GKI Power and Telecommunications Infrastructure

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EXECUTIVE SUMMARY

This report has been prepared by AECOM Pty Ltd on behalf of GKI Resort Pty Ltd to provide an assessment of power and telecommunications requirements for the proposed Great Keppel Island (GKI) Resort Revitalisation Plan and mitigation measures to address these impacts. This report has been prepared to address sections 2.5.3, 3.2.4 and 3.7 of the *Terms of Reference for EIS – Great Keppel Island Resort Project* issued by the Queensland Coordinator-General.

The GKI Resort Revitalisation Plan (refer to Appendix A – GKI Resort Revitalisation Plan) proposes to create a low rise, eco-tourism resort on Great Keppel Island. The Project will incorporate a 4 or 5 star resort hotel at Fisherman's Beach, a marina facility at Putney Beach, a ferry terminal, emergency services facilities, a yacht club, dry dock storage, a retail village, an 18-hole golf course, a runway and airport terminal, 750 eco-tourism villas, 300 eco-tourism apartments, a submarine connection of power, water and telecommunications between the Island and mainland, associated service facilities and utilities, 200 bed staff accommodation facilities, establishment of the GKI Research Centre and Biodiversity Conservation Fund (BCF), a new sports oval and restoration of the original Leeke's Homestead.

The GKI Resort Revitalisation Plan will be constructed in stages, with Stage 1 involving construction of the Fishermans Beach hotel and day spa, the marina facility including retail precinct, one hundred and fifty (150) apartments and internal infrastructure (power, water, sewerage, roads). It is expected that Stage 1 will take approximately 18 months to construct at a cost of approximately $150 million. Completion of the GKI Resort Revitalisation Plan is expected to take 12 years, finishing around 2023 via future staged development.

The GKI Resort Revitalisation Plan targets a carbon positive Project by utilising energy efficient design solutions and providing renewable energy production. This results in carbon offsets from onsite renewable energy sources in excess of the energy used from non-renewable sources during operation of the Project.

It is estimated that the GKI Resort Revitalisation Plan will consume 11,430,000 kWh/year of electrical energy, 2,120,000 kWh/year of gas energy (kitchens within the hotel and retail areas) and burn 8,376 litres/year of diesel per annum (for standby generators). To offset the carbon produced by the above usage and to ensure the Project will be carbon positive, 12,440,000 kWh/year of renewable energy is required to be generated. These figures may be reduced depending on the final designs of the buildings and the extent of energy efficient systems installed.

The GKI Resort Revitalisation Plan will utilise solar PV cells to generate the energy required to power the Island with the mandate that the average energy generated is greater than the average energy consumed on an annual basis post Project completion. It is envisaged that the solar PV cells will be mounted on the rooftops of the villas and other buildings if required.

A submarine cable is required for connection back to ERGON's mainland grid for the exporting of excess renewable energy to allow for the carbon positive status. This submarine cable can also be utilised to source energy from ERGON's mainland grid should supply from the solar PV Cells not be available or the peak power demand of the Island exceeds the generating capability of the solar PV cells, e.g. overcast days and at night.

During times where there is an outage from ERGON's mainland grid, or there is an issue with the submarine cable, diesel powered standby generators located on the Island will be utilised to provide power to the Project.

Underground electrical services will be reticulated around the Island to each building. It is proposed to install the services adjacent to roads to limit the visual impact and the civil works in each area.

In terms of telecommunications, it is estimated that the GKI Resort Revitalisation Plan will require an average bandwidth of 1,344 Mbps for high capacity users and 18 Mbps for low capacity users. The capacity of the existing telecommunications towers is limited to 16 Mbps, resulting in a requirement to upgrade the telecommunications services for the Project. It is envisaged to install fibre cores embedded within the high voltage submarine cable.

NABERs rating schemes for the buildings being constructed for the GKI Resort Revitalisation Plan do not yet exist and as such a formal NABERs rating cannot be determined. The buildings will however be designed in accordance with the philosophies of Green Star and NABERs 5 star ratings with regard to energy efficient design principles(for example facade design, building design, building orientation).

The plant and equipment installed within the buildings include reliable, high performance, cost effective and energy efficient appliances/building services (mechanical, electrical and hydraulic) and Building Management Systems (where applicable) and will be designed to reduce the energy consumption of each building.

Internal lighting systems for areas including living spaces, public spaces, back of house areas and retail spaces will be selected based on colour appearance, dimming ability (if required), glare considerations and ease of maintenance.

External lighting systems for areas including road ways, pathways and building facade will be selected based on safety, energy efficiency, colour appearance, potential ecological impacts, visual amenity, glare considerations and ease of maintenance.

Lighting systems will be controlled to allow energy minimization whilst maintaining functionality usage. Methods of energy control include utilising energy efficient lamp sources, minimising light levels and using task lighting where appropriate. Further controls include utilisation of motion sensors, time clocks, PE cells and dimming.

The environmental impacts associated with the solar PV cells, submarine cable, diesel standby generators and reticulation around the Island can be mitigated utilising measures including architectural and site planning input, carefully detailing a route to limit sea bed disruption, installing sufficient solar PV cells to offset the greenhouse emissions, employing acoustic control to generators and generator buildings and careful planning during civil design.

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1. INTRODUCTION

This report has been prepared by AECOM Pty Ltd on behalf of GKI Resort Pty Ltd to provide an assessment of power and telecommunications requirements for the proposed GKI Resort Revitalisation Plan and mitigation measures to address these impacts. The contents of this report are to be included as part of the overall Environmental Impact Statement (EIS) prepared for the GKI Resort Revitalisation Plan.

1.1 PROJECT OVERVIEW

The GKI Resort Revitalisation Plan (refer to Appendix A – GKI Resort Revitalisation Plan) proposes to create a low rise, eco-tourism resort on Great Keppel Island.

The proposal involves:

- Demolition of the old resort and construction of a new 4 or 5 star resort hotel at Fisherman's Beach comprising 250 suites and day spa;
- Dredging activities for construction of the marina and re-nourishment of Putney Beach using dredge spoil;
- A new all-weather safe access marina facility at Putney Beach comprising 250 berths, a ferry terminal, emergency services facilities, yacht club, and dry dock storage;
- A retail village with a mix of cafes, restaurants and clothing shops around the marina;
- An 18-hole golf course, designed by Greg Norman Golf Course Design and including club house, integrated with essential habitats and ecological corridors, and located on previously disturbed grazing lands;
- New runway and airport terminal;
- 750 eco-tourism villas incorporating sustainable building design, rooftop solar panels and water tanks;
- 300 eco-tourism apartments incorporating sustainable building design, rooftop solar panels and water tanks;
- Installation of submarine connection of power, water and telecommunications between the Island and mainland;
- Associated service facilities and utilities (waste collection area, fire-fighting and emergency services hub, fuel, solar, wastewater treatment plant etc), including 200 bed staff accommodation facilities;
- Establishment of the GKI Research Centre and Biodiversity Conservation Fund (BCF) which will aim to deliver a better understanding of the surrounding marine and terrestrial environments and to actively undertake conservation works to enhance the natural environment;
- A new sports oval which can be used by resort guests and other GKI residents and visitors; and
- Restoration of the original Leeke's Homestead.

It is envisaged that approximately 685 full time, part time and casual staff will be required once the resort is fully operational. Most operational staff will work standard shift hours and will be sourced from the Capricorn Region. The majority of staff will travel to the Island via ferry for each shift, before returning home to the mainland after their shifts. Up to approximately 200 staff may be accommodated in the new staff accommodation to be provided on the Island as part of the GKI Resort Revitalisation Plan.

The GKI Resort Revitalisation Plan will be constructed in stages, with Stage 1 involving construction of the Fishermans Beach hotel and day spa, the marina facility including retail precinct, one hundred and fifty (150) apartments and internal infrastructure (power, water, sewerage, roads). It is expected that Stage 1 will take approximately 18 months to construct at a cost of around $150 million. Completion of the GKI Resort Revitalisation Plan is expected to take 12 years, finishing around 2023.

An average of 220 (per annum) construction workers would be expected to work on the Island at any one time throughout construction. Construction workers will be ferried to and from the Island where possible and practical. It is envisaged that rooms at the old resort as well as other accommodation options on the Island will be utilised to provide accommodation on the Island for some construction workers.

1.2 LOCALITY OVERVIEW

Great Keppel Island is located approximately 12 km off the coast of Yeppoon on the central Queensland coast. GKI is included within the Rockhampton Regional Council local government area.

GKI is the largest island in the Keppel Island Group, which comprises a group of sixteen islands, including North Keppel Island, Corroboree Island, Pumpkin Island, Miall Island, Middle Island, Barren Island, Halfway Island, and Humpy Island. Apart from GKI and Pumpkin Island, all of the other Keppel Islands are designated National Parks.

The proposed GKI Resort Revitalisation Plan applies to the areas of GKI that are leased by GKI Resort Pty Ltd (the proponent), which covers an area of approximately 900 hectares consisting of multiple land tenures. The GKI Resort Revitalisation Plan also includes Unallocated State Land to be developed for the marina and areas to accommodate submarine connections between GKI and the mainland.

There are seventeen beaches on GKI and its natural environment offers a wide range of activities including swimming, diving, snorkelling and bushwalking.

1.3 CURRENT AND PREVIOUS DEVELOPMENT

Until recently the Island has been occupied by a number of different commercial accommodation facilities ranging from camping ground style accommodation to resort level accommodation. The original GKI Resort was the main tourism resort located on the Island and comprised 190 guest rooms. These facilities were closed in early 2008.

The Island is currently occupied by two backpackers' facilities, ten residential properties and ten commercial premises. Access to the Island is currently via ferry and cruise ship services from the Rosslyn Bay / Keppel Bay Marina on the mainland.

In the 1990s, the average daily population on the island (staff, residents, overnight and day visitors) was approximately 765 persons while the maximum possible daily population was approximately 2,600 persons (Foresight Partners, 2011). The peak daily population for the island during operation of the former resort (ie. 2,600 persons) is therefore comparable with the anticipated average daily population projected for the revitalised resort (ie. 2,274 persons) (Foresight Partners, 2011).

1.4 SCOPE AND OBJECTIVES

This Report has been prepared to address sections 2.5.3, 3.2.4 and 3.7 of the *Terms of Reference for EIS – Great Keppel Island Resort Project* issued by the Queensland Coordinator-General, which requires the following issues to be considered in the Environmental Impact Statement (EIS):

2.5 Associated Infrastructure

2.5.3 Energy
Describe all energy requirements, including electricity, natural gas, and/or solid and liquid fuel requirements for the construction and operation of the project. The location, design and capacity of power generation and transmission infrastructure for construction and ongoing use should be detailed. Consideration and design arguments for alternative energies as a source should be detailed. The locations of any easements must be shown on the infrastructure plan.

3.2 Land

3.2.4 Lighting
An assessment of all potential impacts of lighting of the project, during all stages, is to be provided, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid:

- *the visual impact at night*
- *night operations/maintenance and effects of lighting on fauna (including marine fauna)*
- *night operations/maintenance and effects of lighting on visitors and residents*

3.7 Greenhouse Gas Emissions

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

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

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

3.7.2 Potential impacts and mitigation measures
This section of the EIS should discuss the potential for greenhouse gas abatement measures. This may include:

- *a description of the proposed measures (alternatives and preferred) to avoid and/or minimise direct greenhouse gas emissions*
- *an assessment of how the preferred measures minimise emissions and achieve energy efficiency*

2. BACKGROUND

2.1 EXISTING POWER INFRASTRUCTURE

The previous resort located on Great Keppel Island consumed energy received from a set of four (4) diesel generators (detailed below) located at the main resort in an industrial compound shed (corrugated iron with no acoustic treatment). The generators have since been decommissioned and removed.

- Generator 1
    - Partner 700 kVA
    - MTU V12 Diesel Motor
- Generator 2
    - Stamford 650 kVA
    - Cummins KTA-38-G 1200 HP Diesel Motor

- Generator 3
    - Stamford 1150 kVA
    - Cummins V16 KTA-50-G 1240 HP Diesel Motor
- Generator 4
    - Partner/Virtus 1000 kVA
    - MTU V18 Diesel Motor

In addition, a separate set of diesel generators were located at Long Beach to supply energy for the water supply bore field in the same location.

The previous resort had a lower maximum demand than what is being proposed for the GKI Resort Revitalisation Plan, hence the new loads will be higher than what is detailed above.

2.2 EXISTING TELECOMMUNICATIONS INFRASTRUCTURE

The previous resort utilised communications originating from Telstra and Optus telecommunications consisting of towers serving as a mobile phone bases, ADSL capable equipment, normal telephony and ISDN equipment. The energy required for the equipment on the towers was supplied via solar panels and a diesel generator backup independent of the resort.

3. DESIGN CRITERIA

The power and telecommunications requirements for the GKI Resort Revitalisation Plan are based on the resort population throughout an average year as detailed below.

3.1 ESTIMATED GKI RESORT POPULATION

The following table is included from the Forecast Economic Impacts report for Proposed Revitalisation of Great Keppel Island prepared by Foresight Partners Pty. Ltd.

The values presented in this table are adopted in this assessment to estimate proposed power and telecommunications demands for the Project.

TABLE 3-1 – Great Keppel Island Forecast Persons

Great Keppel Island Forecast Persons	*Units*	*Avg. Annual Occupancy Rate*	*Persons / Occupied Unit*	*Annual Person Days*
Hotel rooms	250	65%	2.2	130,488
Villas and Apartments	1,050	50%	2.5	479,063
Marina berths	250	20%	2.2	40,150
Day visitors	N/A	N/A	N/A	36,500
Staff accommodation	200	95%	1.3	95,760
Staff commuting	N/A	N/A	N/A	48,000
Annual total				829,960
Average per Day				2,274

3.2 ESTIMATED GKI ENERGY CONSUMPTION

Based on the above table detailing occupancy rates and including all elements as detailed in Section 1.2, we estimate the annual energy consumption and peak demand of the GKI Resort Revitalisation Plan to be in the order of:

• Energy Consumption (electricity)	11,430,000 kWh/year	
• Energy Consumption (gas)	2,120,000 kWh/year	From Arup Report *
• Consumption (diesel)	8,376 Litres/year	
• Peak Demand	6,900 kW	

* Arup Report – Renewable Energy Analysis Report, Issue 4, July, 2011

The above indicative energy consumption values are based on all equipment being provided with an electrical supply with the exception of:

- Hotel and restaurant kitchens where we have assumed a gas supply will be utilised.
- Villa hot water supply where we have assumed a solar hot water system will be utilised.

If an electrical supply is required for the above services the energy consumption and peak demand figures detailed above will increase.

The above estimate of energy consumption may be reduced during the future stages of the project by utilising high performance, energy efficient designs for the buildings to be constructed. The final figures will require clarification by the designers during the design stage.

3.3 ESTIMATED GKI ENERGY GENERATION

The GKI Resort Revitalisation Plan has the objective to provide energy in a manner that achieves a carbon positive result for the electrical energy consumed to post construction works. To achieve a carbon positive result, a renewable energy supply is required to generate energy which is to be supplied back into the Authority's Electrical Grid. The minimum energy to be generated to achieve a carbon positive outcome (and supplied back into the grid) is dependent on the following factors:

- The Energy Consumption (detailed above)
- A carbon factor (greenhouse gas coefficient) as every kWh of electricity consumed produces 1.02 kg CO_2
    - 11,430,000 x 1.02 = 11,658,600 kg CO_2
- A carbon factor (greenhouse gas coefficient) as every kWh of gas consumed produces 0.2 kg CO_2
    - 2,120,000 x 0.2 = 424,000 kg CO_2
- A carbon factor (greenhouse gas coefficient) as every litre of diesel consumed produces 0.73 kg CO_2
    - 8,376 x 0.73 = 6,114 kg CO_2
- A 5% buffer factor to ensure a carbon positive result and to offset the energy consumption during construction phase
    - (11,658,600 + 424,000 + 6,114) x 1.05 = 12,690,000 kg CO_2

Based on the above consumption figures and factors, the energy required to be generated by a renewable source equates to (dividing the above figure by the carbon factor for electricity):

- 12,690,000 / 1.02 = 12,440,000 kWh/year

3.4 ESTIMATED GKI TELECOMMUNICATIONS REQUIREMENTS

We believe the telecommunications requirements will include:

- Telephone and IP Telephony
- Video phone / conferencing
- Television
- Video on demand
- Radio

Usage of the telecommunications service is divided into high users and low users and we have estimated high and low users will exhibit the following internet usage amounts on an average daily basis:

TABLE 3-2 – Internet Usage Details

Description	Low User (LU)	High User (HU)	Comments
Internet	0.55 Mbps	10 Mbps	
Telephone	0.1 Mbps	0.15 Mbps	HU includes VoIP
2 SDTV Channels		6 Mbps	Streaming TV
1 HDTV Channels		32 Mbps	Streaming TV
Mobile Devices		1 Mbps	Blackberry's, Iphones and Ipads
Totals	0.65 Mbps	49.15 Mbps	

We estimate during the high season when the number of visitors is at peak levels, the broadband usage per day is 2 hours and the number of people on line at any one time is 40%. Based on this estimate, internet usage (table 3-2) and table 3-1 above detailing occupancy rates and including all elements as detailed in Section 1.2, we estimate the average bandwidth requirements to be in the order of:

TABLE 3-3 – Bandwidth Requirements

Great Keppel Island Forecast Persons	Bandwidth Requirements HU (Mbps)	Diversity HU (Mbps)	Bandwidth Requirements LU (Mbps)	Diversity LU (Mbps)
Hotel rooms	12,038	261	163	3.52
Villas and Apartments	50,558	843	683	11.38
Marina berths	12,038	80	163	1.08
Day visitors				
Staff accommodation	9,630	305	130	4.12
Staff commuting				
Totals	84,263	1,489	1,138	20.10

- High Users 1,489 Mbps
- Low Users 20 Mbps

The current capacity of the existing telecommunications towers is 16 Mbps, less than the predicted requirement for low end users alone. Installation of additional telecommunications services will be required to meet the demand of the high users.

4. POWER INFRASTRUCTURE

The design of an effective power infrastructure system for GKI requires the following components to ensure a carbon positive result:

- Renewable energy source
- Standby energy source
- Redundancy for the above energy sources
- Connection to an existing network

4.1 POWER SUPPLY REQUIREMENTS

A renewable energy supply is required that has the capacity to generate energy of:

- Energy Generation 12,440,000 kWh/year

A secondary energy supply is required that has the capacity to meet the electrical energy consumption and peak power demand of:

- Energy Consumption 11,430,000 kWh/year
- Peak Power Demand 6,900 kW

Alternative standby energy sources are also required to allow for energy generation during times when the secondary energy source is unavailable, and the renewable power source cannot meet the peak power demand.

4.2 POWER SUPPLY OPTIONS

There are several options available for the supply/generation of energy to the GKI Resort Revitalisation Plan. The options fall into two categories. Those that provide a primary renewable source of energy which will produce a carbon positive result and those that provide a standby source of power for the Project. The options for the supply of power for the resort are limited by the initial decision to create a carbon positive result. These options include the following.

4.2.1 MAINLAND GRID CONNECTION

A mainland grid connection as a primary source of power for the resort would not achieve the main design criteria which is to be carbon positive. A connection to the mainland grid is however essential to allow for excess energy produced by a renewable source to be supplied back into the grid. Therefore, without this connection, a carbon positive result will not be realised.

The connection can be made by installing a submarine cable from the ERGON network on the Mainland to a Main Substation on the Island. The cable will be buried in the sea bed for protection. The advantages of the submarine cable include:

- Having access to an alternative reliable power supply when required
- Can be used as an additional power source should the renewable power supply be unable to meet the power demand for any reason

- Can be used as a standby power source should the renewable power supply be unavailable

The disadvantages of the submarine cable include:

- Utilising an energy source that emits green house gases into the atmosphere (typically coal fired power stations)
- Potential environmental impact of disturbing mangroves, the sea bed and coral during installation
- Installation of cable through Great Barrier Reef Marine Park Zones
    - Conservation Park Zones
    - Marine National Park Zones
- Potential loss of visual amenity as a substation building will be required to house the transformer/s and associated equipment on GKI (in the Industrial Compound)
- The proponent will be required to own and maintain the cable that is buried within the sea bed as the Authority will not accept liability

The submarine cable will be connected to the mainland grid at the “Point of Connection”. Refer to “Appendix B – Mainland Submarine Cable Point of Connection” for the potential point of connection for the submarine cable.

4.2.2 DIESEL POWER GENERATION

Diesel power generation, while not a renewable energy source, could be utilised as a standby energy source for the GKI Resort Revitalisation Plan should the renewable source not be available.

The advantages of diesel generation include:

- Having energy generation on the Island and not being reliant on the mainland grid
- As diesel generator/s were utilised to serve the old resort, storage and delivery of diesel is not a new concept to GKI
- Diesel generators can be installed quickly (compared to the lead time of a submarine cable) allowing for faster connection to construction sites
- Higher power output when compared to same size gas powered generator
- Larger load acceptance and shorter durations between addition of loads when compared to gas
- Initial capital cost lower when compared to same size gas powered generator
- Generally long life
- Maintenance and fitters personnel for diesel generators are generally more available than maintenance and fitters for gas generators

The disadvantages of diesel generation include:

- Diesel is not a renewable resource (biodiesel can be utilised to soften the impact on the environment)
- Production of more greenhouse gas emissions into the atmosphere when compared to gas powered generators
- Use of diesel fuel and emission of diesel exhaust into the atmosphere
- Having to undertake preventative maintenance
- Introduction of noise to the environment when the generators are operating

- Potential loss of visual amenity as a building/s will be required to house the generator/s and associated equipment, including generator stacks
- Additional diesel storage will be required as well as the need for more regular diesel delivery to GKI (the Marina requires a diesel pump station) introducing the possibility of environmental damage due to diesel spills.
- The diesel fuel in storage will have to be laundered to remove bacteria on a regular basis

4.2.3 GAS POWER GENERATION

Gas power generation, while not a renewable energy source, could be utilised as a standby energy source for the GKI Resort Revitalisation Plan should the renewable source not be available.

The advantages of gas generation include:

- Having energy generation on the Island and not being reliant on the mainland grid
- As diesel generators were utilised to serve the old resort, utilising generators is not a new concept to GKI
- Gas generators are a cleaner source when compared to diesel powered generators
- Lower operating cost when compared to diesel powered generators
- Gas generators can be installed quickly (compared to the lead time of a submarine cable) allowing for fast connection to construction sites

The disadvantages of gas generation include:

- Gas is not a renewable resource
- Use of gas and emission of gas exhaust into the atmosphere
- Having to undertake preventative maintenance
- Smaller load acceptance and longer durations between addition of loads when compared to diesel
- Introduction of noise to the environment when the generators are operating
- Potential loss of visual amenity as a building/s will be required to house the generator/s and associated equipment
- Gas storage will be required as well as the need for regular gas delivery to GKI
- Initial capital cost higher when compared to same size diesel powered generator
- Maintenance and fitters personnel for gas generators are generally less available than maintenance and fitters for diesel generators

4.2.4 SOLAR POWER GENERATION (PV CELLS)

Solar power generation (photovoltaic cells) is one example of a renewable energy source that can be utilised on GKI for energy generation.

The advantages of solar power include:

- Renewable energy resource
- Having energy generation on the Island and not being reliant on the mainland grid
- Reduction of greenhouse gas emissions

- Achieves the Developer's requirement for a carbon positive result (with excess energy supplied back to the mainland grid via the submarine cable).

The disadvantages of solar power include:

- Dependent on sunshine
- Potential loss of visual amenity as solar panels will be installed together in a solar array or on roof tops of the various buildings
- Ongoing maintenance costs of keeping the solar panels clean
- Storage capacity will be required if energy is to be stored for occasions where adequate sunshine is not available (overcast days and at night). Batteries can be utilised for storage, however due to the magnitude of energy required the battery installation will be large and will require maintenance
- A large number of panels will be required to satisfy the carbon positive requirement

4.2.5 WIND POWER GENERATION

Wind power generation is another example of a renewable energy source that can be utilised on GKI for energy generation.

The advantages of wind power include:

- Renewable energy resource
- Having energy generation on the Island and not being reliant on the mainland grid
- Reduction of greenhouse gas emissions
- Achieves the Developer's requirement for a carbon positive result (with excess energy supplied back to the mainland grid via the submarine cable).

The disadvantages of wind power include:

- Dependent on wind
- Potential loss of visual amenity as wind turbines will be installed together in a wind farm
- Noise generated by the wind turbines
- Danger to wildlife
- Storage capacity will be required if energy is to be stored for occasions where adequate wind is not available. Batteries can be utilised for storage, however due to the magnitude of energy required the battery installation will be large and will require maintenance
- A large number of turbines will be required to satisfy the carbon positive requirement

4.2.6 FUEL CELLS

Fuel Cells, while not a renewable energy source, could be utilised as a standby energy source for the GKI Resort Revitalisation Plan should the renewable source not be available.

The advantages of fuel cells include:

- Reduction in greenhouse gases (compared to coal fired power stations)
- No noise or vibration when producing electricity

- Energy generation can be located adjacent to the energy consumer, reducing the extent of transmission required

The disadvantages of fuel cells include:

- Gas is not a renewable resource
- Use of gas and emission of gas exhaust into the atmosphere
- Space is required for the fuel cells
- Potential loss of visual amenity as the fuel cells will need to be located external to the buildings
- Large and multiple fuel cells will be required for larger consumers (e.g. hotel)
- Gas storage will be required as well as the need for regular gas delivery to GKI
- Gas reticulation will be required to areas where fuel cells are installed

4.2.7 AUTHORITY CORRESPONDENCE

A connection enquiry form has been submitted to ERGON with a proposed single line diagram and map detailing the requirements to connect the electricity grid on the mainland to the electrical reticulation system on Great Keppel Island. A detailed enquiry response has been received from ERGON detailing preliminary advice only for the below detailed items:

- Scope of Works – detailing two separate options
- Supply Issues for both options
- Indicative Project Lead Times
- Connection Details
- Indicative Financial Terms
- Agreements Covering the Connection
- Retailer
- Application to Connect
- Early Project Initiation

Further discussions will be held with ERGON to progress this issue.

4.2.8 RECOMMENDATION

A submarine cable is required for connection back to ERGON's mainland grid for the exporting of excess renewable energy to allow a carbon positive result. As the ERGON supply is reliable, it can be utilised as a power source should the renewable energy source not provide sufficient peak power.

During daylight hours when sunlight is available, solar panel PV cells will provide primary energy. The submarine cable connected to the mainland grid acts as a secondary energy supply to the solar PV cell supply, and:

- When demand is greater than supply, the excess can be sourced from the grid
- When demand is less than supply, the excess can be supplied into the grid

During the evening hours when no sunlight is available, all energy can be sourced from the grid, however there is no standby source available should the grid connection fail. We therefore recommend an alternative energy source be made available.

We recommend utilising diesel power generation as a standby energy source at night. Should the submarine cable fail or the there is an outage with the mainland supply, the diesel power generation can be utilised to supply part of or the entire Project. While diesel power generation is not as clean as gas power generation, we believe diesel to be the more attractive option as detailed below:

- GKI previously utilised diesel generation and diesel storage (not a new concept)
- Diesel storage is less complicated than gas storage

Each option and recommendation should be reviewed at each stage of the Project to ensure the appropriate system is installed to suit the GKI Resort Revitalisation Plan.

4.2.9 MITIGATION MEASURES

The below mitigation measures can be employed to reduce the environmental impacts of each power supply option.

Mainland Grid Connection

- Utilisation of renewable energy sources on the Island. The more energy supplied back into the grid from renewable sources reduces the amount of greenhouse gases emitted into the atmosphere from other consumers
- Sea bed surveys should be undertaken to select an appropriate route for the submarine cable to reduce the impact of disturbing the environment and not entering sensitive areas
- Architectural input should be sought to improve the look of the substation building/s to blend in with the GKI Resort Revitalisation Plan

Diesel Power Generation

- Utilisation of biodiesel as fuel for the generators
- Utilisation of renewable energy sources on the Island to supply energy back into the grid to offset the emission of diesel exhaust into the atmosphere
- Acoustic input should be sought to decrease the noise being introduced into the environment
- Architectural input should be sought to improve the look of the generator buildings to blend in with the GKI Resort Revitalisation Plan
- Safety measures for the diesel storage tank to be put into place

Solar Panel PV Cells

- The panels should be installed facing North to capture as much sunshine as possible
- Architectural input should be sought to improve the look of the buildings where panels will be installed to blend in with the GKI Resort Revitalisation Plan

4.3 SOLAR PV CELLS INSTALLATION OPTIONS

There are several options available for the location of the solar PV cells including:

- Roof spaces of buildings, namely villas
- In one large array on the Island or on the Mainland
- In several smaller array's on the Island or on the Mainland
- A combination of the above, roof spaces and supplemented by an array

4.3.1 ROOF SPACE INSTALLATION

Installing the solar PV cells on the roof spaces of the buildings is one option available, however roof space is limited and space is required around the solar panels once installed for maintenance purposes.

The advantages of utilising the roof spaces include:

- Eliminates the requirement of clearing additional land for a solar PV cell array
- Eliminates the requirement of constructing separate footings and associated structure to support the PV cells

The disadvantages of utilising the roof spaces include:

- The construction of the apartments and villas are staged and not due for completion until the year 2023 as per the Project Schedule. Depending on power usage and the stage of construction, a carbon positive result will not be realised for several years. Refer to section 9 for further details
- There may be insufficient roof space for all panels required for a carbon positive result, a solar array will then need to be constructed
- Solar panels will need to face North to generate maximum energy, this is dependent on the construction of the buildings
- The weight of the solar panels and associated equipment will require structural support

If the roof space of the villas only are utilised for the Solar Panels, 54 square metres of roof space is required on each villa. This spatial allowance is for panels only and does not allow for other roof services such as solar hot water or space for maintenance. The final area will require clarification by the designers during the design stage and may be reduced depending on the final energy consumption figures. If there is insufficient space on the villa's, other roof spaces (e.g. accommodation buildings) will need to be utilised.

4.3.2 SINGLE ARRAY INSTALLATION

We have estimated that if all of the panels were to be installed in an array, a larger area is required for the when compared to installing the panels on villa roof tops as space is required around the panels for cleaning and maintenance purposes. The spatial requirement for the array is based on the area required for the panels being 60% of the total area required. Therefore, we have estimated the space required will be in the order of 6.7 hectares. The final area will require clarification by the designers during the design stage.

The advantages of- a single array include:

- Installing the solar PV cells in one large array offers the benefit of installing the cells on an as-needed basis
- Expansion can also be carried out easily provided land is available
- Potential for the resort to reach a carbon positive result quickly and maintain the status as buildings progress (as more buildings are constructed, the array can be increased in size in a staged program)
- The array can be installed on GKI or alternatively on the mainland

The disadvantages of a single array include:

- Requirement to clear additional land – environmental impacts
- Requirement to construct footings and associated structure to support the PV cells
- Solar panels will need to face North to generate maximum energy

If an array is selected as the method of installation, we recommend space be made available on GKI. While there will be an environmental impact to clear sufficient space for the installation, if the array is installed on the mainland, it won't be viewed on the Island which may lead to a perception that the carbon positive result is not achieved as there is no renewable energy source on GKI.

4.3.3 MULTIPLE ARRAY INSTALLATION

If multiple arrays are to be installed, the space required will be larger than that required for a single array. The final area for each array will require clarification by the designers during the design stage.

The advantages of a multiple array installation include:

- Installing the solar PV cells in multiple array's offers the benefit of installing the cells on an as-needed basis
- Expansion can also be carried out easily provided land is available
- Array's can be installed in several small areas, not constrained to one large area
- Potential for the resort to reach a carbon positive result quickly and maintain the status as buildings progress (as more buildings are constructed, the array can be increased in size in a staged program)

The disadvantages of a multiple array installation include:

- Requirement to clear additional land – environmental impacts
- Requirement to construct footings and associated structure to support the PV cells
- Solar panels will need to face North to generate maximum energy

4.3.4 RECOMMENDATION

Based on the environmental impact associated with clearing land associated with a solar array, we recommend installing the solar PV cells on the roof spaces of the villas. Each villa installation will include an inverter for connection back to the Island's power reticulation network.

Each option and recommendation should be reviewed at each stage of the Project to ensure the appropriate system is installed to suit the GKI Resort Revitalisation Plan.

4.4 POWER INFRASTRUCTURE REQUIREMENTS

4.4.1 RETICULATION

An underground electrical infrastructure system is required on GKI to deliver the energy supply to buildings, equipment and services. It is proposed that a 22 kV high voltage supply will be made available to GKI via a submarine cable which will be terminated into GKI's main substation. The high voltage will then be stepped down to 11 kV for reticulation around GKI. Ring Main Units and Transformers will be installed at required locations around GKI to step down the voltage to 400 V for consumer use. Refer to "Appendix C – GKI Site

Power and Telecommunications Infrastructure" for a pictorial description of potential substation and generator locations and for schematics of the systems. Note this may change depending on the final master plan and services requirements of the development. Each option and recommendation should be reviewed at each stage of the project to ensure the appropriate system is installed to suit the GKI Resort Revitalisation Plan.

Please note, as the proponent will own the infrastructure services from the point of connection and on the Island, an easement is not required. It is recommended to ensure the underground services are located in such a position that enables future access in case this is required in the future.

4.4.2 POINT OF CONNECTION

Several locations on the mainland were selected as potential points of connection. Locations were considered and commented on by several companies with the main considerations being:

- Absence of prevailing South East winds and tides
- Services are either present or can be reticulated to the area, including
    - Electricity
    - Telecommunications
    - Water
- Services present are suitable, for example, voltage of the electrical supply
- The community will not be adversely affected
- Land is available for services buildings, a telecommunications building will be required and potentially a water pumping station

Refer to "Appendix D – Potential Points of Connection" for further details and "Appendix B – Mainland Submarine Cable Point of Connection" for the preferred location and proposed submarine cable route.

4.4.3 SOLAR ENERGY

The solar cells will generate energy at a low voltage which will be stepped up to 400V for connection to GKI's low voltage reticulated installation. When the solar cells produce more energy than that being consumed, the excess energy will be automatically fed back into the mainland grid via the submarine cable. When the solar cells produce less energy than that being consumed, the grid will provide the excess via the submarine cable.

Refer to "Appendix C – GKI Site Power and Telecommunications Infrastructure" for a schematic of the system.

4.4.4 DIESEL GENERATORS

The diesel generators will produce a 400 V supply, which will either be utilised at that location or stepped up to 11 kV for connection to GKI's high voltage reticulated installation. Low voltage (400 V) generators are being considered instead of high voltage (11 kV) due to lead time and costs and to ensure generator maintenance can be carried out by local low voltage contractors rather than high voltage specialists.

For scenarios where the voltage requires to be stepped up to 11kV for reticulation, transformers will be required.

The extent of standby generation will depend on the requirements of standby power in the event the primary energy source (solar) is unavailable and the secondary energy source (mainland grid) has failed.

One option is to allow for the whole of the GKI Resort Revitalisation Plan to be operated on the diesel generators and another option is to allow only selected sections of the Project to continue operating.

- If the first option is selected, additional costs will be required for larger / additional generators and associated plant to be installed.
- If the second option is selected, additional costs will be required for additional infrastructure to be installed that allows sections of the Project to be shut down.

Depending on the final designed configuration will dictate which option above is more expensive.

For the purpose of this report we will assume only sections of the GKI Resort Revitalisation Plan are to be operational under standby generator power, comprising of:

- The Hotel
- Sections of the Marina
    - Emergency Services Facility
    - Ferry Terminal
    - Yacht Club
    - Cafes
    - Restaurants
    - Clothing Shops
    - Waste Collection Area
    - Fire Fighting and Emergency Services Hub
- The Golf Club
- Waste Water Treatment Plant
- Airport Operations

With regard to the generator installation, either all of the standby power can be supplied from a single generator house, or the generators can be distributed around the Island in locations where needed. We recommend separate locations for standby generators to be installed. Each Generator House will provide sufficient energy to the surrounding areas and consist of one generator only. This option allows for services to remain running in case of issues with the high voltage network.

- Industrial Compound
- The Hotel
- The Marina
- The Golf Club
- The Airport

The below information is based on Caterpillar Prime rated Diesel Generator Sets. The final sizes of generator sets will require clarification by the designers during the design stage.

<u>The Industrial Compound</u>

The peak load of the Industrial Compound is estimated to be 325 kW. Based on a generator not exceeding 80% of load, operating at a 0.8 power factor, a 500 kVA generator will be required. The fuel consumption rate of the generator assuming 325 kW of standby power is required is in the order of 65 litres per hour.

The Hotel

The peak load of the hotel is estimated to be 1,070 kW. Based on a generator not exceeding 80% of load, operating at a 0.8 power factor, a 1,700 kVA generator will be required. The fuel consumption rate of the generator assuming 1,070 kW of standby power is required is in the order of 270 litres per hour.

The Marina

The peak load of the Marina facilities listed above is estimated to be 1,086 kW. Based on a generator not exceeding 80% of load, operating at a 0.8 power factor, a 1,700 kVA generator will be required. The fuel consumption rate of the generator assuming 1,086 kW of standby power is required is in the order of 230 litres per hour.

The Golf Club

The peak load of the golf club is estimated to be 400 kW. Based on a generator not exceeding 80% of load, operating at a 0.8 power factor, a 635 kVA generator will be required. The fuel consumption rate of the generator assuming 400 kW of standby power is required is in the order of 97 litres per hour.

The Airport

The peak load of the airport is estimated to be 100 kW. Based on a generator not exceeding 80% of load, operating at a 0.8 power factor, a 275 kVA generator will be required. The fuel consumption rate of the generator assuming 100 kW of standby power is required is in the order of 36 litres per hour.

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From the above figures, when the above nominated services are operating at full load under standby generator power, the fuel consumption rate will be in the order of 698 litres per hour. This and the above figures will change during operations depending on the extent of services being utilised. For example, during the low season, when the population on GKI is reduced, the consumption rate will reduce as fewer services are being utilised.

Apartment Buildings

Standby generator power will be provided to fire and emergency services within the apartment buildings. The power will either be per building or from an adjacent building to be clarified by the designers during the design stage due to the relatively small amount of power required for these services.

Staff Accommodation Buildings

Standby generator power will be provided to fire and emergency services within the staff accommodation buildings. The power will either be per building or from an adjacent building to be clarified by the designers during the design stage due to the relatively small amount of power required for these services.

Preventative Maintenance

The generators will be required to undergo monthly preventative maintenance tests to improve performance when the generators are required. To undertake the tests, the generators require a connection to an electrical load. This can be provided by utilising a load bank or the electrical load can be provided utilising the live load of the Island.

If a load bank is to be utilised, it can either be purchased for the use of preventative maintenance or it can be hired from the mainland and shipped over for the duration of the tests. Additional infrastructure will need to be provided within switchboards to enable connection of the load bank for the duration of the tests.

If the existing load is to be utilised, a load bank is not required, however authority approval will be required in the form of parallel generation agreements.

The expected fuel consumption rate during preventative maintenance will be in the order of 698 litres per hour – each generator will be loaded to approximately 80% of full load power for a one hour period each month. This equates to a fuel usage of 698 x 12 = 8,376 litres per year.

4.5 POWER DESIGN

The buildings for the GKI Resort Revitalisation Plan will be designed in accordance with the philosophies of Green Star and NABERs 5 star ratings with regard to energy efficient design principles. There are no NABERs rating scheme for any of the buildings being constructed as part of the GKI Resort Revitalisation Plan, hence the philosophies only will be utilised.

The design philosophies will be applied to the buildings (for example facade design, building design, building orientation) and the systems installed within the buildings.

The systems installed within the buildings include:

- Reliable, high performance, cost effective and energy efficient appliances
- Reliable, high performance, cost effective and energy efficient building services (mechanical, electrical and hydraulic)
- Building Management Systems (where applicable)

4.6 CAPITAL COSTS

The following works will need to be undertaken based on the recommendations provided in this section. Also detailed is the payer of the capital costs:

- Connection to the mainland grid – to be discussed with ERGON
- Submarine cable – to be paid for by the proponent
- Solar PV cells – to be paid for by the proponent
- Diesel generators – to be paid for by the proponent
- Reticulation of underground services on the Island – to be paid for by the proponent

5. LIGHTING

5.1 INTERNAL LIGHTING REQUIREMENTS

Internal lighting consists of living spaces, public spaces, back of house areas and retail spaces.

- Living spaces include hotel suites, staff accommodation, villa's and apartments
- Public spaces include hotel areas, cafes, restaurants, the golf club and the airport
- Back of house areas include kitchens and offices
- Retail spaces include clothing shops

Correct selection of light fittings is important to ensure that the selected lamp type is suitable for the requirements of that area including:

- Colour appearance

- Dimming ability (if required)
- Glare considerations
- Ease of maintenance
- Energy efficiency

5.2 EXTERNAL LIGHTING REQUIREMENTS

External lighting consists of road way lighting, pathway lighting, building facade and runway lighting.

- Road way lighting will be required on the roads to allow drivers of vehicles to use the roads safely during the evening hours
- Pathway lighting will also be required for pedestrians for similar reasons
- Building facade lighting to illuminate buildings for aesthetic reasons

Correct selection of light fittings is important to ensure that the selected lamp type is suitable for the requirements of that area including:

- colour appearance
- potential ecological impacts e.g. lighting in proximity to Putney Beach and Fisherman's Beach should have greater consideration to potential marine fauna impacts
- visual amenity considerations e.g. eliminate glare above the horizontal due to an airport operating on the Island
- glare considerations
- ease of maintenance

5.3 LIGHTING SELECTION

There are several types of lamps that can be utilised for lighting, these options include the below.

5.3.1 HIGH PRESSURE SODIUM LAMPS

The advantages of high pressure sodium lamps include:

- Most efficient of light sources
- The colour appearance of the lamps do not have an adverse effect to marine turtles

The disadvantages of high pressure sodium lamps include:

- Reduced colour rendering, different colours tend to look the same under a high pressure sodium light source

5.3.2 LOW PRESSURE SODIUM LAMPS

The advantages of low pressure sodium lamps include:

- The colour appearance of the lamps do not have an adverse effect to marine turtles
- Long lamp life compared with most discharge type lamp sources

The disadvantages of low pressure sodium lamps include:

- Low pressure sodium lamps are prohibitively expensive and difficult to maintain
- Orange colour appearance is not as visually appealing as a whiter coloured light source

5.3.3 METAL HALIDE LAMPS

The advantages of metal halide lamps include:

- Extremely good colour rendering, white light emitted from the lamps allows for excellent colour reproduction, allowing for different colours to be clearly seen

The disadvantages of metal halide lamps include:

- Shorter life when compared to high pressure sodium
- White light effects marine turtle behaviour

5.3.4 LED LAMPS

The advantages of LED lamps include:

- Longer life
- Easy to control
- Instant start
- Low temperature

The disadvantages of LED lamps include:

- Expensive when compared to other lamp sources
- Less efficient than high pressure sodium lamps

5.3.5 COMPACT FLUORESCENTS

The advantages of compact fluorescent lamps include:

- Longer life when compared to incandescent lamps
- Utilise less energy when compared to incandescent lamps
- Produce less heat than incandescent lamps

The disadvantages of compact fluorescent lamps include:

- Higher capital cost when compared to incandescent lamps
- Particular lamps are required if dimming is required

5.4 ENERGY USAGE

There are several ways that lighting systems can be controlled to allow energy usage to be reduced for the light fixtures. These include but are not limited to:

- Utilise energy efficient lamp sources – to minimise energy usage

- Minimise light levels – to reduce energy consumption
- Motion sensors – to switch lights off after a preset time
- Time clocks – to switch lights on and off at pre-determined times
- Photo electric cells – to switch lights on at dusk and off at dawn
- Dimming – to reduce lighting levels within conference rooms and the like
- Use of task lighting – to reduce overall lighting levels in large areas

5.5 RECOMMENDATION

Utilise lamps, light fittings and control measures suited to the area of installation.

Each option and recommendation should be reviewed at each stage of the Project to ensure the appropriate system is installed to suit the GKI Resort Revitalisation Plan.

6. TELECOMMUNICATIONS INFRASTRUCTURE

6.1 TELECOMMUNICATIONS SUPPLY REQUIREMENTS

A telecommunications system is required to serve the requirements of the GKI Resort Revitalisation Plan. Services that may be required include:

- Telephone and IP Telephony
- Video phone / conferencing
- Television
- Video on demand
- Radio

A standby telecommunications system is also required to allow for communication during times when the primary system is not available.

6.2 TELECOMMUNICATIONS SUPPLY OPTIONS

There are several options available for the supply of communications to GKI, these options include the below.

6.2.1 MAINLAND EXCHANGE

A connection can be made to the mainland exchange by installing a fibre optic submarine cable from the Mainland to an Exchange on the Island. The cable will be buried in the sea bed for protection.

There are several carriers available (including Telstra and Optus) for connection to GKI via the submarine cable. A small air conditioned exchange building (approximately 7.0 metres x 4.0 metres) will be constructed on the mainland coast at the “Point of Connection” where the submarine cable will be installed for installation of telecommunication racks. Typically the building will house one rack per Carrier as well as

one rack for the proponent. The proponent's rack will then be connected to the submarine cable which will incorporate a set number of fibre cores for each of the carriers.

The advantages of the fibre optic submarine cable include:

- Having access to a reliable exchange when required
- Access to multiple carriers
- Fast internet and download performance

The disadvantages of the submarine cable include:

- The environmental impact of disturbing the sea bed during installation
- Potential loss of visual amenity as an exchange building will be required to house telecommunications equipment at the "Point of Connection" and another exchange building on GKI (in the Industrial Compound)
- The proponent will be required to own and maintain the cable that is buried within the sea bed.

The submarine cable will be connected to the mainland grid at the "Point of Connection". Refer to "Appendix B – Mainland Submarine Cable Point of Connection" for the potential point of connection for the submarine cable.

6.2.2 MOBILE / RADIO TOWER

Telstra has an existing functioning wireless network for telecommunications on GKI consisting of a tower serving as a mobiles base, ADSL capable equipment and normal telephony and ISDN equipment. This is limited in capacity and while can be utilised as a standby supply, there is insufficient capacity to provide the level of service typically required for a Project of this size and type.

The advantages of the tower include:

- Existing installation – no additional impact to the environment

The disadvantages of the tower include:

- Limited capacity
- Slow speeds

6.2.3 AUTHORITY CORRESPONDENCE

We have submitted details of the Project and the preferred "Point of Connection" to Telstra and have received a response indicating our proposal of a fibre cable incorporated into the submarine cable should be acceptable.

We have requested details of the process required similar to the "connection enquiry form" as per ERGON, but have not received a response.

6.2.4 RECOMMENDATION

A submarine cable is required for connection back to ERGON's mainland grid for the exporting of excess renewable energy to allow for a carbon positive result. A fibre cable can be incorporated into this power cable and connected to the mainland exchange. This will allow several high speed telecommunications

systems to be utilised on GKI. Additional fibre cores can be installed to allow for spare capacity and changes in use as future devices allow for faster download speeds without having to upgrade the submarine cable. A number of fibre cores (say 144 within the submarine cable) will provide an abundance of bandwidth for users.

We recommend retaining the existing Telstra tower as a standby system to allow for limited communications to continue in the event of the submarine cable experiencing any problems.

Each option and recommendation should be reviewed at each stage of the Project to ensure the appropriate system is installed to suit the GKI Resort Revitalisation Plan.

We have requested information from Telstra with to requirements for an enquiry form or similar as per the ERGON application procedure but have received no response.

6.3 TELECOMMUNICATIONS INFRASTRUCTURE REQUIREMENTS

An underground telecommunications infrastructure system is required on GKI to deliver telecommunications services to buildings and equipment. It is proposed that a fibre optic cable will be made available to GKI via a submarine cable which will be terminated into GKI's main communications room. The fibre optic cable will then be reticulated around GKI. Fibre splice cases will be installed at required locations around GKI to allow for fibre connections for consumer use.

6.4 CAPITAL COSTS

The following works will need to be undertaken based on the recommendations provided in this section. Also detailed is the payer of the capital costs:

- Connection to the mainland exchange – to be discussed with telecommunications carriers
- Submarine cable – to be paid for by the proponent
- Reticulation of underground services on the Island – to be paid for by the proponent

7. ENVIRONMENTAL IMPACTS

We are recommending the following infrastructure solution for the GKI Resort Revitalisation Plan:

- Submarine power and telecommunications cable installed between the mainland and Great Keppel Island
- Solar PV Cells on villa/apartment roof tops on Great Keppel Island
- Diesel Power Generation on Great Keppel Island for standby purposes
- Underground power and telecommunications reticulation services

Based on the above, the environmental impacts include:

<u>Submarine Cable</u>

- Disruption to the sea bed is required for the installation of the submarine cable. A survey will be undertaken to limit the disruption including re-routing of the cable to avoid coral and marine features

- Non-renewable fuel (coal) used to generate electricity while the mainland grid is utilised – this will be limited as the cable will be used to supply power only as supplementary supply or on loss of power from the Island's solar PV cells

Solar PV Cells

- Potential loss of visual amenity as solar PV cells will be installed on roof tops – can be addressed through appropriate site planning and architectural design

Diesel Power Generation

- Emission of diesel exhaust fumes into the atmosphere – can be addressed with emission control and engine efficiency techniques
- Green house gas emissions from the standby diesel power station into the atmosphere – this will be limited to times where neither the mainland grid or PV cells system cannot meet the demand
- Non-renewable fuel utilised to power the generators – can be limited by using biodiesel
- Introduction of noise into the environment – can be addressed by acoustic control techniques
- Potential loss of visual amenity as an industrial building will be required to house the generators – this can be addressed by the design team to minimise the impact

Underground Reticulation

- Disruption to the environment to bury cables – addressed by careful selection of the cable route and undertaking all civil works in that area once only

Other Impacts

The Climate Change Technical Report prepared by Opus details other expected environmental impacts including higher temperatures, higher sea levels and higher intensity tropical cyclones. The design will need to take into account these impacts when providing solutions for the final installation. Design solutions may include installation of services above the projected future sea level, utilising equipment rated to higher winds and equipment that can withstand the projected ambient temperature.

8. TECHNICAL FEASIBILITY

We are recommending the following infrastructure solution for the GKI Resort Revitalisation Plan:

- Submarine cable installed between ERGON's mainland grid and Great Keppel Island
- Roof mounted Solar PV Cells on villas
- Diesel Power Generation on Great Keppel Island for standby purposes
- Underground reticulation of services

Based on the above, the technical feasibility of the solution is listed below. No new or unproven technology is being proposed for the GKI Resort Revitalisation Plan.

Submarine Cable

- Submarine cables have been provided to several islands including; Hamilton Island, Magnetic Island, Hayman Island, South Molle Island, Daydream Island and Dunk Island. All are connected to the Mainland Grid and have operated successfully over a substantial period of time

Solar PV Cells

- Solar Panels have been installed worldwide for energy production

Diesel Power Generation

- Diesel power generators have been installed worldwide for energy production
- Diesel power generators were utilised on Great Keppel Island before being decommissioned

9. STAGING OF GKI

We understand the GKI Resort Revitalisation Plan will be staged over several years with energy requirements increasing as the Project grows. In order to provide sufficient energy for the construction works and the operation of the Project as construction is completed, we recommend the below.

From the schedule, we assume that the below services will be provided in line with the buildings connected by theses services:

- Roads
- Public Walkways/Bicycle Tracks
- Wastewater Treatment Facilities
- Power/Telecommunications Reticulation

For the below table, the GKI Resort Revitalisation Plan only becomes carbon positive once the generated energy from the solar panels that have been installed exceeds the energy consumption of the Project.

If the solar panels are to be installed on the villas only, the carbon positive result will only be achieved at the end of the project (2023).

If the solar panels are to be installed in a large array, the carbon positive result will be achieved at an earlier date.

TABLE 9-1 – Energy and Telecommunications Sources

Duration	Buildings / Areas under Construction	Energy Source	Telecommunications Source
2012 – 2013	• Marina Facility • Ferry terminal • Barge facility • Runway and Airport Terminal • Fishermans Beach Hotel and Day Spa • Retail Precinct • Eco-tourism apartments – Stage 1 (150 apartments) • Submarine cable	Prior to the submarine cable and reticulation being commissioned • Standby diesel generators (construction purposes) as required • Standby/emergency diesel generators (permanent) installed within buildings After the submarine cable and reticulation has been commissioned • Mainland electricity grid	Prior to the submarine cable and reticulation being commissioned • Existing telecommunications towers After the submarine cable and reticulation has been commissioned • Mainland exchange

Duration	Buildings / Areas under Construction	Energy Source	Telecommunications Source
2014	• Eco-tourism apartments – Stage 2 (75 apartments) • Eco-tourism villas – Stage 1 (75 villas) • Golf Course (2 year period)	• Standby diesel generators (construction purposes) as required • Standby/emergency diesel generators (permanent) installed within buildings • Mainland electricity grid • Solar power from villas	Mainland exchange
2015	• Eco-tourism apartments – Stage 3 (75 apartments) • Eco-tourism villas – Stage 2 (75 villas) • Golf Course and Golf Resort Facility	• Standby diesel generators (construction purposes) as required • Standby/emergency diesel generators (permanent) installed within buildings • Mainland electricity grid • Solar power from villas	Mainland exchange
2016 - 2023	• Eco-tourism villas – Stage 3 to Stage 10 (600 villas)	• Standby diesel generators (construction purposes) as required • Standby/emergency diesel generators (permanent) installed within buildings • Mainland electricity grid • Solar power from villas	Mainland exchange

10. RECOMMENDATIONS

The calculations and information provided are based on concept design documentation issued to AECOM.

This assessment indicates it is possible to achieve a carbon positive result for electrical energy consumed by post construction works.

Further detailed analysis will be required by the designers during the design stage of the GKI Resort Revitalisation Plan to finalise the extent of services required to verify the results.

10.1 INSTALLATION

As stated above, we recommend the following electrical and telecommunications installation for the GKI Resort Revitalisation Plan:

- Submarine Cable – Power incorporating Telecommunications
- Solar PV Cells – Area of 52 square metres per villa will be required
- Diesel Generation – Standby Power – to be installed in various locations around the Island as detailed below
    - Industrial Compound
    - The Hotel
    - The Marina
    - The Golf Club
    - The Airport

- Radio Towers – Telecommunications (existing)
- Underground Reticulation – Power and Telecommunications

10.2 IMPACTS

The installation of the above detailed electrical and telecommunications infrastructure and services for the GKI Resort Revitalisation Plan have the potential to impact the environment during the construction and operational phases of the Project.

A risk assessment of potential impacts for the Project has been undertaken and is described below in Tables 10-2 and 10-3, along with mitigation measures to address each risk. A standard risk assessment matrix detailed below in Table 10-1 has been utilised for the purpose of assessing each risk.

TABLE 10-1 – Risk Assessment Matrix

Probability	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Medium
Unlikely	Low	Low	Medium	Medium	Medium
Moderate	Low	Medium	Medium	High	High
Likely	Low	Medium	Medium	High	Extreme
Almost Certain	Medium	Medium	High	Extreme	Extreme

A summary of the potential impacts and proposed mitigation for the construction phase of the Project is provided in Table 10-2 below. Construction of the Project will be undertaken in stages as detailed above in Table 9-1 and is expected to take 12 years.

Some of the construction items detailed below will be completed within 18 months of the project commencing (e.g. submarine cable), others will be ongoing for the majority of the project (underground reticulation).

TABLE 10-2 – Potential Power and Telecommunications Impacts – Construction Phase

Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
Disruption to the seabed (increased turbidity and sediment)	High	Medium	• Best practice seabed construction methods (e.g. water-jetting); and • Isolation of disturbed area Refer Great Keppel Resort Revitalisation EIS – Aquatic Ecology Report prepared by FRC Environmental for further details.
Ground disturbance as a result of underground reticulation.	Medium	Low	• Undertake works in conjunction with road network construction • Undertake rehabilitation in accordance with Flora and Fauna Management Plan applicable to proposed operational works
Construction noise on fauna (in particular threatened fauna)	Medium	Low	Noise impacts will be minimised through: • Limited noise exposure intervals; and • Timing (specific times of day) to avoid certain critical periods for threatened wildlife Refer Section 3 of the EIS for further detail.

A summary of the potential impacts and proposed mitigation for the operational phase of the Project is provided in Table 10-3 below. It is expected that the Project will begin operations within 18 months of the project commencing with additional areas beginning over the succeeding 10.5 years.

TABLE 10-3 – Potential Power and Telecommunications Impacts – Operational Phase

Potential Environmental Impact	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
Standby generator noise on fauna (in particular threatened fauna)	Low	Low	• Standby generator noise will be limited to the area in proximity of the Industrial Compound area; and Standby generator noise emissions will be subject to appropriate acoustic treatment to minimise potential for noise impacts on threatened fauna. Further, standby generator use in the operational phase will be restricted to emergency use and testing only.
Non-renewable resources (mainland coal fired substations) being utilised to generate energy.	Low	Low	Solar (PV) cell installation and mainland electricity grid connection – carbon positive energy.
Potential loss of visual amenity as a result of solar (PV) cell use on the roof of resort development.	High	Low	Solar (PV) cells to be appropriately oriented and screened by vegetation (between Resort buildings) to reduce individual and cumulative impacts. Refer Visual Assessment Technical Report prepared by Chenoweth Environmental Planning and Landscape Architecture for further detail.
Non-renewable resources (diesel for standby generators)	Medium	Low	• Emission controls; • Engine efficiency (high environmental performance); • Use of biodiesel; and • Standby generators will only be used for emergency backup and testing in the operational phase.

11. CONCLUSION

The GKI Resort Revitalisation Plan will be designed and constructed to mitigate the environmental impacts of the construction and operational phases of the Project including minimising the Project's contribution to global greenhouse gas emissions.

For the GKI Resort revitalisation Plan to be considered carbon positive, the following measures will be implemented:

- Solar PV cells will be mounted on the roof tops of the villas to generate electricity
- Energy produced by the solar PV cells will be supplied to the Project and/or the mainland as detailed below
    - If supply exceeds demand, the excess generated energy is supplied to the mainland grid via the submarine cable
    - If demand exceeds supply, the excess required energy is supplied from the mainland grid via the submarine cable
- Sufficient solar PV cells will be installed to ensure more energy is generated than is consumed by the Project over an annual period

Energy demand reduction measures will be explored during the design stages to reduce the overall demand of the Project. This will be achieved by:

- Reliable, high performance, cost effective and energy efficient appliances

- Reliable, high performance, cost effective and energy efficient building services (mechanical, electrical and hydraulic)
- Building Management Systems (where applicable)

The key environmental impacts likely to affect the development have been identified as:

- Disruption to the seabed during installation of a submarine cable
- Disruption to the land during installation of underground services
- Introduction of noise
- Potential loss of visual amenity
- Utilisation of non-renewable resources

These factors will be incorporated into the design of the Project to ensure the impacts of the services to be installed are:

- Relocated to eliminate the impact
- Reduced to an acceptable level
- Adapted to lessen the impact

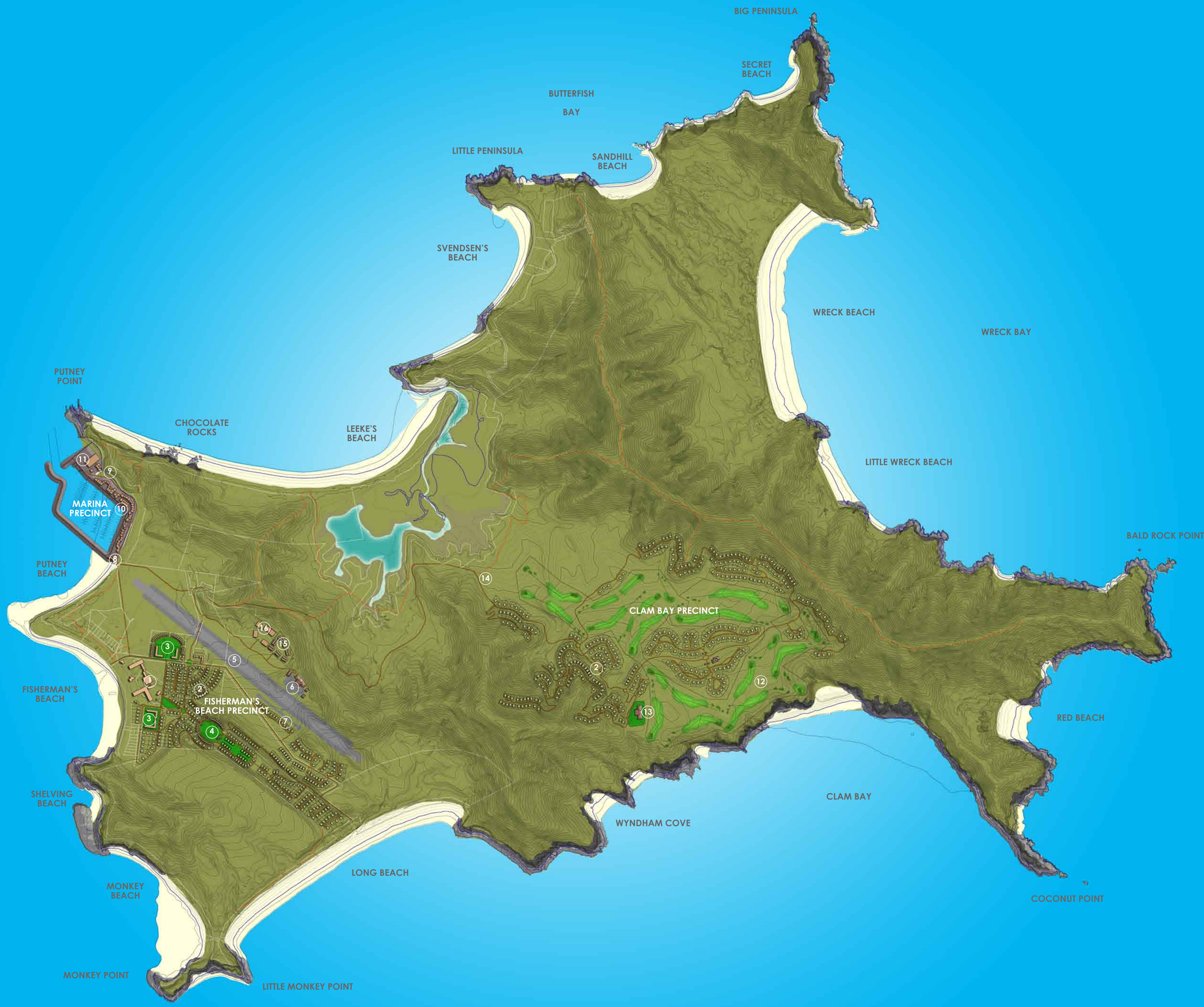
The above treatments will be assessed utilising methods including:

- Surveying of cable routes to ensure coral and other marine life is not affected
- Appropriate noise treatment applied to buildings
- Ensuring buildings are sited through appropriate site planning and designed with architectural input

APPENDIX A – GKI RESORT REVITALISATION PLAN

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

PUBLIC ACCESS TRACKS



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GREAT KEPPEL ISLAND RESORT ~ REVITALISATION PLAN

REVITALISATION PLAN 2011

PROJECT #: 093024
08 JULY 2011

GREG NORMAN GOLF COURSE DESIGN

WATG

APPENDIX B – MAINLAND SUBMARINE CABLE POINT OF ENTRY

Drawing BC N-B0160.00 – SK01 details an area where the proposed “Point of Connection” and exchange building may be located. The current preferred option is Ritamada Road for the connection of the submarine cable to the mainland services and the location of the exchange building.

The final location of the “Point of Connection” and exchange building are yet to be determined on agreement from a number of parties, including:

- ERGON
- Local council
- Telecommunication carriers
- Land owner

Drawings:

- Drawing BC N-B0160.00 – SK01 – Infrastructure Services Sheet 1 of 6

Rev	Date	Amendment Description	By	Chk

Consulting Engineer

AECOM

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

Project

GREAT KEPPEL ISLAND RESORT REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES

SHEET 1 OF 6

Scale @ A3	1:20000
Date	21-07-2011
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Project No. **QLD-B11-0271**

Revision **R0**

Drawing No. **BC N-B0160.00**

Sketch No. **SK01**

Sheet No. 1 of 6

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Xrefs: | ABS-SHT-A3-H.dwg | E-MAINLAND.dwg

APPENDIX C – GKI SITE POWER AND TELECOMMUNICATIONS INFRASTRUCTURE

The below listed drawings detail indicative locations / routes for the following services:

- High Voltage Electrical Cables Routes
- Low Voltage Electrical Cables Routes
- Telecommunication Cables Routes
- Substation – Building
- Substation – Ground Mounted
- Generator – Building
- Telecommunications – Exchange Building
- Telecommunications – Fibre Distribution Point

The drawings also detail pictorial representations of single line diagrams of the systems.

The final number, sizes, locations, routes of services will require clarification by the designers during the design stage.

Drawings:

- Drawing BC N-B0160.00 – SK02 – Infrastructure Services Sheet 2 of 6
- Drawing BC N-B0160.00 – SK03 – Infrastructure Services Sheet 3 of 6
- Drawing BC N-B0160.00 – SK04 – Infrastructure Services Sheet 4 of 6
- Drawing BC N-B0160.00 – SK05 – Infrastructure Services Sheet 5 of 6
- Drawing BC N-B0160.00 – SK06 – Infrastructure Services Sheet 6 of 6

LEGEND

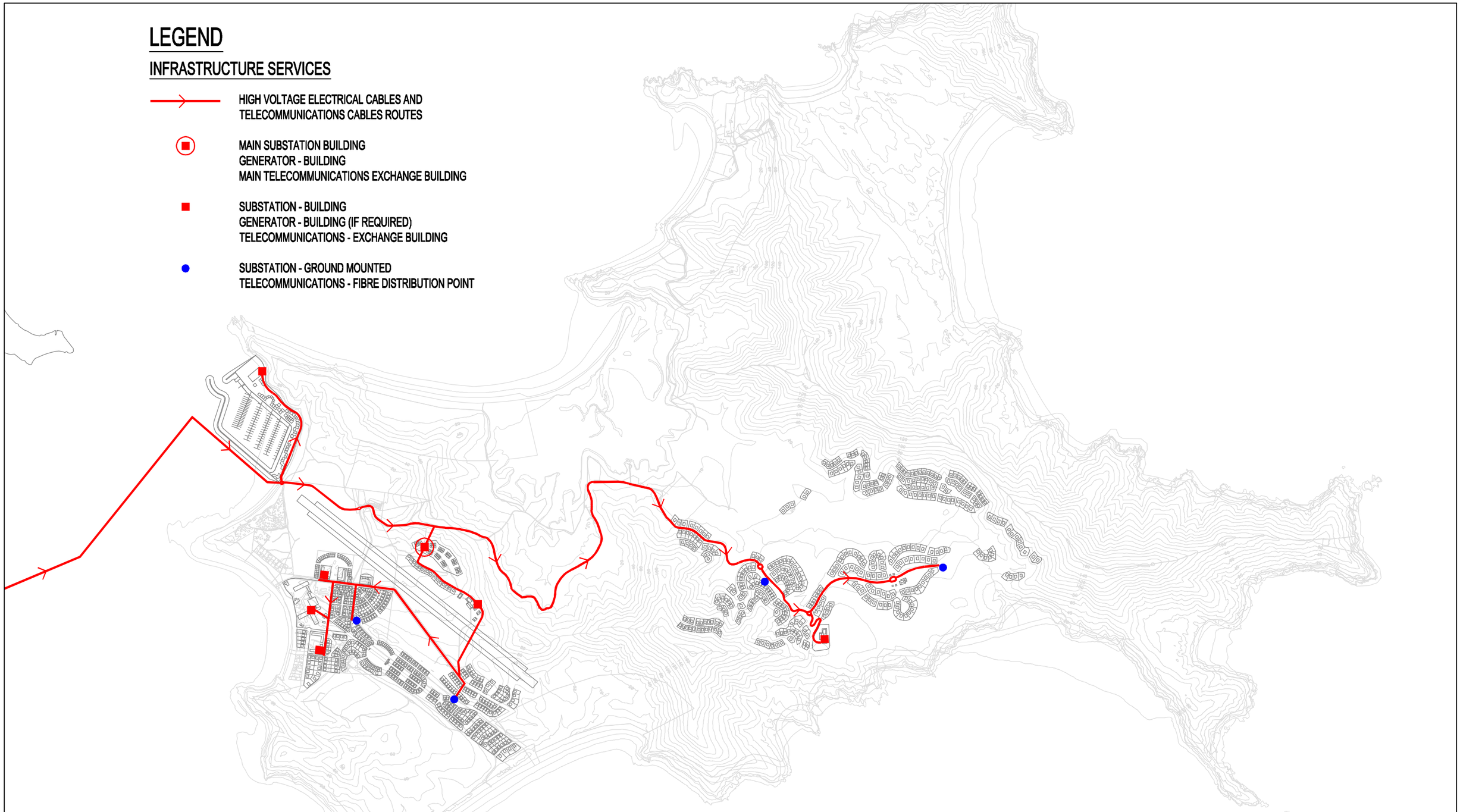
INFRASTRUCTURE SERVICES

HIGH VOLTAGE ELECTRICAL CABLES AND
TELECOMMUNICATIONS CABLES ROUTES

MAIN SUBSTATION BUILDING
GENERATOR - BUILDING
MAIN TELECOMMUNICATIONS EXCHANGE BUILDING

SUBSTATION - BUILDING
GENERATOR - BUILDING (IF REQUIRED)
TELECOMMUNICATIONS - EXCHANGE BUILDING

SUBSTATION - GROUND MOUNTED
TELECOMMUNICATIONS - FIBRE DISTRIBUTION POINT



Rev	Date	Amendment Description	By	Chk

Consulting Engineer

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GREAT KEPPEL ISLAND RESORT
REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES
SHEET 2 OF 6

Scale @ A3	1:20000
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Project No.
QLD-B11-0271

Revision
R0

Drawing No.
BC N-B0160.00

Sketch No.
SK02

Sheet No. 2 of 6

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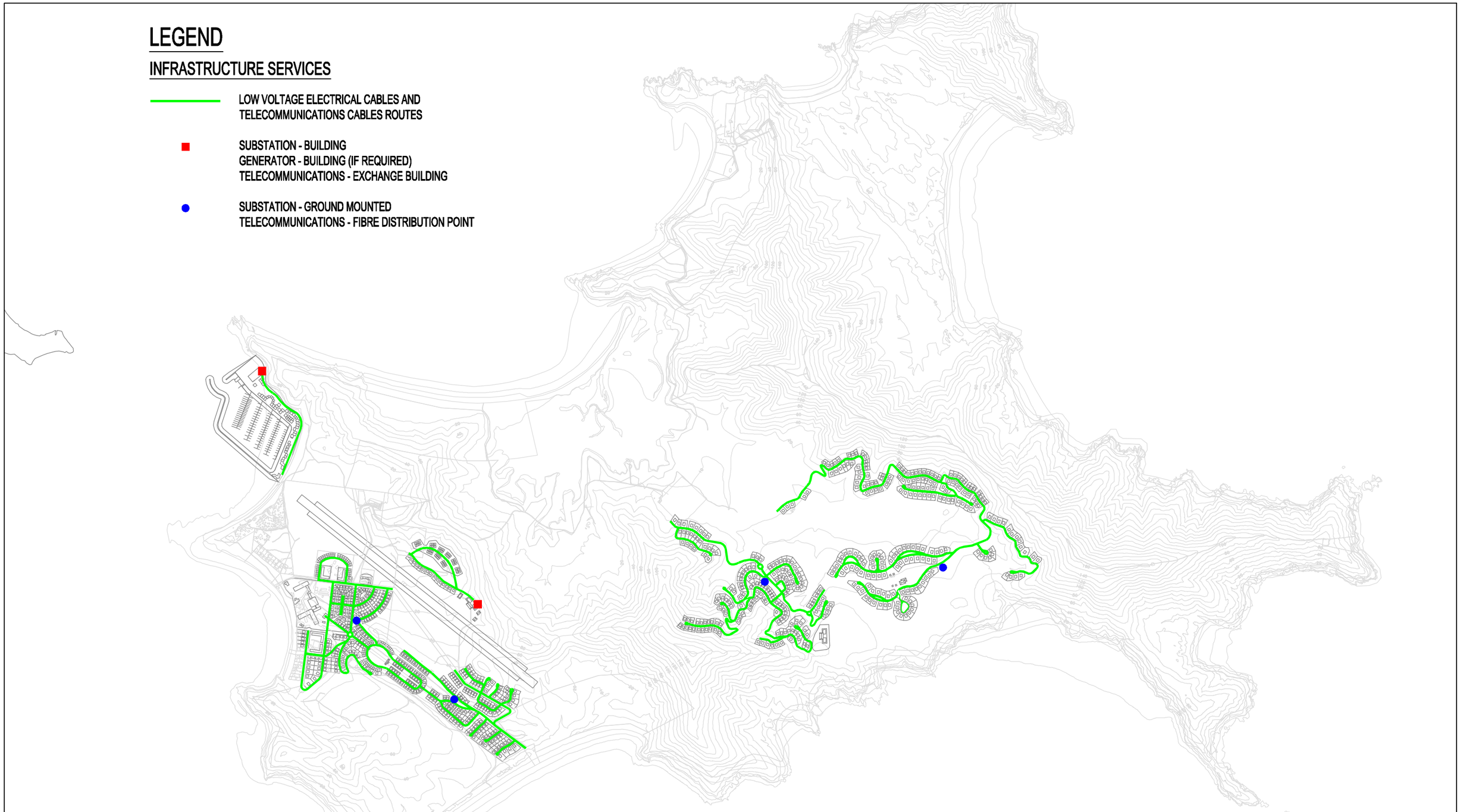
LEGEND

INFRASTRUCTURE SERVICES

LOW VOLTAGE ELECTRICAL CABLES AND
TELECOMMUNICATIONS CABLES ROUTES

SUBSTATION - BUILDING
GENERATOR - BUILDING (IF REQUIRED)
TELECOMMUNICATIONS - EXCHANGE BUILDING

SUBSTATION - GROUND MOUNTED
TELECOMMUNICATIONS - FIBRE DISTRIBUTION POINT



Rev	Date	Amendment Description	By	Chk

Consulting Engineer

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Project

GREAT KEPPEL ISLAND RESORT
REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES
SHEET 3 0F 6

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QLD-B11-0271

Revision

R0

Drawing No.

BC N-B0160.00

Sketch No.

SK03

Sheet No. 3 of 6

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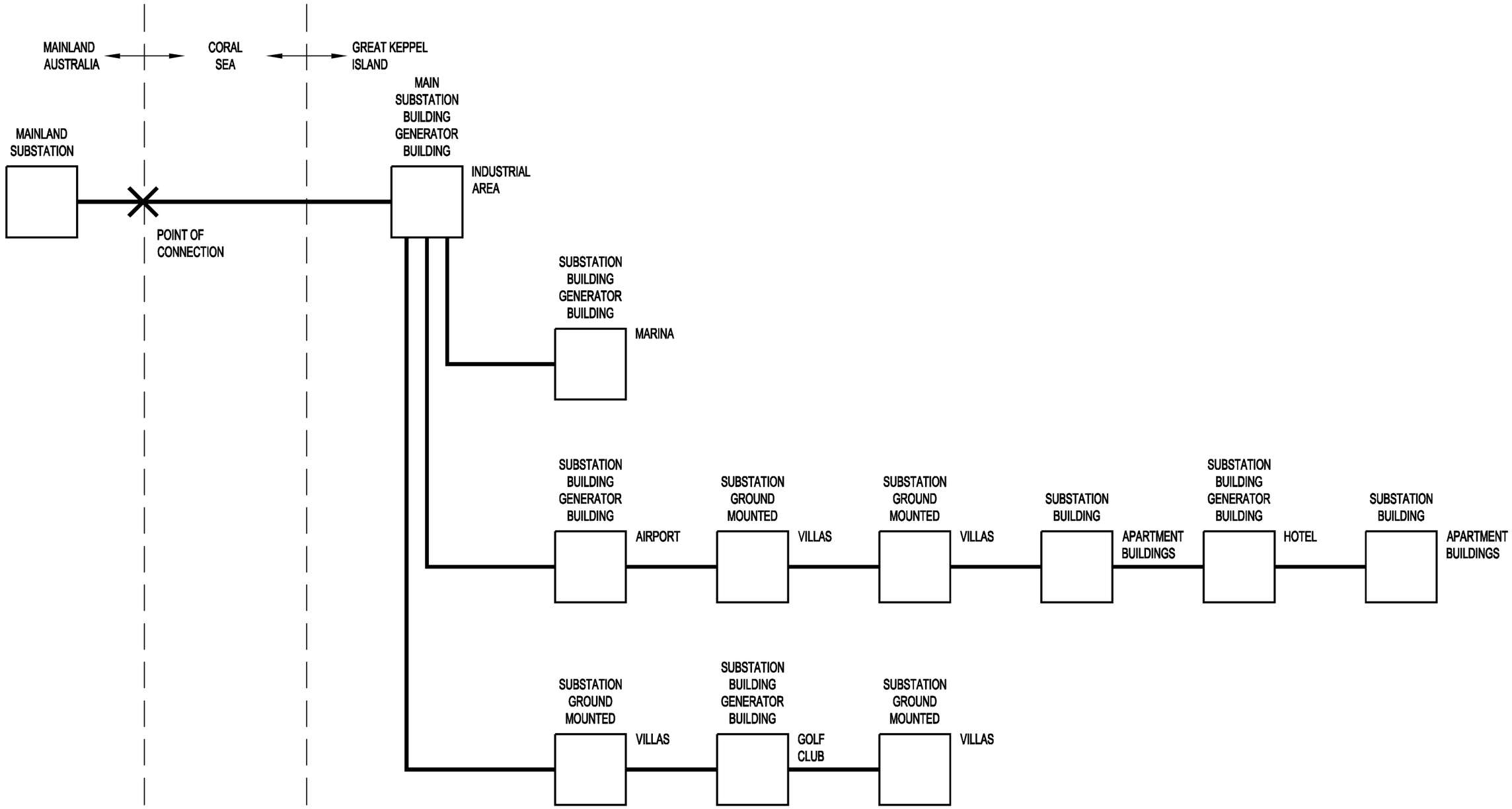

GKI HIGH VOLTAGE INFRASTRUCTURE - SITE

NOT TO SCALE

Rev	Date	Amendment Description	By	Chk

Consulting Engineer

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Project

GREAT KEPPEL ISLAND RESORT REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES

SHEET 4 OF 6

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Date	21-07-2011
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Project No. **QLD-B11-0271**

Revision **R0**

Drawing No. **BC N-B0160.00**

Sketch No. **SK04**

Sheet No. 4 of 6

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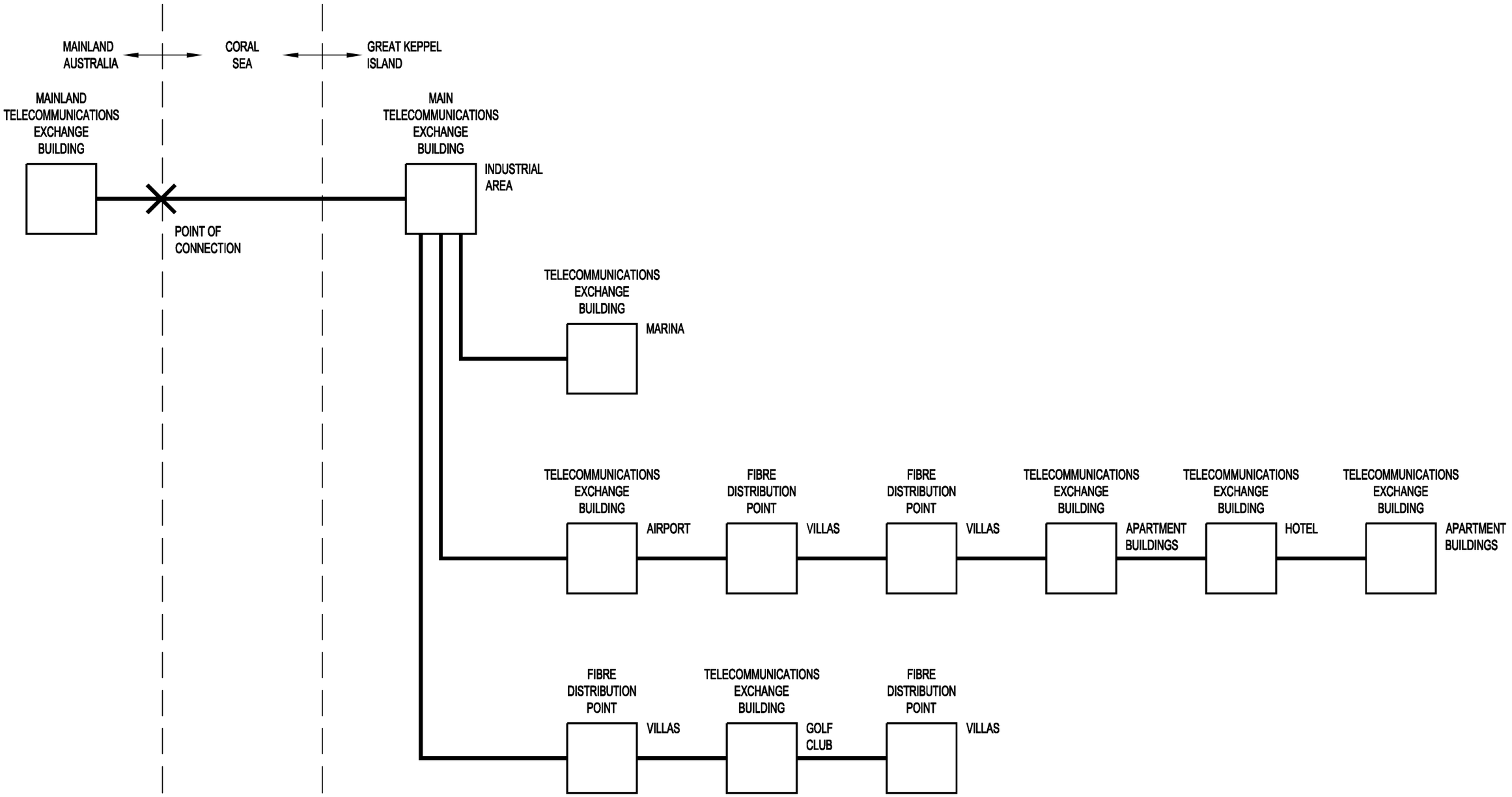

GKI TELECOMMUNICATIONS INFRASTRUCTURE - SITE

NOT TO SCALE

Rev	Date	Amendment Description	By	Chk

Consulting Engineer

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GREAT KEPPEL ISLAND RESORT REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES

SHEET 5 OF 6

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Project No. **QLD-B11-0271**

Revision **R0**

Drawing No. **BC N-B0160.00**

Sketch No. **SK05**

Sheet No. 5 of 6

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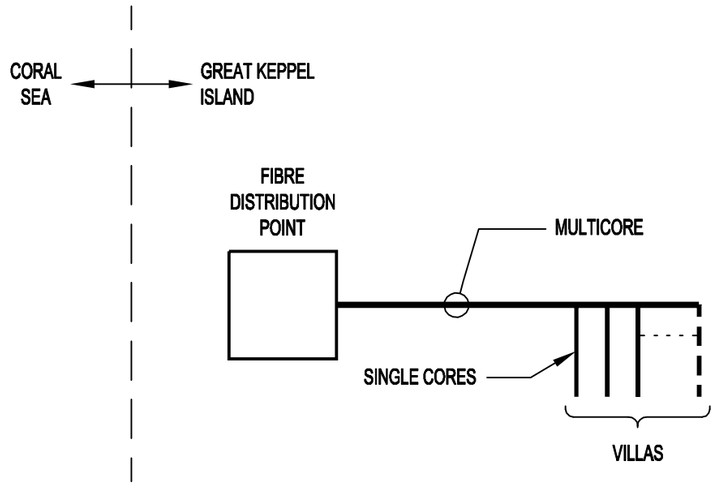

GKI TELECOMMUNICATIONS INFRASTRUCTURE - VILLAS

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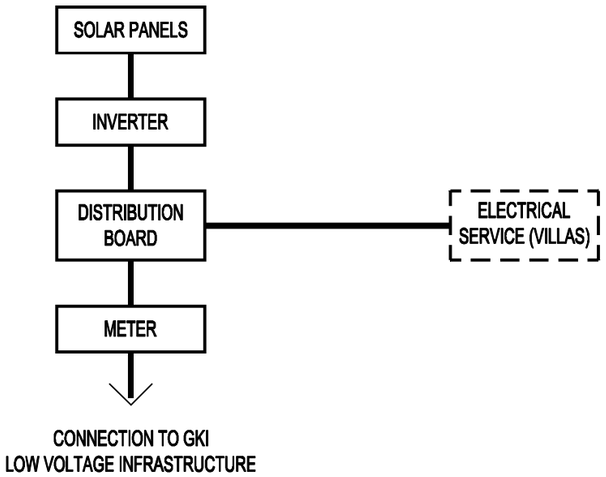

TYPICAL GKI VILLA SOLAR PANEL CONNECTION SCHEMATIC

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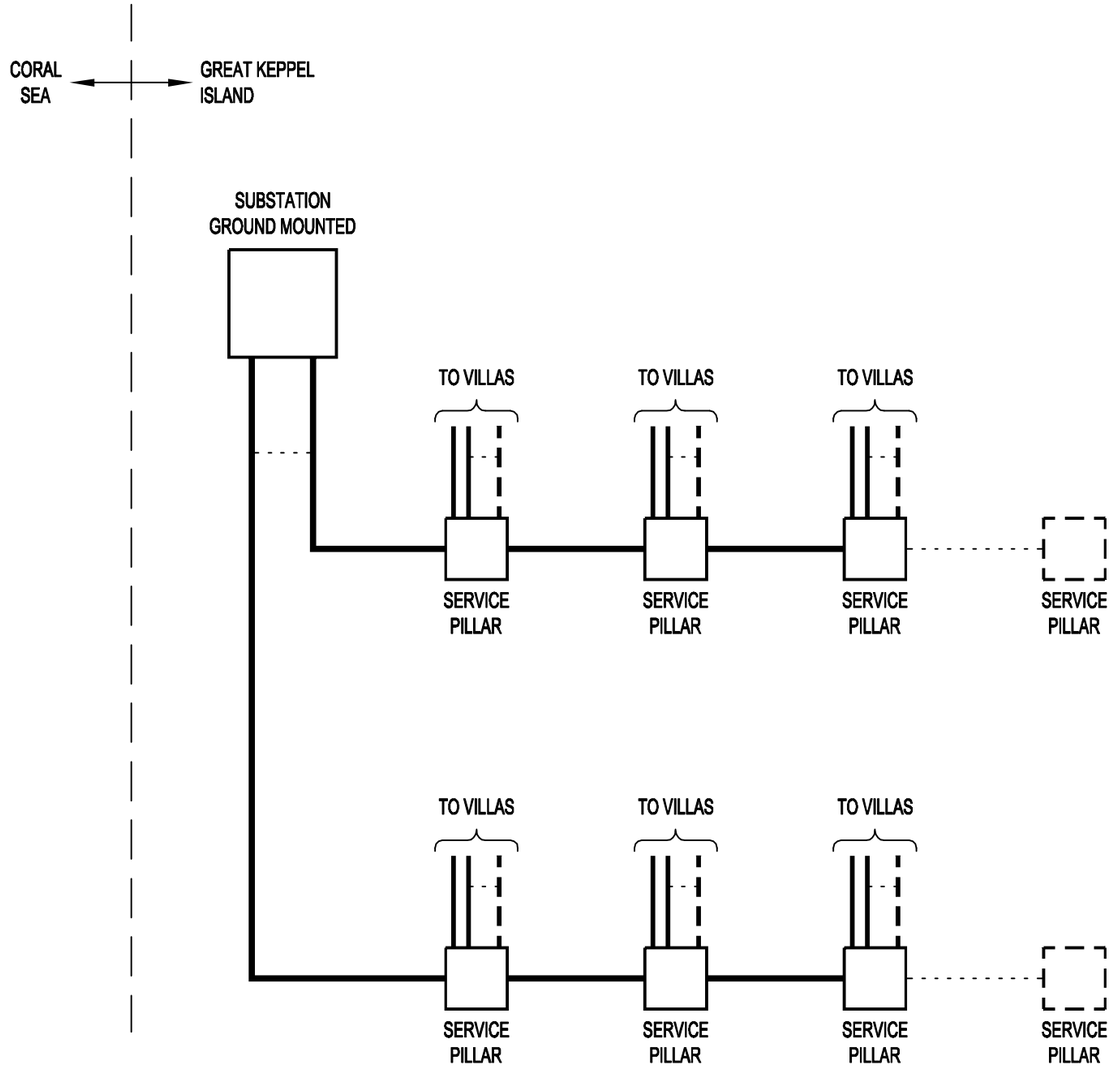

GKI LOW VOLTAGE INFRASTRUCTURE

NOT TO SCALE

Rev	Date	Amendment Description	By	Chk

Consulting Engineer

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Project

GREAT KEPPEL ISLAND RESORT REVITALISATION PLAN 2011

Drawing Title

INFRASTRUCTURE SERVICES

SHEET 6 OF 6

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Project No. **QLD-B11-0271**

Revision **R0**

Drawing No. **BC N-B0160.00**

Sketch No. **SK06**

Sheet No. 6 of 6

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APPENDIX D – POTENTIAL POINTS OF CONNECTION

The following table details the potential points of connection reviewed for the Project and comments from associated parties resulting in recommendations.

Potential Point of Connection (listed in order of preferred location, most preferred first)	Comments on Potential Point of Connection					
	ERGON	**Telstra**	**Council**	**CQ Consulting**	**HYPower**	**AECOM**
Ritamada Road	22kV supply from Tanby Substation, preferred location for ERGON. There is an existing 3 phase overhead line parallel to an existing unsealed road to the foreshore, an undeveloped area. A hill to the east will protect the cable and line from prevailing SE winds and tides.	A secure air conditioned building will be required for the installation of a Telstra customer premises rack. Other carriers can also install racks within this building as well as a Client owned rack for connection to the Carriers racks and the fibre cable within the Submarine cable.			Ritamada Road appears to be the best option however the hydrographic survey is the only way to confirm same and look at the extent of mud. Seabed soil temperatures at - 1.5 mtrs will be required to assess the De-rating factor that will apply to the cable and consequently its size	Preferred location – dependent on results from survey. Protected by prevailing SE winds and tides. Good service for electricity.
Bell Park, Hill Street	22kV supply from Tanby Substation. Underground services will be required for 500m – 1000m depending on council requirements. Further from Tanby Substation than Ritamada Road – voltage drop and rebuilding are concerns.	An application will be required to install equipment within the Emu Park exchange.	Good services in this location. The beach is disturbed and bonus points could be gained from the community if the boat ramp was upgraded as part of the works.	Likely to create problems with the community - popular beach utilised for many events and is a high profile location.	The Bell Park option seems to have a number of issues that could be a problem for the cable & poly pipe during installation and into the future	Protected by prevailing SE winds and tides. Good infrastructure for council services. If a boat ramp was constructed it could be utilised for protecting the services entering the water. However from Google Maps it appears it would have to be a long boat ramp to reach the water from the road (at least 250 metres).
Haven Road	22kV supply from Tanby Substation, in the middle of a developing residential area, some underground will be necessary raising the costs of the installation.		Poor infrastructure for council provided services. Environmentally sensitive area.			Protected by prevailing SE winds and tides. Due to poor infrastructure, Haven Road is not a preferred location.
Keppel Bay Marina	Concerns regarding supply as this is an 11kV area. Marina is not the best solution as it is prone to silting and subject to regular dredging.					Due to the issue regarding silting and dredging, the marina is not a preferred location.
Intersection - Scenic Highway / Vin E Jones Memorial Drive	Concerns regarding supply as this is an 11kV area. Open to prevailing SE winds and tides, historically had erosion issues - potential for the cable to become exposed.					Due to prevailing SE winds leading to the potential for erosion, this area is not a preferred location.