 2**). This approach ensured detection of emerged clutches located in the swale section of the beach profile. On Facing Island the entire supra-tidal zone (area above the high tide mark) was surveyed for evidence of hatchling emergences.

The feral animal population on Curtis Island is currently managed by the QPWS. Clutches are identified following oviposition and covered with a mesh (**Figure 2**) designed to prevent dogs from digging up clutches during incubation and wide enough to allow hatchlings to emerge and migrate toward the ocean.

Figure 2: Beach profile at Curtis Island showing A) primary dune B) swale C) secondary dune. Dashed lines show path taken by survey team during monitoring to ensure capture of clutches within the swale. Dashed circle shows clutch protected by mesh to protect incubating eggs from predation by the local wild dog population.

2.3.2 Hatchling Orientation Measurements

The methods used for monitoring hatchling orientation were developed by Pendoley (2005) and are based on Salmon & Witherington (1995). These methods are designed to measure hatchling dispersal patterns immediately following emergence from the clutch as hatchlings orient toward the ocean. Hatchling tracks are not persistent in sand over time and detection is limited almost entirely to hatching events occurring on the night preceding the survey day.

Hatchling orientation was measured as the range of dispersion (°; spread angle) of tracks from the emergence point and the degree of deflection (°; offset angle) of the hatchling tracks from the most direct route to the ocean. Offset angle is determined as the angle between the vector bisecting the dispersion angle and the vector representing the most direct route toward the ocean (**Figure 3**).

A clutch was recorded as a successful emergence if five or more tracks were sighted (Pendoley 2005). A Global Positioning System (GPS) location was obtained for each hatched clutch, defined by a depression in the sand from which hatchling tracks were seen to emerge. To determine the spread angle (dispersion), a hand-held compass was used to measure the bearing along the outside arms of each group of emergent tracks (vector A and B; **Figure 3**). For tracks that did not orient directly toward the ocean, bearings were taken at either the point where the tracks crossed the high tide line, or five metres from the clutch emergence point (whichever distance was shortest). An angle of spread angle was then calculated from these bearings. The orientation of the tracks as a group relative to the most direct line to the ocean (vector X; **Figure 3**),the offset angle, was determined by calculating the angle between the most direct line to the ocean (X) and the bearing bisecting the spread angle (vector C; **Figure 3**).

2.3.2.1 Species confirmation

Species was confirmed by:

- examination of hatchling track morphology;
- quantification of tracks emerging; and
- considered in the context of available knowledge regarding relative levels of nesting per species at each location (ERMP 2013).

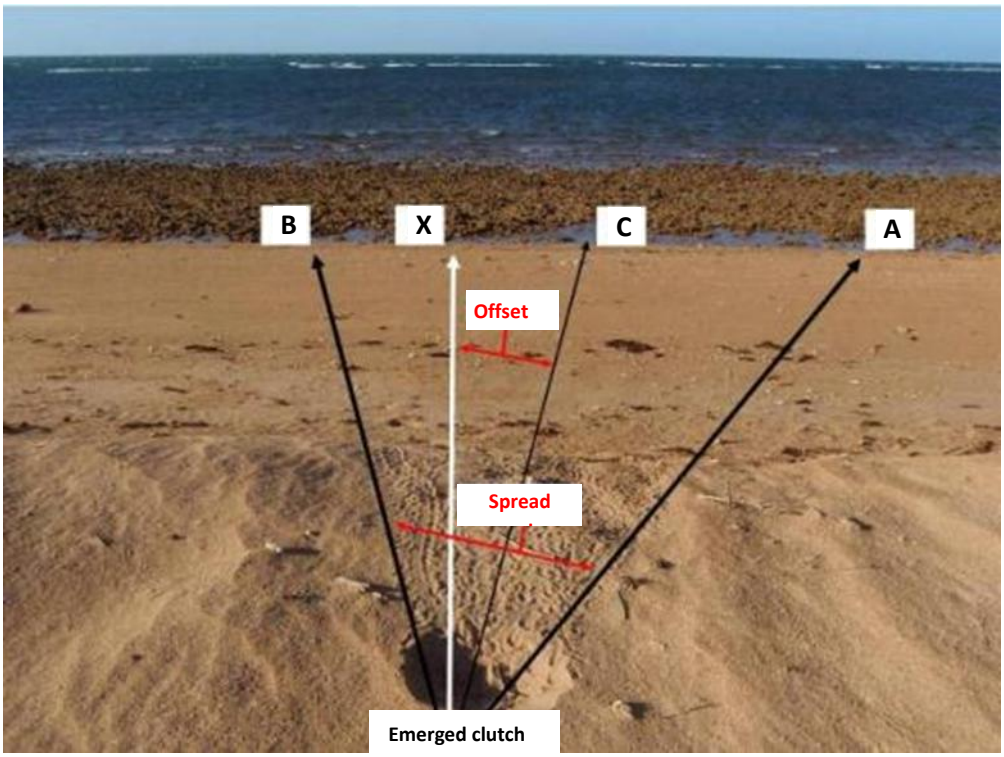


Figure 3: Hatchling orientation spread and offset angles. Spread: measure of dispersion; Offset: measure of deviation from the most direct route toward the ocean.

2.3.3 Light Measurements

The collection and analysis of 'baseline' light data was commissioned by GPC and completed by Pendoley Environmental in 2011 (Sky-Cam 42^{TM}; Pendoley Environmental 2012) and relevant results are summarised in the discussion section.

Assessment of artificial light was not included in the Scope of Works for monitoring in 2013/14, however ambient light data from Peak and Curtis Islands were collected in 2013/14 as part of the collaborative research program described in **Section 2.1**. This dataset and additional supplementary light data from the 2011 surveys (as per Pendoley Environmental 2012) are held in archive at Pendoley Environmental for inclusion in analysis and reporting, should the proposed 2014/15 GPC/PENV Artificial Light Monitoring Surveys go ahead. These data form a critical element of a more robust, multi-annual dataset based on three consecutive seasons of artificial light surveys (2011/12 – 2014/15) at these locations.

2.4 Data Analysis

2.4.1 Hatchling Orientation Monitoring Program

Geomorphological parameters known to influence orientation, such as aspect and elevation, vary with location. Consequently, impacts of artificial light vary with location. To minimise the loss of information inherent in grouping and averaging (binning) data for analysis, data from each island and distinct geomorphic feature were considered separately and are presented individually.

This approach is important and provides the format for future identification of site-specific variation among sampling seasons and, in particular, between current 'construction' seasons and future 'operational phase' seasons at each location.

Beaches at Curtis Island feature what is known as a 'swale', an elongated and relatively narrow miniature valley that forms between two fore-dune beach ridges (**Figure 2**). Where nesting female marine turtles traverse the fore-dune and deposit a clutch within the swale, hatchling orientation is subject to a specific set of influencing parameters distinct from those facing hatchlings emerging and navigating seaward on the ocean-facing side of the dune. Swale and fore-dune data are therefore treated separately in analyses and discussion.

2.4.2 Statistical Analyses

Basic statistics describing the data were prepared in XLSTAT (AddinSoft, 2009). Data are presented as a median value and variance within each dataset, described by the interquartile range, where sample size was limited (n=2) we describe these data with mean and range values. Data were not robust enough to satisfy the minimum criteria for analyses of variance (ANOVA) and hence were not tested for statistical significance of variance among locations.

In the interest of best practice, qualitative interpretation of variation among location data sets is provided, with suggested avenues to increase sample sizes and provide adequate and robust data samples should future surveys be conducted.

2.4.3 Lunar Phase

Hatchling orientation surveys are typically scheduled to occur during new moon conditions in order to isolate the effects of artificial light. These works were scheduled to take place during the new moon phase of the lunar cycle in February 2014, however logistical constraints required survey dates to be shifted forward and monitoring was conducted during a waning moon cycle leading up to and including the new moon on 31st January 2014. The difference in proposed versus actual schedule did not impact data quality as sampling capture the period up to and including the new moon in January.

2.4.4 Licencing Requirements

All works were performed under a Queensland Government, Department of Environment and Heritage licence to Take, Use, Keep or Interfere with Cultural or Natural Resources (for Scientific Purposes) under Nature Conservation (Administration) Regulation 2006 (Licence number WITK13719813).

2.5 Survey Limitations

This monitoring program was subject to the following limitations:

2.5.1 Logistical Constraints

- Commercial accommodation on Curtis Island is limited, and does not exist on Facing Island.
- All food supplies must be carried to both Curtis and Facing Islands.
- Access to survey sites on Facing Island is only available on a low tide.
- Ferry schedules to and between the islands and the mainland dictate the timing of the surveys, and in the case of Peak Island a special trip is required.
- The QPWS restrict access to Peak Island to scientists (only) due to the very high conservation value of the island. Consequently logistical support for Peak Island is complicated and expensive.
- There are no permanent facilities on Peak Island so all food and water must be carried to the island, all wastes must be removed and survey teams must camp on the beach.

2.5.2 Environmental Constraints

- Overnight winds, high tides, rainfall, storm surge and predator activity can erase/obscure hatchling tracks, making observation and accurate interpretation difficult.
- The time that hatchlings emerge from the nest may influence their orientation patterns, as hatchlings respond primarily to visual cues within a restricted cone of acceptance along the horizon (e.g. a risen moon may have relatively little effect on orientation, whilst the sky glow from a setting or rising sun or moon may have a greater effect on orientation; Salmon et al. 1992; Lohmann et al. 1997). The current sampling method does not allow for time of emergence to be determined.
- Hatchling orientation surveys are typically scheduled to occur during new moon conditions, however logistical constraints dictated these works were conducted six days earlier than proposed. Samples and data were not compromised however as new moon phase was still captured.
- The beach profile on Curtis Island includes a vegetated 'swale' area behind the primary dune, which increases the difficulty in detection of tracks and location of the point of emergence of hatchlings from the clutch.

2.5.3 Analyses

- Statistical analyses to assess variance and determine significance could not be performed due to constrained sample sizes at Facing Island (flatback: n = 4) and Curtis Island (green: n = 1) primary dune locations and in the swale section at Curtis Island (flatback: n = 2). Qualitative interpretation of median values is therefore provided, and the data presented as median (interquartile range) throughout.

3 RESULTS

All clutches were identified as flatback turtle clutches, with the exception of a single clutch of green turtle (*Chelonia mydas*) hatchlings on Curtis Island, where species was confirmed by sighting a hatchling.

3.1 Spatial Sampling Distribution

Survey dates and locations are detailed in **Table 1**. Survey (days) were conducted at Curtis (*n* = 6) and Facing (*n* = 5) Islands. No data are available from Peak Island in this season (2013/14) and no clutches were located on Ocean Beach 1 or Ocean Beach 2 on Facing Island.

Across all surveyed locations, a total of 28 turtle clutches (27 flatback and one green) were identified and assessed. The number of clutches assessed per location is shown in **Table 2**. The location of all assessed clutches and the degree of dispersion (spread) of emergent hatchling tracks is shown in **Figure 4**. Data for each clutch, including latitude and longitude and spread and offset angles are provided in **Appendix 2.**

Table 2: Spatial distribution of assessed clutches.

Location	Emerged clutches (*n*)	
Island	Flatback	Green
Curtis	23	1
Facing	4	0

3.1.1 Flatback Turtle Hatchling Orientation

3.1.1.1 Spread angle

The median spread angle of emerged clutches of flatback turtle hatchlings at Curtis Island (primary dune) in 2013/14 was 35° (interquartile range: 27 – 47°, *n* = 21). The median spread angle at Settlement Beach, Facing Island was 34° (interquartile range = 33° – 43°, *n* = 4). The mean spread angle at Curtis Island (swale) was 174° (range = 137° – 210°, *n* = 2) (**Table 3**).

Median spread angles among primary dune locations at Curtis and Facing Islands were considered to be similar, being 35° and 34° respectively. Mean spread angles of clutches located in the swale at Curtis Island was substantially greater (174°) than those located along the primary dune and facing the ocean.

3.1.1.2 Offset angle

The median offset angle of emerged clutches of flatback turtle hatchlings at Curtis Island (primary dune) in 2013/14 was 8° (interquartile range: 5° – 15°, *n* = 21). The median offset angle at Settlement Beach, Facing Island was 9° (interquartile range = 5° – 18°, *n* = 4). The mean spread angle at Curtis Island (swale) was 35° (range = 19° – 51°, *n* = 2). (**Table 3**).

Median offset angles among primary dune locations at Curtis and Facing Islands were considered to be similar, being 8° and 9° respectively. The mean offset angle of clutches located in the swale at Curtis

Island was substantially greater (35°) than those of clutches located along the primary dune and facing the ocean.

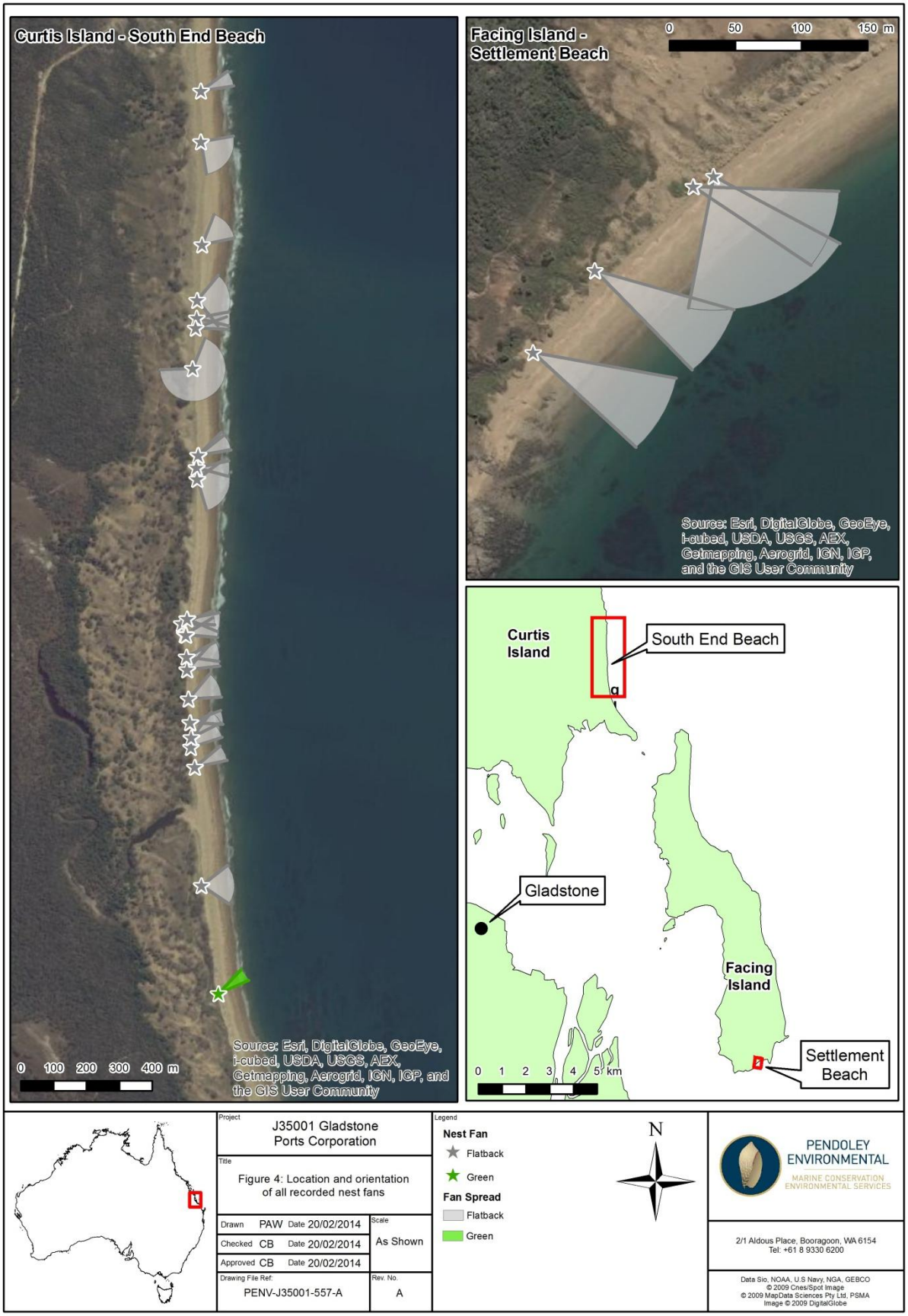
Table 3: Flatback turtle hatchling orientation indices per location. Pd; Primary dune, Sw: Swale.

Location	Orientation Indices						Assessed Clutches
	Spread (°)			Offset (°)			
(Island/dune)	Upper IQ	Median	Lower IQ	Upper IQ	Median	Lower IQ	*n*
Curtis – Pd	27	35	47	5	8	15	21
Curtis – Sw	137	174	210	19	35	51	2
Facing – Pd	33	34	42	5	9	18	4
Total							27

3.1.2 Green Turtle Hatchling Orientation

3.1.2.1 Spread and offset angles

The orientation of hatchlings emerging from the single green turtle clutch recorded in the primary dune area at Curtis Island was 23° (spread) and 3° (offset).


Curtis Island - South End Beach
0 100 200 300 400 m
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Facing Island - Settlement Beach
0 50 100 150 m
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Curtis Island
South End Beach
Gladstone
Facing Island
Settlement Beach
0 1 2 3 4 5 km
Project
J35001 Gladstone Ports Corporation
Title
Figure 4: Location and orientation of all recorded nest fans
Drawn PAW Date 20/02/2014
Checked CB Date 20/02/2014
Approved CB Date 20/02/2014
Scale
As Shown
Drawing File Ref:
PENV-J35001-557-A
Rev. No.
A
Legend
Nest Fan
Flatback
Green
Fan Spread
Flatback
Green
N
PENDOLEY ENVIRONMENTAL
MARINE CONSERVATION ENVIRONMENTAL SERVICES
2/1 Aldous Place, Booragoon, WA 6154
Tel: +61 8 9330 6200
Data Sio, NOAA, U.S Navy, NGA, GEBCO
© 2009 Cnes/Spot Image
© 2009 MapData Sciences Pty Ltd, PSMA
Image © 2009 DigitalGlobe

4 DISCUSSION

Hatchlings follow three primary cues when sea-finding; movement toward brighter regions, movement away from high beach silhouettes (e.g. dunes) and when these cues are inconsistent, movement in relation to elevation (Bartol & Musick 2003). The degree to which geomorphological shape and form influence hatchling sea-finding is thought to be a graded response that corresponds with differing magnitudes of co-occurring visual stimuli (Tuxbury & Salmon, 2005) i.e. which is most visible to the hatchling. Artificial light is a competitive visual stimulus that hatchlings must integrate with natural light intensity, wavelength, directivity, and horizon/elevation cues. In the absence of modifications to dune topography and/or the use of lighting sources or types that override topographical cues, it is assumed that hatchlings will be able to navigate successfully toward the ocean.

4.1 Indices of Orientation

These data were gathered to allow for detection of potential variation in indices of hatchling orientation that may result from the influence of artificial lighting profiles associated with construction works and future operational lighting at the Curtis Island LNG gas plant.

4.1.1 Primary Dune

Based on the limited survey data, flatback and green turtle hatchlings emerging from clutches located on the primary dune at both Curtis and Facing Islands orientated successfully toward the ocean without detectable disruption (e.g. **Figure 5**).

4.1.2 Swale

Variation in orientation values among samples was identified in clutches located in the swale area of the beach profile at Curtis Island (**Figure 2**). Hatchlings emerging in the swale section are likely to spend greater periods of time on the beach immediately following emergence, due to variation in topographical cues that confound sea-finding. As a result of extended exposure (dehydration) and the increased likelihood of predation, these individuals may exhibit decreased survivorship. It was not possible to define this variation with statistical confidence and it is not known if these findings reflect inherent (topographical), and therefore consistent nightly variation or alteration of the dark-sky night horizon associated with rapid industrial expansion. It is also not known if this variation is considered significant, given the limitations of the sample set size.

Kamrowski et al. (in review) describe hatchling orientation at this location as orienting away from the ocean, in contrast to that of hatchlings emerging from clutches on the primary dune face. Limited access to typical sea-finding cues frequently results in dis-or mis-orientation at this location (e.g. **Figure 6**) and hatchlings typically orient parallel to the ocean, along the valley of the swale (Kamrowski et al. in review)**.** The impact on survivorship is not known.

4.2 Artificial Light Profiles

Images of artificial light profiles gathered during baseline surveys conducted in 2011 (Pendoley Environmental 2012) show the predominant detectable light as a broad band of sky glow originating

from the city and Port of Gladstone. This light merged with glow from the nearby coal load out port facilities and the alumina plant and port facilities approximately 11 km away to the south and west. A minimal amount of light was also visible from the settlement at South End Beach on Curtis Island.

A second, small area of bright glow originated from the region of the Boyne Smelter and Boyne Island/Tannum Sand residential area, approximately 20 km west-south-west of Facing and Curtis Islands. This light merged with the Gladstone area glow (Pendoley Environmental 2012).

Despite rescheduling or works to the earlier dates in January 2014, sampling was able to capture orientation under new moon conditions and in the days leading up to new moon. We are therefore able to infer from these data that artificial light had little observable impact on indices of hatchling orientation at sampled locations.

4.3 Additional Threats

The QWPS is responsible for managing feral animal populations on Curtis Island; predation on turtle eggs has decreased by 90% since the early 1980s (ERMP, 2013). The protective mesh used to prevent wild dogs from digging up clutches during incubation is effective, but it does not protect hatchlings from predation following emergence. Should survivorship rates decline in the future, management of predation levels immediately following emergence could be an area considered for attention.

4.4 Future surveys

4.4.1 Sample Size

Sample size was the primary constraint in data analysis and assessment of findings. In order to ensure adequate, robust sample sizes in future surveys we recommend extending survey duration in future sampling seasons to account for low nesting density and inclement weather conditions.

4.4.2 Lunar Phase

Further and if possible, scheduling surveys to distribute sampling days to ensure the new moon phase is captured will ensure data quality. Ideally, sample days should be scheduled equally either side of and over the new moon phase. If this cannot be accommodated, scheduling of the days leading up to or after the new moon, ensuring capture of dark (no moon) nights are included, is acceptable.

Figure 5: Emergent hatchling fan (within the shaded area) from a clutch located on the primary dune of Curtis Island, showing successful seaward orientation.

Figure 6: Tracks of hatchlings in the swale area of the beach profile at Curtis Island. The location of the clutch from which these hatchlings emerged was not identified.

5 CONCLUSION

Existing sources of light identified by Pendoley Environmental (2012) that may influence hatchling orientation include offshore ships, residential lighting from properties located at the south end of Curtis Island and Gladstone City, light from Gladstone Port, and associated industrial and residential facilities including Boyne Smelter and the Boyne Island/Tannum Sand residential area. Detection and analysis of sea-finding pathways in emergent hatchlings at Curtis and Facing Islands did not provide any evidence of disruption due to sources of artificial light.

Clutches located in the swale section of the beach profile at Curtis Island had greater spread and offset values than those located on the primary dune face. This increased variability is understood to be associated with topographical complexity (Kamrowski, in review), and is not considered to be related to artificial light profiles in the region.

In consideration of ongoing construction in the region, and the limited sample sizes obtained at some monitored locations, along with the absence of data from Peak Island in this monitoring season, it is suggested that this dataset be augmented with additional sampling in upcoming seasons (**Section 4.4**). Decision-making regarding these rookeries and management of artificial light sources associated with the Western Basin Dredging Project and facilities at the Curtis Island LNG plant must be evidence-based. Ongoing collection and analysis of quantitative data regarding artificial light profiles in tandem with indices of hatchling orientation in the region will provide a sound scientific basis for decision-making and advice.

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APPENDIX 1: MANAGEMENT OF CHANGE (SCOPE CA130031): RECORD OF COMMUNICATIONS BETWEEN DEHP, PENV AND GPC REGARDING DEVELOPMENT AND APPROVAL OF SURVEY DESIGN

From: Catherine Bell [mailto:catherine.bell@penv.com.au]
Sent: Monday, 18 November 2013 12:01 PM
To: Limpus Col
Cc: Ruth Kamrowski; Kellie Pendoley
Subject: GPC - hatchling orientation surveys: Gladstone-Yeppoon coastline

Hi Col,

I wondered if you'd been able to give any thought to areas of known or potential nesting/hatching of any species along the Gladstone-Yeppoon coastline. We were hoping to identify three locations however if nesting is sparse (which it appears to be) then two or even one will suffice.

With regards and thanks in advance,

Catherine

Dr Catherine Bell

Senior Scientist/Business Development

Pendoley Environmental Pty Ltd

Marine Conservation - Environmental Services

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From: Limpus Col [mailto:Col.Limpus@ehp.qld.gov.au]
Sent: Monday, 18 November 2013 5:27 PM
To: Catherine Bell
Cc: Ruth Kamrowski; Kellie Pendoley; Limpus Col
Subject: RE: GPC - hatchling orientation surveys: Gladstone-Yeppoon coastline

Catherine,

The principle nesting beaches in the Port Curtis - Port Alma area are

1. Peak Island, ~15km off the coast from Yeppoon

2. South End Curtis Island, a 5km long beach

3. Settlement Bay at the southern end of Facing Island - has small numbers of nesting flatbacks (10s of females annually) - the best concentration for Facing Island.

There are no other beaches in the Gladstone area with predictably nightly nesting of flatback turtles during the mid nesting season.

Dr Colin LIMPUS

Chief Scientist,
Threatened Species Unit,
Department of Environment and Heritage Protection

Adjunct Associate Professor,
School of Veterinary Science, University of Queensland.

Adjunct Associate Professor,
School of Earth & Environmental Sciences, James Cook University.

Ph: 61 (0)7 3170 5617; Mobile Ph: 0427 002 633
Block C1, 41 Boggo Rd., Dutton Park Qld 4102
ESP, PO Box 2454 City, Qld, 4001, Australia

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From: Kellie Pendoley
Sent: Monday, 18 November 2013 6:30 PM
To: Limpus Col; Catherine Bell
Cc: Ruth Kamrowski

Subject: RE: GPC - hatchling orientation surveys: Gladstone-Yepoon coastline

Col thanks for this, confirms what we suspected but didn't have the supporting evidence for. We are planning the hatchling orientation program for Gladstone area for next year and the scope of work the GPC sent us included monitoring sites not only on Peak, Curtis and Facing Island but also along the mainland coast. So the question we have is

1. should we monitor some selected sections of the mainland coast to confirm no nesting (given it will only be a couple of days of surveys so confirming may be too strong a word) or
2. should we use the time we have approved to conduct additional survey nights on the island sites (if so we will need some support from you to change the scope of work from GPC).

Cheers

Kellie

Dr Kellie Pendoley

Pendoley Environmental Pty Ltd

Marine Conservation - Environmental Services

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19th November 2013

** In response to this email, there is documentation of a phone conversation on the 19th November between Dr Kellie Pendoley and Dr Colin Limpus during which Dr Pendoley's notes show that selection of survey locations was finalised, in addition to determination of data sharing arrangements. This conversation prompted the following email to ensure all agreements were captured in writing.

Should you require further confirmation it may be possible to contact Dr Colin Limpus and ask him to put something in writing confirming that the conversation took place; however with attention to the previous and following emails we believe it is clear that this agreement was arrived at in consultation between Dr Colin Limpus and Pendoley Environmental.

From: Catherine Bell

Sent: Monday, 25 November 2013 1:31 PM
To: Arvind Singh
Cc: Kellie Pendoley; Tracey Starr
Subject: CA130031 - Hatchling Orientation survey Jan 2014 - Project Update

Hi Arvind,

Below is an update / summary of developments to date in the planning phase of this project. Please provide confirmation of GPCs acceptance regarding dataset augmentation and sharing opportunities described within.

In preparation for upcoming surveys (scheduled for January/February 2014) to address marine turtle hatchling orientation in the vicinity of the GPC Western Basin Dredging Project, we have consulted widely to ensure to provision of the highest quality of research, analysis and advisory services and in doing so have encountered the following:

- There is little or no consistent nightly nesting on the mainland coast in the vicinity of Gladstone/Yepoon; abundance of nesting females is low
- We have preliminary permission to access Peak Island, however as the area is considered highly sensitive, permits were issued for the requested two survey nights only and with the condition that the duration of stay at Peak Island is minimised where possible; and
- In terms of size, the nesting population at Peak Island is comparatively substantial within the region and may, therefore, be under represented by only two nights of data.

In light of this and in order to obtain the highest quality of data we therefore recommend the following approach:

- PENV to conduct surveys to assess hatchling orientation for a period of two weeks from 27 January to 9 February 2014 as proposed;
- During this time, PENV will collect seven nights of data from Curtis Island and a further seven from Facing Island;
- Data gathered from the mainland coast will likely be sparse and the data set inadequate with regards to the robustness required for meaningful analysis;
- Project scope does not allow for the additional survey time required for capture of a robust sample size at this location;
- Combined with nesting population size and distance of the area from the site, collection of these data is considered inefficient and we recommend this requirement is moved out of scope;
- Dr Colin Limpus is scheduled to visit Peak Island for a period of two weeks in mid-February during which time he will gather two weeks of hatchling orientation data on our behalf, and which he will share with PENV and the GPC; and
- PENV and GPC would then agree to share data gathered on Curtis and Facing Islands with Dr Colin Limpus**.

  ** Pendoley Environmental recognises data gathered within this scope are the property of Gladstone Ports Corporation and seeks confirmation of acceptance regarding data set augmentation and sharing opportunities.

The overall benefits to your project are:

- Value add: a significantly greater dataset with sample sizes at each location potentially tripled due to elimination of non-productive mainland sites and collaborative data set augmentation and sharing opportunities between PENV and Dr Colin Limpus;
- Value-add: more robust dataset and higher quality analysis and reporting;
- Value-add: collaboration with Dr Colin Limpus in publication of findings; and
- Savings on travel costs discussed during the initial meeting for the project as there will be no additional fee for the boat to transfer to Peak Island (estimated ~$2500-$3000).

I trust you will find these developments exciting and look forward to your response,

With regards

Catherine

Dr Catherine Bell

Senior Scientist/Business Development

Pendoley Environmental Pty Ltd

Marine Conservation - Environmental Services

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From: Col.Limpus@ehp.qld.gov.au
Sent: Monday, 13 January 2014 9:12 PM
To: Kellie Pendoley; Ruth Kamrowksi
Cc: Catherine Bell
Subject: RE: Skycams

Kellie,
I will be pleased to collaborate with you in quantifying hatchling orientation during beach crossings from nests at Curtis and Peak Islands and to freely share the data with you for your GPC funded studies at these islands.

I am still waiting on final approval from Marine parks for our team to go to the island -- I am planning on their presence at Peak Island for 8 days within the first 2 weeks of February.

I would appreciate a session with you to ensure that we are using the same methodology at both sites.

Do you have a standard data sheet for recording your hatchling fan data.

Dr Colin LIMPUS
Chief Scientist,
Threatened Species Unit,
Department of Environment and Heritage Protection

Adjunct Associate Professor,
School of Veterinary Science, University of Queensland.

Adjunct Associate Professor,
School of Earth & Environmental Sciences, James Cook University.

Ph: 61 (0)7 3170 5617; Mobile Ph: 0427 002 633
Block C1, 41 Boggo Rd., Dutton Park Qld 4102
ESP, PO Box 2454 City, Qld, 4001, Australia

Note, the planning for the Peak Island program was preliminary in November 2013 and consequently the number of days proposed then does not match the number of days in the final (January 2014) planning.

APPENDIX 2: MARINE TURTLE FLATBACK & GREEN HATCHLING ORIENTATION DATA, CURTIS AND FACING ISLANDS 2014

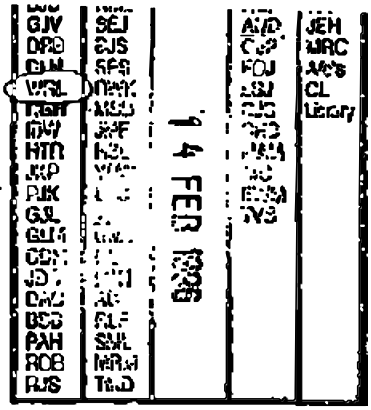
Clutch ID	Date	Island	Position (dune)	Latitude (dd.dddd)	Longitude (dd.dddd)	Spread (˚)	Offset (˚)
1	21/01/2014	Curtis	primary	–23.71856	151.2955	91	61.5
2	21/01/2014	Curtis	primary	–23.72140	151.296	57	28.5
3	21/01/2014	Curtis	swale	–23.72295	151.296	101	2.5
4	21/01/2014	Curtis	primary	–23.72344	151.2961	25	14.5
5	21/01/2014	Curtis	primary	–23.72372	151.2961	22	9
6	21/01/2014	Curtis	swale	–23.72485	151.2962	246	67
7	21/01/2014	Curtis	primary	–23.72723	151.2967	29	2.5
8	21/01/2014	Curtis	primary	–23.72722	151.2967	35	5.5
9	21/01/2014	Curtis	primary	–23.73193	151.2969	24	2
10	21/01/2014	Curtis	primary	–23.73222	151.2971	36	5
11	21/01/2014	Curtis	primary	–23.73223	151.2971	36	5
12	21/01/2014	Curtis	primary	–23.73283	151.2972	36	18
13	21/01/2014	Curtis	primary	–23.73318	151.2973	42	7
14	21/01/2014	Curtis	primary	–23.73531	151.2977	50	11
15	21/01/2014	Curtis	primary	–23.73584	151.2979	28	2
16*	22/01/2014	Curtis	primary	–23.74200	151.29956	23	2.5
17	23/01/2014	Curtis	primary	–23.72757	151.2967	27	13.5
18	23/01/2014	Curtis	primary	–23.72789	151.2968	110	41
19	23/01/2014	Curtis	primary	–23.73178	151.2971	34	8
20	23/01/2014	Curtis	primary	–23.73398	151.2974	47	1.5
21	24/01/2014	Curtis	primary	–23.73504	151.2977	25	5.5
22	25/01/2014	Curtis	primary	–23.71716	151.2953	28	6
23	25/01/2014	Curtis	primary	–23.73463	151.2976	25	14.5
24	25/01/2014	Curtis	primary	–23.73908	151.2986	72	23
25	28/01/2014	Facing	primary	–23.87555	151.3836	70	39
26	29/01/2014	Facing	primary	–23.87562	151.3834	34	2
27	29/01/2014	Facing	primary	–23.87675	151.3824	34	6
28	30/01/2014	Facing	primary	–23.87619	151.3828	31	11.5

*Green turtle clutch. All other data represent flatback turtle clutches

Attachment F: Minister for the Environment Determination (1996)

Senator John Faulkner

Minister for the Environment, Sport and Territories



Mr W Loughnan
Sly & Weigal Cannan and Peterson
Lawyers
GPO Box 407
BRISBANE QLD 4001

09 FEB 1996

Dear Mr Loughnan

I am writing to you concerning the proposal by Queensland Resort Enterprises Pty and Monte Christo Pty Ltd to acquire leasehold interests and freehold interests in land known as "Monte Christo", Curtis Island, Gladstone, Queensland to be used for a proposed tourist resort development.

As the proposal is likely to effect the environment to a significant extent, Queensland Resort Enterprises Pty and Monte Christo Pty Ltd were designated by the Assistant Treasurer, the Hon George Gear MP, as proponents for the proposal in accordance with the Administrative Procedures under the *Environment Protection (Impact of Proposals) Act 1974* on 18 July 1995.

I have determined, in accordance with paragraph 3.1.1.(b) of the Administrative Procedures, that neither an environmental impact statement nor a public environment report is necessary to meet the object of the Act and I have advised the Assistant Treasurer accordingly. In making this determination I have made a number of recommendations aimed at providing additional environmental protection. A copy of these recommendations is attached.

Yours sincerely

JOHN FAULKNER

Enclosure

Parliament House, Canberra, ACT 2600 Telephone 06 277 7640 Facsimile 06 273 4130

Monte Christo Pty Ltd and Queensland Resort Enterprises- Monte Christo Tourism Resort Proposal.

Recommendations for Environmental Protection

1. Turtle nesting

The proponent shall consult with QDEH (National Parks and Wildlife Service) to develop measures to ensure that there is minimal impact on turtle populations.

2. Boating impacts

The proponent shall in association with QDEH and the Gladstone Port Authority, monitor the impact of resort vessels on Graham Creek and Hobble Gully with respect to wake erosion, increased turbidity and impacts on seagrasses and fringing mangroves.

3. Dugong Protection

The proponent shall identify, in consultation with QDEH, any areas used by Dugong for breeding calving or feeding in the operational areas of Hobble Gully and Graham Creek. Any areas identified should be subject to a restriction on boat speed to less than 5 knots per hour.

4. Aboriginal Consultation

The proponent shall liaise with the Queensland Department of Family and Community Services (DFCS) regarding appropriate mechanisms for consultation with Aboriginal communities about the proposal. Following these consultations, reports should be provided to QDEH and DFCS.

5. Community Consultation

The proponent shall formulate a community consultation plan to be approved by QDEH. Following its implementation, a report should be provided to QDEH for consideration in drafting conservation and management plans for both the leased areas, including the Nature Refuge and Conservation Park, and the proposed National Park.

6. Compliance with relevant obligations, commitments and conditions

The proponent shall carry out the project consistently with the documents provided and abide by the relevant conditions and undertakings as set out in the Impact Assessment Study 1990, approval from Calliope Shire Council, determination of the Planning and Environment Court 1992, detailed lease conditions for Crown land (including the proposed Conservation Parks and Nature Refuge) and additional information supplied by the proponent to the EPA on 17 October 1995.

Attachment G: Lighting Design (Green Leaf 2011)

Level 3, The Icon Centre
15 Malt Street
Fortitude Valley Q 4006
Brisbane, Australia
T: +61 (0) 73358 3046
www.greenleafengineers.com

Our ref.: 5984
23 August 2011
Mark Kinsella
Greenleaf Engineers.
Level 3, The Icon Centre, 15 Malt St
Fortitude Valley
Qld 4006

To Whom it may concern of Gladstone Regional Council,

The following letter provides a design approach and criteria to meet condition 13 of the design approval for the Turtle St Beach development on Curtis Island. Condition 13 is shown below. This letter will be accompanied by a partial external lighting layout.

Condition 13
The lessee must at all times take the necessary precautions to ensure that all lights on or above the leased land are shielded to prevent glare or reflection which may interfere with safe navigation of surrounding waterways or with reasonable enjoyment of neighbouring properties or nesting sites for turtles.

Turlte St Beach - DA Compliance Condition 13

Background.

Within the DA, condition 13 gives no explicit guidelines in relation to illuminance levels, only stating that all lights are shielded to prevent glare or reflection. A literature review of measures that can be taken to minimise light pollution of nesting sites for turtles has been conducted. An approach and criteria for external lighting selection for the development was selected from the reports listed below

- Environmental Protection Authority. Environmental Assessment Guidelines No. 5. *Environmental Assessment Guideline for protection marine turtles from light impacts.* November 2010 WA.
- Queensland Parks and Wildlife Service (QPWS). Department of Environment and Resource Management (DERM). *Turtle Friendly Guide 'Bright lights and marine turtles don't go together'.* BP0059 Sept. 2009. Qld.
- Florida Department of Environmental Protection. Blair E. Witherington and R. Erik Martin. *Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches.* FMRI Technical Report TR-2. 1996.
- Mackay Regional Council. Recommendations for reducing the impact of light pollution problems on sea turtle nesting beaches. www.gbrmpa.gov.au

The Gladstone regional council was also contacted for explicit guidelines in relation to illuminance levels. Karen Andrews provided the following two conditions to be followed where turtles nest.

1. During construction any security lighting shall be so designed to ensure that nuisance is not caused to adjoining areas by the spillage of light.
2. Technical parameters, design, installation, operation and maintenance of outdoor lighting are to comply with the requirements of AS4282 – Control of the Obtrusive Effects of Outdoor Lighting in order to restrict spill onto the beach area. The vertical illumination resulting from direct, reflected or other incidental light coming from a site is not to exceed 8 lux when measured at any point 1.5m outside of the boundary of the property at any level from ground level up.

These conditions have been incorporated into the approach and criteria of external lighting selection.

APPROACH

The points stated above have been considered in our approach to the external lighting design for the Turtle St Beach Resort development. To maximise functionality, while minimising light pollution to the surrounding waterways, neighbouring properties and beach areas the following principles will be implemented.

- No Filters will be used. The filters waste energy, up to 70% of the Light Output Ratio (LOR) is reduced. This reduction in LOR requires up to 3 times as many lighting fixtures for the same amount of light. This has the effect of tripling the wattage (energy usage). The additional building material required and energy consumption make for an unsustainable approach.
- Lights are to be low mounted.
- Low wattage lamps are to be used to avoid visibility from the beach/ocean.
- lowest illumination level possible while still meeting Australian standard, AS1158.
- Lamps and light fittings to be directional with full cut off optics to avoid light spill.
- Orientation of all lights away from the beach/ocean.

Criteria

To implement the above principles the design must meet the following criteria:

- Comply with AS/NZS 1158.3.1:2005 Category P4
    - Minimum Average horizontal illuminance - 0.85 lux
    - Minimum (point horizontal illuminance) - 0.14 lux
    - Uniformity - 10 (max/average).
- have a minimum spacing of 25m for category P4
- have a mounting height less than 2.5m
- light fitting to have a full cut off, no light above 90deg.
- Comply with AS/NZS 4282
- Maximum average illumenance - 3.0 lux
- light fitting to be a symmetrical - light directed on roadways
- lamps to be low wattage/ intensity.
- Reduced/ eliminated short wavelength light. Low pressure sodium lamp preferred but high pressure sodium lamp and LED can be used.

The following light fittings have been shown to meet said criteria.

- Bega 7834 26.6W LED - 34.5m spacing at 2.5m pole heights.
- We-ef VFL540 S70 38W LED - 26.9m spacing at 2.5m pole heights.

Data sheets have been included for the above fittings.

Yours sincerely,

Green Leaf Engineers

Mark Kinsella
Design Engineer

TURTLE STREET BEACH RESORT

CURTIS ISLAND

ELECTRICAL SERVICES DRAWING LIST

5894 - E00 COVER SHEET
5894 - E01 EXTERNAL LIGHTING LAYOUT 1
5894 - E02 EXTERNAL LIGHTING LAYOUT 2

LIGHTING LEGEND (2 OPTIONS).

SYMBOL	LAMP	DESCRIPTION	MOUNTING	COLOUR	DISRIBUTOR	MODEL
L1	AMBER XP-E LED 38W, 4000K	SLIM PROFILE POST TOP AREA LIGHT. PROVIDE 2.5m POLE, FOUNDATION AND MOUNTING	POLE MOUNTING MAX HEIGHT 2.5m	TBC	WE-EF	VFL540 S70
	LED 26.6W, 5000K	SLIM PROFILE POST TOP AREA LIGHT. PROVIDE 2.5m POLE, FOUNDATION AND MOUNTING	POLE MOUNTING MAX HEIGHT 2.5m	TBC	BEGA	7834

DRAWING LABELLING LAYOUT
1:5000

NOTE:
E01 & E02 HAVE BEEN PROVIDED AS EXAMPLES OF LIGHTING APPROACH TO BE USED THROUGHOUT THE DEVELOPMENT. SUBJECT TO APPROVAL A FULL EXTERNAL LIGHTING LAYOUT WILL BE PROVIDED.

NOTES:

REV	DATE	DRN.	CHD.	DESCRIPTION
A	23/08/11	MK	AA	DA APPROVAL

SCALE 1:50 0 0.5 1 1.5 2 2.5 Metres
SCALE 1:100 0 0.5 1 2 3 4 5 Metres
DO NOT SCALE, USE FIGURED DIMENSIONS ONLY

CLIENT
CLIENT

ARCHITECT

PROJECT
TURTLE STREET BEACH

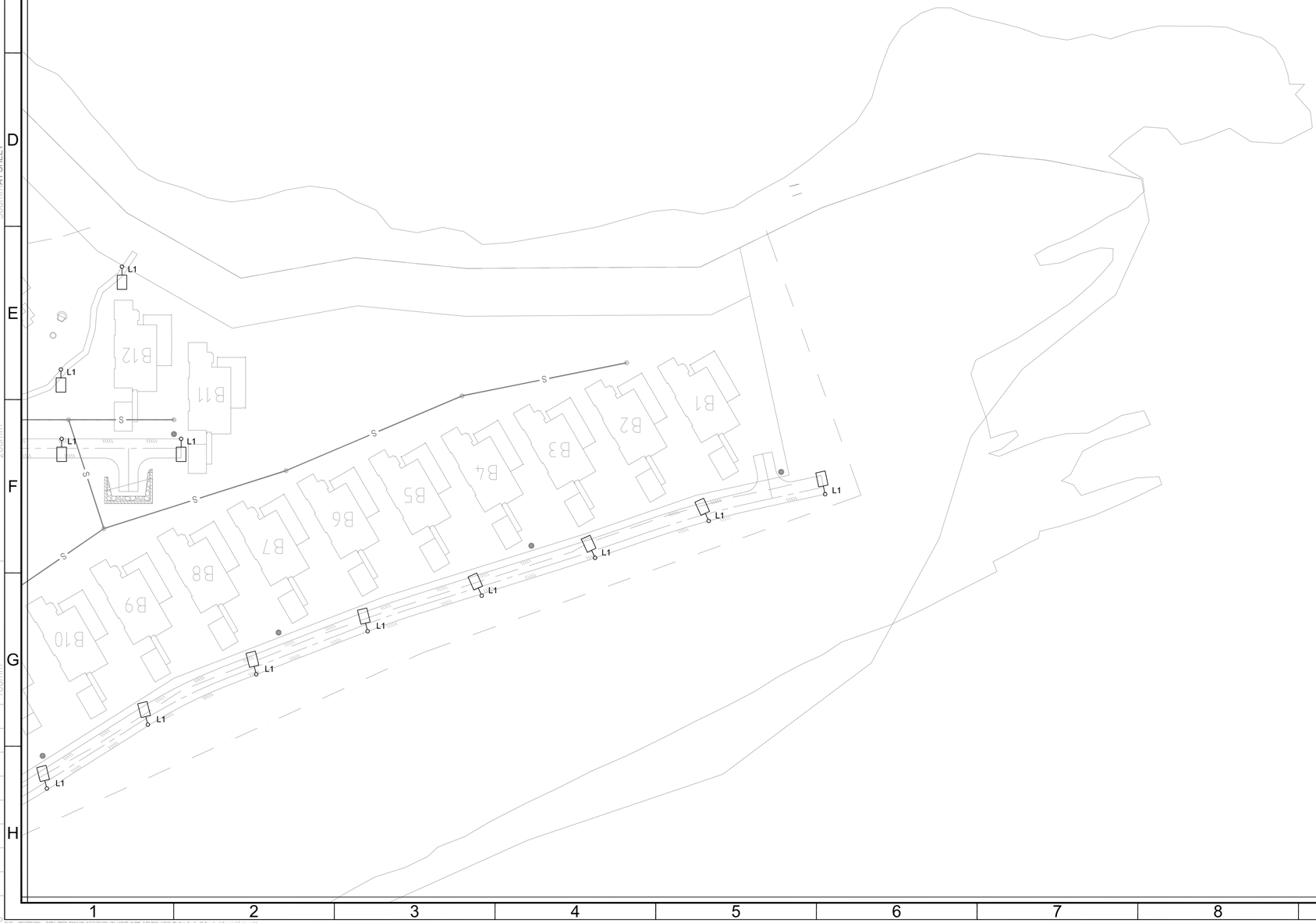
CONSULTANT

GREENLEAF ENGINEERS
Level 3, The Icon Centre,
15 Malt Street,
Fortitude Valley, Qld. 4006
tel.: +61 (07) 3358 3046
www.greenleafengineers.com

SERVICE
ELECTRICAL SERVICES

DRAWING TITLE
COVER SHEET

DRAWN A.A. ENGINEER A.A.
CHECKED R.D. DATE AUGUST 2011
DRAWING SCALE AS SHOWN
PROJECT No 5894 DRAWING No E00 REVISION A



NOTES:

1. DO NOT SCALE FROM DRAWINGS. ALL DIMENSIONS & LEVELS TO BE VERIFIED ON SITE BEFORE MANUFACTURE AND/OR CONSTRUCTION.
2. L1 LIGHT SHOWN AT 25m SPACING.

REV	DATE	DRN	CHD	DESCRIPTION
A	23/08/11	MK	AA	DA APPROVAL

SCALE 1:50 0 0.5 1 1.5 2 2.5 Metres

SCALE 1:100 0 0.5 1 2 3 4 5 Metres

DO NOT SCALE, USE FIGURED DIMENSIONS ONLY

CLIENT

CLIENT

ARCHITECT

PROJECT

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Level 3, The Icon Centre,
15 Malt Street,
Fortitude Valley, Qld. 4006
tel.: +61 (07) 3358 3046
www.greenleafengineers.com

SERVICE

ELECTRICAL SERVICES

DRAWING TITLE

EXTERNAL LIGHTING LAYOUT
1 OF 7

DRAWN	ENGINEER
M.K.	A.A.
CHECKED	DATE
R.D.	AUGUST 2011
DRAWING SCALE	
N.T.S.	1:1000 @ A3

PROJECT No	DRAWING No	REVISION
5894	E01	A

300mm A1 SHEET

NOTES:

1. DO NOT SCALE FROM DRAWINGS. ALL DIMENSIONS & LEVELS TO BE VERIFIED ON SITE BEFORE MANUFACTURE AND/OR CONSTRUCTION.
2. L1 LIGHT SHOWN AT 25m SPACING.

REV	DATE	DRN.	CHD.	DESCRIPTION
A	23/08/11	MK	AA	DA APPROVAL

SCALE 1:50 0 0.5 1 1.5 2 2.5 Metres

SCALE 1:100 0 0.5 1 2 3 4 5 Metres

DO NOT SCALE, USE FIGURED DIMENSIONS ONLY

CLIENT

CLIENT

ARCHITECT

PROJECT

TURTLE STREET BEACH

CONSULTANT

GREENLEAF ENGINEERS

Level 3, The Icon Centre,
15 Malt Street,
Fortitude Valley, Qld. 4006
tel.: +61 (07) 3358 3046
www.greenleafengineers.com

SERVICE

ELECTRICAL SERVICES

DRAWING TITLE

EXTERNAL LIGHTING LAYOUT 2 OF 7

DRAWN	ENGINEER
M.K.	A.A.
CHECKED	**DATE**
R.D.	AUGUST 2011
DRAWING SCALE	
1:500 @ A1	1:1000 @ A3

PROJECT No	DRAWING No	REVISION
5894	E02	A