Ella Bay Developments Pty Ltd

Ella Bay
Master Planned Community
Environmental Impact Statement

Infrastructure Requirements
and
Waste Management

Date: 17 January 2007

Job Code: JHSREB01

ETS GROUP

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Author: Keith Howells
Doug Gillespie
Adam Allen

Checker: Keith Howells

Approver: Keith Howells

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1 Introduction

Located in North Queensland's Johnstone Shire, 88 km south of Cairns and 10 km north east of Innisfail, Ella Bay is recognised as one of the last available significant beachfront development sites on the Queensland Coast between Hervey Bay and Port Douglas. Ella Bay is located in a natural amphitheatre, surrounded on three sides by world heritage tropical rainforest and hemmed by 4 km of pristine Coral Sea coastline.

Ella Bay Developments Pty Ltd propose to transform the existing 450-hectare operating cattle station into a fully master-planned, integrated tourism and residential lifestyle community over a ten to fifteen year period, with the opportunity to set new benchmarks for sustainable development worldwide. The proposed development will incorporate 540 residences located around an 18-hole golf course, with ocean or heritage listed rainforest views, four five-star resort precincts with prime ocean frontage and beach access, a village precinct comprising of mixed retail, professional services, dining and office usage, an educational precinct comprising of a St Peter's Lutheran College international school, a sustainable development research institute in partnership with James Cook University and The University of Queensland, a 'signature' championship 18-hole golf course, and associated public infrastructure. All infrastructure will be delivered in a manner which sets new standards in ecologically sustainable development, designed to promote self-sufficiency, particularly in relation to energy, water and sewerage management. In order to construct a modern, sustainable community, the restoration and rehabilitation of existing degraded land together with the preservation of existing remnant vegetation is a key component of the design philosophy.

Summary of key components

Town centre / Village precinct

The cosmopolitan community village precinct will service the needs of the visiting and resident population. The proposal features a free public pool, together with a village area up to four storeys in height consisting of a small supermarket, cafés and restaurants and resort fashion stores. Offices for professional services, such as a solicitor, accountant, real estate office and medical practitioners will service the local community, while a floor of private offices will also be provided to support the working professional residents within the Ella Bay community. Modern information and communications technologies will be pursued with separate serviced offices linked through broadband also proposed.

Resort precincts

There are four distinct resort precincts within the Ella Bay development proposal. These are the R1, R2 and R3 resort precincts as well as the CC resort and golf course precinct identified on the Master Staging Plan

These resorts are likely to be five-star and comprise of self-contained apartments typically ranging from one to three bedrooms, as well as a small number of penthouses, with a total of 860 dwellings. The target audience for these resorts will be predominantly the tourist market, however, some may have a mix of permanent 'lifestyle living' residents. Each of the resort precincts is designed to also service the immediate residential areas, with sharing agreements between the resorts and the surrounding lots. It is anticipated that two of the resorts will include conference facilities and that the meetings and incentives market will be a significant proportion of the visitors staying at Ella Bay.

R1 resort precinct

It is proposed that the R1 resort precinct will comprise of up to four-storey beachfront apartments with rooftop terraces integrated into the village precinct, incorporating restaurants, a pool, a day spa and conference facilities. These proposed self-contained resort apartments would have half-basement car/buggy parking with lifts providing access to each floor.

R2 resort precinct

The proposed R2 boutique resort precinct comprises of two-storey eco-beachfront apartments, with rooftop terraces and half-basement car/buggy parking. The precinct will also include a restaurant, day spa and pool intended to service both the tourist and residential populations.

R3 resort precinct

The proposed R3 boutique resort precinct comprises of single-storey eco-beachfront villas, with a centralised parking area. The precinct will also include a restaurant, day spa and pool intended to service both the tourist and residential populations.

All beachfront buildings will be set back from the strip of coastal vegetation that will be retained so as to protect the natural amenity of the area.

CC resort and golf precinct

The CC resort area is likely to consist of up to four-storey country club-style apartments with direct access to the golf course clubhouse. The proposed distinctive clubhouse will incorporate a bar, restaurant and conference facilities.

The golf precinct will consist of a signature championship 18-hole golf course as part of the development, designed by Graeme Marsh. At present, the closest golf course in the region is Paradise Palms which is over 1 ½ hours drive north (140 kilometres away). The golf course will be designed to maximise the opportunity for environmental regeneration, through the retention of the vast majority of existing vegetation and extensive tree replanting, as well as being irrigated with recycled water treated to Class A+ standard. The proposal will offer golf course frontage to many of the proposed residences.

Residential precincts

It is proposed that there will be a total of 540 residential lots within the development ranging between 700m^2 and 1,000m^2 in size. Given the natural sloping of the site, most lots will enjoy ocean views, with many having direct golf course frontage. Other lots will enjoy pristine rainforest views, overlooking the world heritage listed national park. The protection of these pristine rainforest areas will be ensured with their designation as conservation precincts under binding conservation covenants. Conservation zones are to be preserved for the environment, and no building works are allowed.

In keeping with Ella Bay Developments' environmental philosophies, measures will be put in place to ensure sustainable housing design is adopted throughout the Ella Bay site, with the intention to minimise the disturbance of the natural environment throughout the life of the development. To achieve this, Ella Bay Developments Pty Ltd intends to establish building covenants that follow the Smart Housing principles. Housing submissions will be appraised by an architectural review committee and subject to stringent environmental controls.

The incorporation of sustainable housing principles will improve the marketability of both the residential and resort components and will fit well with the eco-tourism experience being offered.

Education precinct

The education precinct is located immediately west of the village precinct/town centre and is proposed to consist of a St Peter's Lutheran international school, a community recreation centre, a small church and a proposed institute for sustainable development in collaboration with the University of Queensland and James Cook University. The collaboration with the universities will ensure a process of ongoing improvement in best practice sustainable development technology.

Conservation corridors

An important aspect of the Ella Bay development is the presence of wildlife, including vulnerable and endangered listed species including the endangered southern cassowary. The development proposal aims to incur no negative impacts upon the native fauna population, through the net expansion of potential habitat and the protection and widening of east-west and north-south movement corridors. The proposed wildlife corridors will link the Ella Bay national park on three sides of the property so that wildlife can be safely re-established. The proposal indicates certain areas where fauna could potentially be harmed, such as major road and beach areas where they may come into contact with human populations. Such sites will be fenced off and designated crossing points established so as to allow for safe movement of all fauna, including the southern cassowary. As part of the revegetation proposal, approximately 500 thousand trees will be planted, thickening the current movement corridors and serving to enhance the visual amenity while increasing the size of possible habitat.

Figure 1-1 Ella Bay Master Planned Community

2 Infrastructure - Transport

A review of the traffic and transport related elements of the *Ella Bay Integrated Resort Project – Terms of Reference for an Environmental Impact Statement* has been completed with the key information and findings presented in detail. The issues from the EIS Terms of Reference are included for easy reference.

2.1 Existing transport elements

TOR - Existing pedestrian or cycle paths within 10km of the site boundaries.

- Pedestrian and cycle paths within 10km of the site boundaries consist of local pedestrian and cyclist paths through Flying Fish Point. It is not proposed that these paths will provide connections for pedestrian or cyclists between the subject site and Flying Fish Point.

TOR - Existing public passenger transport services within 10km of the site boundaries, including school bus, schedules bus, taxi and ferry; and provide details of timetables, contract areas, patronage, and associated infrastructure.

- ***Local Bus Services***

The area of local bus service coverage within 10km of the subject site is

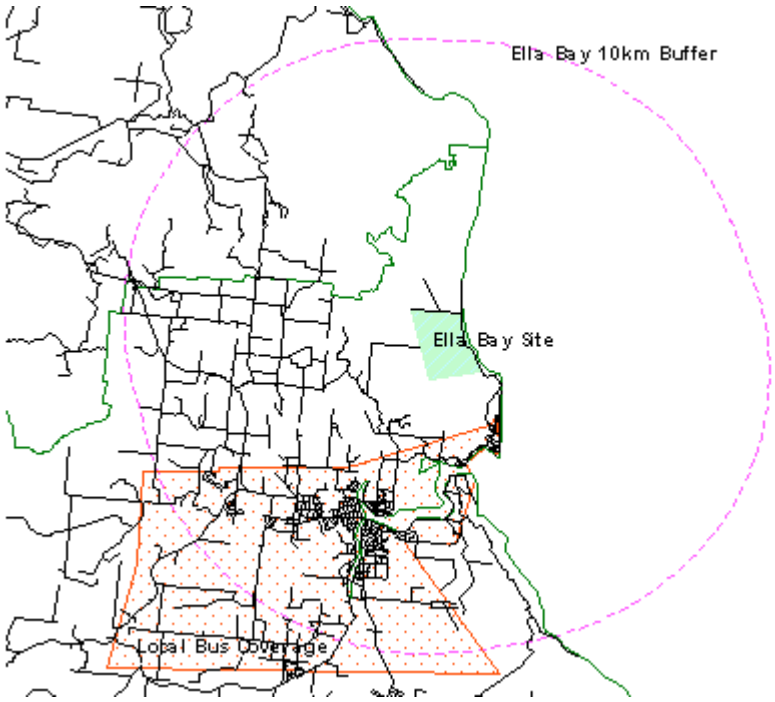


Figure 2-1 Local Bus Service Coverage

Two local bus services operate within this coverage.

- TransNorth Bus and Coach:
  - School services during weekday mornings and afternoons;
  - Local scheduled services between Monday to Saturday inclusive;
  - Hourly scheduled services between 9:00am and 2:30pm;
  - No services to Flying Fish Point; and
  - No connection to rail services.

- Hasties Bus and Coach:
  - School services during weekday mornings and afternoons;
  - Local services between Monday to Saturday inclusive;
  - Seven town-based local scheduled services per day; and
  - Coverage includes Flying Fish Point to Ella Bay turn-off.

Local bus service patronage was not able to be provided by the operators. However, existing patronage is expected to be quite low.

- ***Taxi Services***

The area of taxi service coverage within 10km of the subject site is shown in Figure 2-2.

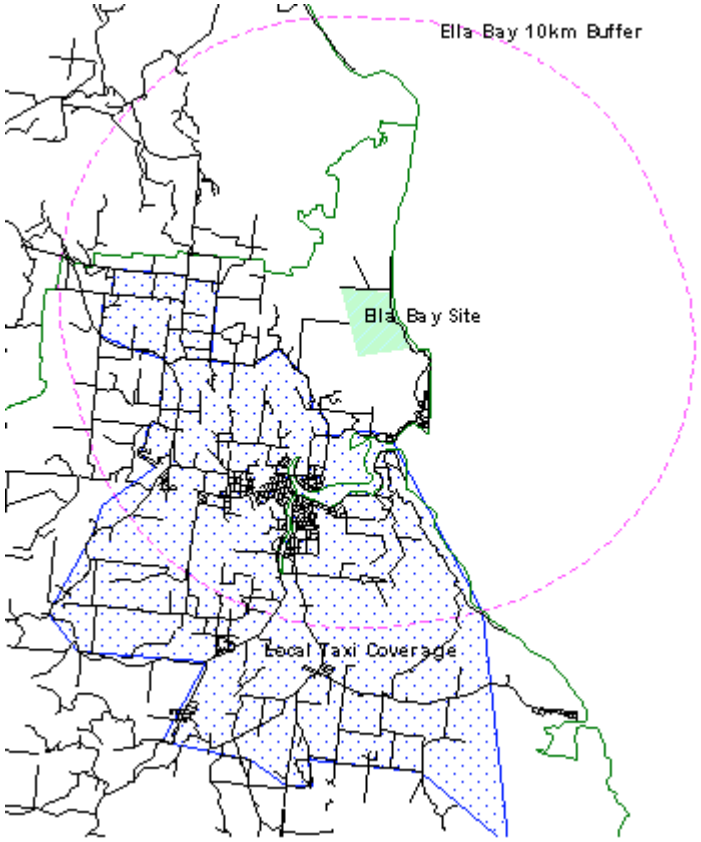


Figure 2-2 Taxi Service Coverage

Within this coverage area Queensland Transport has allocated ten taxi licences. Local taxi patronage was not available.

- ***Ferry Services***

Within 10km of the subject site there are no ferry services.

TOR - Existing rail infrastructure within 10km of the site boundaries, including usage patterns for freight traffic, passenger traffic, and railway level crossings.

Within 10km of the subject site existing rail infrastructure consists of the Brisbane to Cairns rail line. This rail line passes through Innisfail Station, also within 10km of the subject site. This infrastructure is presented in Figure 2-3.

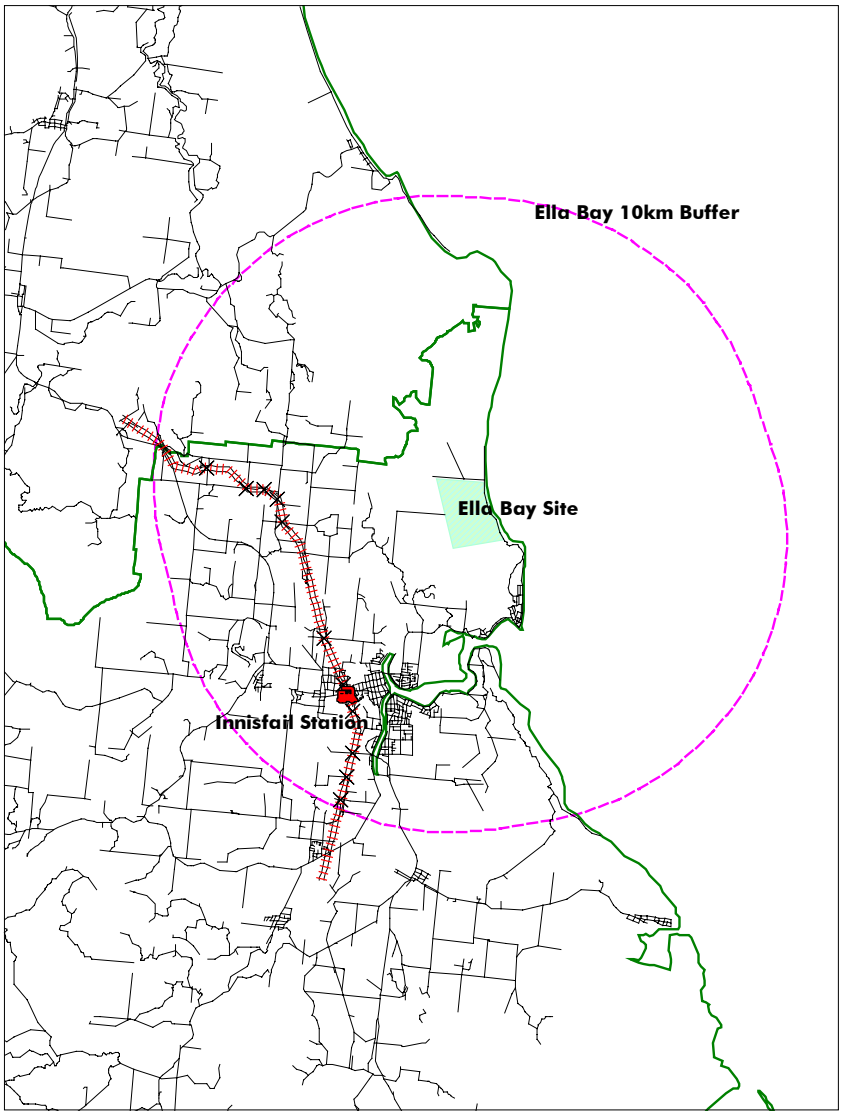


Figure 2-3 Rail Infrastructure

The Brisbane to Cairns rail line caters for both freight and passenger tranportation, with Innisfail Station providing a stop for the loading and unloading of freight as well as for passenger embarkment / disembarkment (ie Sunlander and Tilt Train services).
At this station trains are able to attach and. / detach carriages.

Information pertaining to the quantum of freight and passengers was not available. However, passenger rail service information was obtained and is summarised in Table 2-1.

Table 2-1 Passenger Rail Services

Day of Week	Service Direction	
	Northbound	Southbound
Monday	1	-
Tuesday	-	3
Wednesday	1	1
Thursday	-	1
Friday	1	-
Saturday	3	3
Sunday	-	1
Total Weekly	6	9

Source: Queensland Rail

A number of railway level crossings are located within 10km of the subject site. These are described (ie location, type) in Table 2-2.

Table 2-2 Railway Level Crossings

Road Crossing	Type	Infrastructure
Aerodrome Road	Public Level	Signs only
Douglas Road	Occupation	Signs only
Backhaus Street	Occupation	Signs only
QR MTCE Crossing	QR	Nil
Bruce Highway	Public Level	Flashing Lights
Power Street	Public Level	Flashing Lights
SeePoy Road	Public Level	Flashing Lights
Old Ferry Road	Occupation	Signs only
Garradunga Road	Public Level	Signs only
Todd Road	Occupation	Signs only
Mamu Road	Public Level	Signs only
Goldmine Road	Public Level	Signs only

Source: Queensland Rail

TOR - Existing aviation facilities and services within 10km of the site boundaries, including civilian airport, navigational aids and communication facilities; and their usage patterns.

Aviation facilities and services are located at the Innisfail Aerodrome within 10km of the subject site, as shown on Figure 2-4.

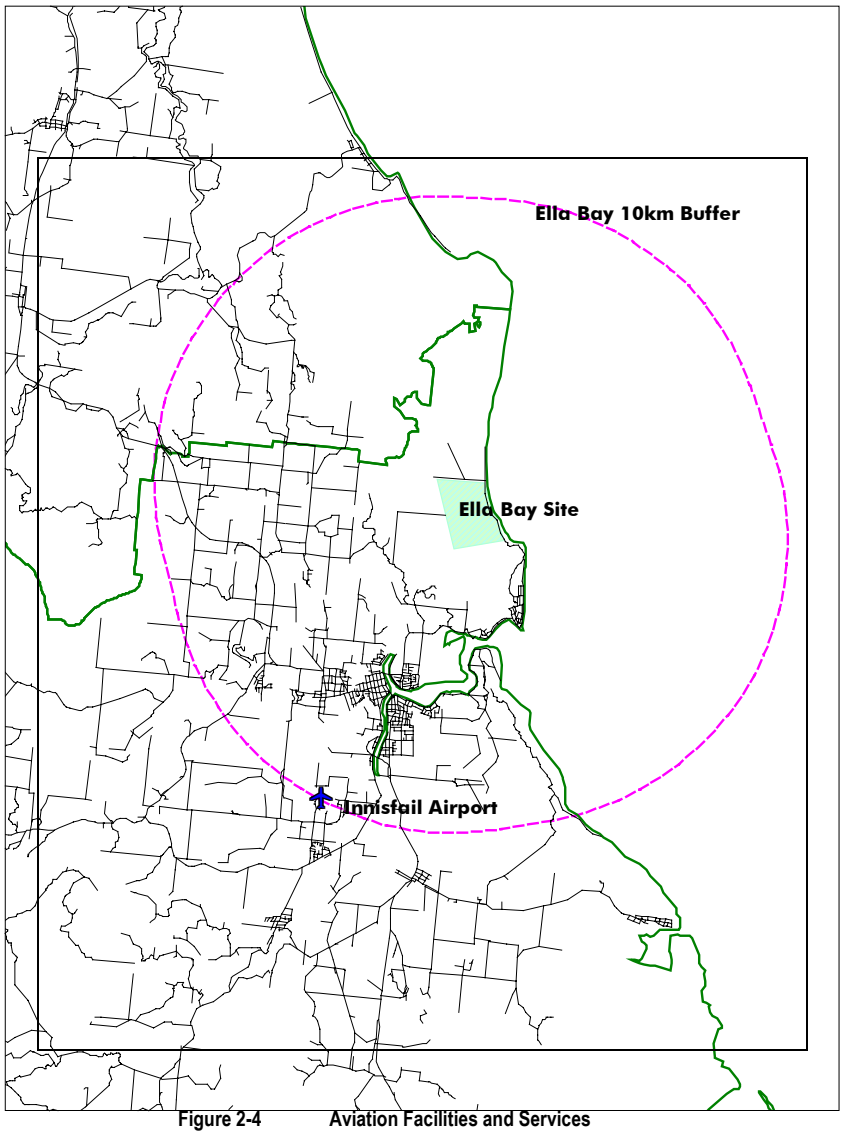


Figure 2-4 Aviation Facilities and Services

Key aspects of the Innisfail Aerodrome are as follows:

- Categorised as a Registered Aerodrome (registration number R133) (According to the Civil Aviation Safety Authority, the maximum level of service provided for a Registered Aerodrome is the provision of repeat or frequent charter of more than 30 passengers);

- Includes pilot training operations;
- Includes chatter flight operations;
- Usage patterns are quite low and irregular; and
- Does not cater for domestic aviation services. The airstrip has a bitumen seal and is 1,353m long. In comparison the airstrip at Maroochydore Airport (which caters for domestic services) is 1,797m long. It would be required that the Innisfail Airstrip extend in length by approximately 450m in order to cater for domestic aviation services.

2.2 Road transportation requirements

TOR - Arrangements for the transport of plant, equipment, products, wastes and personnel during both the construction phase and operational phases of the project. The description should address the use of existing facilities and all requirements for the construction, upgrading or relocation of any transport related infrastructure.

2.2.1 Site Access

Several different options to provide road access to the site have been investigated.

Option 1 - Ella Bay Road

The development conditions for the adjacent site at Little Cove Ella Bay specified that the Ella Bay Road be upgraded to a bitumen road from its current gravel condition. The width of the road from Flying Fish Point to Heath Point is to be 6m then 4m wide continuing to the development. The current road is in relatively good condition so the upgrade should only require minimal construction. The upgraded road will provide a suitable access road for the Little Cove development as well as for the initial stages of the Ella Bay Masterplanned Community development, but it should be noted that the road will only support a low speed environment (40 to 50km/h) due to the topography and consequently winding road geometry.

Below are the design drawings for the upgrade as part of the works carried out for the Little Cove development.

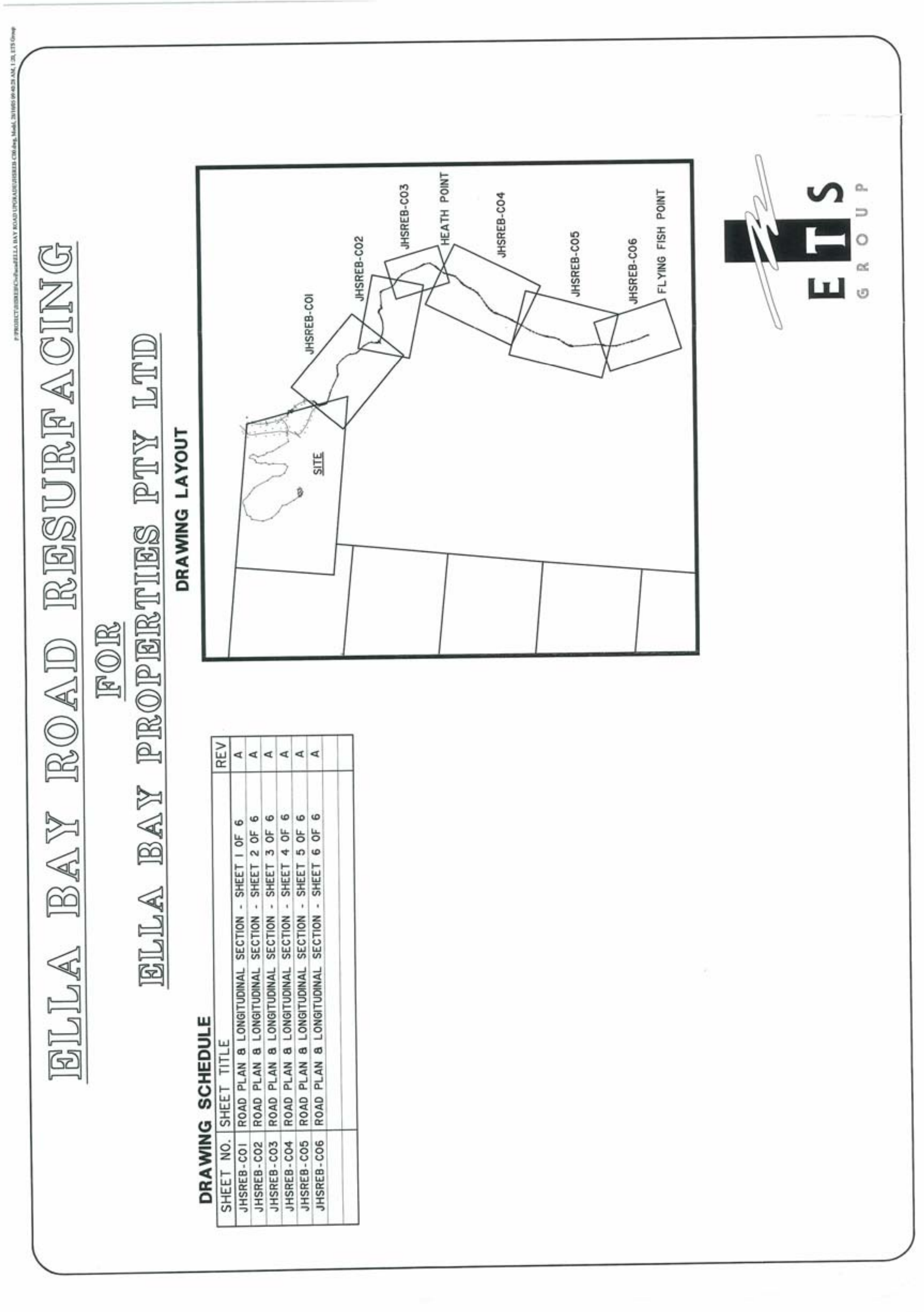
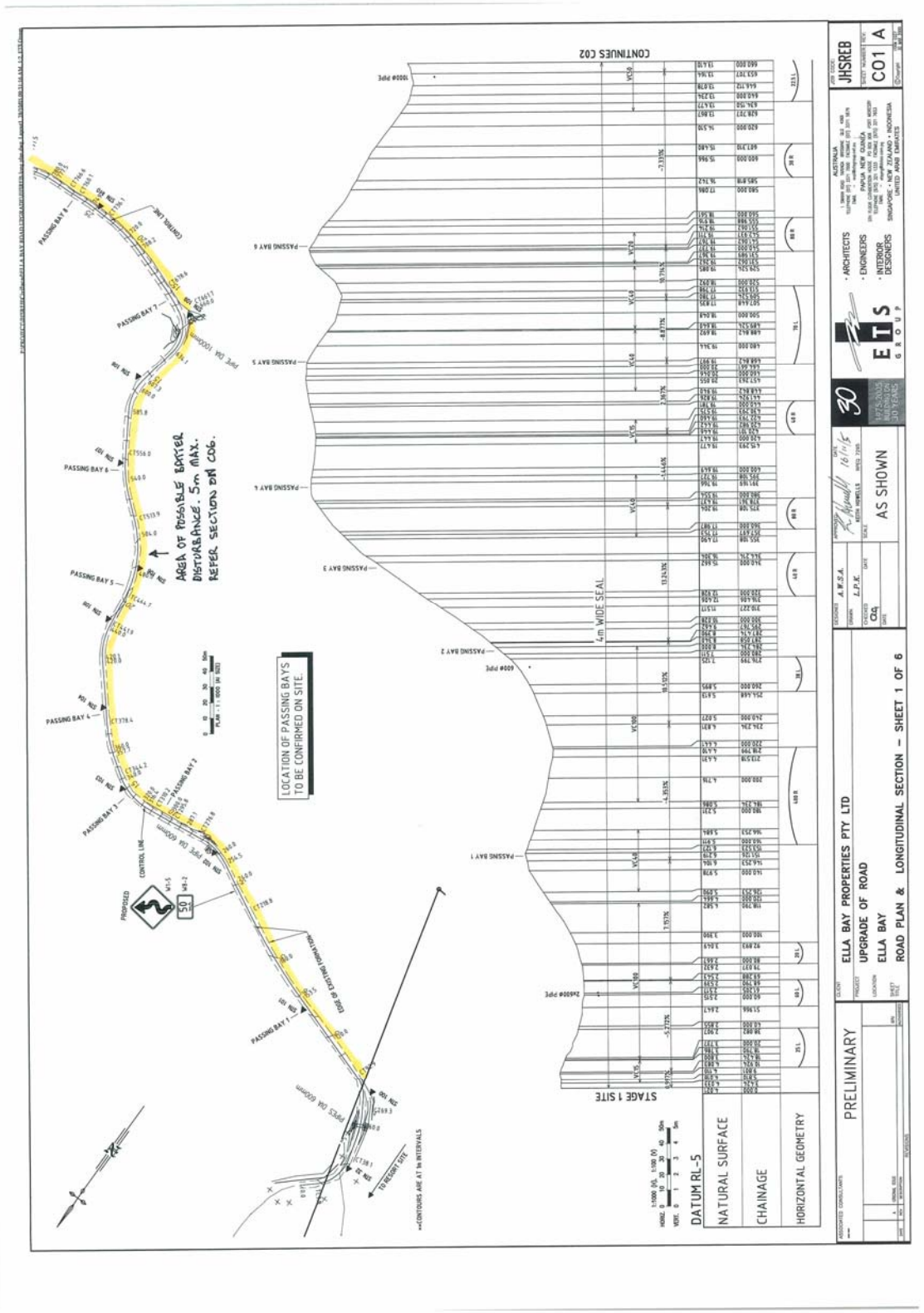
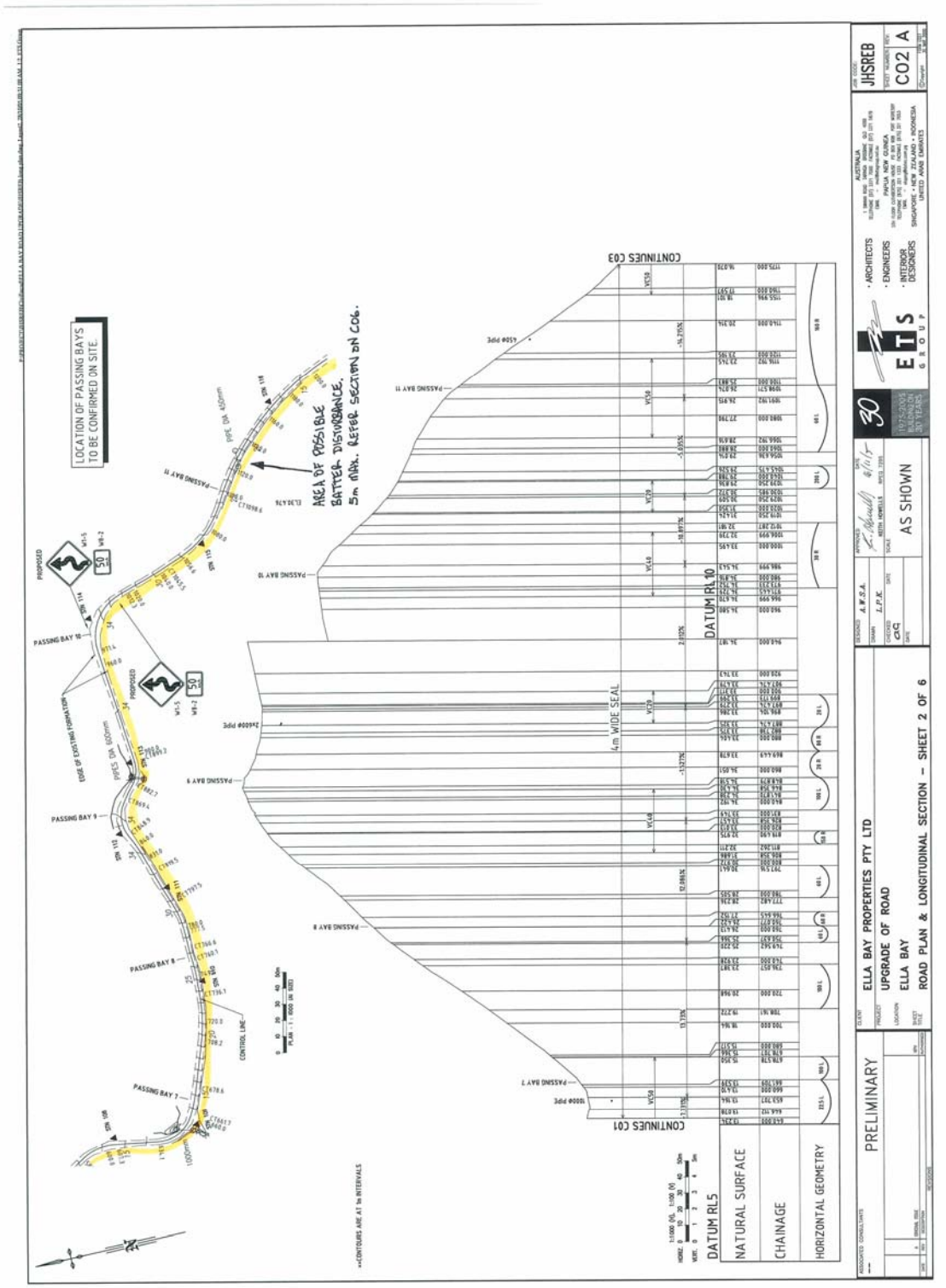
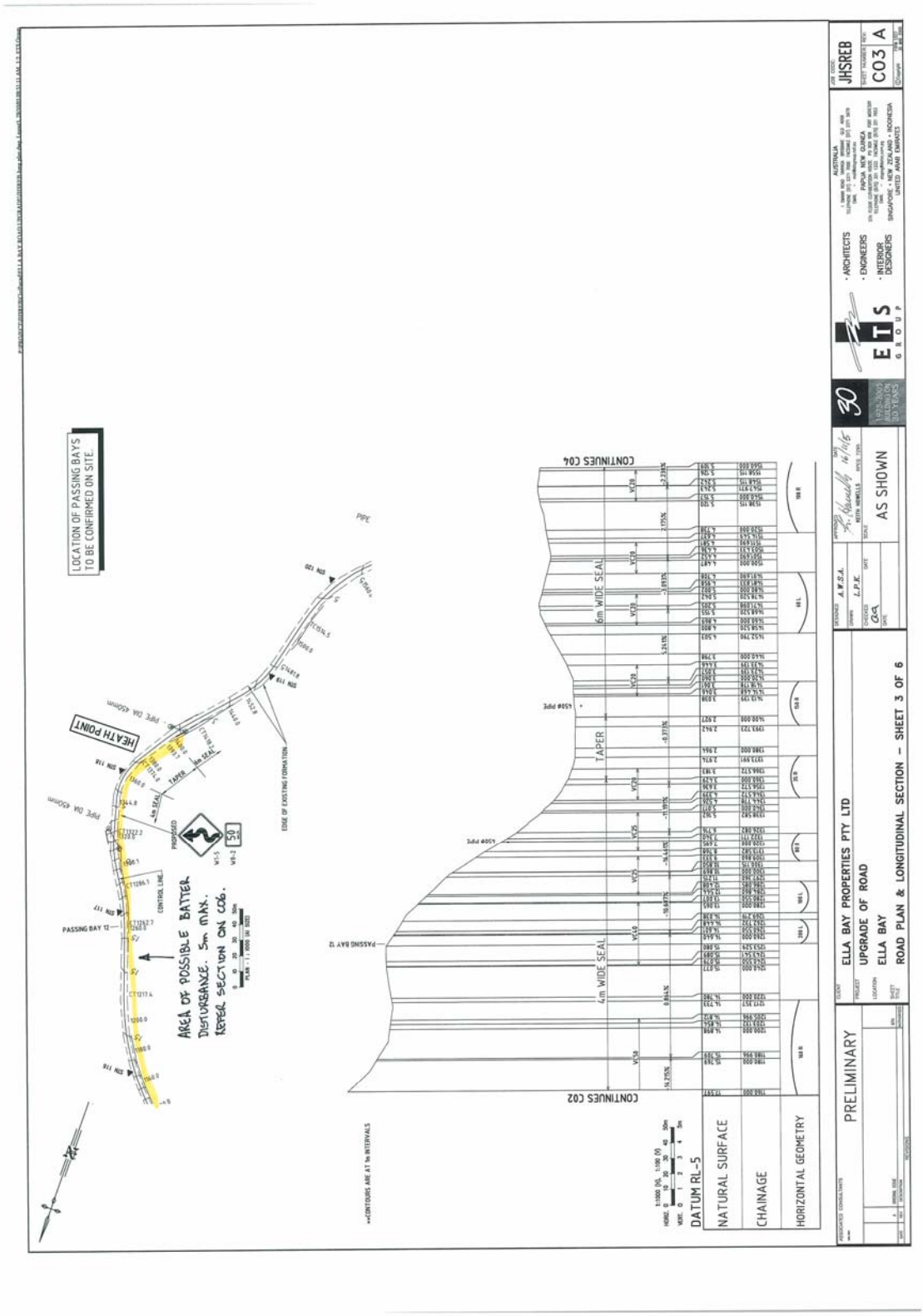
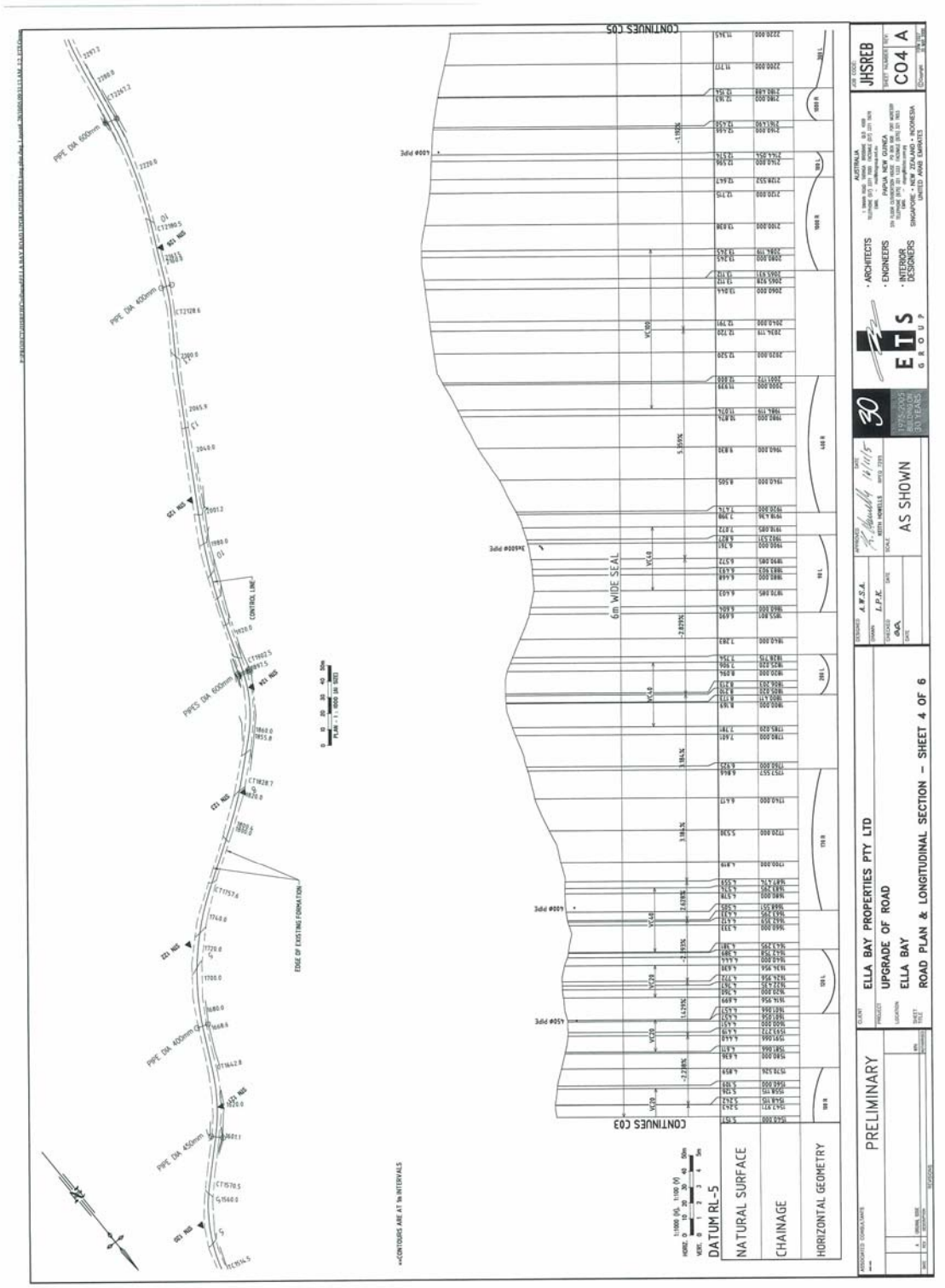


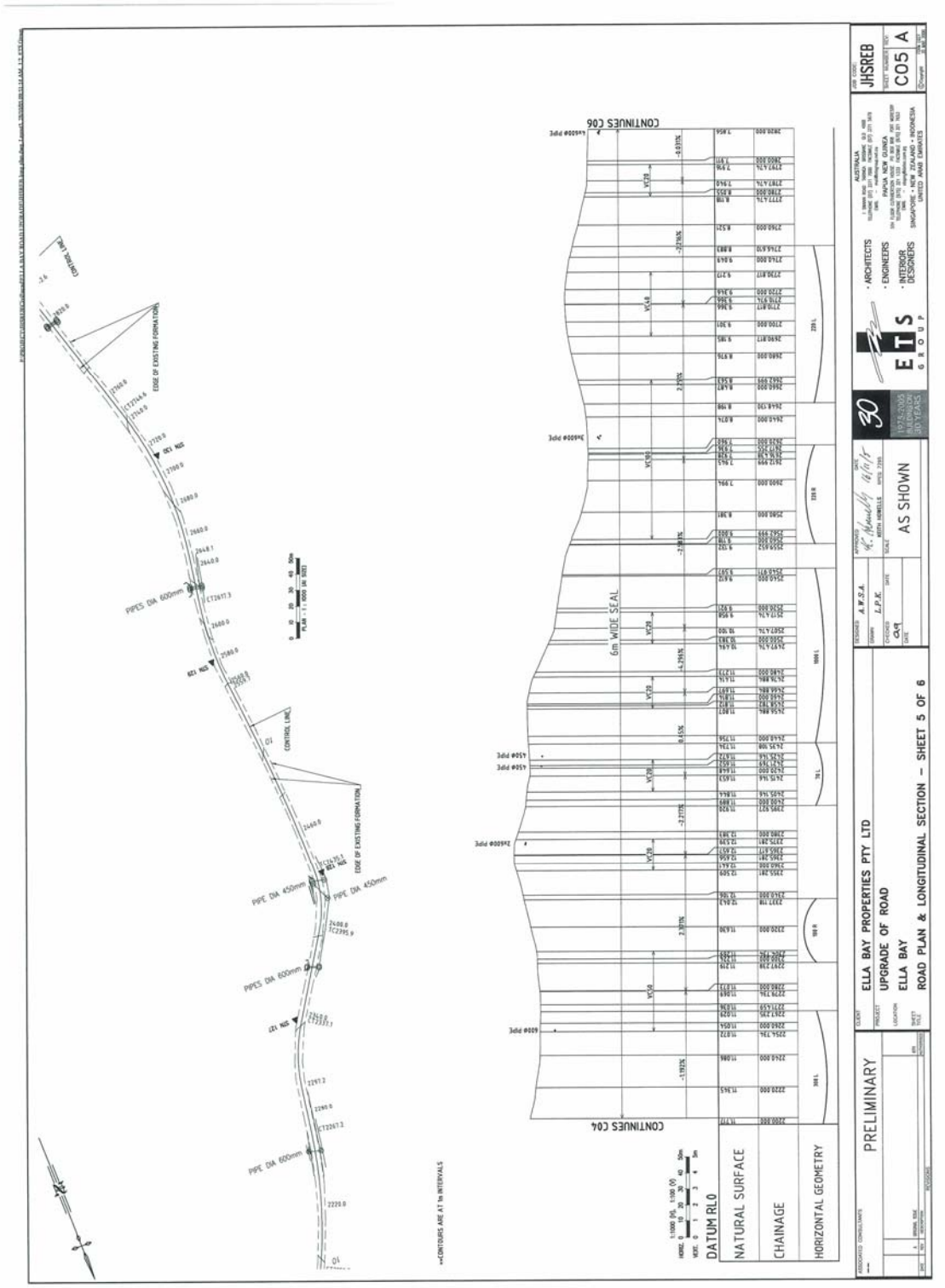
Figure 2-5 Ella Bay Road Upgrade Design Drawings

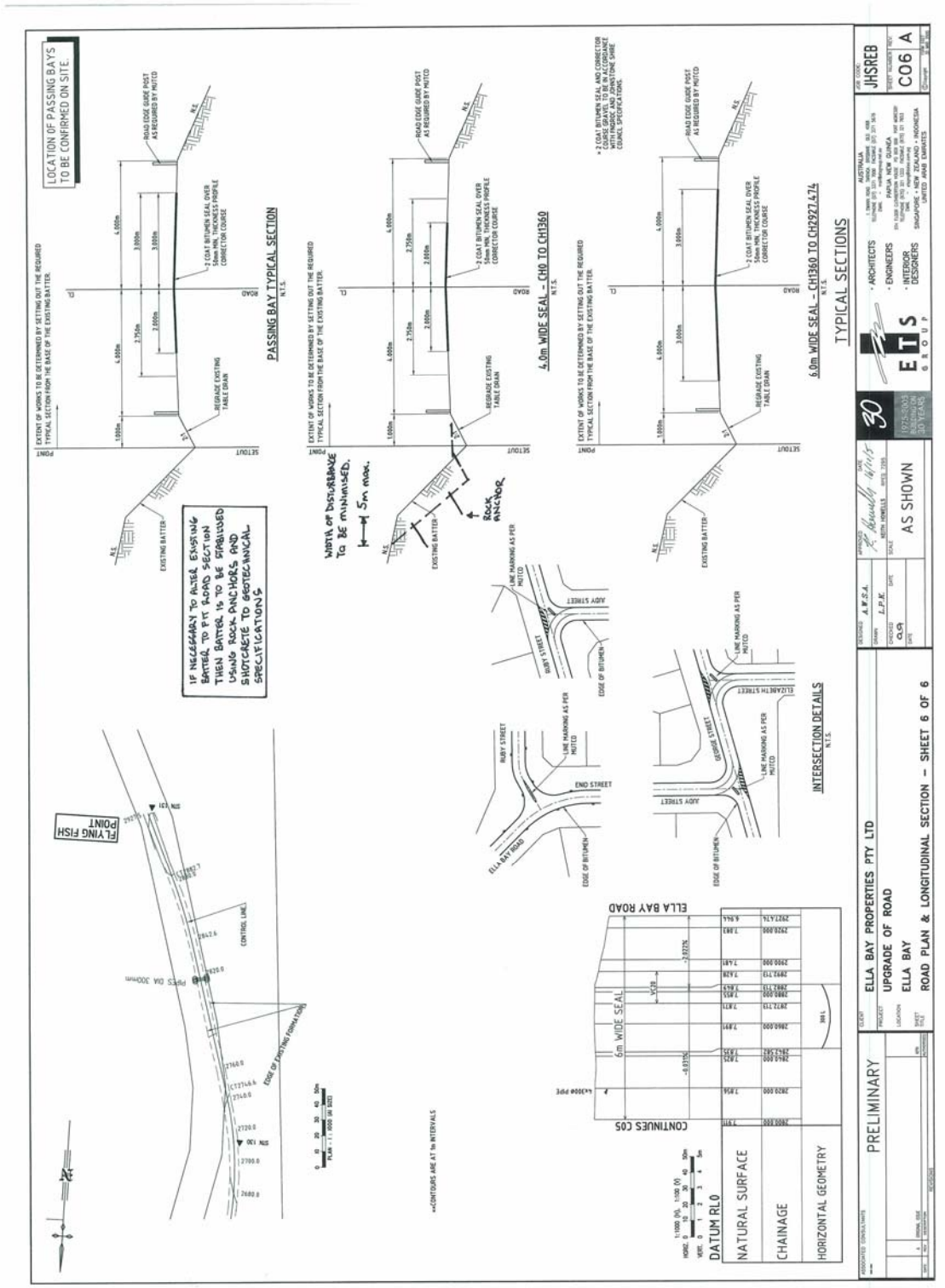

CONTINUES C02
AREA OF POSSIBLE BATTER DISTURBANCE. 5m MAX. REFER SECTION DM 006.
LOCATION OF PASSING BAYS TO BE CONFIRMED ON SITE.
4m WIDE SEAL
STAGE 1 SITE
DATUM RL-5
NATURAL SURFACE
CHAINAGE
HORIZONTAL GEOMETRY
PASSING BAY 1
PASSING BAY 2
PASSING BAY 3
PASSING BAY 4
PASSING BAY 5
PASSING BAY 6
PASSING BAY 7
PASSING BAY 8
TO RESORT SITE
PRELIMINARY
ELLA BAY PROPERTIES PTY LTD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION – SHEET 1 OF 6
JHSREB
C01 A
AS SHOWN
ARCHITECTS
ENGINEERS
INTERIOR DESIGNERS
ETS GROUP


LOCATION OF PASSING BAYS TO BE CONFIRMED ON SITE.
AREA OF POSSIBLE BATTER DISTURBANCE. 5m MAX. REFER SECTION ON C06.
PASSING BAY 10
PASSING BAY 9
PASSING BAY 8
PASSING BAY 7
PROPOSED
EDGE OF EXISTING FORMATION
CONTROL LINE
CONTINUES C03
CONTINUES C01
DATUM RL 10
4m WIDE SEAL
DATUM RL5
NATURAL SURFACE
CHAINAGE
HORIZONTAL GEOMETRY
PRELIMINARY
ELLA BAY PROPERTIES PTY LTD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION – SHEET 2 OF 6
JHSREB
C02
A
AS SHOWN
ETS GROUP


LOCATION OF PASSING BAYS TO BE CONFIRMED ON SITE
HEATH POINT
AREA OF POSSIBLE BATTER DISTURBANCE. 5m MAX. REFER SECTION ON C06.
PASSING BAY 12
CONTINUES C02
CONTINUES C04
6m WIDE SEAL
4m WIDE SEAL
TAPER
PRELIMINARY
ELLA BAY PROPERTIES PTY LTD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION – SHEET 3 OF 6
AS SHOWN
JHSREB
C03
A


PRELIMINARY
ELLA BAY PROPERTIES PTY LTD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION – SHEET 4 OF 6
AS SHOWN
JHSREB
C04 A
NATURAL SURFACE
CHAINAGE
HORIZONTAL GEOMETRY
DATUM RL -5
CONTINUES C05
CONTINUES C03
6m WIDE SEAL
EDGE OF EXISTING FORMATION
CONTROL LINE
PIPE DIA 600mm
PIPE DIA 450mm
PIPE DIA 400mm
PIPE DIA 375mm
PWCS DIA 600mm
3450Ø PIPE
600Ø PIPE
450Ø PIPE
1000Ø PIPE
ARCHITECTS
ENGINEERS
INTERIOR DESIGNERS


ELLA BAY PROPERTIES PTY LTD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION – SHEET 5 OF 6
PRELIMINARY
JHSREB
C05 A
AS SHOWN
A.P.S.A.
L.P.K.
ARCHITECTS
ENGINEERS
INTERIOR DESIGNERS
NATURAL SURFACE
CHAINAGE
HORIZONTAL GEOMETRY
DATUM RL0
CONTINUES C04
CONTINUES C06
6m WIDE SEAL
PIPES DIA 600mm
PIPE DIA 450mm
EDGE OF EXISTING FORMATION
CONTROL LINE


TYPICAL SECTIONS
PASSING BAY TYPICAL SECTION
4.0m WIDE SEAL - CH0 TO CH1360
6.0m WIDE SEAL - CH1360 TO CH2927.474
INTERSECTION DETAILS
ELLA BAY ROAD
UPGRADE OF ROAD
ELLA BAY
ROAD PLAN & LONGITUDINAL SECTION - SHEET 6 OF 6
PRELIMINARY
ELLA BAY PROPERTIES PTY LTD
JHSREB
C06 A
AS SHOWN
FLYING FISH POINT
NATURAL SURFACE
CHAINAGE
HORIZONTAL GEOMETRY
DATUM RL0

Option 2 - Mountainous Road Option

A second road access from the west was investigated to supplement Ella Bay Road.

The route of this option was chosen so as to disturb areas within the National Park as little as possible. As a result, the route has a number of hairpin bends and switchbacks and also traverses a high part of the range.

The possible alignment identified transversed the range with an average grade of 6% and a maximum grade of 10%. The alignment has been indentified using a topographic photo and will need more detailed survey of the site to confirm whether it is suitable or even possible at the required grades. Figure 2-6 is a sketch plan of the alignment.

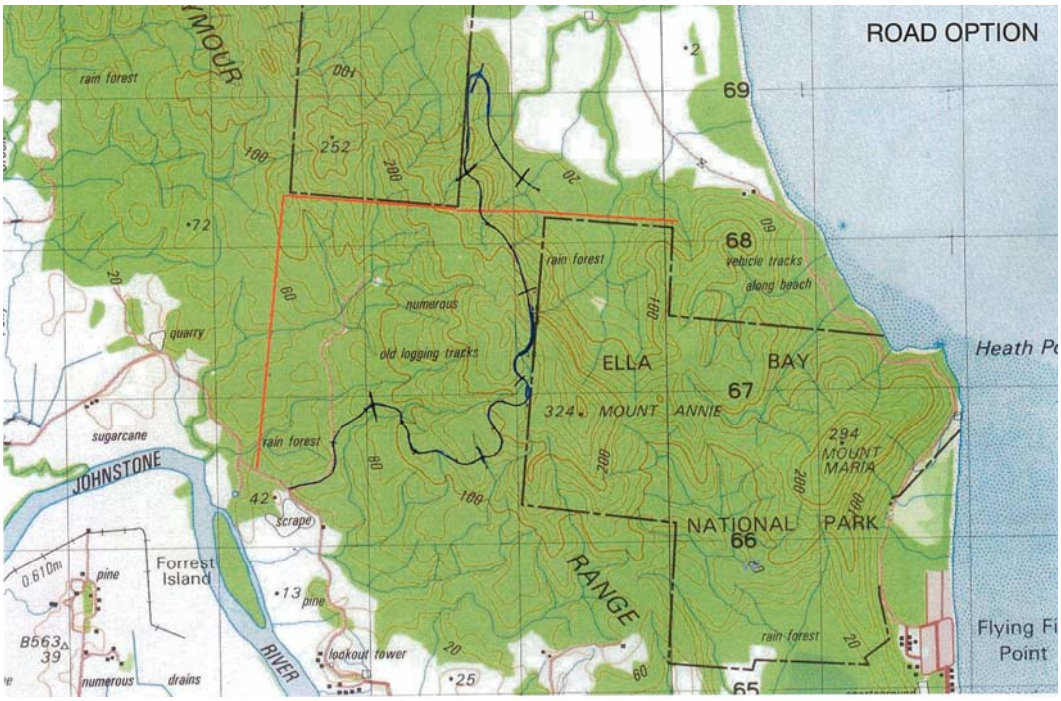


Figure 2-6 Mountainous Access Road Option

After discussion with the Queensland Environmental Protection Agency and the Department of Environment and Heritage (Federal) it was decided not to pursue this option further because this option involves passing through World Heritage Rainforest and environmentally sensitive vegetation.

Option 3 - Tunnel

To eliminate the topographical and environmental problems with the mountainous road a tunnel option was investigated. A dedicated road reserve currently exists along the southern boundary of the site heading west and then south and preliminary data showed that a tunnel was possible. However, due to the associated environmental issues and excessive cost this option was determined not to be viable.

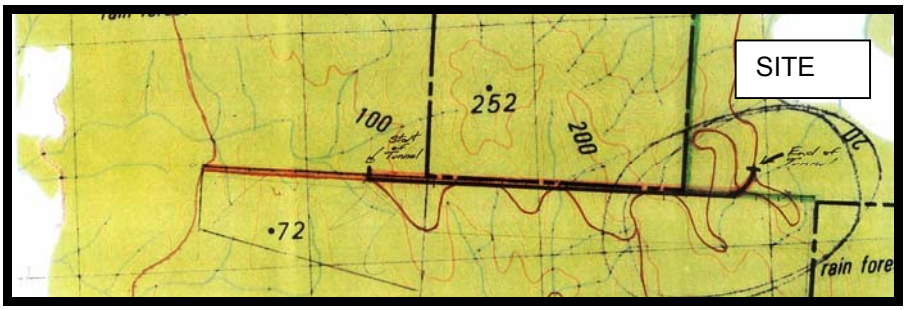


Figure 2-7 Tunnel option – route plan

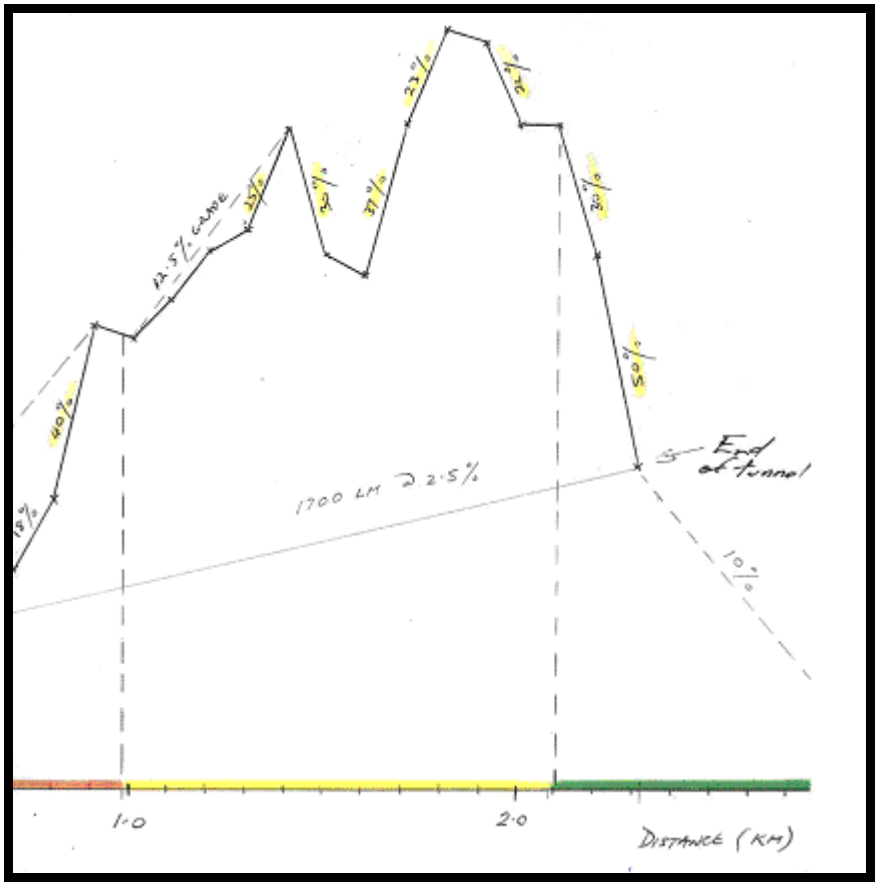


Figure 2-8 Tunnel option - section

Recommended Access

After extensive analysis and discussions with the relevant stakeholders and government departments, it was concluded that the upgrading of Ella Bay Road was the best option for Ella Bay Developments Pty Ltd to pursue.

However, there are a number of alternative routes / options from where Ella Bay Road meets Flying Fish Point and the Coconuts. These further sub-options are discussed in Section 2.2.4.

2.2.2 Traffic Generated

As established in Section 2.2.1, Ella Bay Road would form the sole connection for movements between the proposed development and Flying Fish Point by motor vehicles. The traffic generated by the development has been calculated as follows.

1. The traffic generating characteristics of the proposed development during its operational phase have been assessed in accordance with Main Roads' *Resort Traffic Surveys* (1989). This report uses data from traffic count and guest interview surveys conducted at 22 resorts in Queensland to develop guidelines for quantifying the traffic generating characteristics of new tourist accommodation facilities.

2. The size and characteristics of the proposed development were compared to similar facilities surveyed for the Main Roads report. These were found to include:

    - Port Douglas
    - Capricorn Iwasaki
    - Kooralbyn Valley

3. This assessment takes into account:

    - the expected scale of the development (ie 860 resort apartments + 540 residential lots);
    - the range of on-site facilities (ie retail, commercial, educational, restaurant and dining, recreation and personal services);
    - its function as a destination in itself (as opposed to a base for extensive day trip activities);
    - the relative remoteness of the resort from major urban conurbations; and
    - the expected number of guest, resident, staff, service and bus trips generated during an average day.

4. The number of daily vehicle trips generated by guests and residents (ie to/from the resort) during peak holiday times has been estimated accordingly:

   - Guest Trip Rate: 0.7 - 1.5 vpd / occupied room
   - Number of Rooms: 1,400 rooms (ie apartments + residential dwellings)
   - Design Occupancy: 90%
   - Guest Trips: 880 - 1,890 vpd

5. The number of resort staff expected during peak holiday times has been estimated accordingly:

   - Staff Ratio: 1.2 – 1.6 staff / fully serviced occupied room
   - Number of Rooms: 860 rooms (ie apartments only)
   - Design Occupancy: 90%
   - Number of Staff: 930 - 1240 staff

6. Staff are expected to reside off-site and commute to the resort on a daily basis. Thus, the number of daily vehicle trips generated by staff (ie to/from the resort) during peak holiday times has been estimated accordingly:

   - Staff Trip Rate: 20 + 1.32 * No Staff
   - Number of Staff: 930 - 1240 staff
   - Staff Trips: 1250 - 1,660 vpd

7. The number of daily service vehicle trips (ie to/from the resort) during peak holiday times has been estimated accordingly:

   - Service Vehicle Trip Rate: 0.6 * No. Staff + 14 (for up to 450 staff)
   - Staff numbers are 930 – 1240 and economies of scale apply beyond 450 staff. Therefore 450 staff is used in the calculation.
   - Service Vehicle Trips: 280 vpd

8. The number of bus/coach trips (ie to/from the resort) during peak holiday times has been estimated accordingly:

   - Bus/coach Trip Rate: 0.2 vpd / occupied room
   - Number of Rooms: 860 rooms (ie apartments only)
   - Design Occupancy: 90%
   - Bus/coach Trips: 160 vpd

9. The total number of daily vehicle movements to/from the resort during peak holiday times is summarised in Table 2-3. This equates to 2570 – 3,990 vpd.

Component	Low	High
Guests	880	1,890
Staff	1250	1,660
Service Vehicles	280	280
Buses / Coaches	160	160
Total	2,570	3,990

Table 2-3 Daily Trip Generation – Operational Phase (vpd two-way)

TOR - Anticipated times at which movements may occur.

The distribution of resort traffic by time of day during peak holiday times has been estimated based on the data presented in Main Roads' Resort Traffic Surveys (1989) and is shown in Figure 2-9. On average, traffic flows to/from the resort are expected to peak during the late morning (ie 11am to 12noon). Significantly lower volumes are expected during the traditional commuter peak periods. The expected variation in these figures is shown in Figure 2-9.

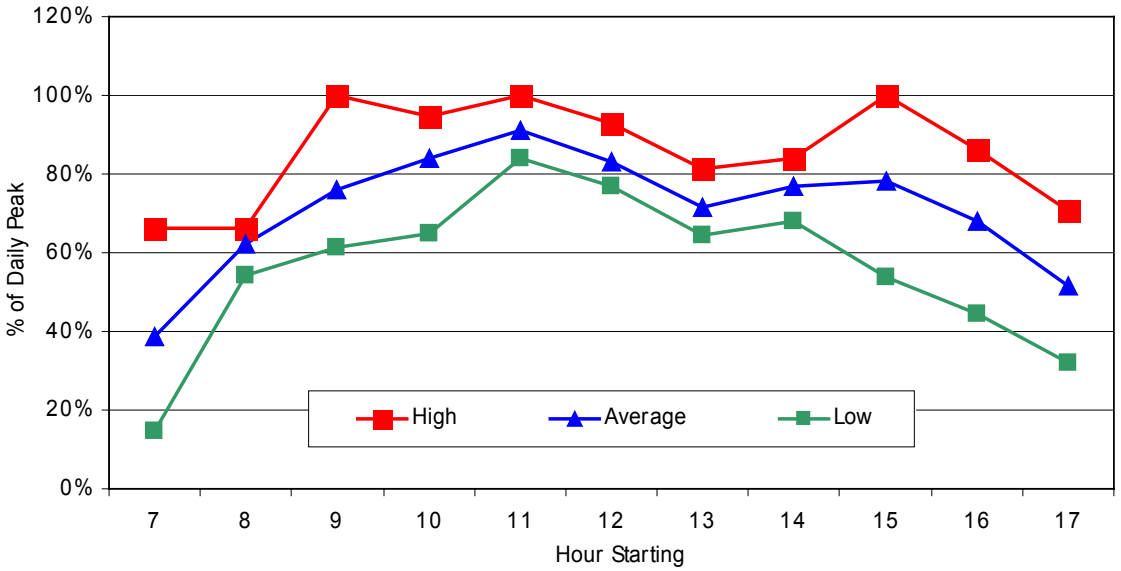


Figure 2-9 Hourly Trip Generation Profile (two-way)

Similarly, the distribution in resort occupancy, and hence resort traffic, by month of year has been estimated based on the data presented in Main Roads' Resort Traffic Surveys (1989). This is shown in Figure 2-10. On average, traffic flows to/from the resort are expected to peak during the summer months / school holiday periods (eg July to October). Significantly lower volumes are expected during cooler / non-school holiday times (eg February to May).

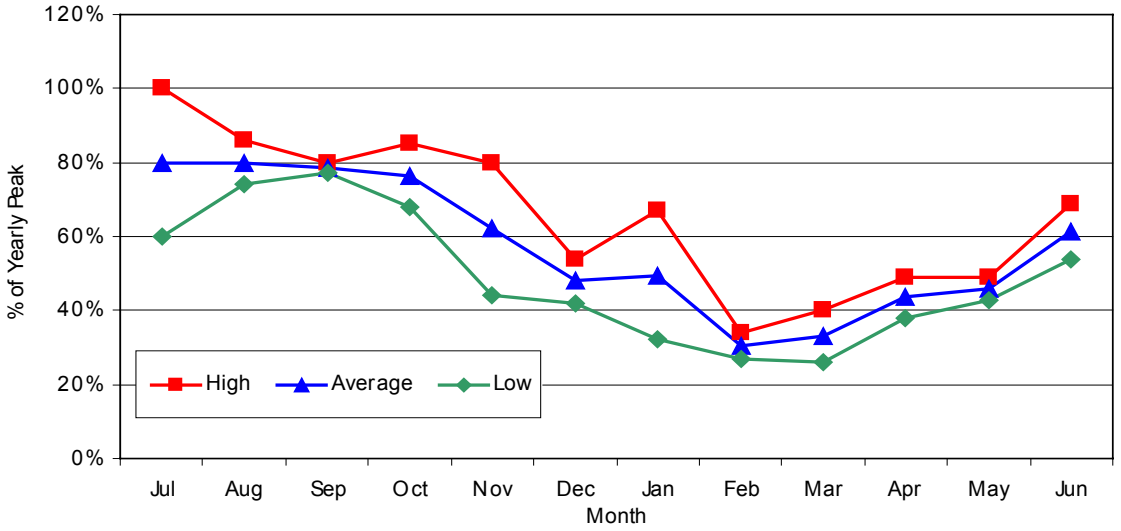


Figure 2-10 Monthly Variation in Occupancy and Vehicle Trips

2.2.3 Impacts on Ella Bay Road

Based on the calculations in Section 2.2.2, the total number of daily movements to/from the proposed development during peak holiday times is expected to be in the order of 2570 – 3990vpd.

A review of AUSTROADS' *Rural Road Design – A Guide to the Geometric Design of Rural Roads* suggests single carriageway road widths as shown in Table 2-4.

Table 2-4 Single Carriageway Road Widths

Element	Design AADT	
	1,000-3,000	>3,000
Traffic Lanes	7.0m (2 x 3.5m)	7.0m (2 x 3.5m)
Total Shoulder	2.0m	2.5m
Shoulder Seal	1.0m	1.5m

Source: AUSTROADS' "Rural Road Design

It should be noted that the road widths presented in Table 2-4 are based on **average annual daily traffic (AADT)** volumes. Given that the proposed development's traffic volumes have been estimated for;

- peak holiday times,
- a higher number of staff than is likely as not all rooms are fully serviced on a daily basis,

it would be reasonable to expect that AADT volumes generated by the proposed development would be somewhat less than that calculated.

Therefore, as the volumes can be expected to be on average less than 3,000 AADT it is concluded that Ella Bay Road, which connects the proposed development to Flying Fish Point, would need to exhibit (and be maintained at) the following road widths:

- Traffic Lanes: 7.0m (2 x 3.5m)
- Total shoulder: 2.0m (unless the terrain and fauna does not allow)
- Shoulder seal: 1.0m

The locations at which this road would need to be upgraded consistent with the above requirements will be identified through a detailed design process. However it is envisaged that construction work at any location where additional road width (above that already provided) is required will be sympathetic with the existing fauna and topography to ensure there is little to no impact on the surrounding environment. The upgrading of the road to the above standards will be done on a staged process with the timing of such works determined by the actual traffic generated by the community population.

2.2.4 Impacts on Flying Fish Point

TOR - The proposed transport routes (including waterway crossings).

The possible transport routes through Flying Fish Point are as follows:

Option 1.

A route through the Flying Fish Point urban area was specified in accordance with the development approval of the existing development, Ella Bay. The route required intersection upgrading and channelisation works to the Ruby/Judy St and Judy/George St intersections. The entire route involved the use of Elizabeth, George, Judy and Ruby Streets before connecting onto Ella Bay Road.

This option provides the benefit of the use of the existing street network as well as minimal upgrading of the existing road pavements.

However, there will be increased traffic through the existing urban area as a result of this option, impacting on existing Flying Fish Point residents.

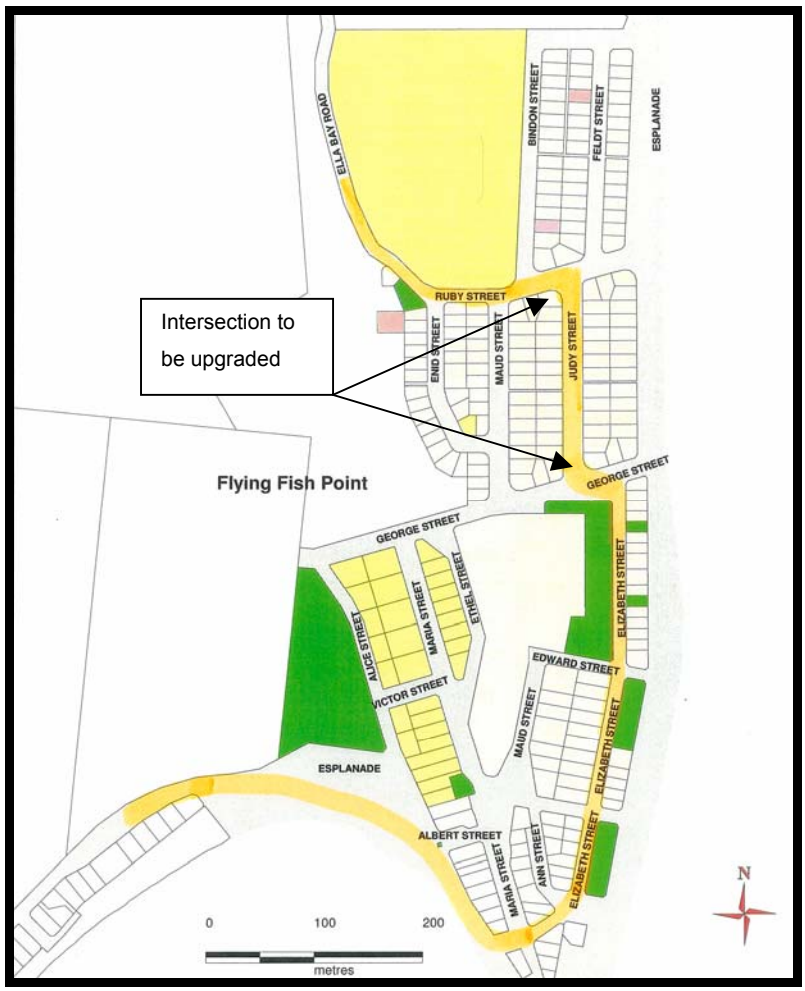


Figure 2-11 Flying Fish Point, Traffic Route – Option 1

Option 2.

Option 2 involves the construction of a new road on the western side of the existing urban area.

This option provides the benefit of reducing through traffic in the local streets within Flying Fish Point by diverting or bypassing traffic directly to Ella Bay Road. This option does not directly affect existing properties, although it does pass the back of some sites.

The negative aspect of this option is that there will be an impact on the rain forest environment directly behind the urban area. The route is mountainous and will require significant earthworks. There will be a need to extensively clear vegetation along the route including remnant vegetation that is mapped as 'being of concern'. This will disturb and impact on fauna and cassowary habitat. The proposed route is not within a dedicated road reserve and will require a change in title arrangements to in the road reserve. This option may also reduce the economic opportunity available to the Flying Fish Point community because any traffic to the development will bypass the established area.

Figure 2-12 Flying Fish Point, Traffic Route – Option 2

Option 3.

This option allows all traffic to enter the start of the urban area and then diverts through traffic onto an esplanade road. At the northern end of the urban area the new road would divert west, passing below the existing aquaculture farm, to join Ella Bay Road. The section of Ella Bay Road from the connection point south to Ruby St will be closed.

Previously an esplanade road had existed along the full length of beach front before it was washed away. The dedicated road reserve for that road still exists. This section of beach front has in recent years become very unstable and rock protection walls have been installed in an attempt to manage the problem (with limited success). The road has been fully constructed along the top of this rock wall between George St and Ruby Street but the remainder of the road will need reconstruction. At the northern most end of the esplanade the Council has erected fencing to stop pedestrian access after a child was killed in a wall collapse a few years ago. Currently beach erosion directly affects approximately 34 residential lots that are on the eastern side of the un-constructed section of the esplanade.

The benefits of this option are;

- the construction of the esplanade road will provide a protection buffer to existing residences from the ocean and there may be an opportunity to make the existing sea wall safe.
- Closure of that section of Ella Bay Road provides the environmental benefit of restoring the connection between currently forested areas either side of the road.
- Affects approximately the same number of residents as Option 1.

However, the negative impacts of this option are;

- Clearing of vegetation
- Potential title issues
- Rectification of the sea wall will be expensive
- Existing water front residents that currently adjoin the beach will now have an esplanade road between their property boundary and the beach.
- Little reduction in the social impacts of increased traffic on the residents of Flying Fish Point when compared to Option 1.

Figure 2-13 Flying Fish Point, Traffic Route – Option 3

Option 4

This option uses the same route through Flying Fish Point as Option 3, but instead of constructing a connection road along the southern boundary of the aquaculture farm, it is proposed to extend the esplanade road north along the remainder of the road reserve up to Heath Point.

This option has many of the benefits of Option 3. Additionally, it allows for more of the existing Ella Bay Road to be closed, thus restoring environmental connectivity.

The benefits to this option are:

- The construction of the esplanade road will provide a protection buffer to existing residences from the ocean and there may be an opportunity to make the existing sea wall safe.
- Closure of that section of Ella Bay Road provides the environmental benefit of restoring the connection between currently forested areas either side of the road.
- Affects approximately the same number of residents as Option 1. Allows for more of the existing Ella Bay Road to be closed, thus restoring environment connectivity.

Figure 2-14 Flying Fish Point, Traffic Route – Option 4

However, the negative impacts of this option are:

- Clearing of 'Of Concern' vegetation
- Potential title issues
- Construction in a Erosion Control Zone
- Construction in a Coastal Management Zone
- Loss of critical fauna habitat through clearing of vegetation that is mapped 'as of concern'.

Analysis of options

Based on the previous information in Section 2.2.4, a critical analysis of the options can be carried out.

- Due to a number of significant environmental issues, Option 2 at this stage of the investigation is the least favourable option.
- Option 3 and 4 may marginally reduce the impact on the existing urban area but also require significant works to be carried out along the beach foreshore. This would mean that significant coastal management and environmental issues need to be resolved.
- Option 1 is an existing road system and while the use and upgrade of this system will impact on the local community, it appears to provide the best environmental outcome.

As such it is recommended that Option 1 should be investigated and developed in the most detail for further discussion / approval. Option 3 and 4 should not be totally discounted for further investigation if all stakeholders agree that these options may be viable from approval, construction, operation, environmental, social and economic view points.

2.2.5 Impacts on Coconuts

The residential area on the coastline between Innisfail and Flying Fish Point is called Coconuts. This residential area is relatively small and has Flying Fish Point Road passing through it.

With the predicted increase in traffic it is anticipated that the four way intersection with Bay Road and the Esplanade will require upgrading. The current concrete kerb channelisation would need to be replaced with a roundabout of suitable size. Another option would be to locally divert Flying Fish Point Road to the north of this area. The terrain and vegetation in this area would make this a viable option to be further investigated.

Figure 2-15 Coconuts, Traffic Route

2.2.6 Impacts on Maintenance

TOR - Need for increased road (and waterway crossing) maintenance and upgrading.

With the increase in population in the area it is expected that increased maintenance will be required along major access routes. The extent of increased maintenance to the existing roads and infrastructure would be calculated and controlled by the existing maintenance facilities provided by Johnstone Shire Council. Any upgrading works would be carried out at a time when population growth made it necessary for this to occur.

2.2.7 Transport Within the Community

TOR - Method of movement (including vehicle types and number of vehicles likely to be used).

Reduce dependency on cars (more transport choices).

The transport vision of Ella Bay Development Pty Ltd is that the residents will actively participate in a culture for the community that is not dominated by cars as the main form of transport.

Due to the relative remoteness of the development from nearby air and rail terminals, it is expected that a high proportion of guests would arrive by car or coach (in the order of 80% and 20% respectively. However, given that internal transport systems of the proposed development, it is envisaged that there will be a reduction in the dependency on private motor vehicle once guests have arrived in the community.

A conventional road system will be installed allowing cars, trucks, etc. to access all areas of the community. However, it is envisaged that many of the internal trips by residents will be made using electric and gas powered golf buggies or similar style transportation. To support this further the community management company will operate a small shuttle bus service throughout the community. If a resident wishes to use their car to travel to the Village Precinct, it is likely that they will be required to park in a central location (for a fee).

Day visitors to the community who will be using the Village Precinct and Facilities will also be required to park in the central location and then use the shuttle bus.

All residents, guests and visitors will also be encouraged to cycle or walk for internal trips and numerous pedestrian and cycle paths will be provided throughout the development.

In conjunction with the internal shuttle bus service, the community management is likely to operate an external shuttle bus service between the site, Flying Fish Point and Innisfail. This would provide for such users as:

- Employees of the proposed development residing in the Flying Fish Point or Innisfail area; and
- Persons staying within the proposed development travelling to/from Flying Fish Point or Innisfail for other needs or services not provided at the proposed development.

There may also be an opportunity for the existing public transport facilities, which operate in and around Flying Fish Point and also Innisfail, to provide services to the community.

2.2.8 Impact Mitigation

The developer should consider implementation of proposals that will reduce the impact of the development on the community of Flying Fish Point. Such measures could include;

- foreshore beatification landscaping, and
- streetscape beautification landscaping

2.3 Construction Traffic

TOR - The volume of traffic generated by workforce personnel, visitors and service vehicles.

In terms of the total numbers of construction vehicles at any time, it is not expected that the number and type of traffic generated during the construction period will be significantly different to that generated by a typical residual / resort development (eg predominantly tradeperson' vans, concrete trucks and earth moving equipment).

It is impossible at this point to accurately determine the volume of traffic generated by construction activities as the staging of works will be drawn out over a period of time generally determined by the sales rate. An order of magnitude estimate would indicate that;

- During the civil construction works a construction team of 40 people would be required and materials deliveries would average ten a day. The construction period would be approximately 20 weeks for each stage.
- During the construction of each dwelling a construction team of five people would be required and material deliveries would average five a day. It can be assumed that four dwellings would be under construction at the same time and a construction period of 20 weeks.
- During construction of a resort precinct and town centre a construction team of 100 would be required and material deliveries would average 15 a day. The construction period would be in excess of 52 weeks.

TOR - The volume, composition (types and quantities), origin and destination of goods to be moved including construction materials, plant, raw materials, wastes, hazardous materials.

The number and size of heavy vehicle movements generated during the construction phase will depend significantly on the degree of cut / fill balance achieved on-site. The movement of large over-dimension loads to/from the site are not expected. To reduce the possibility of heavy vehicle movements appropriate measures will be put in place. These include the use of a community title management, control of the architectural designs to ensure slope sensitive and minimal impact designs, plus road design to ensure all earthworks are minimised. Because the site is relatively flat the likelihood that heavy machinery is needed will also be reduced.

It is expected that the majority of the raw materials used during the construction process would be delivered by road from Innisfail, the surrounding Johnstone Shire area, Townsville, Cairns and to a less extent Brisbane. The composition of these raw materials

would include items such as, gravel, pipes, asphalt, cement, timber, bricks, building materials, etc.

A recycling program will be in place to reduce waste but any waste generated during the construction phase will either be recycled onsite or transported to the nearest appropriate waste disposal facility in Innisfail.

The actual volumes of materials coming to and leaving the site can not be accurately determined at this stage but procedures will be put in place to minimise these volumes.

TOR - Details of vehicle traffic and transport of heavy and oversize indivisible loads (including types and composition).

Construction plant movement numbers would be small as items of plant could be expected to spend significant periods of time on site between arrival and departure movements. It is expected that the concrete deliveries will comprise the major portion of large vehicle trips along with material supply vehicles. It is expected that these vehicles will make their deliveries on an irregular basis, most likely out of peak traffic hours.

While Ella Bay Road is currently able to be used by large rigid vehicles, the use of oversized vehicles will be restricted due to the topography of the road. If large floats are needed, traffic control and possibly temporary closure of the Ella Bay Road might be required, to enable plant to be transported to the site.

2.3.1 Reduce emissions and therefore improve air quality.

TOR - Proposed methods and procedures to maintain acceptable EPA and community standards in relation to dust and exhaust emissions.

The provision of the proposed development will increase motor vehicle emissions, given that demand for new motor vehicle movements will be generated (in comparison to that currently existing for the subject site).

During the operation of the development it is envisaged that the internal transport for the development will be via the use of electric or gas powered golf buggies and small shuttle buses. Because of the use of these types of vehicles, the pollution generated on site is not expected to be equivalent to that produced from a standard development.

During the construction phase, Noise and Dust Management will be incorporated into an Environmental Management Plan for the development. Below is a typical example.

Purpose: Noise and Dust Management	
Element	To minimise the impact of noise and dust nuisance generated by earthworks and construction activities and maintain amenity for adjoining residents. Compliance with this objective is to meet the requirements set out in the Environmental Protection Reg. 1998 Part 2A Environmental Nuisance.
Policy	All works undertaken on site are to comply with the above documents.
Performance Requirements	**Noise** Civil Engineering Works Specification Clause 9 included within the contract with the Principal Contractor nominates the following normal hours of on site work: • 6.30am to 6.30pm Monday to Saturday or business days • No work on Sundays or Public Holidays Any construction or earthworks activities outside of the hours nominated above will only be permitted with the prior written approval of both the Principal and the relevant Local Authority delegate. **Dust** Civil Engineering Works Specification Clause 21 included within the Contract with the Principal Contractor specifies: • Dust generated from the site and from earthworks is to be controlled so as not to adversely affect adjoining properties, and to meet the requirements of the Environmental Protection Act. • No visible dust emissions must occur at the boundaries of the site during earthworks and construction activities on the site. • If at any time during the earthworks and construction activities, dust emissions exceed the levels specified above, dust-generating activities must cease until sufficient corrective actions have been implemented to reduce dust emissions to acceptable levels or wind conditions are such that acceptable levels are achieved. • In order to ensure minimal response times for implementation of corrective actions and continuity of the construction processes, watering equipment shall be available on site at all times during earthworks and construction activities to dampen down disturbed areas.
Monitoring	The monitoring and control of both noise and dust nuisance is to be a continuous process for the duration of the earthworks and construction activities at all times including non working days.
Reporting	The superintendent is to take note of noise and dust levels: • During regular site inspections throughout the earthworks and construction activities; • Immediately following receipt of any complaints.

Corrective Action	The superintendent in consultation with the Principal Contractor is to determine the source of the unacceptable noise and dust emissions and;
	• Devise a method to attenuate offending noise emissions either through maintenance of plant or revised work practices, and
	• Reduce dust emissions through either:
	  ○ Suspension of works until weather conditions are favourable;
	  ○ Damping down of work areas; or
	• Revision of work practices.

2.4 Marine Transport

TOR - Existing marine usage within 10 kilometres of the site boundaries, including both recreational and commercial boating.

TOR - Usage patterns of existing marine infrastructure within 10 kilometres of the site boundaries, including details of peak use periods (hours/days/seasons).

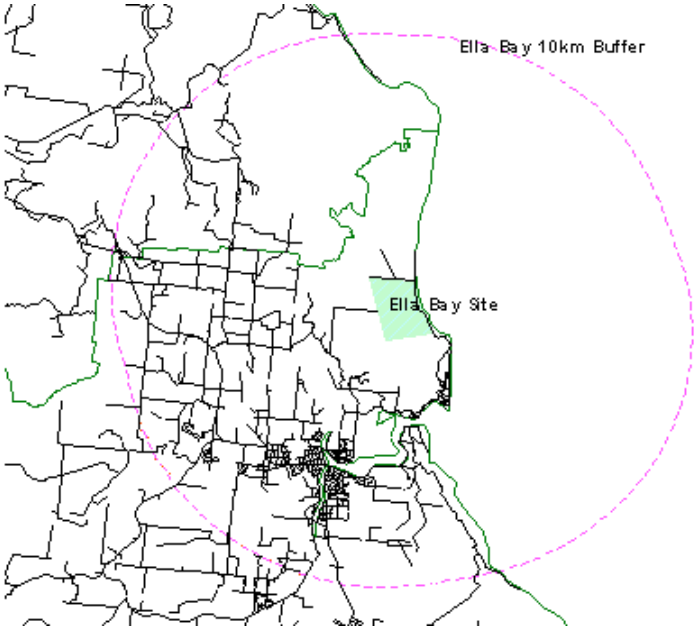


Figure 2-16 Marine Area within 10km

Both commercial and recreational boating activities occur within 10 kilometres of the site. The main location for this activity is the Johnstone River. Commercial fishing companies operate out of Innisfail from jetties and port facilities along the river all year long. There is also a ship servicing facility at Coconuts / Flying Fish Point.

A number of recreational boats also use the river for sailing, fishing, water skiing, etc. It is anticipated that the usage patterns for recreational activities would be constant through the year. There are a number of small boat ramps in the area that cater for recreational activity.

2.5 Community Issues

TOR - Communication of these issues to the public.

A proactive community consultation process will be initiated to provide the public a forum to be informed of and raise issues relating to the development. The public will also be able to receive a periodic newsletter that will keep them update with the status of the development.

3 Infrastructure - Energy

TOR - 3.5.2 Energy

The EIS should describe all energy requirements, including electricity, natural gas, and/or solid and liquid fuel requirements for the construction and operation of the proposal. The locations of any easements should be shown on the infrastructure plan. Energy conservation should be briefly described in the context of any Commonwealth, State and local government policies.

3.1 Vision

A core value and main objective in the development of the Ella Bay Community is that it will set new standards in sustainable development and design. In the terms of energy use, generation and management, achieving this objective requires a very high level of self-sufficiency and or electricity to be generated from green resources. To achieve this each building will be designed to minimise energy use and the major electricity supply will be produced by a combination of Standalone Power Supply systems with a back-up supply provided by a grid connection at Flying Fish Point.

3.2 Energy Demand

Given the tropical climate in the Ella Bay region, the use of energy in is an important issue. The challenge faced by the developer is to minimise energy use. This can be achieved by reducing energy waste while increasing use efficiency. This should be achieved while at the same time maintaining the high standard of living intended by the developer. Electricity will be the most consumed energy in the development once operational. Gas and petroleum fuels will be used as well.

3.2.1 During Construction

It is envisaged that the construction of the proposed development would require the use of the following energy sources:

- Electricity
- Liquid fuel (diesel and petrol)
- Gas

The main consumers of electricity would be power supply for construction compound(s) comprising:

- lighting,

- office equipment operation,
- air conditioning, and
- exterior flood lights.

This electricity supply would be obtained either from the State Supply Grid by a connection to the existing infrastructure or by generator.

The construction equipment would be the main consumer of liquid fuel with the use of the following:

- Operation of excavation machinery,
- Road transport of materials,
- Operation of concrete pumps and agitators, and
- Operation of water carts, graders, compactors, asphalt plants and rollers; etc.

A variety of plant and equipment would be used in construction of various components of the development project. The construction contractor will manage the total consumption of energy by construction equipment as efficiently as possible, as this will reduce operating costs. A reduction in fuel consumption and energy requirements could also be achieved by using alternative fuels for heavy vehicles such as Biodiesel, Ethanol, Diesohol and Liquefied natural gas (if the construction contractor was able to do so).

3.2.2 Operation phase

Electricity will be the most used energy source during the operation of the development along with gas and petroleum (petrol and diesel). Electricity will be consumed to operate all buildings and infrastructure such as street lighting, water pumps, sewerage treatment systems, communications, etc.

As no actual load demands are know at this stage, an estimate of the electrictiy load demand produced by the proposed development was calculated using general demand method based on Energex requirements. Table 3-1 shows the estimated demand produced by each precinct and gives an approximate total of 8 mega watts peak demand for the whole development.

Component	Estimated electricity demand	Number / Size of proposed dwellings / commercial areas	Estimated electricity demand MW
Town centre / Village precinct	100 W/m^2	10,400m^2 GFA	1.04
Resort precincts	5 kW	860 dwellings	4.3
Residential precincts	4 kW	540 residential lots	2.16
Education precinct	80 W /m2	6,000m2 GFA	0.48
TOTAL			7.98

Table 3-1 Estimated Electricity Demand

This estimate is based on a worst case with no allowance for energy conservation measures.

As the Ella bay development will be using worlds best practise in the use of energy efficient building designs and appliances it is expected that the actual power demand of the development is then estimated to be as per Table 3-2.

With energy efficient appliances, 2kW solar panel array on each residential house and chilled water air-conditioning used by the resort precincts.

Component	Estimated electricity demand	Number / Size of proposed dwellings / commercial areas	Estimated electricity demand MW
Town centre / Village precinct	80 W/m^2	10,400m^2 GFA	0.83
Resort precincts	3.5 kW	860 dwellings	3.02
Residential precincts	2.5 kW	540 residential lots	1. 35
Education precinct	65 W /m2	6,000m2 GFA	0.39
TOTAL			5.59

Table 3-2 Estimated Efficient Electricity Demand

3.2.3 Conservation Strategies to Reduce Demand

In order to minimise the demand on power and therefore reduce the use of energy, building designs and orientations incorporate the latest best practice energy provisions of the Sustainable Housing Code in relation to orientation, building materials, insulation, glazing, sealing and shading; and the recommendations of the Queensland Government discussion paper – Towards Sustainable Housing in Queensland (2004) in relation to hot water generation and conservation and lighting. All buildings will be required to achieve a minimum 5 star energy-efficiency rating and a grid connected Solar (PV) system (2kWp Min.) designed into the buildings will also be required to be install.

Other energy reduction measures include:

- Solar water heaters.
- Install energy smart management systems, energy efficient lighting and appliances.
- Educate residents to develop energy conservation practices.
- Provide educational brochures to new purchasers and holiday-makers on how to use the dwellings efficiently.
- Price Control.
- Reward Systems such as one idea to allow guests to use as much electricity at they like but they are encouraged not to. Guests are given an 'eco-target' to aim for during their stay and guests who use the least power are rewarded with prizes while on the other hand, if they use too much, the cost of their stay goes up by for each kilowatt/hour.
- Provide feedback to residents about energy use. The computer-regulated generators record how power is used all over the resort and Management can track how much power each unit uses. Every dwelling/unit has a dedicated viewing meter (eg. TV channel or in-house meter) that shows its daily power usage.
- Regularly audit and replace equipment when new products with lower energy demand become available
- Being a tropical location, climate control is expected to be one of the main energy demand issues. The following measures will be specifically investigated to reduce a/c energy requirements:
    - The selection of energy saving ac systems;
    - Extensive use of fans;

- Architectural design of buildings to reduce airconditioning requirements. Such measures include natural ventilation, effective insulation of buildings, optimum orientation of buildings and windows to maximise efficient use of the natural climate, overhangs, sunshades, etc;
- Sun control measures;
- Modern design promoting indoor/outdoor living; and
- Smart a/c management systems ie zones are switched off auto when not in use.

- 'Waste' heat from the generators and air conditioning used to heat water and keep the swimming pool warm

3.3 Energy Supply

A number of options have been considered for supplying energy to the development.

3.3.1 State Grid Supplied Electricity

This will involve the installation of a line back to the main grid and probable upgrading of a transformer station. A grid with in the development will also need to be installed to supply power to residents. The point of connection into the grid will need to be determined after consultation with the supplier (Ergon) and after a complete energy model has been done for the whole development.

3.3.2 On site Generation of Electricity

To achieve the vision of sustainable development it is important that the energy needs of the development be provided from renewable resources. One way of achieving this is to install a Standalone Power Supply System (SPS) that utilises energy from renewable sources. Information on this type of system is covered in more detail on the included information sheets obtained from EPA (Qld) but can be summarised as follows;

- SPS, formerly known as Remote Area Power Supply systems (RAPS), have traditionally relied on diesel generators. Power systems incorporating photovoltaic cells (solar), wind turbines or micro-hydro turbines are increasingly being used. An SPS can be designed to suit the locality and loads, combining renewable energy resources and conventional generating sets.

- Properly designed, installed and maintained, an SPS can be more reliable than grid power due to problems with wire infrastructure as well as voltage sags and surges. In contrast, the technology used in SPS is similar to that used for Un-interruptible Power Supplies and provides continuous energy, free from the interruptions often associated with mains supply.

- An SPS provides an ecologically sustainable energy supply. It creates much less pollution and greenhouse gas emissions than any other electricity supply option.

- Using an SPS requires careful planning as these systems are designed for a specific daily energy use. Because the system is being created for the whole development, it can be decided how that power is going to be used. Supply and demand can be controlled but if usage increases significantly, the system can be expanded if adequate allowance is made for future growth in the initial design. The modular nature of SPS

components usually makes expansion simple and suits the staged development approach at Ella Bay.

A centralised power generation plant will be built on site to supply electricity to the development. The size of the plant will be determined after a complete energy model has been undertaken to estimate demand loads. The generators will most likely be run by either diesel or LPG this will be determine by availability and cost.

The service company will operate the generation plant and the power sold to the residents and commercial operators. To decrease the electricity demand further the exhaust heat generated by the generator could be used to run an ammonia-water absorption chiller plant. The chilled water produced could then be sold to the resorts, apartments and town precincts to be used for space cooling instead of traditional air conditioning. As well as the chilled water, hot water could also be produced from the exhaust heat and sold on to consumers.

How it Works

A solar collector system provides power to the reticulation system. This power supplies enough power for daily use and on a normal day, excess power from the renewable energy sources will charge battery storages. At night, during poor weather, or during periods of heavy power use, there may be insufficient power from the renewable sources and then the batteries discharge to provide the additional power required. During these longer periods of poor weather, a generator provides power and recharges the batteries. This generator could be a state-of-the-art clean-fired diesel or LPG generator that gives off one-tenth of the greenhouse gases produced by diesel equivalents. Also rather than building one large generator, smaller ones can be built as required and then linked together with a load-sharing computer to make sure that there is enough power in the busy holiday seasons, but no waste in off-peak times.

Collection System

It is proposed that a decentralised energy system that would be managed from a central control.

The system will be a hybrid system of;

- Solar (PV) designed into the buildings;
- Wind turbine (optional small residential roof style). This provides for increased sustainability and reliability through cloudy periods;
- Localised back up generation units;
- Grid supply network linking the entire development together; and

- Connection to state grid to provide power supply if necessary or conversely to supply power into the grid in times of excess generation.

With a decentralised system having both the energy generator system and consumer close together the collection system can be divided into distinct areas:

- Small scale producers / consumers (residential); and
- Large scale producers / consumers (commercial, resorts, school, infrastructure, etc.)

It is proposed that each building will have a collection system with the small scale elements being able to provide sufficient supply for that building/use as well as providing excess to a central storage to help supply the larger consumers. Refer to the attached schematic drawing.

3.3.3 Back Up Power Supply

As discussed above in Section 3.3, a SPS designed and installed correctly does not need a back up power supply. Onsite generators will provide supply if there is no energy generation available within the system. A power line will be installed back to the Innisfail main power grid to supply the community in the case of an emergency. This line will be installed in an underground trench running along Ella Bay Road. A grid-connected system allows you to draw electricity from the network when you don't generate enough for your needs but also allows any excess electricity generated by the system to be supplied to the grid. As such this development has the potential to be a green energy exporter and benefit the existing adjoining community.

3.3.4 Gas

The use of gas appliances will be encouraged for cooking and for back up boosting of solar hot water systems. This has the benefit of further reducing the demand on the electricity supply. The Service Company will supply gas cylinders to households.

3.3.5 Liquid Fuels

The back up power generator may be run by diesel fuel or gas. Fuel will be stored on site in accordance with Australian standards and best practices.

3.3.6 Easements

All power lines will be located in their designated easements located in the road reserves in accordance with the local authorities guidelines. By placing the easements within the road corridors it will ensure minimal disturbance to the flora and fauna.

3.3.7 Management

A services company will be set-up to management the energy supply to the development.

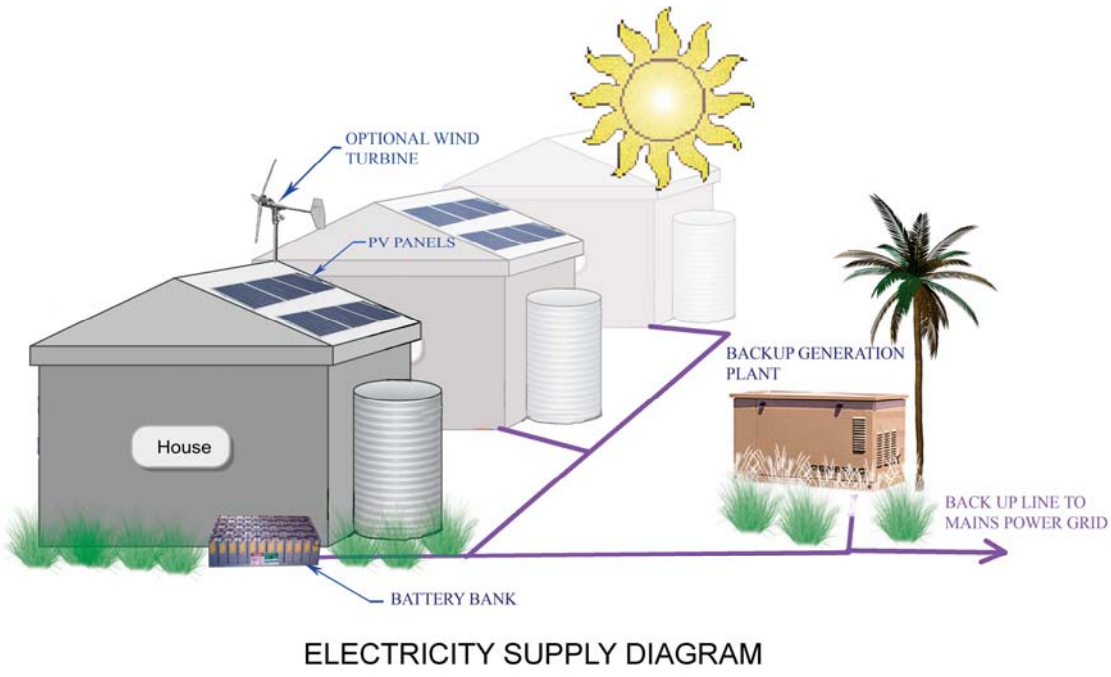


Figure 3-1 On Site Electricity Generation Schematic

The Environmental Protection Agency is Queensland's lead agency to promote energy efficiency, renewable power and other initiatives that reduce greenhouse gas emissions throughout the state.

CLEANER ENERGY

Renewable energy

Stand-alone Power Systems (SPS)

Fact sheet Stand-alone Power System

Electricity

Electricity is an essential part of our way of life that we take for granted. It provides energy services, such as lighting, refrigeration and home entertainment. For the thousands of houses and homesteads too far away from the electricity grid, independent electrical power is required.

Stand-alone Power Systems (SPS), formerly known as Remote Area Power Supply systems (RAPS), have traditionally relied on diesel generators. Power systems incorporating photovoltaic cells (solar), wind turbines or micro-hydro turbines are increasingly being used.

An SPS can be designed to suit the locality and loads, combining renewable energy resources and conventional generating sets.

Benefits of SPS

Depending on distance and terrain, the cost of connection to the electricity supply grid can be high - up to tens or even hundreds of thousands of dollars. An SPS using renewable energy can often be a far cheaper option and save hundreds or thousands of dollars every year.

In some circumstances, houses located a short distance from power lines may be supplied by an SPS at a lower cost than connecting to the grid. Properly designed, installed and maintained, an SPS can be more reliable than grid power.

Grid power in rural areas is supplied through hundreds of kilometres of overhead wires, and subject to falling trees, storms and lightning strike as well as voltage sags and surges. By contrast, the technology used in SPS is similar to that used for Uninterruptible Power Supplies that provide power to critical computer electronics when grid power fails.

In the last decade, SPS technology has improved greatly and power failures are rare in well-designed and maintained systems.

An SPS provides an ecologically sustainable energy supply. It creates much less pollution and greenhouse gas emissions than any other electricity supply option.

An SPS provides continuous energy, free from the interruptions often associated with mains supply. Furthermore, SPS support local employment as they encourage associated industries into the area.

Using an SPS requires careful planning as these systems are designed for a specific daily energy use. If usage increases significantly, the system can be expanded if adequate allowance is made for future growth in the initial design. The modular nature of SPS components usually makes expansion simple.

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Figure 3-2 EPA Inforamation on Stand-alone Power Systems

How an SPS works

- The solar array, wind turbine or micro-hydro generator provides power to the system.
- This power runs connected loads such as lights and appliances etc.
- On a normal day, excess power from the renewable energy sources will charge the batteries.
- At night, during poor weather, or during periods of heavy power use, there may be insufficient power from the renewable sources and the batteries discharge to provide additional power.
- During longer periods of poor weather, a generating set provides power for the loads and recharges the batteries.
- An SPS generates low voltage DC (direct current) while household appliances use AC (alternating current). An inverter converts the DC power into AC.

How much will an SPS cost?

Most SPS designers or installers would need to do a formal quote to give a cost estimate. Costs vary greatly due to the range of factors involved. As a rough guide:

- daily energy use of around five kWh AC, the installed cost may be around $15,000 - $20,000.
- daily use of eight kWh AC, the installed cost may be around $20,000 - $30,000.

Government support

An SPS for your residence, business or community may be eligible for a rebate from the Queensland Government (see contact details).

2 of 2 BP1431 (SI-SE-007) Oct 2002

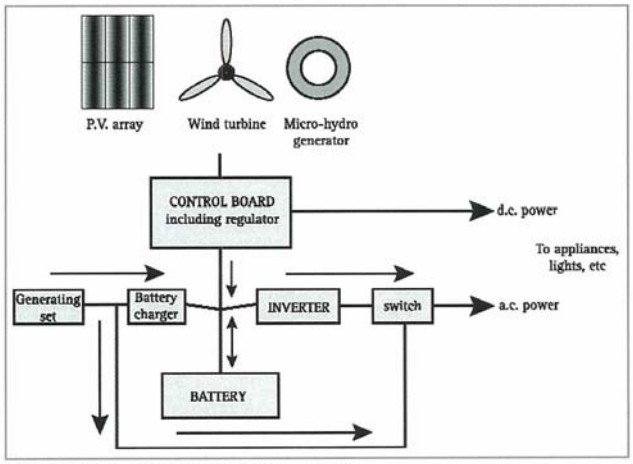
Renewable energy

Renewable energy comes from sources that are essentially inexhaustible such as the sun, the wind and the heat of the Earth, or from replaceable fuels such as plants. Prior to the industrial revolution, these sources were virtually the only forms of energy used by humans. During the past 150 years, modern civilisation has become increasingly dependent on fossil fuels - oil, coal and natural gas. Fossil fuels form so slowly in comparison with the rate of energy use that they are considered finite or a limited resource.

Using renewable energy can provide many benefits, including:

- making use of secure, local and replenishable resources;
- reducing dependence on non-renewable energy;
- helping to keep the air clean;
- helping to reduce the production of carbon dioxide and other greenhouse gases; and
- helping to create jobs in renewable energy industries.

Geothermal, solar, wind, hydro, biomass and wave are all examples of renewable energies.



Block diagram of major SPS components (N.B. - system configurations vary depending on actual equipment used).

For more information

call 1300 369 388
visit www.epa.qld.gov.au/sustainable_industries
email sustainable.industries@epa.qld.gov.au

Greenhouse Office
The lead Commonwealth agency on greenhouse matters

Queensland Government
Environmental Protection Agency

4 Infrastructure - Water Supply and Storage

TOR - 3.5.3 Water supply and storage

The EIS should provide information on water usage by the project, including the quality and quantity of all water supplied to the site and discharged from the site. In particular, the proposed and optional sources of water supply should be described (eg. bores, any surface storages such as dams and weirs, municipal water supply pipelines).

Estimated rates of supply and discharge from each source (average and maximum rates) should be given. Any proposed water conservation and management measures should be described.

Determination of potable water demand should be made for the project, including the temporary demands during the construction period. Details should be provided of any existing town water supply to meet such requirements. If water storage and treatment is proposed on site, for use by the site workforce, then this should be described.

Integrated Water Management will be one of the keys to the sustainability of the Ella Bay Master Planned Community. The proposal vision is for the community to be self-sufficient in potable water supply through the use of a decentralised system with a centralised augmentation backup system.

4.1 Sources of Water

The potable water supply for the site can be supplied from a number of sources and is to be examined as part of the entire water cycle of the site.

4.1.1 Source 1 Potable - Local Authority System

A water reticulation supply network services the existing residential area at Flying Fish Point. A main to supply water to the Ella Bay Master Planned Community could be connected to the existing reservoir. The existing network in Flying Fish Point has a low capacity to supply water with the largest main being only 225mm diameter. As such the existing system is currently inadequate to provide for the supply needs of the development without substantial upgrading of the system. A low-pressure trickle feed main to reservoir storage within the development would be the only viable connection to the existing system.

4.1.2 Source 2 Potable - Groundwater Extraction

This source was initially proposed in the planning reports for the adjacent Little Cove development as a supply option. However, the preliminary geotechnical report (Golder Associates, 1995) raised a number of environmental issues in lowering the water table, particularly the possible effects of increased salinity. In Golder's report (2006) DPI indicated that there was a need for controlled pumping to reduce the potential impacts of salt water intrusion.

The Seafarm Prawn Hatchery to the south of the site has a 40m deep bore that extracts water from the bedrock but no information is available about the long term sustainability. It is recommended that groundwater extraction should only be considered as an emergency backup supply option, and only after detailed hydrogeological investigation and assessment of potential impacts.

4.1.3 Source 3 Potable - Roof Collection of Rainwater

The high annual rainfall of the area makes this a viable option to supply potable water.

4.1.4 Source 4 Surface water storages

The master plan for the community does not include surface water storages for stormwater runoff that will be utilised for potable supply. As such this potential supply source has not been considered.

4.1.5 Source 5 Recycled water

The use of recycled water within the community is a viable option. The recycled water will be treated to Class A+ requirements of the EPA permit issued for sewage treatment.

Through analysis, it can be determined that a supply system based on rain and recycled water is the most feasible option, together with a backup supply system (trickle feed) to the mains supply at Flying Fish Point. The following sections of the report examine the supply network, supply demand and generation, storage requirements and maintenance.

4.2 Water Demand

4.2.1 Demand Estimate

For the development to be sustainable and achieve a balance in the water model it is important that the amount of water supplied can meet the required demand. To achieve this we have first estimated the water demand and from this data determined supply.

	Demand (Litres/day/user)	Number of users	Approximate quantity of water demand (Litres/day)
Town Centre Commercial / Retail	125,000	1	125,000
Resort Precincts	390	860	336,000
Residential Precinct	680	540	367,000
Educational Precinct	4,000	1	4,000
Other Usage	10,000	1	10,000
TOTAL			842,000

Table 4-1 Estimated Daily Water Demand

The values in Table 4-1 are a maximum demand estimate. The values do not include any use of recycled water or the use of additional water saving devices, such as waterless urinals, in buildings. It has also been assumed that recycled water will be provided for fire fighting.

Commercial / Retail Usage Calculations

Restaurants
As most units are self-contained it is assumed that guests will dine once a day outside of their unit.

860 units x 2 guests per unit x 90% occupancy
= 1,548 guests/day x 1 meal x 60 L/day/meal
= 93,000 L/day

Staff 1240 staff x 20 L/day/person
= 25,000 L/day

Miscellaneous = 7,000 L/day

Educational Precinct Usage Calculations

Staff / Users 200 people x 20 L/day/person
= 4,000 L/day

Residential Usage Calculations

Preliminary estimates of the water consumption in residential and resort precincts are detailed in tables below.

	Litres/person/day	Residential 3 persons / dwelling	Resort 2 persons / unit
Kitchen	15	45	30
Bathroom	100	300	200
Toilet	20	60	40
Laundry	35	105	70
Total Indoor	170	510	340
Outdoor	145	435	190
TOTAL	315	945	530

Table 4-2 Residential and Unit Demand (no demand management)

	Litres/person/day	Residential 3 persons / dwelling	Resort 2 persons / unit
Kitchen	14	42	28
Bathroom	86	258	172
Toilet	12	36	24
Laundry	26	78	52
Total Indoor	138	414	276
Outdoor	88	264	114
TOTAL	226	678	390

Table 4-3 Residential and Unit Demand (with demand management)

	Litres/person/day	Residential 3 persons / dwelling	Resort 2 persons / unit
Kitchen	14	42	28
Bathroom	86	258	172
Toilet	0	0	0
Laundry	26	78	52
Total Indoor	126	378	252
Outdoor	0	0	0
TOTAL	126.0	378.0	252.0

Table 4-4 Residential and Unit Demand (demand management + recycled water)

Table 4-4 shows that demand management strategies and provision of recycled water provides a significant reduction in the water demand. Some possible demand management strategies are detailed in Section 4.2.2. For the purpose of being conservative with the preliminary demand calculations, the values of Table 4-3 have been used to determining the daily demand.

Other Usage Calculations

Swimming pool replenishment, etc. = 10,000 L/day

4.2.2 Reducing the demand on Potable Water

Significant reductions in the potable water demand can be achieved through the incorporation of demand management initiatives.

- Recycled water is to be supplied to all premises via a dual reticulation network, for toilet flushing and outdoor use. This will reduce the demand on the potable water supply from the rainwater tanks considerably. Recycled water will also be used for public open space irrigation and fire hydrant supply. Class A+ recycled water will be supplied from the on site sewage treatment plants;
- Encouraging residents to plant water sensitive and water efficient garden designs;
- Encouraging residents to use water efficient household appliances and fixtures for example:
  - The use of 3A (minimum) shower heads & taps,
  - The installation of 4A (minimum) clothes washers & dishwashers and discourage the use of garbage grinders, and
  - Installation of toilets that are ultra low flush (5A rating);
- Educating people on water wise behaviour;
- Pressure management by appropriate pump selection to limit the internal water pressure; and
- Managing demand through price control (top-up of rainwater tanks).

4.3 Water Supply

As detailed in Section 4.1 a number of water sources were investigated. Based on the fact that the Ella Bay region has a high annual rainfall, the collection of rainwater from building roofs is a viable source of water to supply the development.

To calculate the supply generated by rainwater collection, the development was broken down into elements (i.e. Town centre, resort precincts, residential precincts) for analysis of their individual requirements.

The methodology applied was to optimise an element's storage size so that it became self-sufficient for the majority of time. Doing this would reduce the probability of the storage needing supply from a backup system but would also allow overflow to a central storage it times of high rainwater capture.

An assumption of the available roof area was made and, based on current research by Gardner *et al.* (2004), a catch efficiency of 90% was used to make allowance for losses due to first flush devices. Using rainfall information from the Bureau of Meteorology (B.O.M.) and the assumed roof area, the volume of water captured per rain event was estimated. Using this information and rain event frequency information from the B.O.M a 'daily capture verus usage' graph was generated. By adjusting the different parameters of the graph and examining the 'supply verus demand' daily patterns we were able to estimate the optimal storage volume for rainwater tanks on each element.

As expected it was clearly determined that during the wet season months there is a surplus volume of rainwater but conversely during the dry season there is a deficit. To ensure a continuous supply to the development a central overflow storage is required to augment supply during the dry season.

Final storage tank sizes will be determined after a detailed rainwater tank modelling has been undertaking. A computer-modelling programme such as "Probabilistic Urban Rainwater Reuse Simulator (PURRS)" developed by Urban Water Cycle Solutions or "Aquacycle" will be used with appropriate rainfall data to size the rainwater tanks.

To reduce the demand on the rainwater system, recycled water will be supplied for toilet flushing, hose washdown, irrigation and fire fighting purposes.

What is the weather usually like?

- Climate Averages for Australian Sites -

Averages for INNISFAIL

Make sure you understand what the Climate Averages are all about before you make use of the following information. A comma separated text file of these averages is also available for download which can be graphed in software such as a spreadsheet

032025 INNISFAIL Commenced: 1881 Last record: 2004
Latitude:-17.5250 S Longitude: 146.0344 E Elevation: 8.0 m State: QLD

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	No. Yrs	%age comp
Mean Daily Max Temp (deg C)	30.8	30.6	29.8	28.3	26.4	24.5	24.1	25.1	26.7	28.4	29.7	30.8	27.9	95.5	99
Mean no. Days, Max >= 40.0 deg C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	47.2	99
Mean no. Days, Max >= 35.0 deg C	0.9	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	2.6	47.2	99
Mean no. Days, Max >= 30.0 deg C	20.3	16.0	12.3	2.9	0.4	0.0	0.0	0.0	0.5	3.2	9.5	17.6	82.7	47.2	99
Highest Max Temp (deg C)	40.1	38.8	37.8	34.2	31.2	29.4	30.0	30.4	32.2	35.6	38.8	40.3	40.3	47.3	100
Mean Daily Min Temp (deg C)	22.7	22.8	22.0	20.4	18.3	16.0	15.1	15.3	16.8	18.8	20.7	21.9	19.2	95.4	99
Mean no. Days, Min =< 2.0 deg C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.3	100
Mean no. Days, Min =< 0.0 deg C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.3	100

Lowest Min Temp (deg C)

17.2	18.0	17.2	10.5	9.4	6.5	6.2	8.2	10.1	12.2	16.0	17.2	6.2	47.3	99

Mean 9am Air Temp (deg C)

27.0	26.5	25.7	24.1	21.9	19.6	18.9	19.7	22.1	24.8	26.5	27.3	23.7	96.0	100

Mean 9am Wet-bulb Temp (deg C)

24.6	24.6	23.9	22.4	20.3	18.2	17.3	17.9	19.7	21.7	23.3	24.2	21.5	92.3	96

Mean 9am Dew Point Temp (deg C)

23.4	23.6	22.9	21.5	19.6	17.1	16.1	16.8	18.0	19.9	21.6	22.6	20.3	46.8	99

Mean 9am Relative Humidity (%)

82	85	85	86	87	86	86	83	78	75	75	76	82	62.8	94

Mean 9am Wind Speed (km/hr)

5.7	5.1	6.2	6.5	5.3	5.0	5.1	5.0	5.9	6.5	6.3	5.7	5.7	46.9	99

Mean 3pm Air Temp (deg C)

29.2	29.0	28.3	26.8	25.1	23.3	22.9	23.8	25.4	27.1	28.4	29.2	26.6	59.3	97

Mean 3pm Wet-bulb Temp (deg C)

25.4	25.6	24.7	23.3	21.6	19.7	19.1	19.8	20.9	22.5	23.9	25.0	22.6	56.2	91

Mean 3pm Dew Point Temp (deg C)

23.5	23.8	22.9	21.6	19.7	17.3	16.3	17.2	18.1	20.0	21.7	22.8	20.4	45.8	97

Mean 3pm Relative Humidity (%)

72	75	74	74	73	70	68	68	65	66	68	70	70	56.8	92

Mean 3pm Wind Speed (km/hr)

12.9	11.7	12.8	12.9	11.3	12.1	13.3	13.7	14.9	15.3	15.1	13.7	13.3	44.2	93

Mean Rainfall (mm)

506.5	597.6	659.1	466.3	301.4	188.6	133.0	119.1	86.1	83.0	155.7	262.8	3559.1	109.7	89

Median (Decile 5) Rainfall (mm)

_ 452.8	503.9	622.9	407.2	263.0	161.5	112.8	97.5	63.8	59.6	106.3	178.1	3505.0	109	

Decile 9 Rainfall (mm)

_ 1009.0	1054.8	1140.7	794.5	556.3	387.1	227.7	239.0	220.0	183.2	367.9	573.3	4776.6	109	

Decile 1 Rainfall (mm)

_ 135.3	262.0	213.1	154.7	91.4	41.2	35.0	20.6	3.1	5.6	16.6	39.1	2510.4	109	

Mean no. of Raindays

16.4	17.1	19.4	18.8	16.8	13.0	11.8	10.5	8.6	7.8	9.8	12.1	162.2	103.4	88

Highest Monthly Rainfall (mm)

1581.6	1515.2	1650.5	1652.5	1063.0	527.4	505.7	536.0	426.2	461.5	997.2	1303.6		109.7	89

Lowest Monthly Rainfall (mm)

20.6	59.8	87.4	31.0	13.8	9.9	4.8	0.0	0.0	0.0	0.0	9.8		109.7	89

Highest Recorded Daily Rain (mm)

531.1	435.1	394.5	520.7	214.4	203.2	92.5	310.0	161.0	342.1	336.2	539.0	539.0	103.0	88

Mean no. of Clear Days

3.9	2.6	3.3	3.9	5.0	6.6	8.0	9.1	10.5	10.3	6.8	5.5	75.6	47.4 100

Mean no. of Cloudy Days

15.9	17.2	17.1	16.8	16.4	13.4	12.7	10.8	7.7	6.6	9.1	11.1	154.7	47.4 100

Last modified 16 August 2004

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ESTIMATED HOUSE WATER DEMAND

Conservative no demand management

	Litres/person/day	House hold 3 persons	Units / 2 persons
Kitchen	15	45	30
Bathroom	100	300	200
Toilet	20.0	60	40
Laundry	36.0	108	72
Total Indoor	171	513	342
Outdoor	145	435	188.5
TOTAL	316.0	948.0	530.5

With demand management

(with water saving appliances and low flush toilets)

	Litres/person/day	House hold 3 persons	Units / 2 persons
Kitchen	14	42	28
Bathroom	86	258	172
Toilet	12.0	36	24
Laundry	26.0	78	52
Total Indoor	138	414	276
Outdoor	88	264	114.4
TOTAL	226.0	678.0	390.4

With demand management and recycled water

(with water saving appliances and recycled water used for flush toilets and outdoor use)

	Litres/person/day	House hold 3 persons	Units / 2 persons
Kitchen	14	42	28
Bathroom	86	258	172
Toilet	0.0	0	0
Laundry	26.0	78	52
Total Indoor	126	378	252
Outdoor	0	0	0
TOTAL	126.0	378.0	252.0

WATER CAPTURE AND DEMAND FOR HOUSES

Month	Mean Rainfall (mm)	Percentage of rain days per month	Average Rainfall per rain day (mm)	Roof area per house (m2)	Quantity of roofwater per rain day(litres)	Loss rate	Roofwater Caputured per rain day (litres)	Estimated usage per person per day (litres)	Estimated persons per house	Estimated usage per house per day (litres)
January	455.9	52.9	27.8	120	3,335	10%	3,002	130	3	390
Feburary	537.8	61.1	31.5	120	3,774	10%	3,397	130	3	390
March	593.2	62.6	30.6	120	3,669	10%	3,302	130	3	390
April	419.7	62.7	22.3	120	2,679	10%	2,411	130	3	390
May	271.3	54.2	16.1	120	1,938	10%	1,744	130	3	390
June	169.7	43.3	13.1	120	1,567	10%	1,410	130	3	390
July	119.7	38.1	10.1	120	1,217	10%	1,096	130	3	390
August	107.1	33.9	10.2	120	1,224	10%	1,102	130	3	390
September	77.5	28.7	9.0	120	1,081	10%	973	130	3	390
October	74.7	25.2	9.6	120	1,149	10%	1,034	130	3	390
November	140.1	32.7	14.3	120	1,716	10%	1,544	130	3	390
December	236.5	39.0	19.5	120	2,346	10%	2,111	130	3	390

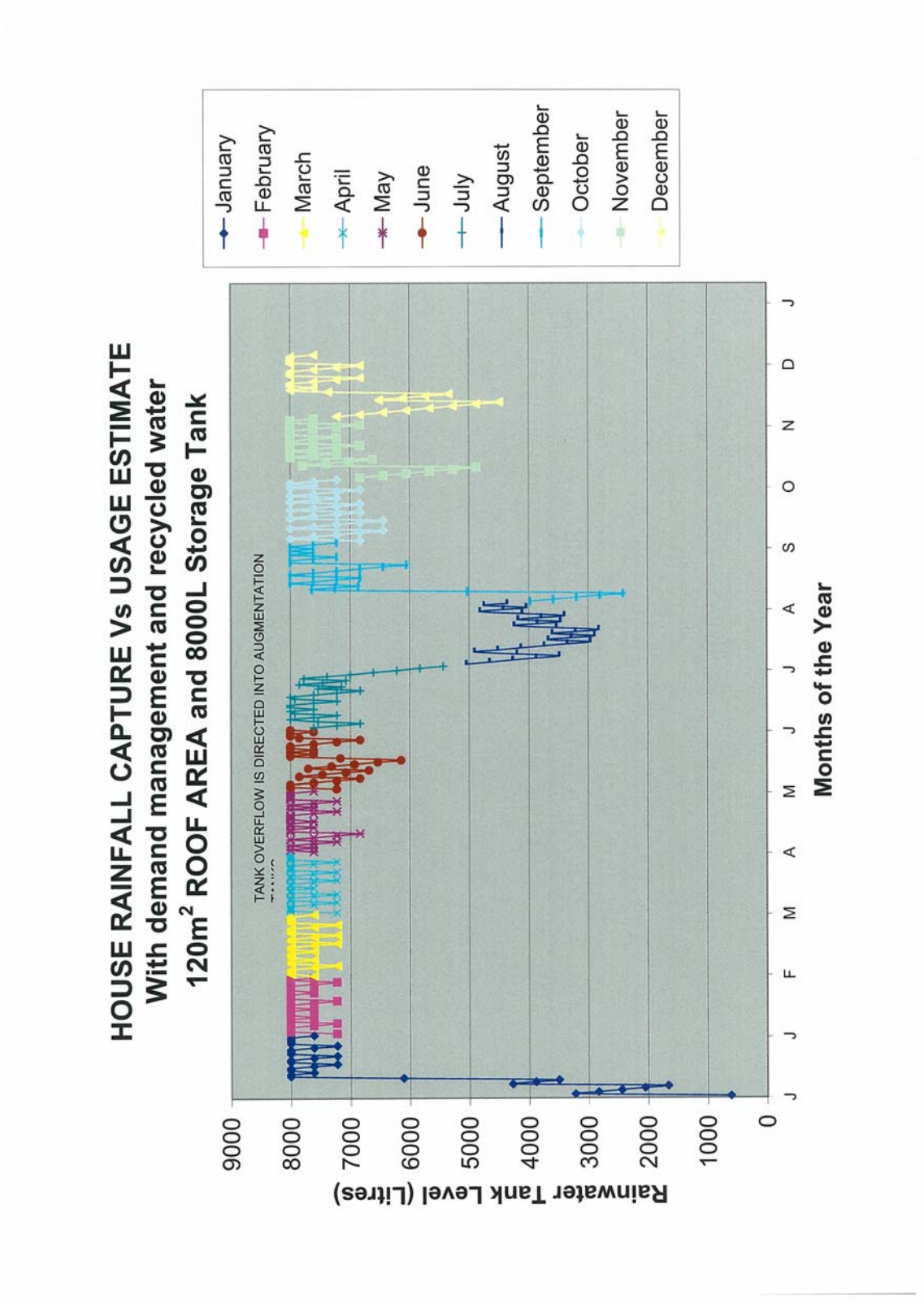

Figure 4-2 Rainwater Capture Vs Usage Graph - Residential

WATER DEMAND RESORT VILLAS

		UNITS	Usage/day/person	Litres/person/day
Average shower AAA rated	90	*9L/min for 10min.*	1.5	135
Toilet flush *half*	3	*L per Flush*	2	6
full	6	*L per Flush*	1	6
Bath Tub *1/2 to 3/4 full*	150	*L per Bath*	0.50	75.0
Washing Machine	0	*L per Load*	0.29	0.0
Dishwasher	0	*L per Load*	0.29	0
Dripping Tap	10	*L per day*	0.33	3.3
Hand basin	4	*L per uses*	6	24
Drinking Cooking Cleaning	15	*L per day*	2	30
Pool top up	20	*L per day*	1	20
TOTAL				299.3

WATER CAPTURE AND DEMAND FOR 18 UNIT APARTMENT BLOCK

Month	Mean Rainfall (mm)	Percentage of rain days per month	Average Rainfall per rain day (mm)	Roof area per house (m2)	Quantity of roofwater per rain day(litres)	Loss rate	Roofwater Caputured per rain day (litres)	Estimated usage per person per day (litres)	Estimated persons per Apartment block with 18 units with occupancy rate of 80%	Estimated usage per house per day (litres)
January	455.9	52.9	27.8	10000	277,957	10%	250,162	126	32	4,032
Feburary	537.8	61.1	31.5	10000	314,526	10%	283,074	126	32	4,032
March	593.2	62.6	30.6	10000	305,768	10%	275,191	126	32	4,032
April	419.7	62.7	22.3	10000	223,229	10%	200,906	126	32	4,032
May	271.3	54.2	16.1	10000	161,464	10%	145,318	126	32	4,032
June	169.7	43.3	13.1	10000	130,569	10%	117,512	126	32	4,032
July	119.7	38.1	10.1	10000	101,441	10%	91,297	126	32	4,032
August	107.1	33.9	10.2	10000	102,000	10%	91,800	126	32	4,032
September	77.5	28.7	9.0	10000	90,105	10%	81,094	126	32	4,032
October	74.7	25.2	9.6	10000	95,769	10%	86,192	126	32	4,032
November	140.1	32.7	14.3	10000	142,990	10%	128,691	126	32	4,032
December	236.5	39.0	19.5	10000	195,471	10%	175,924	126	32	4,032

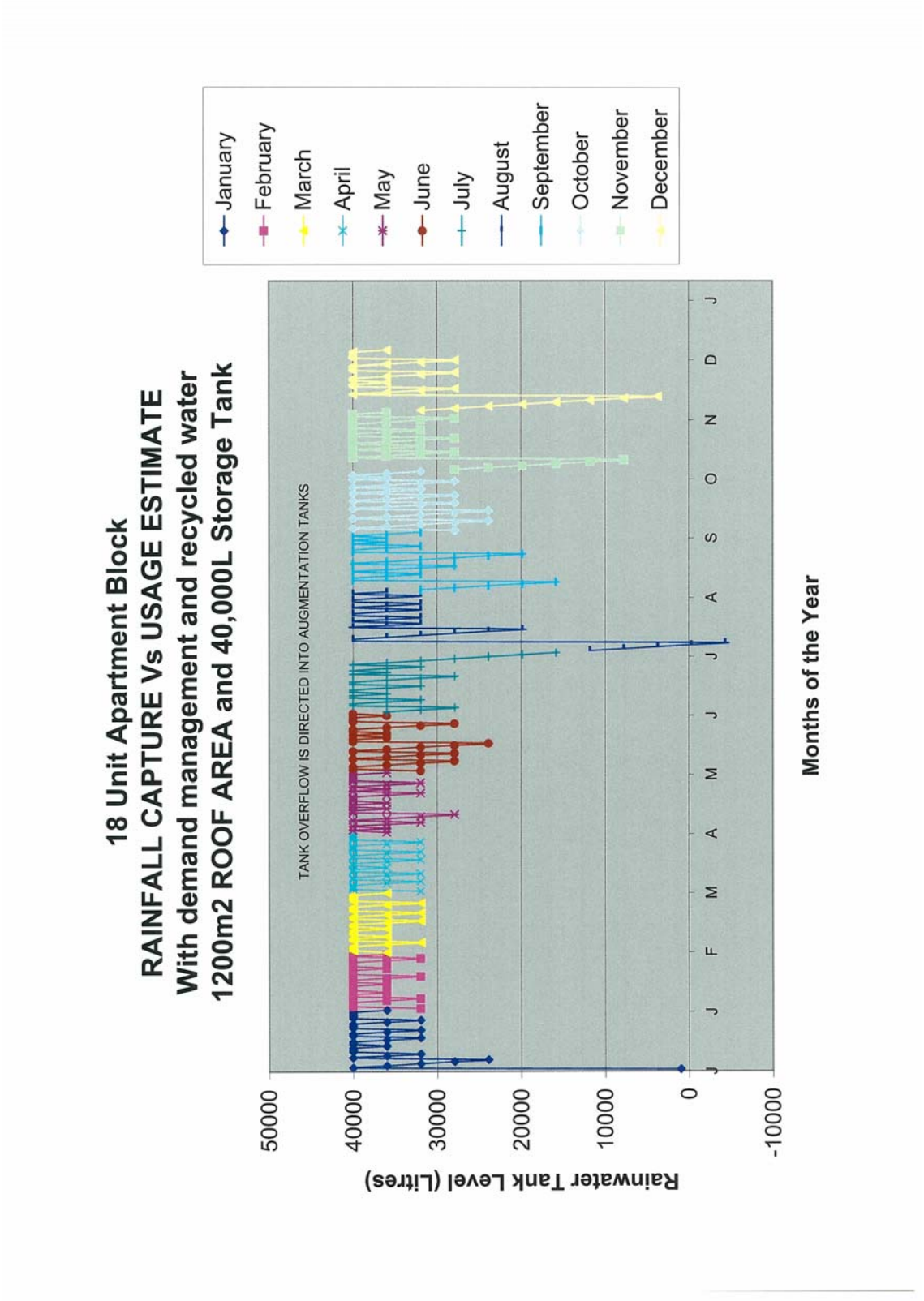

Figure 4-3 Rainwater Capture Vs Usage Graph – Multi Unit Resort Building

WATER CAPTURE AND DEMAND FOR 2 UNIT RESORT VILLAS

Month	Mean Rainfall (mm)	Percentage of rain days per month	Average Rainfall per rain day (mm)	Roof area per 2 Unit Villa (m2)	Quantity of roofwater per rain day(litres)	Loss rate	Roofwater Caputured per rain day (litres)	Estimated usage per person per day (litres)	Estimated persons per 2 Unit Villa 80% Occupancy	Estimated usage per 2 Unit Villa per day (litres)
January	506.5	52.9	30.9	240	7,412	10%	6,671	300	3.2	960
Feburary	597.6	61.1	34.9	240	8,387	10%	7,549	300	3.2	960
March	659.1	62.6	34.0	240	8,154	10%	7,338	300	3.2	960
April	466.3	62.7	24.8	240	5,953	10%	5,357	300	3.2	960
May	301.4	54.2	17.9	240	4,306	10%	3,875	300	3.2	960
June	188.6	43.3	14.5	240	3,482	10%	3,134	300	3.2	960
July	133.0	38.1	11.3	240	2,705	10%	2,435	300	3.2	960
August	119.0	33.9	11.3	240	2,720	10%	2,448	300	3.2	960
September	86.1	28.7	10.0	240	2,403	10%	2,163	300	3.2	960
October	83.0	25.2	10.6	240	2,554	10%	2,298	300	3.2	960
November	155.7	32.7	15.9	240	3,813	10%	3,432	300	3.2	960
December	262.8	39.0	21.7	240	5,213	10%	4,691	300	3.2	960

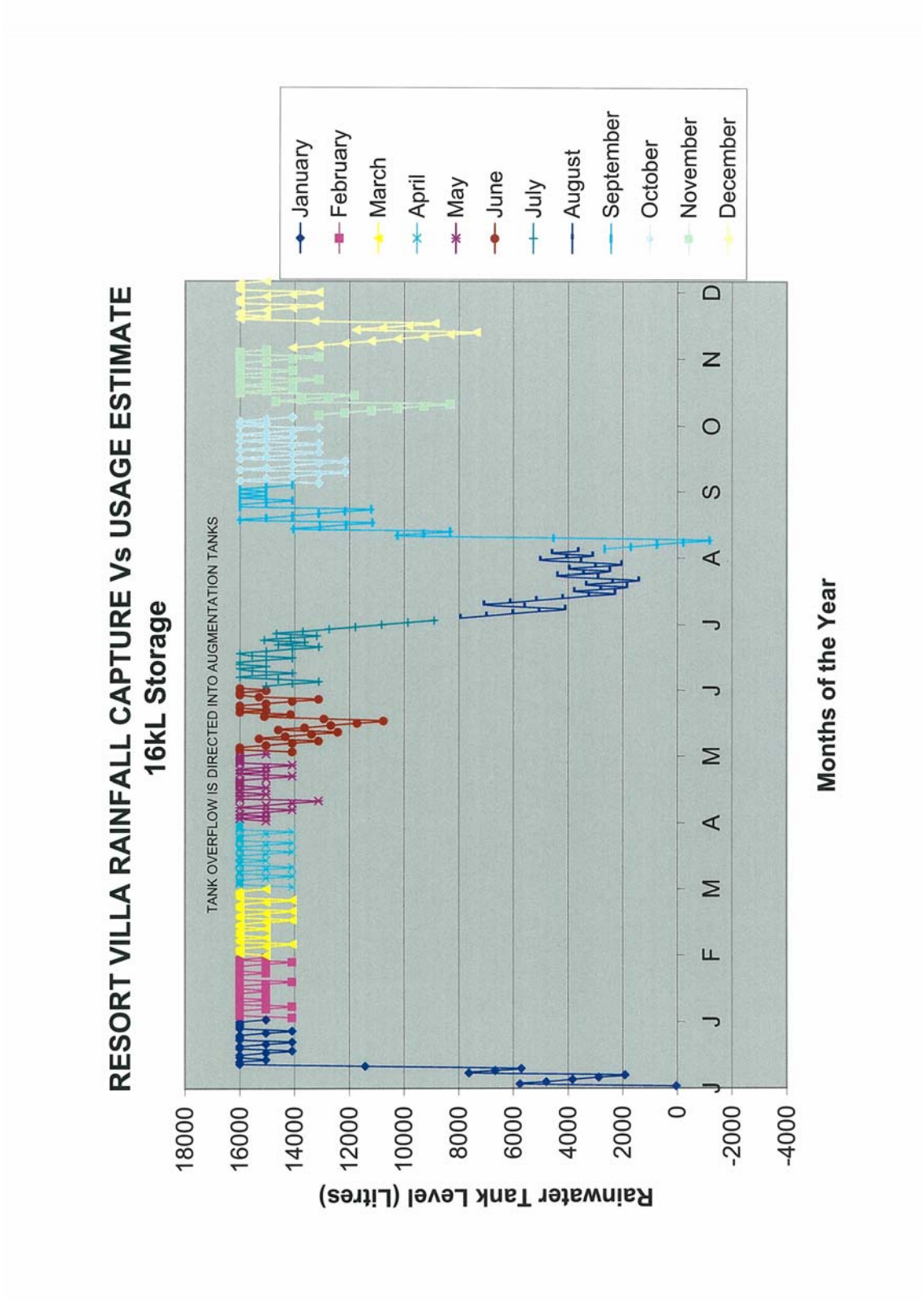

Figure 4-4 **Rainwater Capture Vs Usage Graph – 2 Unit Resort Building**

4.4 Collection and Augmentation Network

The schematic diagram of the collection system is shown in Figure 4-5.

The rainwater is stored in a tank close to the source and demand location (ie. each dwelling, unit, villa, etc). The effective collection of roof water requires a number of screenings and a first flush diverter to ensure leaf matter; etc does not affect water quality. On going maintenance of this system involves cleaning of the screens and filters on a regular basis or after rain events and is vital to minimise the load of contaminants entering the tank.

The proposed systems have the same initial screening process:

- Gutter mesh (4mm mesh)
- Down pipe filter (to remove particles over 550 microns)
- First flush divertor (to remove water borne pollutants)
- Inlet screens on tanks
- Mosquito control and backflow prevention devices

At the supply end of the system it is proposed that a water filter be used to ensure clean water is supplied to indoors. These filters can be cotton, carbon or UV treatment. Where there is a concern about rainwater quality, UV light sterilisation or other disinfection systems can be added to rainwater tanks to ensure a high quality potable water supply is maintained. A rainwater tank health check scheme to maintain quality will be considered and could be under taken by the service company on a regular basis.

Any overflow is taken to a centralised augmentation tank from where the augmentation reticulation network can replenish supply when required. The augmentation system operates via a float switch at each rainwater tank. The reticulation main can be constructed using pressure polypipe (PN12 or similar) and because of the pipes flexibility and ease of construction, this provides many advantages.

All buildings will be designed with consideration to the incorporation of rainwater tanks and in areas of higher user density (eg. Town Centre, resort precincts, school, etc.) consideration will be given to the provision of shared tanks.

A separate recycled water reticulation network will be installed through out the development. This network will deliver recycled water for toilet flushing, irrigation and fire fighting purposes.

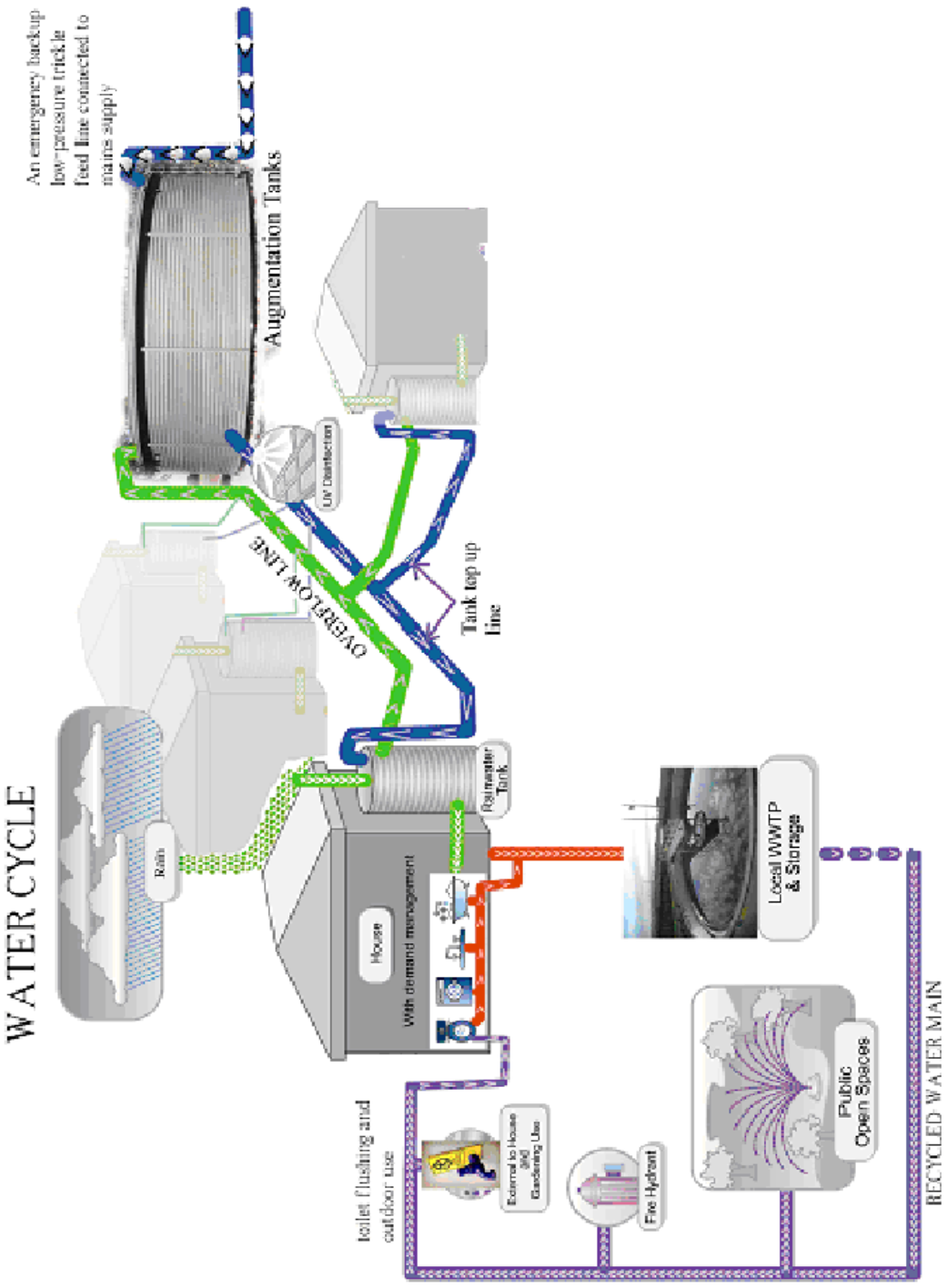

Figure 4-5 Schematic Water Supply System

Figure 4-6 Water Supply System Network Plan

4.4.1 Emergency Supply

An emergency backup main will be constructed along Ella Bay Road and connected into the reticulation network at Flying Fish Point. This main will supply the augmentation storage tank in an extreme situation. As a secondary emergency supply option the service company could organise for water to be delivered by road in a tanker.

4.4.2 Construction Water Demand

Temporary water storage tanks will be used to supply the water need during construction. These storage tanks will be supplied with water imported to site by tankers and roofwater collected from temporary buildings. A possible alternative supply could be drawn from the groundwater via a bore if a hydro geological investigation is favourable to this.

5 Infrastructure - Stormwater Drainage

TOR - 3.5.4 Stormwater drainage

A description should be provided of the proposed stormwater drainage system and the proposed disposal arrangements, including any off-site services. A Stormwater Management Plan should be prepared for the site.

5.1 Vision

The stormwater drainage system will be designed using best practice engineering based on the principles of Water Sensitive Urban Design (WSUD). This will incorporate elements to manage not only the quantity of storm water runoff but also provide quality treatment to ensure that the development has no negative impacts on receiving waters. Where possible natural drainage paths within the development will be kept or enhanced.

Development increases impermeable surfaces and subsequently can create problems within the original environment as the stormwater runoff increases. Stormwater management methods are more affective when applied close to the runoff source. By keeping the natural drainage paths and then incorporating elements near the flow paths, there exists an opportunity to combine landscaping outcome and water quality management. This approach promotes soil conservation and reduces nutrient transfer.

5.2 Stormwater Management Plan

5.2.1 Stormwater Quantity

The stormwater system will be designed so that stormwater discharge from the development will not exceed pre-development flow levels. This will be achieved through hydraulic calculations of the major and minor storm events for both pre-developed and post developed scenarios and detention/retention of additional stormwater flow. The final stormwater system is to be determined during the detailed design phase.

5.2.2 Stormwater Quality

The quality of stormwater runoff and its effects on the environment has in recent years been the focus of much research and subsequently this has caused the development industry to change the approach taken when managing stormwater. Water Sensitive Urban Design (WSUD) is now common practice as designers try to incorporate water quality treatment devices into the stormwater system. WSUD requirements have varied from location to location and recently in an attempt to standardise practices Engineers Australia released in 2006 a design guide “Australian Runoff Quality”.

The quality of the stormwater runoff is important and the nutrient levels of the runoff will need to meet both the EPA and GBRMPA quality requirements. To achieve these quality requirements a detailed stormwater design will need to be undertaken to determine which water quality treatment devices are required and their location. Each sub-catchment, lot, local and regional scale options will be modeled in the detail design phase of the project to get an optimised water quality treatment train. In order to assess pollutant loads, a computer modeling program such as MUSIC (Model for Urban Stormwater Improvement Conceptualisation) will be used for the development. This section of the report examines at a conceptual design level what treatment train needs to be incorporated into the design of the stormwater system to ensure water quality objectives are achieved.

The main pollutants typically generated by the proposed development are listed below.

Construction Phase:

- Litter from construction packaging, paper, food packaging, off cuts, etc;
- Sediment from erosion of exposed soils and stockpiles;
- Hydrocarbons - from fuel and oil spills, leaks from construction equipment;
- Toxic Materials - cement slurry, solvents, cleaning agents, wash waters;
- pH altering substances - cement slurry, wash waters.

Operations Phase:

- Litter – paper;
- Sediment - from erosion of exposed soils and stockpiles on house sites;
- Oxygen demanding substances - organic matter;
- Nutrients - from fertilisers;

5.2.2.1 Treatment Options Investigated

There are numerous methods of conveying the increase in stormwater runoff and removing pollutants within the stormwater to ensure any impacts on the environment are minimised. Some of the techniques that will be implemented within the development are listed below.

- Installation of roof water tanks will not only provide a source of potable water but also significantly reduce the impact of the development on the environment.

- Porous paving can be used at all opportunities for paved areas such as driveways, outdoor entertaining areas, etc. to enable stormwater in infiltrate faster into the ground.
- Gross pollutant traps to capture the larger pollutants carried by stormwater.
- Street based swales and or bio-retention systems in local streets and as a feature on the major boulevard type approach roads will be used as primary treatment devices. All streets within the development could have a swale and bio-retention system incorporated into their design these will only be required on one side of each street. The swale system is designed to carry out primary and/or secondary treatment processes of stormwater treatment and retard flows. This retention or retardation of the flow of stormwater can enable sediments to precipitate out of the water taking along with it some pollutants.
- Lot Scale elements such as roof water tanks, “rain garden” areas that allow infiltration of stormwater into the soil and porous paving.
- Development of an education and awareness program to inform residents of how to maintain water quality devices and their importance within the water cycle should be undertaken.
- On a regional scale, gross pollutant traps, infiltration basins, wetlands and regional bio retention. These regional size treatment and flow attenuation devices can be incorporated into the proposed golf course and other landscaped areas.
- The use of underground systems such as underground permeable chambers;

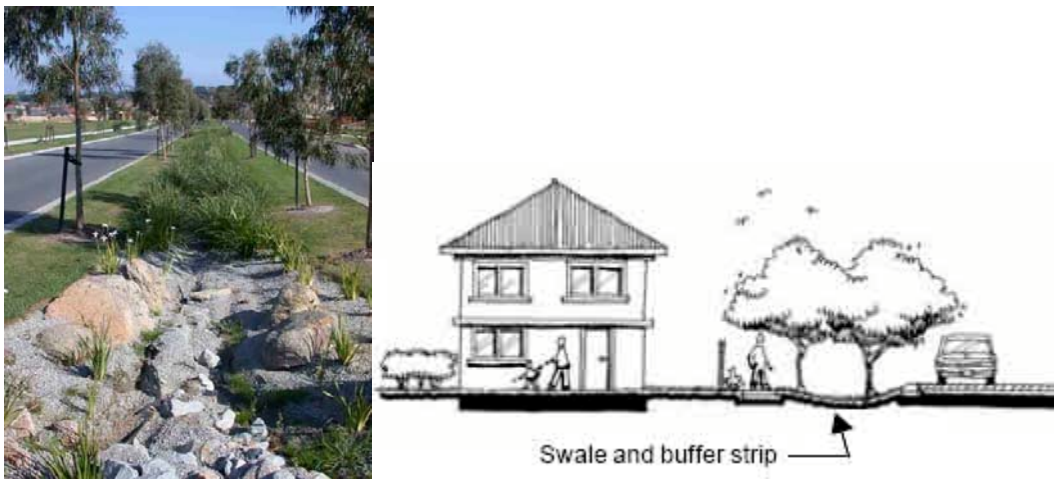

Figure 5-1 Typical stormwater swale

5.2.2.2 Stormwater Quality Policy

Purpose:	
Element	To maintain or enhance pre-development water quality and natural vegetation during the construction and operation of the development. Compliance with this objective is to meet requirements set out in the *Environmental Protection Act* (1994) the *Environmental Protection (Water) Policy* (1997) and Guideline on Identifying and Applying Water Quality Objectives. And the Great Barrier Marine Park Water Authorities requirements.
Policy	The Principal Contractor is to be made aware of the requirements with respect to water quality within the *Environmental Protection Act* (1994) and the *Environmental Protection (Water) Policy* (1997) at the time of tendering. The Principal Contractor is to implement the measures for *Erosion and Sediment Control* to reduce contaminants entering the waterway system. Refer to the *Erosion and Sediment Control* section for full details.
Performance Indicators	Measured levels for water quality indicators shall fall within the value range as set out in the EPA and GBMPA guidelines. In addition the measured levels shall not exceed the baseline levels by more than 10% during the construction period and the measured levels shall not exceed the baseline levels during the maintenance period.
Monitoring	Monitoring frequency shall be in accordance with industry standards. In addition, visual inspections will be performed periodically, but at no less than fortnightly intervals, during the construction and maintenance period and during seasons of traditionally low rainfall (autumn, winter). Visual inspections performed periodically, but at no less than weekly intervals during the construction and maintenance period and during seasons of traditionally high rainfall (spring, summer). Undertake tests after any significant rainfall in any 24-hour period. A significant rainfall event is defined as rainfall of more than 20mm as measured by the Bureau of Meteorology at the nearest rain gauging station.
Reporting	The Development Manager shall receive the results of any testing and analysis conducted by the testing authority. Comparison of results with the baseline measurements shall be undertaken and the comparison results and recommendations reported on a monthly basis along with production of an annual report that will summarise the results for the year and identify any trends.
Corrective Action	Identify the reasons for the deterioration of water quality and determine if it is linked to construction activities. If construction activities are responsible, then isolate the specific cause and determine the best method to prevent the incident from occurring again. The work practice causing the pollution is to cease immediately and clean-up operations to commence immediately and to be completed within 5 working days. If other sources are responsible, then notify the Local Authority of the situation for their action.

5.2.2.3 Erosion and Sedimentation Management

Purpose:	
Element	To minimise the adverse impact on the quality of the environment by: • Minimising the potential of on-site erosion; and • Controlling the off-site deposition of sediment, In accordance with the requirements of the Environmental Protection Policy (Water) 1997 and the EPA and GBMPA's Erosion and Sediment Control Standard.
Policy	These objectives will be achieved by the implementation of an Erosion and Sediment Control Program during the construction phase of the development.
Performance Requirements	The preparation of an Erosion and Sediment Control Program will be the responsibility of the construction contractor or the consulting engineers for the development. The program will consist of the following elements: • The characteristics of the site will be investigated including a soils investigation to determine soil characteristics as they apply to soil erosion and sediment control; • The exitent of proposed drainage patterns will be determined; • Areas suitable for stockpiling soil and construction materials will be identified; • The need for temporary erosion control devices will be assessed and suitable devices selected; • Medium and long term measures to rehabilitate and stabilise the site will be formulated; • Preparation of erosion and sediment control plans as required by Council's Subdivision Approval. The control plans will be designed in accordance with: o ESC Standard, EPA and GBMPA o Design of sediment basins, EPA and GBMPA o Soil Erosion and Control, Engineering Guidelines for Queensland Sites, Institute of Engineers The control plans will incorporate the following: • Design details of structures; • A program for implementation and phasing of erosion control activities; and • An on going program detailing maintenance and servicing requirements of control structures. This document will be dynamic and as such will be subject to scrutiny and revision as the development progresses.
Performance Requirements	The following indicators are used to gauge the implementation and effectiveness of the Erosion and Sediment Control Plan (ESCP) process: Construction Phase • Installation of temporary erosion and sediment control devices in accordance with contract documentation and a council approved ESCP to this site; • Maintenance of temporary erosion and sediment control devices; • Minimal evidence of erosion after significant rainfall; • Capture of sediment within devices after significant rainfall; and • Measured levels for water quality in the area below the flood line within acceptable levels. • Compliance with EPA and GBMPA's ESC standard.

	Maintenance Phase • Installation of temporary and permanent erosion and sediment control devices prior to the establishment of ground cover in accordance with the contract documentation and the approved ESCP; • Maintenance of temporary and permanent erosion and sediment control devices; • Minimal evidence of erosion after significant rainfall; • Capture of sedimentation within devices after significant rainfall; • The presence and maintenance of grass strike and turfed areas; and • Measured levels for water quality in the area below the flood line within acceptable levels. • Compliance with EPA and GBMPA's ESC standard. Post Maintenance • Maintenance of permanent sedimentation control devices; • Negligible erosion after significant rainfall; • Capture of sediment within devices after significant rainfall; • Maintenance of grass strike and turfed areas; and • Measured levels for water quality in the area below the flood line within acceptable levels.
Monitoring	The monitoring of erosion and sediment control processes will be a periodical visual inspection by consulting engineer and/or the Principal Contractor but at no less than weekly intervals during the construction and maintenance periods.
Reporting	The consulting engineer will: • During periodic site inspections ensure that all erosion and sediment controls are installed and maintained in accordance with the Contract Documents; EPA AND GBMPA City Council's Erosion and Sediment Control Standard and the approved ESCP. • Instruct the Principal Contractor to install additional measures to prevent erosion as determined necessary during periodic site inspections; and • Liaise with EPA and GBMPA's inspection officer during the construction and maintenance periods. • Liaise with EPA and GBMPA's Erosion and Sediment Control Standard Officer.
Corrective Action	The superintendent in consultation with the Principal Contractor is to determine the source and the reason for the erosion and/or sedimentation and: • Implement measures to prevent further erosion occurring; and/or • Locate the source of the sediment entering the system and implement measures to prevent further ingress of sediment to the system; and • Where practicable remove the sediment deposited in the system.

5.2.2.4 LIFECYCLE COST ASSESSMENT

The developer will fund the initial capital cost of a system to convey and treat stormwater runoff. The lifecycle of the management options outlined in Section 5.2.2.3 can be stated as relatively long. This is due to the use of structural devices with long design life and natural systems that are self-regulating. Maintenance costs associated with such management options will be high in the early stages of the life cycle but as the developed area stabilises the costs will decrease. Due to the long life of the devices it can be stated that a very low lifecycle cost will be achieved. The management / services company will carry out all maintenance of the proposed devices.

5.2.2.5 WATER QUALITY MONITORING PROGRAM

A water quality-monitoring program may be required for the site under the conditions imposed by the Development Permit. Below is a conceptual phase monitoring program that will be updated to a detailed design level with each stage of the development.

Objective / Target	To maintain or enhance pre-development water quality and natural vegetation during the construction and maintenance period. Compliance with this objective is to meet requirements set out in the *Environmental Protection Act (1994)*, the *Environmental Protection (Water) Policy (1997)* and the *Ipswich City Council Engineering Manual*.
Management Strategy	*During construction* To reduce the amount of contaminants entering the waterway system by using best practices. Refer to the Sediment and Erosion Control Plan. Retention of existing vegetation along the waterway corridor (where applicable) with the early establishment of landscaping and rehabilitation work to minimise the potential mobilisation of contaminants. *Post construction and during the Maintenance Period* Regular inspection of the works to ensure flora is establishing, contaminants are being removed and that the system's ecological health is of an acceptable quality.
Tasks / Actions	During construction the Principal Contractor is to • Be made aware of the requirements regarding the water quality issues on the site. • Implement the measures and methodology detailed in the Erosion and Sediment Control Plan to reduce contaminants entering the waterway system. • Perform monitoring of the quality of water based on rainfall events or discharge requirements using hand sampling and visual assessment techniques. • Complete landscape and rehabilitation works as required during the construction phase to ensure protection of sensitive areas. During the maintenance period perform monitoring of the quality of water based on rainfall events or periodic inspection, using hand sampling and visual assessment techniques.

Performance Indicators	Capture of sediment and litter in the Sediment and Erosion control devices. Visual indicators of the efficient removal of nutrients such as nitrogen and phosphorus. Such indicators include growth of flora, fauna within the area, an ecological health assessment, etc.
Frequency / Deadline	Visual inspections shall be performed periodically, but at no less than weekly intervals during the construction period, monthly during the maintenance period and after any significant rainfall in any 24-hour period.
Responsible Party	During the construction phase of the development the Principal Contractor is responsible for maintaining the quality improvement devices and strategies. The Superintendents for civil works and landscape works will be responsible for carrying out visual inspections and ordering any corrective action required. The Principal Contractor will notify the Superintendents if any changes occur in the conditions on site so that inspections can be carried out. During the maintenance period of the development the Superintendents will carry out inspections and order any corrective action required.
Reporting and Review	*During construction* Site notes will be made of any inspections / tests carried out. A copy of these notes can be supplied to the Council Inspection Officer as requested. All works will be inspected by Council Inspection Officer's prior to acceptance "On Maintenance" to ensure the Objective / Target is being achieved and that the Performance Indicators are in place. *During the Maintenance Period* Site notes will be made of any inspections / tests carried out. A copy of these notes can be supplied to the Council Inspection Officer as requested at time of "Off Maintenance". All works will be inspected by Council Inspection Officer's prior to acceptance "Off Maintenance" to ensure the Objective / Target has been achieved.
Corrective Action	Identify the reasons for the deterioration of water quality and determine if it is linked to construction activities. If construction activities are responsible, then isolate the specific cause and determine the best method to prevent the incident from occurring again. The work practice causing the pollution is to cease immediately and clean-up operations to commence immediately and to be completed within 5 working days. If other sources are responsible, then notify the Local Authority of the situation for their action.

5.2.2.6 MAINTENANCE PLANS

The services / management company will maintain the drainage system and water quality treatment devices as required. Below are typical maintenance plans for different stormwater quality elements. The schedule is a guideline only. Routine clean out should be scheduled based on the outcome of routine inspection and/or manufacturers guidelines

GROSS POLLUTANT TRAPS

SCHEDULE OF SITE VISITS													
Purpose of Visit	Frequency	J	F	M	A	M	J	J	A	S	O	N	D
Routine inspection	Half /year	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Annual inspection	1/year				✔								
Routine maintenance	4/year		✔		✔				✔				✔
Routine clean out of sediment	1 year				✔								

INSPECTION	
1.	**Routine Inspection**
1.1	. Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when cleanout of the GPT is required.
1.2	The depth of sediment/gross pollutant in the GPT should be measured according to design specifications.
1.3	Complete an appropriate Maintenance Form. Routine cleanout of sediment/gross pollutants should be scheduled when the depth of sediment/gross pollutants in the GPT exceed design levels.
2.	**Annual Inspection**
2.1	Once a year, the condition of the GPTs should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.
ROUTINE MAINTENANCE	
1.	**Purpose**
1.1	Routine maintenance of the GPT involves weed control and the collection of any gross pollutants, if required.
2.	**Weed Management**
2.1	If weeds have been observed during the routine inspection, these weeds should be removed by the GPT. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roost when the weeds are less than 3 months old; otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used, as they would contaminate the water in the creek.
2.4	The weeds should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.0	Gross Pollutant Management
3.1	Remove and dispose of gross pollutants that may be visible around the GPT perimeter.
CLEAN OUT OF SEDIMENT	
1.	**Set up and Prepare Site for Cleanout**
1.1	Notify adjacent residents of cleanout at least three days prior to date of cleanout.
1.2	Setup equipment onsite including pump.
2.	**Cleanout of Sediment**
21.	The preferred method of cleanout of the GPT is by using equipment as specified by the GPT designer.

2.2	Position the equipment on the side of the GPT to allow easy access into the sediment area and transfer of material into adjacent tipper truck/ disposal bins etc. The truck should be positioned so that water from the truck body drains into the GPT.
2.3	Drain waste in the truck thoroughly before proceeding to the disposal point.

EXTENDED DETENTION BASINS

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	Half /year	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Annual inspection	1/year			✔									
Routine maintenance	2/year	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Clean out of sediment	5 year			✔									

INSPECTION	
1.	**Routine Inspection**
1.1	Routine inspection should be carried out, as a minimum, on a regular monthly basis. The purpose of the inspection is to indicate when maintenance of the extended detention basin is required.
1.2	Inspections should consider erosion sediment deposition, condition of vegetation, ponded water.
1.3	Complete appropriate Maintenance Form. Maintenance is required if: · Excessive erosion has occurred · Excessive sediment deposition has occurred · Vegetation is over grown · Water is ponding for excessively long periods of time.
2.	**Annual Inspection**
2.1	Once a year, the condition of the extended detention basin should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.

ROUTINE MAINTENANCE	
1.	Purpose
1.1	Routine maintenance of the extended detention basin involves weed control and the collection of any litter, removal of dead or diseased vegetation (eg. Reeds), and mowing of embankments.
2.	**Weed Management**
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the extended detention basin. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old; otherwise weeds infestation rapidly occurs and is difficult to control.
2.3	Herbicides should not be used as they may contaminate the water in the orchid habitat.
2.4	The weeds should be disposed of appropriately.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.0	Litter Management
3.1	Remove and dispose of litter that may be visible around the extended detention system.

4.	Dead or Diseased Vegetation
1.4	Remove or dispose of any dead or diseased vegetation within system
5.	Mowing of Embankments

5.1	Mowing will be required to maintain grass at reasonable levels.
CLEANOUT OF SEDIMENT	
1.	Setup and Prepare Site for Cleanout
1.1	Notify necessary parties at least three days prior to date of cleanout
1.2	Setup equipment onsite.
2.	Cleanout of Sediment
2.1	The preferred method of cleanout of the extended detention basin is removing the clogged medium.
2.2	Position the equipment on the side of the system to allow easy access into the extended detention basin and transfer of material into adjacent tipper truck/ disposal bins etc.
2.3	Remove waste in a truck at an appropriate disposal point.

BIO RETENTION SYSTEMS

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	Half /year	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Annual inspection	1/year				✔								
Routine maintenance	2/year				✔						✔		
Routine clean out of sediment	1/2 year				✔								

INSPECTION	
1.	Routine Inspection
1.1	Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when maintenance of the Bio retention system is required.
1.2	Inspections should consider erosion, condition of vegetation, ponded water.
1.3	Complete appropriate Maintenance Form. Maintenance is required if failure of the above sediment.
2.	Annual Inspection
2.1	Once a year, the condition of the bio retention system should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action.
ROUTINE MAINTENANCE	
1.	Purpose
1.1	Routine maintenance of the bio retention system involves weed control and the collection of any litter, removal of dead or diseased vegetation, and mulch replacement.
2.	Weed Management
2.1	If weeds have been observed during routine inspection, these weeds should be removed from the bio retention system. Weeding generally involves manual removal of perennial species.
2.2	The aim is to remove the weed including the roots when the weeds are less than 3 months old; otherwise weeds infestation rapidly occurs and is difficult to control.

2.3	Herbicides should not be used, as they would contaminate the water in the creek.
2.4	The weed should be disposed offsite at appropriate waste management facility.
2.5	Replant appropriate plant species, where necessary, in areas that have been extensively weeded.
3.	**Litter Management**
3.1	Remove and dispose of litter that may be visible around the bio retention system.
4.	**Dead or Diseased Vegetation**
4.1	Remove or dispose of any dead or diseased vegetation within system
5.	**Mulch Replacement**
5.1	Mulch replacement is recommended when erosion is evident or system looks unattractive.
CLEANOUT OF SEDIMENT	
1.	**Setup and Prepare site for Cleanout**
1.1	Notify adjacent residents at least three days prior to date of cleanout.
1.2	Setup equipment onsite
2.	Cleanout of Sediment
2.1	The preferred method of cleanout of the bio retention system is replacing the clogged medium.
2.2	Position the equipment on the side of the system to allow easy access into the bio retention system and transfer of material into adjacent tipper truck. The truck should be positioned so that water from the truck body drains into the bio retention systems.
2.3	Drain waste in the truck thoroughly before proceeding to the disposals point.

6 Infrastructure - Sewerage

TOR - 3.5.5 Sewerage

This section should describe, in general terms, the sewerage infrastructure required by the project. Information is required on the on site treatment if grey water including ownership, maintenance safeguards to be used, how discharge standards are to be met, details of proposed wet weather storage (locations and capacities proposed).

If a treatment system is proposed for the development, further information is required on:

- *The options proposed for wastewater treatment*
- *The peak design capacity evaluation of the wastewater treatment system and associated*
- *infrastructure using equivalent persons;*
- *Determination of the potential emergency effluent storage that would be required in an extended rain event (50 and 100 year ARIs);*
- *The siting and maintenance regime for the system;*
- *Treated effluent quality, particularly nutrient content; and treated effluent flow rates and volume available at different development stages.*

The Ella Bay Master Planned Community requires a sewage treatment system onsite. The system will incorporate a collection reticulation network, treatment plant, recycled water supply network and irrigation disposal. Treated effluent will be sufficiently treated to allow for safe reuse or disposal and will comply with all authority standards and requirements. The aim is to provide an economically viable and environmentally sustainable solution to meet the unique challenges of wastewater management in a sensitive environment. All system components of the treatment system will be owned and maintained by the services company.

6.1 Options for Treatment System

The conventional system for sewage treatment has been to use a collection reticulation network to convey the sewage to a common treatment plant and then dispose of the generated effluent. The adjacent Little Cove development of 100 villas has received approval and an operating license for a central treatment plant. Effluent from this plant will then be irrigated onto designated disposal areas.

A site based management plan will be implemented to ensure that actual and potential environmental impacts resulting from the proposed treatment system are managed in a sustainable way. Simmonds & Bristow prepared the Site Based Management Plan and operating license submission for the adjacent Little Cove project. This report has been included as an appendix and has provided some of the background data summarised in this section. Please refer to the appendix.

The technology of Option 1 as detailed in Section 6.1.1 has already been approved for use on the adjoining Little Cove development. Effluent disposal was a major concern of the Little Cove Development due to the topography and dense vegetation. The treatment plant and effluent disposal design resolved this concern and approval for the system was given by EPA (Qld). A copy of this permit is included in Appendix A. The purpose of attaching the Site Based Management Plan and operating license of the adjacent site is to show that waste on the subject site can be managed, including the impacts of waste on the environment. As the Ella Bay Master Planned Community has flatter topography and better disposal areas, it is anticipated that a more simple design solution will be required for an acceptable treatment system.

While Option 1 is regarded as being capable of providing the sewage treatment needs of the development, further research into other available systems and their technology will be undertaken. The sustainable development institute being proposed within the development and partnered by James Cook University and the University of Queensland will likely participate in the necessary research. A brief description of another system is outlined in Option 3.

6.1.1 Option 1 Centralised Treatment Plant

The sewage treatment plant utilises activated sludge treatment technologies to treat the sewage to a discharge level appropriate for unrestricted irrigation and other uses, including toilet flushing and firefighting purposes.

Major components of the treatment process are;

- fine screening for grit removal
- an aerated flow balance tank
- an aeration chamber to support aerobic and anoxic phases for nitrogen removal

with :

- automatically controlled aeration based on dissolved oxygen
- mixer capacity during anoxic periods
- sodium aluminate dosing for phosphorus removal

- a clarifier for sludge settlement, wasting and return
- sand filters for further polishing of clarified effluent
- chlorine dosing and UV disinfection
- an aerobic digester for sludge volume reduction
- treated effluent storage tanks

Sewage first enters the plant through a flow-meter, which allows sewage generation to be tracked. The sewage is then screened, which removes most of the grit and other large particulate matter. It then flows into an aerated balance tank, which allows for surges or shocks in flow to be attenuated. From the balance tank sewage is then pumped into an

aeration chamber that is used for the removal of biological and nutrient contamination, using a series of aerobic, and anoxic cycles. This removes the bulk of organics and nitrogen in the effluent. The treated effluent is then dosed with sodium aluminate for chemical phosphorous removal. From the aeration tank the effluent enters a settling tank, where the bulk of biological material settles out, and is removed as sludge. The effluent then enters a chlorine dosing station, goes through sand filtration for final polishing, and is finally UV disinfected. The effluent is then stored in a storage tank. The sludge removed from the settling tank is recycled to the front of the process (into the aeration balance tank) and a portion is harvested, or 'wasted' to maintain sludge volumes. This wasted sludge enters an aerobic digester, in which its volume is reduced, before being taken offsite by registered waste handlers.

Treated Effluent will be used in a variety of roles, including toilet flushing, irrigation, wash down water and in fire fighting applications

The STP will be owned operated and maintained by the services company. The sewerage treatment plant will be located in a designated services area. As the development is to be constructed in stages the sewage treatment plant chosen will have to be flexible enough to be able to expand as each stage starts to generate sewage.

6.1.2 Option 2 De-centralised Treatment Plant

The development could be serviced by the same technology as Option 1 but by using a number of small plants around the development area. Typical advantages of having a number of smaller units over a single large facility include better operating flows, maintenance and operational efficiencies plus optimal installation timing based on staged construction.

Figure 6-1 Small packaged treatment plant

6.1.3 Option 3 Individual Treatment Plant

With the rapid growth in small lot-scale treatment devices and the need for the effluent output to be managed as part of the entire water cycle, an individual treatment system is another possible solution. This type of system will provide a small treatment device close

to each building and the treated effluent will be re-used at the site or piped away to a common disposal area. These systems are available from a number of manufacturers and use technology such as anaerobic and aerobic process in differing configurations.

Individual treatment systems near each source will allow design parameters such as building use and population fluctuations to be considered when sizing the individual treatment plant. This can be beneficial to treatment system performance especially as the population is expected to peak and trough due to visitors, during public or school holidays and peak tourist seasons.

6.2 Reticulation Network

The reticulation network will be a combination of gravity pressure (where possible) and low pressure sewer system of fully sealed (welded polyethylene) sewer pipes. A major advantage of pressure sewer systems is their flexibility: the pipe system does not need to be graded downhill as it does with a gravity system so the alignment of pipes is much more flexible. This can result in lower environmental impact of construction and maintenance, better accessibility and lower pipe laying costs. The size of pumping equipment required will be designed to meet the parameters required at each individual pump location.

The pipe network has been located within a common services trench and the treatment plant has been located within a service yard. The services yard is located away from residential and community use areas and will be screen planted to reduce visual impact.

For a site plan showing the network, refer to Figure 6-2.

Figure 6-2 Sewage System - Plan

6.3 Design Capacity

The development is estimated to produce a peak daily sewage flow of 370kL/day with a maximum population estimate of 5380 people. This was calculated using the flow allowances and an estimated equivalent population given in Table 6-1.

	Wastewater flow allowance (Litres/ep/day)	Number	Number of EP's	Approximate quantity of sewage (kL/day)
Town Centre Commercial / Retail	30	50	50	2
Resort Precincts[1]	Guests @ 80	860 rooms x 2 people	1720	138
	Staff @ 30	1240	1240	37
	Restaurants @ 20 per meal	1720	-	34
Residential Precinct[1]	80	560 dwellings x 3 people	1620	130
Educational Precinct	30	250	750	23
Miscellenous	-	-	-	6
TOTAL			5380	370

Table 6-1 Generated Sewage Flows

[1] *Full water-reduction 3A fixtures including 6/3 litre dual flush toilets, 4A clothes washers & dishwashers.*

The Sewage Treatment Plant has a Average Dry Weather Flow (ADWF) design capacity of 370 kL/day. Peak Wet Weather Flow (PWWF), taking into account rainfall in the wet season, and groundwater infiltration, etc, is 777 kL/day and is calculated as 2.1 times the ADWF. The PWWF factor has been sourced from the Sewer Code of Australia, on the basis that the sewer system will be newly installed. The pipework for the system is also shallow, so there should be no groundwater infiltration into the system.

6.4 Effluent Management

Effluent is to be managed as a part of the entire water cycle and is to be considered as a resource not a waste material to be disposed of.

6.4.1 Effluent Quality

The plant and equipment has been designed to achieve an effluent with quality characteristics equivalent to or less than those specified in the table below.

Parameter	Unit	Maximum
Suspended Solids	mg/L	< 1
Turbidity	NTU	< 2.0
Biological Oxygen demand-5	mg/L	< 10
Total Nitrogen	mg/L	< 10
Total phosphorous	mg/L	< 1
Faecal Coliform *	org/ml	< 10
pH		6.5 - 8.0
Dissolved Oxygen	mg/L	>2

* Median from 5 samples of final effluent taken at half hourly intervals.

Table 6-2 Treated Effluent Quality

6.4.2 Effluent Disposal

The effluent produced from the proposed sewage treatment plant is to be disposed of by way of recycling and effluent irrigation. The site characteristics have been assessed and are considered suitable for effluent disposal via irrigation. Preliminary analysis indicates the irrigation area available is more than adequate. A detailed MEDLI model of the site will be undertaken to determine the actual area required for efficient effluent disposal. In order to model the application areas and rates effectively a MEDLI model needs to be prepared for different irrigation rates. MEDLI also calculates the amount of effluent available for irrigation after recycling and accounts for stormwater infiltration automatically based upon the rainfall data entered for the model. In addition to this the wet weather storage available was split along the same parameters to keep the model consistent.

6.4.2.1 Irrigation

Treated effluent will be evenly applied on a daily basis from the wet weather storage to a low pressure droplet irrigation system, using appropriate sprinklers or similar devices to reduce the risk of effluent drift. Irrigation will be halted during periods of heavy rainfall (ie. rainfall events resulting in runoff from irrigation areas) with effluent being diverted to wet weather storage facility. When the capacity of the wet weather storage is reached, rather

than have the storage tank overflow, excess effluent will be applied evenly across the irrigation area. To manage surface runoff from the irrigation areas in such events, a proposed system of cutoff and runoff bunds provide control of point source releases, encouraging additional absorption and diffuse release into the surrounding forest areas. The release of effluent during rain events is most likely to occur during the wet season. Dilution of this effluent by rainfall and natural runoff can be calculated and will result in significant reductions in the concentration of nutrients.

It can be calculated to show that the lowest possible rainfall that may cause an overtopping event still results in significant dilution of the nutrients present in the irrigated effluent. Of the months of the wet season (December to May) an overtopping event requiring irrigation during rainfall is most likely to occur in March as it has the highest rainfall of the year. If irrigation was required, to prevent the Wet Weather Storage Tank/s from overflowing, during heavy rain fall, for one day in March, the concentrations likely to occur in the effluent/stormwater runoff should present no threat to the environment. The nitrogen discharge should be well below the requirement of <10 mg/L discharge standard for the Great Barrier Reef Marine park, and the <0.1 mg/L for fresh water nitrogen eutrophication concentration.

An irrigation plan will be prepared along with the supporting MEDLI model outputs. Each of the irrigation areas will be irrigated at a different rate based upon their slope. This is to prevent the occurrence of runoff under normal operating conditions as far as is possible. Areas of slope up to approximately 15% will be irrigated at a rate of 2mm/day. Slopes from 15% to 25% will be irrigated at 1mm/day. Slopes from 25% to 50% will be irrigated at 0.25mm/day.

The aim of the physical components of the irrigation system is to deliver the effluent to the irrigation areas while causing as little environmental impact as is possible. Above ground distribution systems will be used where possible unless subsurface systems are better suited to the irrigation area ie. golf course fairways.

All systems are planned to be pressure balanced, and have pressure monitors on each line. These pressure monitors provide burst protection by detecting variations in pressure, which indicate damage to the irrigation distribution system, and shutting off the appropriate line automatically. Maintenance personnel can then assess the damage and repair it as necessary.

6.4.2.2 Recycle

Recycling of effluent is a vital part of a balanced water cycle. It has the potential to reduce the demands on the water supply system. Recycling effluent is estimated to account for up to 25% of the daily flow through the plant. A dual reticulation system, where a separate network of pipes is constructed in the streets to carry the Class A+ recycled water to each house for approved non-potable uses such as, flushing toilets, watering gardens, hose washdown and fire fighting. This water recycling scheme is to be in compliance with all relevant regulatory provisions, including state, federal and local government laws.

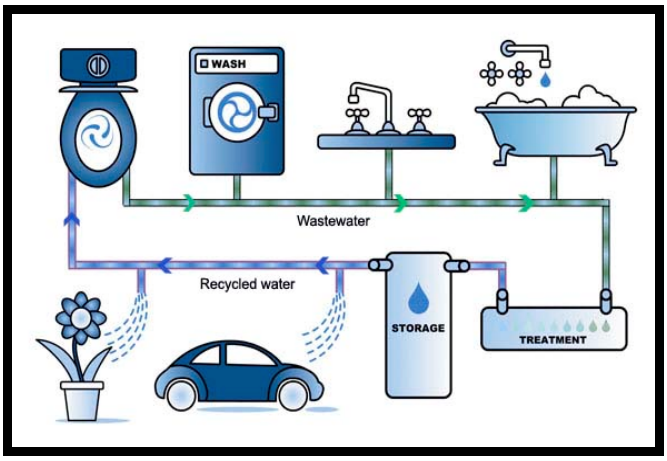

Figure 6-3 Recycled water system diagram

6.4.2.3 Fire Fighting Storage

A sufficient volume of recycled water will need to be stored so that the required fire fighting requirements are met. The proposal is that dedicated storage tanks be located around the development similar to requirements for rural areas. In the event of a fire the mobile fire fighting tankers can draw water from the storages then travel to the fire location. The pumps on the tankers will provide pressure to the fire hoses.

6.4.3 Wet Weather Storage

In extended wet periods (up to the 100 year ARI event), it will be necessary to store effluent until the receiving ground is no longer saturated. Ground moisture sensors could be used to control the effluent discharge to irrigation. The MEDLI model will be used to calculate the optimum wet weather storage capacity needed to be provided during wet weather periods in which ground conditions are unsuitable to receive additional watering. An overtopping event requiring irrigation during rainfall is most likely to occur during the wet season months of December to May. If overtopping does occur the effluent will be diluted to a level that it should present no threat to the environment.

Optimum sizing reduces the risk of overtopping. The MEDLI modelling, conducted by Simmonds and Bristow for the adjoining Little Cove development, determined that the optimum wet weather storage was 500kL. With this amount of storage an overtopping event would occur only 3 times in every 10 years. Based on this and considering that the design flow for the Master Planned Community is approximately 8 times that of Little Cove, an approximate wet weather storage volume of 4000 kL is likely. The exact volume will be determined at the detailed design stage.

6.5 Operation and Maintenance of System

A site based management plan will be prepared and submitted to EPA as part of the approval process to obtain a permit to operate a Sewerage Treatment Plant. The objective of this plan is to ensure that actual and potential environmental impacts resulting from the environmentally relevant activity are managed in a sustainable way.

The plan will incorporate:

- Routine operating procedures to prevent or minimise environmental harm, however occasioned or caused during normal operations;
- Maintenance practices and procedures;
- Contingency plans and emergency procedures to seal with foreseeable risks and hazards including corrective responses to prevent and mitigate environmental harm;
- Monitoring of the release of contaminants into the environment including procedures, methods, record keeping and notification of results;
- Assessment of the environmental impact of any release of contaminants into the environment including procedures, methods, record keeping and notification of results;
- Handling of environmental complaints;
- Keeping and protection of environmental records and reports;
- Lines and methods of communication to be utilised for communication of procedures, plans, incidents, potential environmental problems and results, including feedback mechanism to ensure that management is made aware of potential environmental problems and any failure of procedures adopted; and
- Staff training and awareness of environmental issues related to the operation of the environmentally relevant activities, including responsibilities under the EP Act.

The operation and maintenance procedures will be developed once the treatment system is chosen and the plant construction and commissioning phase is complete.

Emergency Response Contingency Plans & Procedures for the sewage treatment, effluent disposal scheme Plant relate to events that may cause or result in uncontrolled release of effluent or sludges that may cause or have caused adverse environmental harm and or public health exposure.

6.6 Management Plans

To ensure affective operation and maintenance of the system, a number of management plans will be required. Below is a summary of some typical management plans. Future details on each of these can be found in the Site Based Management Plan for Little cove included in the appendix.

6.6.1 Stormwater Management Plan

The objective of the stormwater management plan is to detail how the design and operation of the sewage treatment plant and effluent disposal system will prevent and/ or minimise the release or likelihood of release of contaminated effluent / runoff from the licensed place to any stormwater drain or waters or the bed or banks of any such waters.

6.6.2 Effluent Irrigation Management

The objective of the Effluent Irrigation Management Plan is to describe how the actual and potential environmental impacts resulting from the onsite disposal of treated effluent from the treatment plant will be minimised and managed.

6.6.3 Vermin Management

Both pigs and ants seek moisture in the dry season. The irrigation system provides a source of moisture for both of these pests which may damage the irrigation system.

The objective of the Vermin Management Plan is to describe how the actual and potential environmental impacts resulting from the activity of local pests will be minimised and managed.

6.6.4 Equipment Failure Management

The objective of the Equipment failure Management Plan is to describe how the actual and potential environmental impacts resulting from the equipment failure will be minimised and managed.

6.6.5 Solid Waste Management

The objective of the waste management plan is to detail how the actual and potential environmental impacts resulting from the handling of solid waste from the treatment plant be minimised and managed.

6.6.6 Noise and Odour Management

The object of the Noise Management Plans is to describe how the actual and potential environmental and personal impacts resulting from the noise produced by the treatment of both Sewage and Potable Water will be minimised and managed.

6.7 MONITORING & REPORTING

Routine monitoring is required to meet environmental responsibilities under the environmental authority. Additional monitoring may be required in emergency situations as specified in the various Emergency Response Contingency Plans and Procedures.

6.7.1 Routine Monitoring Program - Sewage Treatment Plant

All routine monitoring samples are to be collected by NATA Certified Field Samplers or trained operators in compliance with current Australian Standards and EPA Standards for Environmental Monitoring. All analysis is to be performed by NATA Certified Laboratories, except for daily and weekly tests, which will be conducted by the plant operators.

6.7.2 Emergency Monitoring Program

Emergency monitoring samples are to be collected by NATA Certified Field Samplers or trained operators in compliance with Australian Standards and EPA Standards for Environmental Monitoring. Emergency monitoring requirements are specified in the Emergency Response Contingency Plans and Procedures.

6.7.3 Reporting

Routine Reporting requirements equate to an Annual Return due on the annum to the Environmental Authority. Incident and Emergency reporting requirements are detailed and specified in the Emergency Response Contingency Plans and Procedures. All reports, written correspondence and records associated with the Environmentally Relevant Activity - Sewage Treatment are to be kept at the licenced premises for a period of 5 years.

7 Infrastructure - Telecommunications

TOR - 3.5.6 Telecommunications

The EIS should describe any impacts on existing telecommunications infrastructure (such as optical cables, microwave towers, etc.) and identify the owners of that infrastructure.

7.1 Vision

To maintain and promote Ella Bay Community as a prime location it is important to provide the best telecommunication service available. This not only means providing voice communications but also includes the latest in high-speed computer connections.

7.2 Provision of Infrastructure

There is no existing telecommunication infrastructure on the site. It is envisaged that a decentralised communication network with a centralised control will be set up and maintained by the community management company. This network will be a hybrid system likely incorporate the use of microwave towers, cable network and optic fibre connection. A cable / fibre optic connection to existing infrastructure at Flying Fish Point will be constructed along Ella Bay Road.

The telecommunications infrastructure at Ella Bay will include broadband, as well as the installation of a mobile phone tower. For broadband usage, a microwave link will be established from Mt Bellenden Kerr to the site.

8 Waste Management

TOR - 3.6.1 Character and quantities of waste materials

Provide an inventory of all wastes to be generated by the proposal during the construction and operational phases of the project. In addition to the expected total volumes of each waste produced, include an inventory of the following per unit volume of product produced:

- *the tonnage of raw materials processed;*
- *the amount of resulting wastes; and*
- *the volume and tonnage of any re-usable by-products.*

8.1 Air Emissions

TOR - 3.6.1.1 Air emissions

Describe in detail the quantity and quality of all air emissions (including particulates and odours) from the project during construction and operation. Particulate emissions include those that would be disturbed by wind action equipment during construction (e.g. trucks by passage on unsealed roads). The methods to be employed in the mitigation of impacts from air emissions should be described in section 4.5.

The air we breathe is a mixture of gases and small solid and liquid particles. Air pollution occurs when the air contains substances in quantities that could harm the comfort or health of humans and animals, or could damage plants or materials. Some substances come from natural sources while others are caused by human activities.

Goals for the key indicators of air quality in Queensland are prescribed in the EPP (Air) and a summary of existing ambient air quality standards is in the table below.

Pollutant	**Averaging Time**	**Quality** (max concentration)
Ozone (ppm)	1 hour 4 hours 24 hours 100 days of a growing season	0.098 0.079 0.03 0.03
Nitrogen dioxide (ppm)	1 hour 4 hours 1 year	0.16 0.046 0.01
Particles (ug/m^3) - as TSP - as PM_{10} - as PM_{10} - visibility (km)	 1 hour 24 hours 1 year 1 hour	 90 150 50 20

Sulphur dioxide (ppm)	10 min 1 hour 24 hours 1 year	0.25 0.20 0.04 0.02
Carbon monoxide (ppm)	8 hours	8.0
Lead (ug/m^3)	3 months	1.5

Table 8-1 Air Quality Standards

8.1.1 During Construction

8.1.1.1 Air Emissions Generated

The main potential emissions associated with the construction phase of the proposed development are dust and particulate matter. These emissions could potentially contain extremely small quantities of trace metals and organic compounds. The majority of dust emissions will occur at the construction site. To reduce dust emissions the current gravel surface of Ella Bay Road will be upgraded with a bitumen seal prior to commencement of construction.

Excavators, truck and generators used during construction would also emit small amounts of products of fuel combustion, including oxides of nitrogen, carbon monoxide, sulfur dioxide and particulate matter.

8.1.1.2 Emission Minimisation

The potential for emissions to occur during the construction of the proposed development would be minimised through the development and implementation of a Construction EMP that would be prepared for the project.

The Construction EMP would include:

- efficient use of machinery
- reduction in the number of material deliveries by efficient ordering
- minimising areas of disturbed soils and areas of open excavation
- minimising stockpiling by coordinating excavation, spreading, regrading, compaction and importation activities. Stockpiles would be installed outside hazard areas such as drainage lines and away from heavily trafficked areas
- stabilisation of stockpiles to minimise wind erosion (e.g. water sprays and covering of stockpiles)
- apply water to active earthwork areas, stockpiles and loads of soil being transported to reduce dust as required
- restrict traffic to defined roads and implement a speed limit
- cease work if excess fugitive dust is observed, or phase down while the source is being actively investigated and suppression measures are implemented.

8.1.2 During Operation

8.1.2.1 Air Emissions Generated

Though our daily activities, individuals are directly responsible for a significant amount of overall emissions to the atmosphere. The decision made about the choice of transport mode is a dominant factor. Other sources of pollutants include the use of paints and aerosols, recreational vehicles, lawn mowers and the use of fuel for heating. Wood burning for heating stands out as the single major domestic source of particle emissions (96%). As the development will be actively reducing the use of carbon fuelled transport and providing heating from renewable energy sources such as solar, the emissions generated by the operation of the development will be lower than a traditional development.

The main sources of air emissions during operation will be;

- Car usage
- Generators for electricity production
- Odours
  - Cooking
  - Refuse
  - Sewage Treatment Plant

8.1.2.2 Emission Minimisation

Emissions can be minimised through implementing management systems to reduce the need for vehicle and equipment use. These reductions include:

- Reduction in use of carbon fuel transport within the community;
- Restriction of car use within the community through the provision of an electric / gas shuttle bus service;
- Efficient management of delivery vehicles bringing goods to the community to ensure that unnecessary trips are not made;
- The use of gas heating equipment instead of heating by burning wood;
- Solar heating;
- Solar power;
- Stand alone power systems to be run by renewable energy,
- Appropriate ventilation of cooking / restaurant areas,
- Appropriate storage of refuse, and
- Appropriate deign of the sewage treatment plant.

8.2 Solid Waste Disposal

TOR - 3.6.1.2 Solid waste disposal

The proposed location, site suitability, dimensions and volume of any landfill requirements for solid wastes generated by the project.

A Waste Management Plan for the proposed Ella Bay development will be implemented which will encourage the most efficient use of resources, to reduce environmental harm, and to provide for the continual reduction in waste generation in line with the principles of ecologically sustainable development (ESD). The Waste Management Plan will outline strategies, actions and controls aimed at pursuing waste minimisation and recycling objectives for the development.

Based on the Waste Management Hierarchy, the management plan will ensure that all facets of the community's operations are subject to this concept.

Avoid

The avoidance of excess waste is the key component of any waste management program, by avoiding waste we ultimately decrease the amount needed for disposal. This can be easily put into practice via a simple purchasing policy where many products are delivered in bulk.

Re-use

Re-use is another essential component of the Waste Management Hierarchy, as it effectively extends the life of a product and once again decreases the amount of waste ending up in landfill. A great example of this is the re-use of organic waste that is produced. Once collected, organic waste can be put through a composting or vermiculture system (worm farm) and then used as a soil conditioner and fertiliser.

Recycle

Recycling has the potential to considerably decrease the amount of virgin materials that need to be utilised. The management plan will have an extensive recycling program in place that ensures that all recyclable material is collected, sorted and transported for recycling.

Disposal

The disposal of waste is the least desired component of the Waste Management Hierarchy. Unfortunately, modern society has not yet created a system where all our waste can be re-used or recycled. With this being the case, the community must dispose of some waste to land fill which will be offsite. The management plan will continually seek alternatives and implementing programs that will result in the decrease of waste to land fill.

8.2.1 During Construction

8.2.1.1 Waste Generated

As the site is a green fields site with only a single of existing building there will be very little demolition waste generated. Any material that is recyclable such as timber, concrete, bricks, etc will be reused where possible.

It is estimated that approximately three to four tonnes of waste per house will be generated during construction. Waste materials include clean fill, concrete, bricks, tiles, steel, glass, metal, wood, asphalt, plastics and other materials generally used in the building process. The particular materials wasted during the construction of the proposed development will depend mainly upon the type of buildings being constructed and methods of construction.

The table below gives a summary of the types of wastes and an estimate of the quantity of waste that will be produced by the proposed development.

Construction Waste Composition and Quantity Estimate

Construction Material	Average Percentage of Construction Material Wasted	Approximate quantity of construction waste to go to landfill (tonnes)
Brick	12%	300
Tile	7%	175
Plasterboard	5%	125
Timber	8%	200
Concrete	11%	275
Steel	3%	75
Fibre cement	2%	50
Plastic	2%	50
Soil	50%	Disposed of on site

Table 8-2 Solid Waste Generated - Construction

8.2.1.2 Waste Minimisation

A Construction Waste Management Plan will be developed and implemented for the construction phase of the proposed development. This plan would be incorporated into the Construction EMP for the project. Any licensing requirements (such as EPA licence) for the management and disposal of waste from the site would be identified in the Construction Waste Management Plan. All project personnel would be advised of the waste management strategies and disposal procedures prior to commencing any work. Contractors carrying out site construction works would record the types, quantities and destinations of all waste material taken off-site during construction to assist the reviewing of minimisation strategies.

8.2.1.3 Treatment and Disposal

Waste construction materials will be separated and stored for disposal, reuse or recycling. Waste skips would be collected by a licensed waste contractor on a regular basis and transported for disposal to a licensed landfill or recycling facility as appropriate.

8.2.2 During Operation

8.2.2.1 Waste Generated

The following table gives an estimate of the quantity of operational wastes to be generated by the proposed development.

Type of waste	Approximate quantity of waste generated (tonnes)	Approximate quantity of waste to go to landfill (tonnes)	Approximate quantity of waste to be recovered, reused or recycled (tonnes)
Municipal solid waste	1176	1142	34
Commercial & industrial waste	336	336	0
Construction & demolition waste	302	230	72
Green & organic waste	504	0	504
Biosolids	31	1	30
TOTAL	2349	1709	640

Table 8-3 Solid Waste Generated - Operation

Municipal solid waste

Municipal solid waste is collected via local government kerbside and drop-off services for landfill disposal. In a report prepared by EPA (Qld), "The state of waste and recycling in Queensland 2005", it was estimated that households in the Far North Queensland region generated an average of 420 kg of waste per capita that was collected for landfill. Of the average 420 kg of household waste generated approximately only 12 kg was recovered for recycling or reuse compared with the Queensland average of 50 kg.

Each house will be issued with two wheelie bins, a 240-litre bin for recyclable waste such as glass, paper, plastic, etc. and a 120-litre bin for putrescible waste. A collection service that provides a weekly service to residences will empty the bins and transport the waste to a landfill or recycling plant off site.

The table below give a breakdown of the types and quantity of the municipal solid waste that are likely to be collected and recycled or reused by Johnstone Shire Council based on their current activities and facilities.

MUNICIPAL SOILD WASTE

Household recyclable material	Average Queensland Waste Recovered by Councils for Recycling kg/person/year	Approximate Waste Recovered by Far North Shire Councils for Recycling kg/person/year	Approximate Quantity of recyclabe waste to be poduced by the proposed Ella Bay development tonnes / year
Domestic paper	28.8	1.2	3.4
Glass	11.4	4.5	12.6
Cardboard	4.7	1.8	5.0
Steel cans	1.4	1.15	3.2
HDPE	1.1	1.1	3.1
PET	1	0.55	1.5
Other/mixed plastics	0.8	0.47	1.3
Aluminium cans	0.6	0.98	2.7
Liquid paperboard	0.01	0.25	0.7
Total	49.8	12	33.6

Table 8-4 Solid Waste – Operational Recycling Rates

Secondary waste is the waste other than municipal solid waste, which is not collected by council but still disposed of at landfill sites. They include the following:

- Commercial & industrial waste includes waste from schools, restaurants, offices, retail and wholesale businesses, and manufacturing industries.

- Construction & demolition waste is non-putrescible materials arising from construction or demolition activity, such as brick, timber, concrete and steel etc.
- Green waste includes grass clippings, tree, bush and shrub trimmings, branches and other similar materials resulting from domestic or commercial gardening, landscaping or maintenance activities.
- Biosolids are organic solids derived from biological wastewater treatment processes—eg sewage sludge.

The table below provides an estimate of the quantity of secondary waste to be disposed of to landfill and the percentage that is likely to be recycled.

SECONDARY WASTE

Type of waste	Average Quantity of Secondary Waste Generated in Queensland 2004-2005 kg/person/year	Average Queensland Percentage of Secondary Waste Recovered	Average Far North Percentage of Secondary Waste Recovered	Approximate Far North Secondary Waste to landfill kg/person/year
Construction & demolition	108	32%	24%	82.08
Commercial & industrial	120	5%	0%	120
Green & organic	180	93%	83%	30.6
Biosolids	11	82%	98%	0.22

Table 8-5 Solid Waste – Operational (Secondary Waste) Recycling Rates

Commerical wastes generated within the Village and Resort Precincts will be collected by commercial contractors independent of the house holder collection system. The waste will be transported to the appropriate Johnstone Shire Council waste transfer station (Stoters Hill or Bells Creek) for processing and disposal.

In contrast to the averages provided in Table 8-5, it is proposed that 100% of green and organic waste will be processed within the Ella Bay community. Residents will be encouraged to compost waste where possible and the services company will provide a green waste collection service. Green waste will be processed and returned to the community for use in landscaped areas.

Biosolids such as waste sludge from the STP will be regularly diverted into a storage tank for periodic tankering to a Johnstone Shire Council controlled treatment plant or land fill for further processing. This will eliminate the need for sludge drying beds and any on-site management.

8.2.2.2 Waste Minimisation

Minimisation of waste will be achievable through a policy of recycling, waste management education and the implementation of incentives to reduce waste generations. It is intended that the community understands and actively participates in waste reduction and recycling to reduce the volume of solid waste to be disposed to landfill.

A waste management strategy for recycling waste at the resort could include:

- Kerbside recycling - most household waste recycling will occur through the local kerbside collection service. The Johnstone Shire Council supports this collection and recycling service. Materials recycled predominantly through this service are steel cans paper/cardboard, glass and aluminum cans;
- Reusable – encourage the use of products, which can be reused.
- Composting – Composting can make a worthwhile contribution to the improvement of the environment. Organic wastes comprise about 40% of the total amount of solid material sent to landfill annually. Removing 100% of this material from the waste stream will reduce the load on the kerbside collection system and landfill.

8.2.2.3 Treatment and Disposal

Any solid waste that is generated through the project which can not be easily recycled on site will be taken off site to a Johnstone Shire Council Transfer Station (Stoter's Hill or Bell's Creek) for disposal.

8.3 Liquid Waste

TOR - 3.6.1.3 Liquid waste

A description should be presented of the origin, quality and quantity of wastewater originating from the project. The EIS may need to consider the following effects;

- *Groundwater from excavations*
- *rainfall directly onto disturbed surface areas*
- *run-off from hard surfaces (e.g. roads, development footprint), plant and chemical storage areas*
- *drainage (i.e. run-off plus any seepage or leakage)*
- *water usage for dust suppression, and domestic purposes*
- *evaporation*
- *domestic sewage treatment - disposal of liquid effluent and sludge; and water supply treatment plant - disposal of wastes*
- *aquatic recreation facilities (e.g. backwash from proposed lagoon swimming pool).*

8.3.1 During Construction

8.3.1.1 Liquid Waste Generated

Liquid waste will be generated during the construction. The liquid waste will be treated to the relevant standard and then disposed of.

Pollutant	Quantity	Quality
Groundwater from excavations	nil	na
Run-off from disturbed areas	Dependant on the amount of disturbed area exposed and the amount of rainfall	Treated before discharge
Run-off from hard surfaces	Dependant on the amount of area and the amount of rainfall	Treated before discharge
Water usage for dust suppression	Dependant on the prevailing conditions during construction	Treated before discharge

Table 8-6 Liquid Waste Generated - Construction

Groundwater is not expected to be affected during the construction and operational phases. However, the groundwater will be monitored in accordance with both the proposed development's EMP and the operating permit for the sewage treatment plan. This policy aims to ensure that there are no detrimental effects to the groundwater.

It is envisaged that rainfall directly onto disturbed surface areas and spraying water during dust suppression will cause runoff that contains sediment. As such, all disturbed areas will have appropriate erosion and sedimentation controls installed. As a final treatment, runoff will be directed to a sediment basin where by any remaining sediments

can be removed. The runoff water will be tested to ensure it complies with relevant quality standards before being discharged into a natural watercourse.

The run-off from non-permeable surfaces such as roads will be captured and treated as outlined in the stormwater management plan. This will be done through the use of Water Sensitive Urban Design principles incorporated into the stormwater drainage system.

Potentially contaminated stormwater from chemical storage areas would be prevented from polluting the development by providing appropriate protective devices (bunds, oil traps, etc). Spills and leaks would be minimised by regular inspection and testing of containment areas, and drainage lines. Any detected leaks would be expeditiously repaired as part of ongoing maintenance.

8.3.1.2 Liquid Waste Minimisation

A Construction EMP will detail appropriate measures and management of the construction activities to ensure minimal liquid waste runoff will occur.

8.3.1.3 Treatment and Disposal

All runoff will be treated by erosion and sediment control techniques or by Water Sensitive Urban Design devices.

8.3.2 During Operation

8.3.2.1 Liquid Waste Generated

Table 8-7 outlines the sources of liquid waste during the operation of the development.

Pollutant	Quantity	Quality
Run-off from hard surfaces	Dependant on the amount of area and the amount of rainfall	Treated before discharge
Water use for domestic purposes	As per Sewage Treatment Plant requirements	Treated at STP before discharge
Evaporation	na	na
Domestic sewerage treatment - liquid effluent and sludge	As per Sewage Treatment Plant requirements	Treated at STP before discharge
Water supply treatment plant – disposal of wastes	As per Sewage Treatment Plant requirements	Treated at STP before discharge
Aquatic recreation facilities – pool filtration backwash	As per Sewage Treatment Plant requirements	Treated at STP before discharge

Table 8-7 Liquid Waste Generated - Operation

The run-off from non-permeable surfaces such as roads will be captured and treated as outlined in the stormwater management plan. This will be done through the use of Water Sensitive Urban Design principles incorporated into the stormwater drainage system.

All liquid waste generated from water used for domestic purposes plus backwash from the water supply treatment plant and the swimming pool lagoons will be disposed of through the sewage treatment plant (STP). The treated liquid effluent from the system will be disposed of via on site irrigation as per the treatment plant's operating licence. For more details on the sewage treatment plant refer to Section 6. Any sludge that accumulates in the sewage treatment system will be disposed of at an appropriate facility external to the site.

8.3.2.2 Waste Minimisation

Operational liquid waste will be minimised through efficient water use management.

8.3.2.3 Treatment and Disposal

All the liquid waste in the operational phase will be treated at the sewage treatment plant and the treated effluent disposed of by on site irrigation.

9 REFERENCES

1. Golder Associates, September 1995. *Geotechnical Studies, Proposed Eco-tourist Resort, Ella Bay, Queensland.*

2. Colefax Clayton and Smith, September 1995. *Ella Bay Eco-tourist Resort, Report to accompany combined application for rezoning and subdivision on some engineering aspects of the proposed development.*

3. Gardner T, Baisedn J, Millar G, August 2004*. Rainwater First Flush Devices – Are They Effective?,* Sustainable Water in the Urban Environment 2004 Conference – Brisbane

4. Simminds & Bristow, February 2006. *Site Based Management Plan, Ella Bay, Sewage Treatment Plant Licence Submission*.

APPENDIX A

Little Cove Development

Sewage Treatment Plant Permit

ecoaccess

Notice of decision - permit [1] application

This notice is issued by the Environmental Protection Agency to advise of a statutory decision on a permit application under environmental and/or conservation legislation.

Ella Bay Property Pty Ltd
C/- Planning Far North
PO Box 7801
CAIRNS QLD 4870

Our reference: 289081

Dear Sir/Madam

Re: Decision made in relation to your application under environmental legislation administered by the Environmental Protection Agency (EPA).

The EPA has assessed your application received on 28-FEB-2006 and wishes to advise you of the decision in regard to each application as specified below:

Permit applied for	Permit Number	Decision
Development Approval under Integrated Planning Act 1997	IPDE00375206A11	Granted in full with conditions

For each permit applied for that has been granted, the conditions of approval are attached. Where applicable, a Statement of Reasons is provided in relation to the decision. Please note that for each approval, this Notice of Decision and the relevant attachments constitute the permit documentation. Please retain this approval documentation for your records.

Included with this notice is advice on review and appeal processes that may be available to you. Should you seek a review or appeal, the EPA advises that you seek independent advice before taking such action.

If you require more information, please contact Luke Nicholson, the Project Manager, on the telephone number listed below.

Yours sincerely

Ingrid Famath Minnesma
Environmental Protection Agency
Date 05-MAY-2006

Enquiries:
Cairns District Office (EPA)
PO Box 2066
5B Sheridan Street
CAIRNS QLD 4870
Phone:(07) 4046 6734
Fax: (07) 4046 6606

Attachment - Permit/Statement of Reasons

1 Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation administered by the Environmental Protection Agency and the Queensland Parks and Wildlife Service.

eco

Section 3.5.15 *Integrated Planning Act 1997*

EPA Permit[1] number: IPDE00375206A11

EPA Permit[1] number:	IPDE00375206A11
Assessment Manager reference:	As above.
Date application received by EPA:	06-MAR-2006.
Permit[1] Type:	Development Approval for a MCU involving an ERA.
Date of Decision:	05-MAY-2006
Decision:	Granted with conditions.
Relevant Laws and Policies:	*Environmental Protection Act 1994* and any subordinate legislation.

Development Description

Property	Lot/Plan	Aspect of Development
ELLA BAY ROAD, WANJURA QLD 4860	Lot 337 on Plan NR53	ERA 15(b) - Sewage treatment - operating a standard sewage treatment works having a peak design capacity to treat sewage of 100 or more equivalent persons but less than 1500 equivalent persons.

Additional comments or advice about the application

None

[1] Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation administered by the Environmental Protection Agency and the Queensland Parks and Wildlife Service

Additional information for applicants

The standard currency periods stated in section 3.5.21 of the Integrated Planning Act 1997 or the nominated currency period, apply to each aspect of development in this permit1. For information on when this permit1 takes effect and the relevant currency periods, please see point 3 in the Notice of Decision.

Contaminated Land

It is a requirement of the *Environmental Protection Act 1994* that if an owner or occupier of land becomes aware a Notifiable Activity (as defined by Schedule 2 of the *Environmental Protection Act 1994*) is being carried out on the land or that the land has been affected by a hazardous contaminant, they must, within 30 days after becoming so aware, give notice to the Environmental Protection Agency.

Environmentally Relevant Activities

The aforementioned description of any environmentally relevant activity (ERA) for which this permit is issued is simply a restatement of the ERA as prescribed in the legislation at the time of issuing this permit. Where there is any conflict between the abovementioned description of the ERA for which this permit is issued and the conditions specified herein as to the scale, intensity or manner of carrying out of the ERA, then such conditions prevai to the extent of the inconsistency.

This permit authorises the ERA. It does not authorise environmental harm unless a condition within this permit explicitly authorises that harm. Where there is no such condition, or the permit is silent on a matter, the lack of a condition or silence shall not be construed as authorising harm.

In addition to this permit, the person to carry out the ERA must be a registered operator under the Environmental Protection Act 1994. For the person to become a registered operator, they must apply for a registration certificate under section 73F of the Environmental Protection Act 1994.

Ingrid Fomiatti Minnesma
Delegate
Environmental Protection Agency
05-MAY-2006

CONDITIONS OF APPROVAL

ERA 15(b) - Sewage treatment - operating a standard sewage treatment works having a peak design capacity to treat sewage of 100 or more equivalent persons but less than 1500 equivalent persons.

Agency Interest: General

General 1

Prevent and/or minimise likelihood of environmental harm.

In carrying out an ERA to which this approval relates, all reasonable and practicable measures must be taken to prevent and / or to minimise the likelihood of environmental harm being caused.

General 2

Maintenance Of Measures, Plant and Equipment.

The operator of an ERA to which this approval relates must:
(a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this approval; and
(b) maintain such measures, plant and equipment in a proper and efficient condition; and
(c) operate such measures, plant and equipment in a proper and efficient manner.

General 3

Records.

Record, compile and keep all monitoring results required by this approval and present this information to the administering authority when requested.

General 4

From commencement of an ERA to which this approval relates, a site based management plan (SBMP) must be implemented. The SBMP must identify all sources of environmental harm, including but not limited to the actual and potential release of all contaminants, the potential impact of these sources and what actions will be taken to prevent the likelihood of environmental harm being caused. The SBMP must also provide for the review and 'continual improvement' in the overall environmental performance of all ERAs that are carried out.

The SBMP must address the following matters:
(a) Environmental commitments - a commitment by senior management to achieve specified and relevant environmental goals.
(b) Identification of environmental issues and potential impacts.
(c) Control measures for routine operations to minimise likelihood of environmental harm.
(d) Contingency plans and emergency procedures for non-routine situations.
(e) Organisational structure and responsibility.
(f) Effective communication.
(g) Monitoring of contaminant releases.
(h) Conducting environmental impact assessments.
(i) Staff training.
(j) Record keeping.

(k) Periodic review of environmental performance and continual improvement.

General 5

All records required by this approval must be kept for 5 years.

General 6

The site based management plan must not be implemented or amended in a way that contravenes any condition of this approval.

General 7

Waste Records.

A record of all wastes (sewage tank sludges and residues) must be kept detailing the following information:

a) date of pickup of waste;
b) description of waste;
c) quantity of waste;
d) origin of the waste; and
e) destination of the waste.

Note: Trackable wastes as listed in Schedule 1 of the *Environmental Protection (Waste Management) Regulation 2000* are not covered by this condition. Trackable wastes have similar recording requirements to this condition in accordance with a waste tracking system established under the above Regulation.

General 8

Acid Sulphate Soils.

The latest edition of the Queensland Environmental Protection Agency's INSTRUCTIONS FOR THE TREATMENT AND MANAGEMENT OF ACID SULFATE SOILS, 2001, ('the Instructions') must be complied with when treating and managing acid sulfate soils.

General 9

Acid sulfate soils must be managed such that contaminants are not directly or indirectly released to any waters.

General 10

All ponds used for the storage or treatment of acid sulfate soils or other contaminants must be constructed, installed and maintained:

a) so as to prevent any release of contaminants through the bed or banks of the pond to any waters (including ground water);
b) so that a freeboard of not less than 0.5 metres is maintained at all times; and
c) so as to ensure the stability of the ponds' construction.

General 11

Suitable banks and/or diversion drains must be installed and maintained to exclude stormwater runoff from entering any ponds or other structures used for the storage or treatment of contaminants including acid sulfate soils or wastes.

General 12

All acid sulphate soils must be disposed of or managed within the authorised place.

General 13

Any temporary or permanent dewatering ponds or waterbodies used to contain or treat acid sulphate soils must not be constructed on a watercourse.

General 14

Annual Monitoring Report.

An annual monitoring report must be prepared each year and presented to the administering authority when requested. This report shall include but not be limited to:

a) a summary of the previous twelve (12) months monitoring results obtained under any monitoring programs required under this approval and, in graphical form showing relevant limits, a comparison of the previous twelve (12) months monitoring results to both this approvals limits and to relevant prior results;
b) an evaluation/explanation of the data from any monitoring programs;
c) a summary of any record of quantities of releases required to be kept under this approval;
d) a summary of the record of equipment failures or events recorded for any site under this approval;
e) an outline of actions taken or proposed to minimise the environmental risk from any deficiency identified by the monitoring or recording programs;
f) the number of domestic tenements newly connected to the sewage treatment works during the previous twelve (12) months;
g) the progressive total number of connections; and
h) a summary of any trade waste agreements entered into or amended during the year, including the nature of the industry.

General 15

Notification.

Telephone the EPA's Pollution Hotline or local office as soon as practicable after becoming aware of any release of contaminants not in accordance with the conditions of this approval.

General 16

Information About Spills.

A written notice detailing the following information must be provided to the EPA within 14 days of any advice provided in accordance with condition General 15:

a) the name of the operator, including their approval / registration number;
b) the name and telephone number of a designated contact person;
c) quantity and substance released;
d) vehicle and registration details;
e) person/s involved (driver and any others);
f) the location and time of the release;
g) the suspected cause of the release;
h) a description of the effects of the release;
i) the results of any sampling performed in relation to the release,
j) actions taken to mitigate any environmental harm caused by the release; and
k) proposed actions to prevent a recurrence of the release.

General 17

Monitoring.

A competent person(s) must conduct any monitoring required by this approval.

General 18

Equipment Calibration.

All instruments, equipment and measuring devices used for measuring or monitoring in accordance with any condition of this approval must be calibrated, and appropriately operated and maintained.

General 19

Trained / Experienced Operator(s).

The daily operation of the waste water treatment system and pollution control equipment must be carried out by a person(s) with appropriate experience and/or qualifications to ensure the effective operation of that treatment system and control equipment.

General 20

Spill Kit.

An appropriate spill kit, personal protective equipment and relevant operator instructions/emergency procedure guides for the management of wastes and chemicals associated with the ERA must be kept at the site, and in each vehicle used if the activity is a mobile ERA.

General 21

Spill Kit Training.

Anyone operating under this approval must be trained in the use of the spill kit.

Agency Interest: Air

Air 1

Nuisance.

The release of noxious or offensive odours or any other noxious or offensive airborne contaminants resulting from the activity must not cause a nuisance at any nuisance sensitive or commercial place.

Air 2

Dust Nuisance.

The release of dust and/or particulate matter resulting from the ERA must not cause an environmental nuisance at any nuisance sensitive or commercial place.

Agency Interest: Land

Land 1

Land Disposal.

The only contaminants permitted to be released to land is advanced secondary treated effluent to the areas identified in the Site Based Management Plan, (*Ella Bay Treatment Plant Licence Submission*, Simmonds & Bristow. 23 February 2006 *and in compliance with the Ella Bay Resort Development, Review of Effluent Irrigation Areas. 2 October 2005)*, and in compliance with the limits levels stated in Table 1 - Contaminant release limits to land and the conditions of this approval.

Land 2

The irrigation of effluent must be carried out in a manner such that:

a) vegetation is not damaged;
b) soil erosion and soil structure damage is avoided;
c) there is no surface ponding of effluent;
d) percolation of effluent beyond the plant root zone is minimised;
e) the capacity of the land to assimilate nitrogen, phosphorus, salts, organic matter as measured by oxygen demand and water is not exceeded; and
f) the quality of ground water is not adversely affected.

Land 3

Notices must be prominently displayed on areas undergoing effluent irrigation, warning the public that the area is irrigated with effluent and not to use or drink the effluent. These notices must be maintained in a visible and legible condition.

Land 4

Monitoring must be undertaken and records kept of a monitoring program of contaminant releases to the irrigation area at the monitoring points, frequency, and for the parameters specified in Table 2 - Monitoring program.

Land 5

The daily volume of contaminants released to each area of land must be determined by a precise method, i.e. flow meter, and records kept of such determinations.

Land 6

When conditions prevent the irrigation of treated effluent to land (such as during rain events), alternative measures must be taken to store/dispose of effluent (such as wet weather storage or tankering off site). Wet weather storage must be capable of containing 10 days of effluent production.

Land 7

Pipelines and fittings associated with the effluent irrigation system must be clearly identified. Lockable valves or removable handles must be fitted to all release pipes situated in public access areas.

Land 8

Notwithstanding the quality characteristic limits specified in Table 1 - Contaminant release limits to land, releases of effluent must not have any properties nor contain any organisms or other contaminants in concentrations that are capable of causing environmental harm.

Land 9

Spillage of all chemicals and fuels must be contained within an on-site containment system and controlled in a manner that prevents environmental harm.

NOTE: All petroleum product storage's must be designed, constructed and maintained in accordance with AS 1940 - Storage and Handling of Flammable and Combustible Liquids.

Land 10

Irrigation Monitoring Program.

Implement and maintain an irrigation-monitoring program (IMP) for the release of contaminants to land(s). Monitoring is to be conducted on a annual basis and a s a minimum, the IMP must include:

(a) soil and sub-soil analysis, including assessment of the soils including types, structure, phosphorus adsorption capacity, nutrient status, salinity and sodicity, cation exchange capacity and sodium absorption ratio (SAR) of the contaminant release area(s), to be carried out at each of the irrigation areas 1 – 7 a representative composite monitoring program for the Villa lots at no less than six;

(b) ground water monitoring that determines the existence and rate of infiltration of effluent that has been irrigated to land, and the potential or actual impacts on ground water from such infiltration, to be carried out on an annual basis;

(c) plant analysis to assess nutrient export to be carried out on an annual basis;

(d) determination of the quantity and quality of contaminants applied;

(e) periodic re-assessment, including modelling of the water, nutrient and salt balances and irrigation rate and return period should be undertaken, if necessary, to ensure sustainable use of the contaminant release area is being achieved; and

(f) reporting of monitoring results, and an assessment of the impact of the releases on the contaminant release areas.

Land 11

Provision Of Treated Effluent To Other Persons.

If responsibility of the treated effluent is given or transferred to another person:

(a) the responsibility of such effluent must only be given or transferred in accordance with a written agreement (the third party agreement);

(b) include in the third party agreement a commitment from the person utilising the effluent to use effluent in such a way as to prevent environmental harm or public health incidences and specifically make the

persons aware of the General Environmental Duty (GED) under section 319 of the Environmental Protection Act 1994, environmental sustainability of any effluent disposal and protection of environmental values of waters; and

(c) upon being notified or otherwise becoming aware that the person's use of effluent is causing or threatens to cause environmental harm or is posing a human health risk, and if the person does not rectify the situation upon written request, the giving and transferring responsibility for such effluent must cease.

Land 12

Effluent irrigation is to be conducted in accordance with the Site Based Management Plan, (*Ella Bay Treatment Plant Licence Submission*, Simmonds & Bristow. 23 February 2006 *and in compliance with the Ella Bay Resort Development, Review of Effluent Irrigation Areas. 2 October 2005).*

Irrigation areas are as follows:

Minimum irrigation area – Area 1

A minimum area of 1.93 hectares of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 2.0 mm/day. Irrigation rates must be quantifiable.

Minimum irrigation area – Area 2

A minimum area of 1.21 hectares of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 2.0 mm/day. Irrigation rates must be quantifiable.

Minimum irrigation area – Area 3 and 7

A minimum area of 0.84 hectares of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 0.25 mm/day. Irrigation rates must be quantifiable.

Minimum irrigation area – Area 4 and 5

A minimum area of 0.94 hectares of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 1.0 mm/day. Irrigation rates must be quantifiable.

Minimum irrigation area – Area 6

A minimum area of 1.46 hectares of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 1.0 mm/day. Irrigation rates must be quantifiable.

Minimum irrigation area – Villa Lots

Irrigated villa lots are to have a minimum area of 250 m2 per lot, excluding any necessary buffer zones. These lots must be utilised for the irrigation of treated effluent with a maximum irrigation rate of 0.25 mm/day. Irrigation rates must be quantifiable.

Agency Interest: Noise

Noise 1

Noise Nuisance.

Noise from the ERA must not cause an environmental nuisance at any nuisance sensitive place or commercial place

Noise 2

Noise Monitoring.

When requested by the administering authority, noise monitoring must be undertaken to investigate any complaint of noise nuisance, and the results notified within 14 days to the administering authority. Monitoring must include:
- LA 10, adj, 10 mins
- LA 1, adj, 10 mins
- the level and frequency of occurrence of impulsive or tonal noise;
- atmospheric conditions including wind speed and direction;
- effects due to extraneous factors such as traffic noise; and
- location, date and time of recording.

Noise 3

The method of measurement and reporting of noise levels must comply with the latest edition of the Environmental Protection Agency's Noise Measurement Manual.

Agency Interest: Social

Social 1

Complaint Response.

The operator of the ERA must record the following details for all complaints received and provide this information to the administering authority on request:
a) Time, date, name and contact details of the complainant;
b) reasons for the complaint;
c) any investigations undertaken;
d) conclusions formed; and
e) any actions taken.

Agency Interest: Waste

Waste 1

Waste Management Plan.

From commencement of an ERA to which this approval relates, a waste management program must be implemented. The Waste Management Plan must address at least the following matters:

a) the types and amounts of waste generated by the ERA;
b) how the waste will be dealt with, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices mentioned in the waste management hierarchy (section 10 of the Environmental Protections (Waste Management) Policy 2000);
c) procedures for identifying and implementing opportunities to improve the waste management practices employed e.g. opportunities for beneficial reuse of biosolids;
d) procedures for dealing with accidents, spills and other incidents that may impact on the waste management;
e) details of any accredited management system employed, or planned to be employed, to deal with the waste;
f) how often the performance of the waste management practices will be assessed (at least annually); and
f) the indicators or other criteria on which the performance of the waste management practices will be assessed.

Waste 2

Site Control.

At all times while the ERA is operating, at least one person must be present who is responsible for the control and operation of the facility and whose duties must include but not be limited to:

a) controlling the reception, storage and removal of waste;
b) maintaining the facility;
c) controlling all employees working in the facility; and
d) supervising all persons entering the facility.

Water 1

Erosion protection measures and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment.

Water 2

Contaminants other than settled/treated stormwater runoff waters must not be released from the site to surface waters or the bed or banks of surface waters.

Water 3

Stormwater Management.

There must be no release of stormwater runoff that has been in contact with any contaminants at the site to any waters, roadside gutter or stormwater drain.

Water 4

Contaminant And Sewage Pump Station.

Contaminant pumping stations must be fitted with stand-by pumps and pump-failure alarms as well as high-level alarms to warn of imminent pump station overflow. All alarms must be able to operate without mains power.

Water 5

Suitable banks and/or diversion drains must be installed and maintained to exclude stormwater runoff from entering any ponds or other structures used for the storage or treatment of contaminants or wastes.

Water 6

Contaminant Releases To Groundwaters.

The release of contaminants to groundwaters must not cause environmental harm.

Tables

Table 1 - Contaminant release limits to land

Quality characteristic	Minimum	Maximum	Median	Mean
pH	6.0		8.5	-
Turbidity NTU	-	5	9	2
E.coli cfu/100mL	-	-	<10	-
BOD5 mg/L	-	-	20	-
Total Suspendid Soilds mg/L	-	-	5	-
Totat Nitrogen mg/L	-	-	10	-
Total Phosporous mg/L	-	-	5	-
Free residual Cl* mg/L	0.2	-	0.5	-

* Total residual Chlorine after a minimum contact time of 30 minutes to be sampled prior to reuse in toilet cisterns and wash down water.

Table 2 - Monitoring program

Monitoring point	Quality characteristic	Unit	Frequency
Final effluent quality proir to irrigation.	pH	-	Daily, when irrigating.
Measured before the disinfection point.	Turbidity	NTU	Contiunous**
Final effluent quality proir to irrigation.	E.coli	cfu/100mL	Weekly for the first 4 months of operation, then monthly thereafter.
Final effluent quality proir to irrigation.	BOD5	mg/L	Weekly for the first 4 months of operation, then monthly thereafter.
Final effluent quality proir to irrigation.	Total Suspendid Soilds	mg/L	Weekly for the first 4 months of operation, then monthly thereafter.
Final effluent quality proir to irrigation.	Totat Nitrogen	mg/L	Weekly for the first 4 months of operation, then monthly thereafter.
Final effluent quality proir to irrigation.	Total Phosporous	mg/L	Weekly for the first 4 months of operation, then monthly thereafter.
Effluent prior to reuse in toilet cisterns.	Free residual Cl*	mg/L	Daily, when irrigating.

* Total residual Chlorine after a minimum contact time of 30 minutes to be sampled prior to reuse in toilet cisterns and wash down water.

** Turbidity is to be measured before the disinfection point at the treatment plant. Monitoring at this point must be continuous with an alarm activated at an NTU of 2, and automatic shut-off of supply to the reuse system at an NTU of 5.

Table 3 - Noise limits

Noise level dB(A) measured at:	Mondays to Saturdays			Sundays and public holidays		
	7am - 6pm	6pm - 10pm	10pm - 7am	7am - 6pm	6pm - 10pm	10pm - 7am
	Noise measured at a noise sensitive place					
$L_{A10, adj, 10 mins}$	45 + 5	40 + 5	35 + 0	45 + 5	40 + 5	35 + 0
$L_{A1, adj, 10 mins}$	40 + 10	45 + 10	30 + 5	40 + 10	45 + 10	30 + 5
	Noise measured at a commercial place					
$L_{A10, adj, 10 mins}$	45 + 5	40 + 5	35 + 0	45 + 5	40 + 5	35 + 0
$L_{A1, adj, 10 mins}$	40 + 10	45 + 10	30 + 5	40 + 10	45 + 10	30 + 5

DEFINITIONS

Words and phrases used throughout this permit[1] are defined below. Where a definition for a term used in this permit[1] is sought and the term is not defined within this permit[1] the definitions provided in the relevant legislation shall be used.

"administering authority" means the Environmental Protection Agency or its successor.

"annual return" means the return required by the annual notice (under section 316 of the *Environment Protection Act 1994*) for the section 73F registration certificate that applies to the development approval.

"approval" means 'notice of development application decision' or 'notice of concurrence agency response' under the *Integrated Planning Act 1997.*

""authorised place" means the place authorised under this development approval for the carrying out of the specified environmentally relevant activities.

"commercial place" means a place used as an office or for business or commercial purposes.

"Environmental Protection Agency" means the department or agency (whatever called) administering the *Coastal Protection and Management Act 1995* or the *Environmental Protection Act 1994.*

"erosion prone area" means an area declared to be an erosion prone area under section 70(1) of the *Coastal Protection and Management Act 1995.*

"intrusive noise" means noise that, because of its frequency, duration, level, tonal characteristics, impulsiveness or vibration –

- is clearly audible to, or can be felt by, an individual; and
- annoys the individual.
- In determining whether a noise annoys an individual and is unreasonably intrusive, regard must be given to Australian Standard 1055.2 – 1997 Acoustics – Description and Measurement of Environmental Noise Part 2 – Application to Specific Situations.

"$L_{A\ 10,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

"$L_{A\ 1,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response.

"$L_{A,\ max\ adj,\ T}$" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"land" in the "land schedule" of this document means land excluding waters and the atmosphere.

"mg/L" means milligrams per litre.

"noxious" means harmful or injurious to health or physical well being.

"NTU" means nephelometric turbidity units.

"nuisance sensitive place" includes –

- a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
- a motel, hotel or hostel; or
- a kindergarten, school, university or other educational institution; or
- a medical centre or hospital; or
- a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* or a World Heritage Area; or
- a public thoroughfare, park or gardens; or
- a place used as a workplace, an office or for business or commercial purposes and includes a place within the curtilage of such a place reasonably used by persons at that place.

"offensive" means causing offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive.

"regulated waste" means non-domestic waste mentioned in Schedule 7 of the *Environmental Protection Regulation 1998* (whether or not it has been treated or immobilised), and includes -

- for an element - any chemical compound containing the element; and
- anything that has contained the waste.

"site" means land or tidal waters on or in which it is proposed to carry out the development approved under this development approval.

"watercourse" means a river, creek or stream in which water flows permanently or intermittently-

- in a natural channel, whether artificially improved or not; or
- in an artificial channel that has changed the course of the watercourse.

"waters" includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water natural or artificial watercourse, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater and any part-thereof.

"you" means the holder of this development approval or owner / occupier of the land which is the subject of this development approval.

"95th percentile" means not more than one (1) of the measured values of the quality characteristic is to exceed the stated release limit for any twenty (20) consecutive samples for a sampling point at any time during the environmental activity(ies) works

END OF CONDITIONS

APPENDIX B

Little Cove Development

Sewage Treatment Plant

Site Based Management Plan

Simmonds & Bristow
Established 1965 ACN 010 252 418 Pty Ltd

Site Based Management Plan

Ella Bay
Sewage Treatment Plant Licence Submission

February 2006

Author: Terrence Allen *BE(Chem)*
Client: EPCO Australia
Ref No: 64056
Date: 23rd February 2006

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LIST OF APPENDICES

1.0 INTRODUCTION

This Site Based Management Plan has been prepared by Simmonds & Bristow on behalf of EPCO Australia to be submitted as part the Ella Bay Sewage treatment Plant Development application to the EPA under the *Integrated Planning Act 1997*

This Site Based Management Plan is a documented set of measures which specify how the holder of the environmental authority will manage actual and potential impacts resulting from operations of the Environmentally Relevant Activities, Sewage Treatment and Treating water for domestic use (other than treatment that only involves disinfection).

2.0 OVERVIEW

2.1 Objectives of the Site Based Management Plan

The objective of this plan is to assure that actual and potential environmental impacts resulting from the environmentally relevant activity are managed in an sustainable way.

2.2 Scope of the Site Based Management Plan

The SBMP incorporates:

- Routine operating procedures to prevent or minimise environmental harm, however occasioned or caused during normal operations;
- Maintenance practices and procedures;
- Contingency plans and emergency procedures to deal with foreseeable risks and hazards including corrective responses to prevent and mitigate environmental harm;
- Monitoring of the release of contaminants into the environment including procedures, methods, record keeping and notification of results;
- Assessment of the environmental impact of any release of contaminants into the environment including procedures, methods, record keeping and notification of results;
- Handling of environmental complaints;
- Keeping and production of environmental records and reports;
- Lines and methods of communication to be utilised for communication of procedures, plans incidents, potential environmental problems and results, including feedback mechanism to ensure that management is made aware of potential environmental problems and any failure of procedures adopted; and
- Staff training and awareness of environmental issues related to the operation of the environmentally relevant activities, including responsibilities under the EP Act.

2.3 Application of the Site Based Management Plan

A copy of this Site Based Management Plan and any subsequent amendment must be kept on the licenced place and be available for examination by an authorised person on request.

This management plan must not be implemented or amended where an implementation or amendment would result in a contravention of any condition of the environmental authority. Any amendment to the plan must be submitted to the regulating authority with the annual return which immediately follows the enactment of any such amendment.

3.0 ORGANISATIONAL STRUCTURE & RESPONSIBILITIES

3.1 Organisational Structure & Responsibility

Organisational structure, including responsibilities and lines of communication, should be carried out according to the following section. Included is a list of groups involved in the management of the site, and their suggested responsibilities, and suggested lines of communication between these groups.

Principle Body Corporate

- Licence holder;
- Endorse environmental policy and environment management programs required for legislative compliance;
- Ensure provision of adequate infrastructure through capital works programs
- Ensure that adequate resources are provided for the implementation of works and procedures required to achieve legislative compliance;
- Ensures funding of works and resources to achieve legislative compliance;
- Inform directors of any environmental harm or non compliance, if appropriate;
- Provide statutory submissions to EPA to fulfill legislative requirements.

Operations manager

- Ensure conformance to environmental Licence;
- Endorse environmental policy (if any), environment management programs required for legislative compliance;
- Ensure management, administration and implementation of resources, funding, operation and maintenance, procedures/processes to achieve legislative compliance;
- Appoint Qualified Treatment Plant Operators
- Ensure arrangements of environmental training needs are undertaken as required;
- Ensure environmental audits are undertaken;
- Inform EPA and/or Resort Management Company, as appropriate, of any environmental harm or non compliance and infrastructure operational problems to be addressed.
- Co-ordinate and liaise with centre personnel, plant operator and appointed personnel where engaged, on treatment plant operations and maintenance activities;

Plant Operators

- Minimum Qualification - Certificate II in Water Industry Operations
- Day to day monitoring and operation of the sewage treatment plant and disposal system
- Completion of daily operator log sheets and check lists
- Conduct visual site survey of treatment plant site and irrigation areas at least once a month;
- Liaise with Contractors and Operations Manager on plant operation and performance;
- Report to Operations Manager to arrange emergency repairs and maintenance;
- Inform Operations Manager of any environmental harm or non compliance;
- Ensure that signs and warnings to prevent undesired use of effluent are maintained in a legible and visible condition
- Establish and maintain internal communications between various levels of staff

Maintenance contractors

- Carry out major repairs and maintenance;
- Undertake scheduled maintenance on plant and equipment ;
- Keep detailed records of all maintenance and repairs undertaken
- Liaise with Operations Manager and Plant Operators;
- Establish and maintain internal communications between various levels of staff;
- Inform Operator or Operations Manager of any environmental harm or non compliance

Environmental Consultants / Testing Laboratory

- Primarily Advisory Role
- Advise Operations Manager and License holder on best environmental practice
- Advise Maintenance Contractors on maintenance practice
- Advise Operators on operational practice
- Liaise with the Operations Manager on environmental or operational issues
- Handle off-site testing of samples and issuing of reports regarding compliance with stated standards to the operations manager.

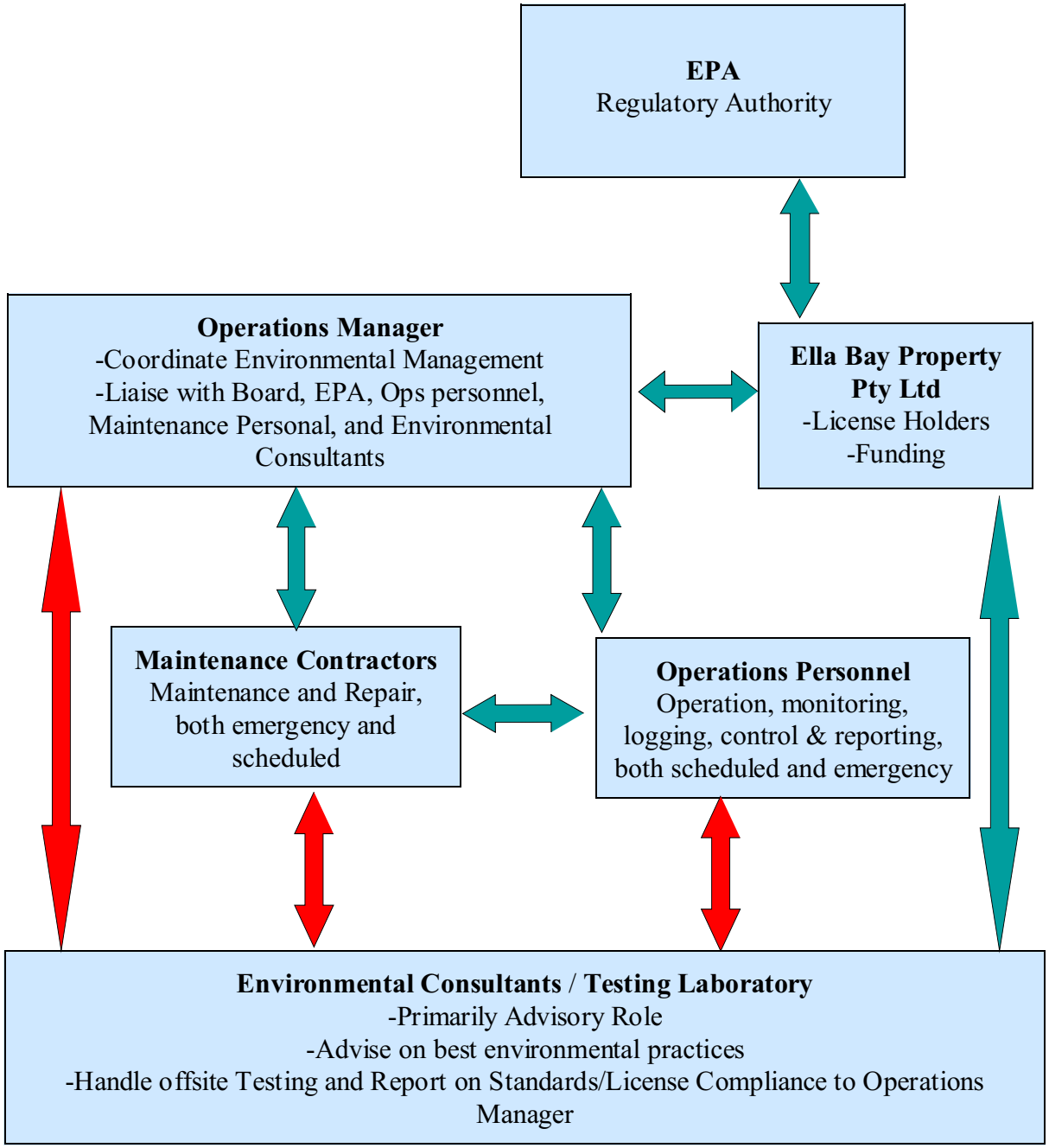
3.2 Methods of Communication

Communication between all involved parties, with the exception of the EPA, will be undertaken using various forms of verbal and written communication (phone, meetings, fax, e-mail, letters, reports) the type of which to be determined by personnel as the most appropriate for each circumstance.

Communication with the EPA will be undertaken using official written means (letters, reports and notices). Various forms of notices that may require submission to the EPA are referred to in the Management and Reporting Procedures included in Appendix C & D.

All written forms of communication (letters, reports, notices) and records associated with the operation and maintenance of the Sewage Treatment Plant must be kept on the licenced premises for a period of at least 5 years.

3.3 Lines Of Communication



Red arrows indicate advisory roles.

4.0 DESCRIPTION OF ACTIVITY

4.1 Environmentally Relevant Activity

The proposed Ella Bay Sewage Treatment Plant is classified as an Environmentally Relevant Activity under the Environmental Protection Act 1994:

ERA 15 (b) - Sewage treatment - operating a standard sewage treatment works having a peak design capacity of 100 equivalent persons or more but less than 1500 equivalent persons.

The proposed Ella Bay Water Treatment plant (for production of potable water from rain water) is classified as an Environmentally Relevant Activity under the Environmental Protection Act 1994

ERA 16 - Municipal Water Treatment plant - Treating water for domestic use (other than treatment that only involves disinfection)

Licenced Premises

Description	Ella Bay Resort Development
Street Address	Ella Bay Road, Ella Bay
Lot No. & Title Reference	Lot 337 on NR 53
County	Johnstone
Parish	Glady

The development is nestled next to the Ella Bay National Park and covers an area of 64.7 Ha. The site has 650m of beach frontage on Ella Bay, and runs almost a kilometre back into the forested hills. The land has significant flat areas adjoining the beach, and rises steeply further back. Within 450m of the beach frontage the land rises to between 100 and 120m above sea level, with some areas rising 110m in 100m, with slopes ranging from 35% to 50%. The land is covered with large stands of primary rainforest on the costal flat and hilltops, with dense to open forest/woodland on the hill slopes. Access is via a permanent, public, road, which follows the coast up from Flying Fish Point.

4.2 Site Description

4.2.1 Surrounding Activities

The area proposed for the sewage treatment plant is located in the services yard to the rear of the main resort complex. The Services yard is located on the inbound road, on the southern side of the resort complex, above the permanent creek that bounds that side of the site. The yard is approximately 150m from the resort complex and is bounded on all sides by rain forest. Site layouts are included in Appendix A.

With the exception of surrounding roadways no rural, industrial or residential development exists within 100 metres of the proposed treatment plant site.

4.2.2 Slope and Drainage

The land surrounding the immediate site (the services yard) slopes gently towards the ocean in the east, and the creek in the south, with a slope of approximately 5%. The land also rises sharply to the west, with slopes varying generally between 27% - 35%. In some areas slopes near 50%. These steepest areas are not being used for effluent disposal.

There exist two primary drainage lines within the site. The first is a creek in the central section of the site, which drains eastward into the marine environment. The next is a gully along the southern section of the site. This gully eventually drains into the creek which forms the southern border of the main resort complex, and eventually flows into the marine environment.

Stands of primary rainforest dominate the coastal areas and the tops of the ridges, with dense to open woodland on the slopes, and riparian vegetation being dominant towards the creek in the south. This rainforest will aid in the diffusion of stormwater draining from the site, although the steep slopes will cause stormwater to run off much more quickly than in flatter areas.

4.2.3 Groundwater

Two sources of groundwater exist beneath the site. The first is an unconfined aquifer in alluvial deposits in the lower areas of the site. Further groundwater exists within the bedrock forming the steeper portions of the site, and underlying the lower areas of the site.

The quality of the groundwater resource underlying the effluent disposal areas is considered to be potable without treatment. (*Refer: Golder Associates, Geotechnical Studies - Proposed Eco-Tourist Resort, Ella bay, Queensland, 1995)*

4.2.4 Vegetation

The coastal flat and ridge-tops are covered mostly in primary rainforest, with the hill-slopes being dominated by open to dense woodland, and riparian vegetation being common along the permanent creek in the south.

4.2.5 Soil Types

Various studies and investigations have been undertaken by both Simmonds & Bristow and Golders Associates to determine the suitability of the site for plant construction.

Soils along the coastal flat consisted of a thin rich organic topsoil over brown/red sandy loamy clays of uniform consistency, though a yellow sandy loamy clay was predominant in the south eastern corner, on the southern side of the significant permanent creek. Soils were generally classified as stiff to very stiff sandy silty clays, with topsoil covering typically 0.3 m thick.

Detailed soil data and reports relative to the treatment plant site are provided in the various reports accompanying this management plan (*Refer; Simmonds & Bristow Review of Effluent irrigation Areas, Golder Associates, Geotechnical Studies - Proposed Eco-Tourist Resort, Ella bay, Queensland, 1995*).

4.3 Sewage Treatment Plant

4.3.1 Process Description

The sewage treatment plant utilises activated sludge treatment technologies to treat the sewage to a discharge level appropriate for unrestricted irrigation and other uses, including toilet flushing and firefighting purposes.

Major components of the treatment process.

- fine screening for grit removal
- an aerated flow balance tank
- an aeration chamber to support aerobic and anoxic phases for nitrogen removal with :
    - automatically controlled aeration based on dissolved oxygen
    - mixer capacity during anoxic periods
    - sodium aluminate dosing for phosphorus removal
- a clarifier for sludge settlement, wasting and return
- sand filters for further polishing of clarified effluent
- chlorine dosing and UV disinfection
- an aerobic digester for sludge volume reduction
- treated effluent storage tanks

Sewage first enters the plant through a flow-meter, which allows sewage generation to be tracked. The sewage is then screened, which removes most of the grit and other large particulate matter. It then flows into an aerated balance tank, which allows for surges or shocks in flow to be attenuated. From the balance tank sewage is then pumped into an aeration chamber which is used for the removal of biological and nutrient contamination, using a series of aerobic, and anoxic cycles. This removes the bulk of organics and nitrogen in the effluent. The treated effluent is then dosed with sodium aluminate for chemical phosphorous removal. From the aeration tank the effluent enters a settling tank, where the bulk of biological material settles out, and is removed as sludge. The effluent then enters a chlorine dosing station, goes through sand filtration for final polishing, and is finally UV disinfected. The effluent is then stored in a 500 kL storage tank.

The sludge removed from the settling tank is recycled to the front of the process (into the aeration balance tank) and a portion is harvested, or ‘wasted’ to maintain sludge volumes. This wasted sludge enters an aerobic digester, in which its volume is reduced, before being taken offsite by registered waste handlers.

A process flow diagram has been included in Appendix B of this document.

Treated Effluent will be used in a variety of roles, including toilet flushing, irrigation, wash down water and in fire fighting applications.

4.3.2 Effluent Quality

The plant and equipment has been designed to achieve an effluent with quality characteristics equivalent to or less than those specified in the table below.

Treated Effluent Quality

Parameter	Unit	Maximum
Suspended Solids	mg/L	< 1
Turbidity	NTU	< 2.0
Biological Oxygen demand-5	mg/L	< 10
Total Nitrogen	mg/L	< 10
Total phosphorous	mg/L	< 1
Faecal Coliform *	org/ml	< 10
pH		6.5 - 8.0
Dissolved Oxygen	mg/L	>2

* Median from 5 samples of final effluent taken at half hourly intervals.

4.3.3 Design Capacity

The Sewage Treatment Plant has a design capacity of 41 kL/day. This was calculated using the values in the following table, which contains a breakdown of the factors contributing to the daily sewage flow. Peak flow, taking into account rainfall in the wet season, and groundwater infiltration is calculated to be approximately 86kL/day.

The maximum population estimated for the site is between 200 and 285 people. This estimate depends on the occupancy rate of the villas. A figure from 2.5 to 3 people per villa has been estimated, and calculations for sewage generation are based upon a population estimate of 285 people. The figure of 400 EP is an equivalent population used for flowrate calculations. It includes water allocation for the Restaurant, Pool, Wash water, cleaning water, etc, that cannot be easily based upon a basic count of the people living in the development.

The Expected Dry Weather Flow of 41 kL/day is what is to be treated on an average day. The peak design capacity of the sewage treatment plant is 86 kL/day, allowing for possible stormwater infiltration into the sewer system of 45 kL/day. The infiltration rate of 2.1 x ADWF has been sourced from the *Sewer Code of Australia,* on the basis that the sewer system will be newly installed. The pipework for the system is also shallow, so there should be no groundwater infiltration into the system. At maximum flow the plant should be able to treat 86 kL/day of effluent to the standard required. The plant should also have a maximum hydraulic throughput of 205 kL/day. Excess effluent will be stored in the wet weather storage tank.

Table 4.3.1
Estimated Water Supply & Sewage Generation Rates

Demand/Generation Source	Water Supply Demand			Sewage Generated		
	Average Daily Fresh Water Demand kL/day	***Mean Day Maximum Month kL/day***	***Reuse Water kL/day***	***Average Dry Weather Flow kL/day***	***Peak Wet Weather Flow kL/day***	***Effluent Reuse***
Main Complex 40 employees @ 30L/ep/day	1.2	1.8	0.3	1.5	3.15	0.5
Restaurant 100 seat 3meals/day @ 20L/meal	6	9	1.5	7.5	15.75	1.5
Hill Top Accommodation Units 70 units @ 3ep/unit @ 80L/ep/day	16	24	4.8	20.8	43.68	7.2
Beach Accommodation Units 30 units @ 2.4ep/unit @ 80L/ep/day	5	7.5	1.25	6.25	13.125	1.8
Manager's Residence 3.5 ep @ 80L/ep/day	0.2	0.3	0.06	0.26	0.546	0.1
Swimming Pool @ 3500m2 @ 25mm/week	12	18	0	4.5	9.45	0
Irrigation (Available)			37.9			37.9
Total	40	61	46	41	86	49
Flow L/ep/day	101	151	114	102	214	122

The rate of 100L/person/day for sewage generation equates well with our experience of controlled communities and flow estimates from AS1547. The appropriate section of AS1547, stating the flow estimates used, has been attached as appendix G.

4.4 Effluent Disposal

4.4.1 Effluent Disposal Scheme

The effluent produced from the Proposed Ella Bay Sewage Treatment Plant is to be disposed of by way of recycling and effluent irrigation.

Recycling effluent is estimated to account for 25% of the daily flow through the plant. This includes recycling for use in toilets, etc.

The site characteristics have been assessed and analysed using MEDLI modelling, and are considered suitable for effluent disposal via irrigation.

The irrigation system comprises of a 500kL wet weather storage tank and above ground low pressure irrigation system.

MEDLI modelling, conducted by Simmonds and Bristow (*ref: Simmonds and Bristow, Review of Effluent Irrigation Areas*), determined that 500kL was the optimum wet weather storage capacity. The modelling indicated that, with 500kL of wet weather storage a overtopping event would occur only 3 times in every 10 years.

Treated effluent will be evenly applied on a daily basis from the wet weather storage to a low pressure droplet irrigation system, using a wobbler sprinklers or similar devices to reduce the risk of effluent drift.

Wobbler heads will be spaced at 10m intervals and approximately a metre off the ground to achieve uniform coverage, and to prevent the majority of vermin interfering with them. The sprinkler heads will be supported and secured by star pickets.

Irrigation will be halted during periods of heavy rainfall (ie. rainfall events resulting in runoff from irrigation areas) with effluent being diverted to wet weather storage facility.

When the capacity of the wet weather storage is reached, rather than have the storage tank overflow, excess effluent will be applied evenly across the irrigation area.

To manage surface runoff from the irrigation areas in such events, a system of cutoff and runoff bunds provide control of point source releases, encouraging additional absorption and diffuse release into the surrounding forest areas. (See Appendix F). A further explanation of the physical arrangement of the bunds has been provided in section *7.2 Effluent Irrigation Management*, later in this document

The release of effluents during rain events are most likely to occur during the wet season.

Dilution of this effluent by rainfall and natural runoff will result in significant reductions in the concentration of nutrients.

The approximate diluted concentration of nutrients has been calculated and are detailed in the table below, for the typical wet season months.

Month	Monthly Rain (m3)	Daily Rain (m3)	Runoff (0.5 Coeff)	Dilution Factor
December	131850	4395	2197	55
January	241200	7780	3890	100
February	276750	9796	4898	120
March	279900	9029	4504	110
April	190800	6360	3180	80
May	148950	4804	2402	60

The volume of dilution water was calculated assuming a catchment area of 45 Ha. This excludes areas covered by the storm water system, i.e. the villas and the resort complex, and the catchment in the north western corner, which flows away from the site.

As can be seen from the table the lowest possible rainfall that may cause an overtopping event still results in significant dilution of the nutrients present in the irrigated effluent.

Of the months of the wet season, stated in the previous table, an overtopping event requiring irrigation during rain fall is most likely to occur in March, as it has the highest rainfall of the year.

If irrigation was required, to prevent the Wet Weather Storage Tank from overflowing, during heavy rain fall, for one day in March, the concentrations in the following table are likely to occur in the effluent/stormwater runoff.

Component	Unit	Concentration
Suspended Solids	mg/L	0.016
BOD5	mg/L	0.16
T.N	mg/L	0.08
T.P	mg/L	0.016
Dissolved Oxygen	mg/L	0.032
F.Coliforms	orgs/mL	0.16

At this level of dilution these values should present no theat to the environment. The nitrogen discharge is well below the requirement of <10 mg/L discharge standard for the Great Barrier Reef Marine park, and the <0.1 mg/L for fresh water nitrogen eutrophication concentration

4.4.2 Irrigation Areas

The current irrigation plan includes irrigating on the numbered sections, presented on the Irrigation Area Map, included in Appendix A, along with the supporting MEDLI model outputs. The current Irrigation system concept also includes irrigating on lots of appropriate slope at a heavily reduced irrigation rate.

Each of the irrigation areas will be irrigated at a different rate based upon their slope. This is to prevent the occurrence of runoff under normal operating conditions as far as is possible. Areas of slope up to approximately 15% will be irrigated at a rate of 2mm/day. Slopes from 15% to 25% will be irrigated at 1mm/day. Slopes from 25% to 50% will be irrigated at 0.25mm/day. Appropriate villa lots will also be irrigated at 0.25 mm/day.

Currently there are no plans to irrigate outside of the areas detailed in this document.

The following list details the amount of usable area avaliable in each irrigation area. This is also detailed on the Irrigation Area Map, in appendix A

- Area 1, approximately 1.93 ha useable irrigation area
- Area 2, approximately 1.21 ha useable irrigation area
- Area 3/7, approximately 0.84 ha useable irrigation area
- Area 4/5, approximately 0.94 ha useable irrigation area
- Area 6, approximately 1.46 ha useable irrigation area
- Irrigated Villa Lots, approximately 250m2 per lot, totalling 1.215 ha useable irrigation area.

As stated the current rationale is based upon irrigating these areas at varying rates based upon their slopes. The irrigation rates are as follows

- Area 1 - 2.0mm/day
- Area 2 - 2.0mm/day
- Area 3/7 - 0.25mm/day
- Area 4/5 - 1.0mm/day
- Area 6 - 1.0mm/day
- Villa Lot Irrigation Areas - 0.25mm/day

MEDLI modelling indicates that these rates, irrigated on these areas should result in no adverse environmental effects.

4.4.3 MEDLI Model

As stated in the previous section, MEDLI modelling has been conducted on each of the application rates and area combinations mentioned above. This section will explain the rationale used when setting up this model.

In order to model the application areas and rates effectively 3 MEDLI models were used. The first model was for irrigation areas 1 and 2, at 2mm/day. The second model was for irrigation areas 4/5 and 6, at 1mm/day. The third was for area 3/7 and the irrigated lots, at 0.25mm/day.

38 kL of effluent is estimated to be available for irrigation after recycling. MEDLI accounts for stormwater infiltration automatically based upon the rainfall data entered for the model. A low infiltration rate was selected for MEDLI, which resulted in a total irrigation volume of 47.6kL/day. This value included 38 kL of effluent, and 9.6 kL of infiltration water.

In order for the model to give representative results the water flow was split into 3, based upon the irrigation rate and size of the irrigation areas associated.

- Areas 1 and 2: 63.4% of Irrigation Flow = 30.2 kL/day
- Areas 4/5 and 6: 31.6% of Irrigation Flow = 15 kL/day
- Areas 3/7 and the Villa Lots: 5% of Irrigation Flow = 2.4 kL/day
- Total = 47.6 kL/day (effluent + infiltration water)

In addition to this the wet weather storage available was split along the same percentages to keep the model consistent, as having the whole 500 kL available separately for each model would cause massive changes in the models results.

- Areas 1 and 2: 63.4% of Wet Weather Storage = 317 kL
- Areas 4/5 and 6: 31.6% of Wet Weather Storage = 158 kL
- Areas 3/7 and the Villa Lots: 5% of Wet Weather Storage = 25 kL
- Total = 500 kL (m^3)

4.4.4 Physical Components

The aim of the physical components of the irrigation system is to deliver the effluent to the irrigation areas while causing as little environmental impact as is possible. Above ground distribution systems have been chosen for various reasons. Above ground systems are laid directly on the ground, and can be covered with a layer of mulch where required. This removes the need to 'dig in' pipe work, keeping soil disturbance to a minimum. Above ground systems also increase the ease of maintenance, since pipework doesn't need to be dug up if leaks or bursts occur.

2 main types of system are intended to be used throughout the resort complex, depending on the characteristics of the application area.

In areas of low slope and low public access an above ground system using wobbler heads for effluent distribution is the preferred method. Wobbler heads produce a distinct droplet, and hence avoid the potential problems with effluent 'aerosoling off' as a fine mist. Due to local fauna activities (especially those of feral pigs) the wobbler heads will need to be placed at least 1m off the ground, and secured to star pickets or the like.

In areas of high slope, or high public access, a drip line system is the preferred distribution method. Drip lines apply effluent through small holes in the line. They provided a wetted area around the line of approximately 0.5m. The lines can be covered in a layer of mulch to avoid accidental contact with people or local fauna. The lines are manufactured with various root discouraging compounds in the plastic, to prevent drip holes being invaded by hair roots or the similar. 'Hardy' pressure compensating drip line will be used, which is significantly stronger than standard trickle tape, in an attempt to prevent the lines being compromised by interaction with local fauna.

Both systems are planned to be pressure balanced, and have pressure monitors on each line. These pressure monitors provide burst protection by detecting variations in pressure, which indicate damage to the irrigation distribution system, and shutting off the appropriate line automatically. Maintenance personnel can then assess the damage and repair it as necessary.

4.5 Potable Water Treatment

4.5.1 Treatment Process Description

The potable water treatment plant will treat rainwater collected from the roofs of the buildings on the site.

From rooftop to tap, the potable water treatment system consists of the following major parts

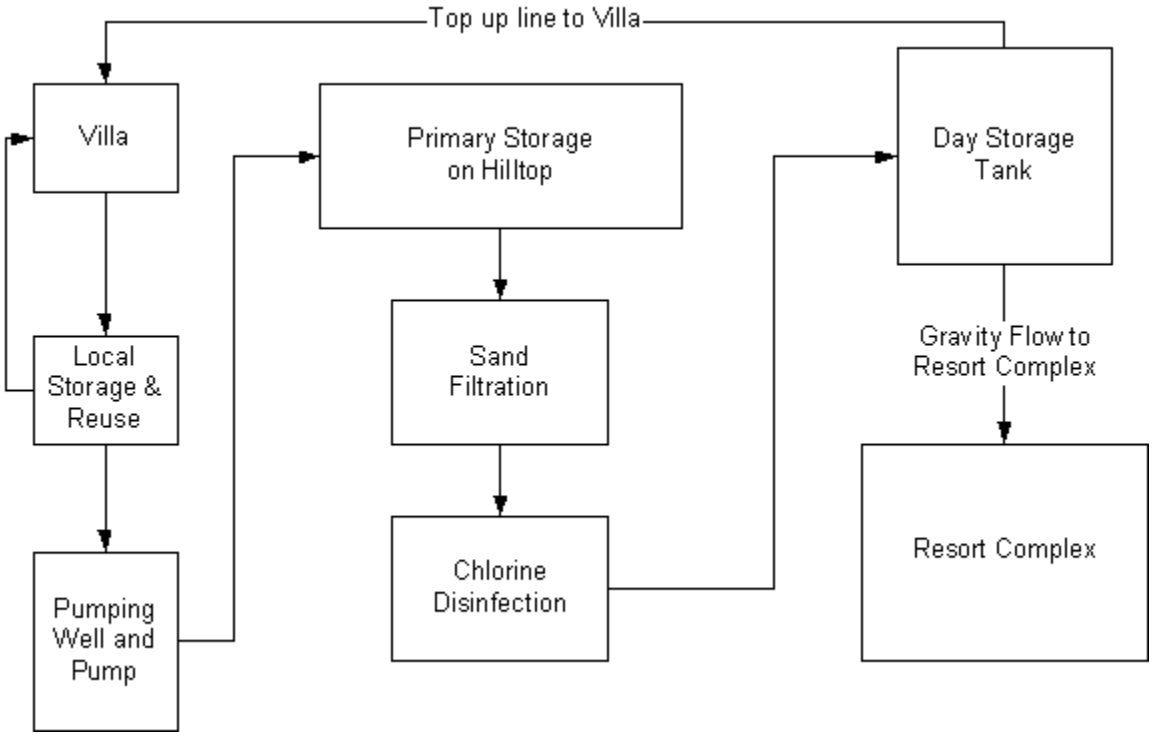
- Rooftop rain water collection
- Raw water storage
- Sand filtration of Raw Water
- Chlorine Dosing of filtered water for disinfection
- UV disinfection of treated water
- Storage
- Pressure balanced distribution of water.

Firstly the water is collected from the rooftops of all the buildings on site, during rainfall. This water enters a small tank adjoining each building on the site. This tank overflows into a pipe network, eventually ending up in the main Raw Water Storage Tank. From this tank water is taken, at a constant rate, and ran through the treatment process. It is first sand filtered to remove any grit or other such particulate matter collected. The water is then chlorine dosed for disinfection. The water is finally stored in a 500 kL storage tank, and piped around for potable use.

This water is directed from the roof of each building into a small holding tank, which overflows into the main raw water storage tank.

4.5.2 Process Layout

The following is a simple process layout for the Potable Water Treatment System



4.5.3 Treated Potable Water Quality

The treatment system will treat raw water obtained by the rain water collection system to a potable standard, in line with the aesthetic values set out in the following table.

Further, the filtration and disinfection system will also aid in achieving the following general chemical, physical and bacteriological qualities.

component	unit	guideline value*
Aesthetic		
pH		6.5-8.5
Colour	HTU	15
Turbidity	NTU	5
Physical		
Conductivity (TDS)	us/cm	790
Hardness/Alk (as CaCO3)	mg/L	200
Dissolved Oxygen	%	>85
Bacteriological		
E. Coli	orgs/mL	<1
Faecal Coliforms	orgs/mL	<1
Hetertrophic Plate Count **	orgs/100mL	100
Chemical		
Chlorine (free)	mg/L	0.6
Iron	mg/L	0.3
Manganese	mg/L	0.1
Sodium	mg/L	180
Chromium	mg/L	0.05
Lead	mg/L	0.01
Zinc	mg/L	3
Nickel	mg/L	0.02
Cadmium	mg/L	0.002
Antimony	mg/L	0.003
N+N (organic Nitrogen)	mg/L	3
Ammonia	mg/L	0.5
Hydrogen Sulphide	mg/L	0.05
Trihalomethanes (THM)	mg/L	0.25

* Guideline limits from the National Health and Medical Research Councils Australian Drinking Water Guidelines, 2004

** Guideline value for a Disinfected Water Supply

4.4.4 Capacity

The Rain water treatment system has to cater for a population of 400ep. Calculations have been conducted (*Simmonds & Bristow: Ella Bay Resort Development, Review of Irrigation Areas)*, indicate a maximum treatment rate of 60kL/day, based on the Mean Day Maximum Month usage, of 1.5 times the Average Daily Demand (40kL) would be sufficient to supply the water requirements of the population.

Piping in the distribution network, which draws water from the day-storage tank, would also need to cater for a load of approximately 60kL/day, as the MDMM figure. The top-up lines for the individual villas can be designed to cater for less flow, as they should only be used intermittently.

This estimate is based upon the fact that residents are using rain water, which naturally causes people to attempt to save water (almost 30% reduction in water usage), with water saving devices, such as 5 star rated low-flow taps and shower heads, installed in all villas. Estimated water use is detailed in AS/NZS 1547:2000, for a household using full water saving fittings with a rooftop rainwater supply, as 80 L/person/day. Addition of approximately 20L/person/day equivalent of backwash water, for the pool filters, gives a total of approximately 100L/person/day. Irrigation of gardens, etc, can be taken care of using recycled effluent.

4.4.5 Storage

A storage tank of approximately 500 000L will be constructed beside the sewage effluent tank, which is of similar capacity. This tank provides both surge and shock capacity for the treatment system to attenuate any variations in water flow.

In addition to the treated water storage tank a pumping well is included in the design of the treatment plant. The well provides a central collection point for rainwater collection, as well also providing buffer capacity for the Potable Water Treatment System.

The capacity of the collection tank is dependent on the pump size. Using the main storage tank on the hilltop for raw water storage, the treatment system is placed after the main storage tank. The treatment plant then feeds a day-storage tank, which feeds the distribution to the Resort Complex.

5.0 IDENTIFIED ENVIRONMENTAL & PUBLIC HEALTH RISKS

The activities associated with the onsite treatment and disposal of effluent at the Ella Bay Development pose various environmental and public health risks which are identified in the table below:

Activity	Aspects Requiring Management
Sewage Plant Operation	Ambient Environment - Noise & Odour - odour - gaseous chemical release - operation of equipment Water Quality - Surface, Storm & Ground Water - effluent spill - chemical spill - poor quality effluent due to plant operational problems - sludge spill Land - Contamination & Degradation - uncontrolled effluent discharge - sludge spill - chemical spill Public Health - operator workplace health & safety - uncontrolled access to plant and equipment
Effluent Disposal	Land - Contamination & Degradation - poor effluent quality - effluent application overload Water Quality - Surface, Storm & Ground Water - poor effluent quality - effluent application overload Public Health - Exposure to Effluent - effluent application overload - exposure to spray aerosols
Effluent Storage	Water Quality - Surface, Storm & Ground Water - uncontrolled effluent discharge Ambient Environment - Noise & Odour - odour Land - Contamination & Degradation - uncontrolled effluent discharge - poor effluent quality Public Health - Exposure to Effluent - uncontrolled effluent discharge - uncontrolled access to plant and equipment
Rainwater Treatment	Ambient Environment - Noise & Odour - operation of equipment Public Health - Poor Treatment Quality - Contamination of Treated water

Environmental aspects identified will be addressed by way of established procedures and management plans detailed in Sections 6.0 and 7.0 of this document.

6.0 PROCEDURES

Procedures associated with the Sewage Treatment Plant and associated infrastructure at the Ella Bay Development can be broadly classified as:

- Operating and maintenance procedures
- Contingency plans and emergency response procedures
- Reporting procedures

6.1 Operation and Maintenance Procedures

The operation and maintenance procedures are to be developed once the plant construction and commissioning phase is complete.

6.2 Emergency Response Contingency Plans & Procedures

The emergency response contingency plans and procedures for the Ella Bay Sewage Treatment, Effluent Disposal Scheme and Potable Water Treatment Plant are summarised in the table below. These procedures relate to events that may cause or result in uncontrolled release of effluent or sludges that may cause or have caused adverse environmental harm and or public health exposure. The detailed procedures are documented in Appendix C.

Emergency Response Contingency Plans & Procedures

Procedure	Title
EB-CP-01	Power failure contingency procedure
EB-CP-02	Overflows from plant and equipment
EB-CP-03	Uncontrolled runoff from effluent disposal system
EB-CP-04	Pump failure contingency procedure
EB-CP-05	Potable Water Contamination
EP-CP-06	Pipe failure contingency procedure
EP-CP-07	Blower failure contingency procedure
EP-CP-08	UV-Disinfection failure contingency procedure
EP-CP–09	Chlorine Dosing failure contingency procedure

6.3 Complaints, Incidents and Exception Reporting Procedures

The procedures for the investigation, processing and reporting of complaints, incidents and exceptions are summarised in the table below. The detailed procedures are documented in Appendix D.

Investigation, Processing & Reporting Procedures

Procedure	Title
EB-01	Complaints reporting procedure
EB-02	Incident / Emergency reporting procedure
EB-03	Exception reporting procedure

7.0 MANAGEMENT PLANS

7.1 Stormwater Management

7.1.1 Management Plan

The objective of the stormwater management plan is to detail how the design and operation of the sewage treatment plant and effluent disposal system will prevent and/ or minimise the release or likelihood of release of contaminated effluent / runoff from the licensed place to any stormwater drain or waters or the bed or banks of any such waters.

Risk Identification, Minimisation & Management

Risk	Minimisation Methods	Management Procedure
Contamination of Incident Stormwater via Infiltration to Sewer & Plant	The treatment plant and effluent storage tanks are constructed in a manner that minimises contamination of incident stormwater in that all treatment and storage tanks are completely enclosed and constructed of sealed storage tanks.	Not Required
Overflows from Treatment Plant	The treatment plant has been sized appropriately to cope with the peak loads expected from the community it services therefore overflows from the treatment facility are not expected.	Not Required
Stormwater contamination via runoff from Chemical Spills	All chemicals are to be stored and managed in accordance with AS1940: 1993 -Storage and Handling of Flammable and Combustible Liquids, with particular emphasis on bunding requirements.	None Required
Overflow From Effluent Storage Tanks	This risk has been minimised by designing the effluent disposal system so that ADWF volumes can be disposal of sustainably on a daily basis. In the event that the storage facility reaches its maximum capacity (during prolonged periods of heavy rainfall) rather than experience a concentrated overtopping event effluent is to be irrigated evenly across all irrigation areas.	ERCPP EB-CP-02 (Appendix C)
Uncontrolled Runoff from STP site, causing erosion	This risk has been minimised through the use of stormwater diffusing methods, namely a jungle swale, in the direction of water flow. More information about the jungle swale is presented later in this document.	None Required
Uncontrolled Runoff from Effluent Disposal System	This risk is minimised by sizing storage capacity for at least 5 days ADWF of sewage effluent. If runoff from the Irrigation sites occur (i.e. effluent is being released through a preiod of heavy rain fall) a system of runoff bunds slow runoff enough to allow it to soak into the surrounding soil. If this system is overloaded the Bunding system directs the water into natural drainage channels. More information on the Bunding system shall be presented later in the document.	ERCPP EB-CP-03 (Appendix C)
Pool Overflow caused by Stormwater	Currently the pool is most likely going to be salt-water 'chlorinated'. This should result in minimal to no impact if an overflow event occurs.	None Required

ERCPP = Emergency Response Contingency Plan & Procedure

7.1.2 Jungle Swale

A jungle swale is similar to a grass swale. This is a stormwater management system which serves to decrease the possible erosion caused by water running off a developed site, in this case the STP area itself. The system involves the planting (or in this case, use of already existing rainforest) to break up stormwater flow over an area, instead of flowing from a point source, to reduce the impact the water has on the land.

7.1.3 Stormwater System

The other developed areas of the site, primarily the roads, also require stormwater management. This includes storm guttering on all roads, and a stormwater drainage system. This system will then deliver the stormwater into natural drainage lines or natural rock formations, through diffusion mounds, for reduced impact via erosion.

Currently proposed areas for stormwater disposal are a rocky gully on the second hill. Stormwater from the first switchback can be piped to this area. With suitable diffusion this water can be piped to the rocky gully, where it will fall upon a rock surface, causing significantly less erosion than the same volume of storm water running down a hillside.

Other possible areas for stormwater disposal are the permanent creek in the southern section, which could service the main complex itself, and the first switchback if needed. There is also a second creek bed, which runs in the wet season, that could also serve the first switchback. Either of the creeks (either the permanent creek or the rainfall generated creek) could serve as a stormwater outlet for the main resort complex, although appropriate steps need to be taken to prevent erosion or alteration of the creek banks, such as appropriate diffusion of stormwater, using rock diffusion mounds or other such methods, over a larger area to prevent any erosion.

7.2 Effluent Irrigation Management

7.2.1 Management Plan

The objective of the Effluent Irrigation Management Plan is to describe how the actual and potential environmental impacts resulting from the onsite disposal of treated effluent from the treatment plant will be minimised and managed.

Risk Identification, Minimisation & Management

Risk	Minimisation Methods	Management Procedure
Overflow From Effluent Storage Tanks	This risk has been minimised by sizing the effluent disposal areas so that average dry weather sewage flow volumes can be disposed of sustainably on a daily basis. In the event that the storage facility reaches its maximum capacity, during prolonged periods of heavy rainfall, rather than experience a concentrated overtopping event, effluent is to be irrigated evenly across all irrigation areas.	ERCPP EB-CP-02 (Appendix C)
Uncontrolled Release from Effluent Disposal System	This risk has been minimised by sizing the effluent disposal areas so that average dry weather sewage flow volumes can be disposed of sustainably (ie. without runoff). In the event of a runoff event the impact will be minimised using a system of bunds which will slow runoff sufficiently to allow natural entry into the soil. This system will be explained in more detail later in this section	ERCPP EB-CP-03 (Appendix C)
Disposal of Poor Quality Effluent	The risk of releasing poor quality effluent from the treatment plant will be minimised as the plant has been sized appropriately to cope with the peak loads expected from the community it services. Flow balancing has also been incorporated into the plant to prevent peak / shock loads on the plant. The correct operation and maintenance of the plant by trained contractors will also assist in ensuring an appropriate quality effluent is released. Regular/monthly monitoring of the effluent from the plant will provide an assessment method of the plants performance.	ERP EB-03 (Appendix D)

ERP = Exception Reporting Procedure

7.2.2 Runoff Control System: Runoff and Run-on Bunds.

The Runoff and Run-on Bunding arrangements consists of a series of contour banks, gutters, and strip drains to prevent effluent runoff.

Run-on contour banks, or bunds, follow the natural contours of the land. They serve to direct any incident stormwater around, and away from, an irrigation area into natural drainage channels.

Runoff bunds consist of slightly permeable rock barriers, dug into the hillsides, preceded by strip drains. The bund serves to halt any runoff or stormwater from within the irrigation area itself. The strip drain then allows water held up by the bund to diffuse into the ground at a higher rate than would be achieved by unaided diffusion.

Runoff bunds are slightly permeable to allow for the diffusion of water through the bund itself. This helps reduce the possibility of the overloading of the strip drains as water should just pool behind the bund, and diffuse through it.

If the bund overtops, runoff stormwater will released over a diffuse area, which is better for erosion control than having a point release. Sketches of the basic Bunding arrangements, and of proposed areas for Bunding around current irrigation zones are included in Appendix F.

7.3 Vermin Management

7.3.2 Explanation of Pig and Ant Activities

Both pigs and ants will be seeking moisture in the dry season. The irrigation system provides a perfect source of moisture for both of these pests. Pigs will destroy irrigation piping searching for moisture, rupturing the supply pipe or wobbler head, then turning the entire area into a wallow. This results in uncontrolled effluent runoff and significant land damage. Ants will build nests in drip or wobbler heads, which clogs nozzles. This causes the heads to burst when turned on, again resulting in uncontrolled effluent runoff.

7.3.1 Management Plan

The objective of the Vermin Management Plan is to describe how the actual and potential environmental impacts resulting from the activity of local pests will be minimised and managed.

Risk Identification, Minimisation, and Management

Risk	Minimisation Methods	Management Procedure
Destruction of Pipes and other Infrastructure by Pig Activity	Regular (6 monthly) control of the local pig population, via non-invasive methods, including hunting with Crossbows. Pressure sensors will also be installed on each irrigation line. Any out of specification reading will trigger an inspection by plant personnel. Appropriate steps will be taken to prevent conflict with any native fauna (i.e cassowaries).	None Required
Destruction of drip heads via ant nests	Pressure sensors will be installed on all irrigation lines. Any out of specification pressure reading will trigger an inspection of the relevant irrigation line by plant personnel.	None Required

7.4 Equipment Failure Management

7.4.1 Management Plan

The objective of the Equipment failure Management Plan is to describe how the actual and potential environmental impacts resulting from the equipment failure will be minimised and managed.

Risk Identification, Minimisation & Management

Risk	Minimisation Methods	Management Procedure
Power Failure	In the event of power failure effluent will be stored. If storage proves insufficient, generated power can be temporarily provided, via a backup diesel generator, to power the treatment process. All pumps are fitted with a backup pump that is capable of running without mains power.	ERCPP EB-CP-01 (Appendix C)
Pump Failure	Correct operation and regular maintenance of pumps is to be preformed by contracted trained operators, therefore minimising the risk associated with unplanned equipment failure. All pumps are to be fitted with standby pumps and pump failure alarms which can operate without mains power.	ERCPP EB-CP-04 (Appendix C)
Pipe Failure	Correct operation and regular maintenance of pipes and fittings is to be performed by contracted trained operators, therefore minimising the risk associated with unplanned equipment failure. Sufficient storage is provided to allow for pipe replacement.	ERCPP EB-CP-06 (Appendix C)
Blower Failure	Correct operation and regular maintenance of blowers and aerators is to be performed by contracted trained operators, therefore minimising the risk associated with unplanned equipment failure	ERCPP EB-CP-07 (Appendix C)
UV Disinfection Failure	Correct operation and regular maintenance of the UV disinfection system is to be performed by contracted trained operators, therefore minimising the risk associated with unplanned equipment failure	ERCPP EB-CP-08 (Appendix C)
Chlorine Dosing System Failure	Correct operation and regular maintenance of the Chlorine dosing system is to be preformed by contracted trained operators, therefore minimising the risk associated with unplanned equipment failure	ERCPP EB-CP-09 (Appendix C)

ERCPP = Emergency Response Contingency Plan & Procedure

7.5 Solid Waste Management

The objective of the waste management plan is to detail how the actual and potential environmental impacts resulting from the handling of solid waste from the treatment plant be minimised and managed.

Risk Identification, Minimisation & Management

Risk	Minimisation Methods	Management Procedure
Sludge Handling & Disposal	Sludges are to be disposed of off-site using regulated waste transporters therefore the risk associated with contamination resulting from sludge handling practices is minimised.	When waste is removed from the licenced place a regulated waste transport certificate must be kept at the licenced place for a period of 5 years.
Grit & Screenings	Grit and screenings are to be disposed of off-site using regulated waste transporters therefore the risk associated with contamination resulting from waste handling practices is minimised.	When waste is removed from the licenced place a regulated waste transport certificate must be kept at the licenced place for a period of 5 years.

7.6 Noise and Odour Management

The object of the Noise Management Plans is to describe how the actual and potential environmental and personal impacts resulting from the noise produced by the treatment of both Sewage and Potable Water will be minimised and managed

Risk Identification, Minimisation & Management

Risk	Minimisation Methods	Management Procedure
Noise from Equipment Operation	Noise generated by the blowers is to be minimised by mounting the blowers on rubber footings, and employing either a noise block out box, or a proprietary noise dampening system.	Noise dampening systems should reduce noise to 5dB at a 10m range. Exceptions will be handled on a complaint basis.
Odour from STP	Odour from the Sewage Treatment Plant is expected to be minimal, as the process is aerobic. In addition there is a vegetation barrier surrounding the services yard and as much of the process is sealed as is practical.	Odour is not expected to be a problem and will be dealt with on a complaint basis.

7.7 Potable Water Management

The object of the Potable Water Management Plan is to describe how the actual and potential environmental and personal impacts resulting from the treatment of rainwater for use in domestic applications will be minimised and managed.

Risk	Minimisation Methods	Management Procedure
Poor Quality Water from Treatment System	Treatment system shall be sized to treat the maximum mean daily usage. Storage tanks also provide a surge capacity if usage exceeds that predicted for a short period. Treatment and storage is sealed to reduce the chances contaminants can enter the system.	ERCPP EB-CP-05 (Appendix C)
Contact with Filter Backwash	Filter backwash will be directed to the STP via a closed system for treatment and disposal. Filters Backwashed as per manufacturers instructions.	None Required
Contact with Chemicals, Chemical Spill.	All chemicals are to be stored and managed in accordance with AS1940: 1993 -Storage and Handling of Flammable and Combustible Liquids, with particular emphasis on bunding requirements.	None Required

8.0 MONITORING & REPORTING

8.1 Monitoring Program

Routine monitoring is required to meet environmental responsibilities under the environmental authority. Additional monitoring may be required in emergency situations as specified in the various Emergency Response Contingency Plans and Procedures included in Appendix C.

8.1.1 Routine Monitoring Program - Sewage Treatment Plant

All routine monitoring samples are to be collected by NATA Certified Field Samplers or trained operators in compliance with current Australian Standards and EPA Standards for Environmental Monitoring. All analysis is to be performed by NATA Certified Laboratories, except for daily and weekly tests, which will be conducted by the plant operators. The routine monitoring and testing program is detailed in the table below.

Sampling Point	Frequency	Analysis Required
STP Final Effluent Post Chlorination	Daily	pH, DO, Chlorine (Free), Turbidity
STP Final Effluent Post Chlorination	Weekly	Ammonia, N+N, OrthoP
STP Final Effluent Post Chlorination	Monthly	BOD, SS, pH, DO, F.Coliforms (5 x ½ hourly samples)TN, Ammonia, N+N, TKN, TP
Groundwater - hydraulically upstream & Downstream of Effluent Irrigation area	Six Monthly	TN, Ammonia, N+N, TKN, TP, F.Coliforms
Effluent Disposal Area	Biennially	pH (Water); EC (1:5); CEC; Exchangeable Ca, Mg, Na, K; Exchangeable Na %; TN; KCl extractable NO3-; Extractable P (colwell)

8.1.2 Emergency Monitoring Program

Emergency monitoring samples are to be collected by NATA Certified Field Samplers or trained operators in compliance with Australian Standards and EPA Standards for Environmental Monitoring.

Emergency monitoring requirements are specified in the Emergency Response Contingency Plans and Procedures included in Appendix C.

8.1.3 Routine Monitoring Program - Potable Water Treatment Plant

All routine monitoring samples are to be collected by NATA Certified Field Samplers or trained operators in compliance with current Australian Standards and EPA Standards for Environmental Monitoring. All analysis is to be performed by NATA Certified Laboratories, except the daily and weekly tests, which will be conducted by the plant operators. The routine monitoring and testing program is detailed in the table below.

Sample Point	Frequency	Analysis Required
Raw Water Storage	Weekly	pH, Colour, Turbidity
	Monthly	E. Coli, F. Coliforms, Heterotrophic Plate Count, Dissolved Oxygen, Iron, Manganese, Hardness, Alkalinity
Treated Potable Water	Daily	Colour, Turbidity, pH, Chlorine (free)
	Monthly	Iron, Manganese, E. Coli, F. Coliforms, Heterotrophic Plate Count
	Quarterly	Hardness, Conductivity (TDS), Sodium, Chloride, Sulfate, Calcium, Magnesium, Alkilinity, pH, Carbon Dioxide
Distribution System (including Storage Tank)	Weekly	Chlorine (Free), pH, Temperature, Turbidity, Colour
	Monthly	Dissolved Oxygen ,Colour, Turbidity, Total Coliforms, Heterotrophic Plate Counts, E. Coli, Trihalomethane (THM's), Manganese, Iron
	Annually	Iron, Manganese, Chromium, Copper, Lead, Zinc, Nickel, Cadmium, Antimony, Nitrate, Nitrite, Ammonia, Hydrogen Sulphide

8.2 Reporting

Routine Reporting requirements equate to an Annual Return due on the annum of the Environmental Authority. Details to be include in the Annual Return are summarised in Appendix E.

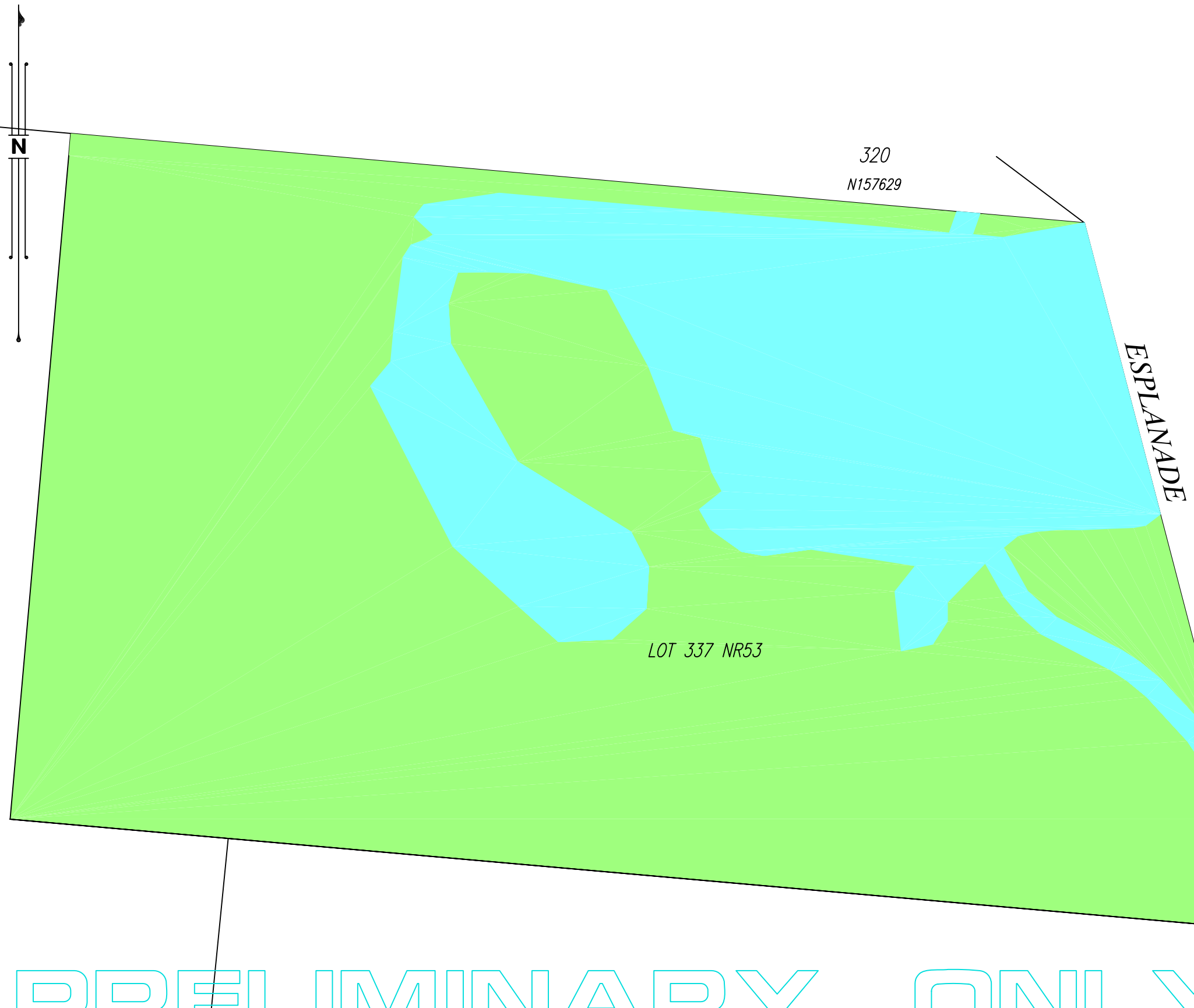
Incident and Emergency reporting requirements are detailed and specified in the Emergency Response Contingency Plans and Procedures included in Appendix C.

All reports, written correspondence and records associated with the Environmentally Relevant Activity - Sewage Treatment are to be kept at the licenced premises for a period of 5 years.

APPENDIX A

SITE &LOCALITY PLAN

SUMMARY	
SITE AREA = 64.73ha	100%
DEVELOPMENT PRECINCT = 18.12ha	28%
CONSERVATION PRECINCT = 46.61ha	72%



LEGEND

- PROPOSED DEVELOPMENT PRECINCT
- PROPOSED CONSERVATION PRECINCT

PRELIMINARY ONLY

0 40 80 120 160 200
metres

SCALE 1:4000 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED
29/11/05	B	REVISED DEVELOPMENT ZONE	KPH
	A	ORIGINAL ISSUE	KPH

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS PTY LTD
PROJECT: ELLA BAY LOT 337 NR 53
LOCATION: ELLA BAY
SHEET TITLE: PROPOSED DEVELOPMENT PRECINCT / CONSERVATION PRECINCT

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED DATE
DATE NOVEMBER 2005

APPROVED DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:4000

30 1975-2005 BUILDING ON 30 YEARS

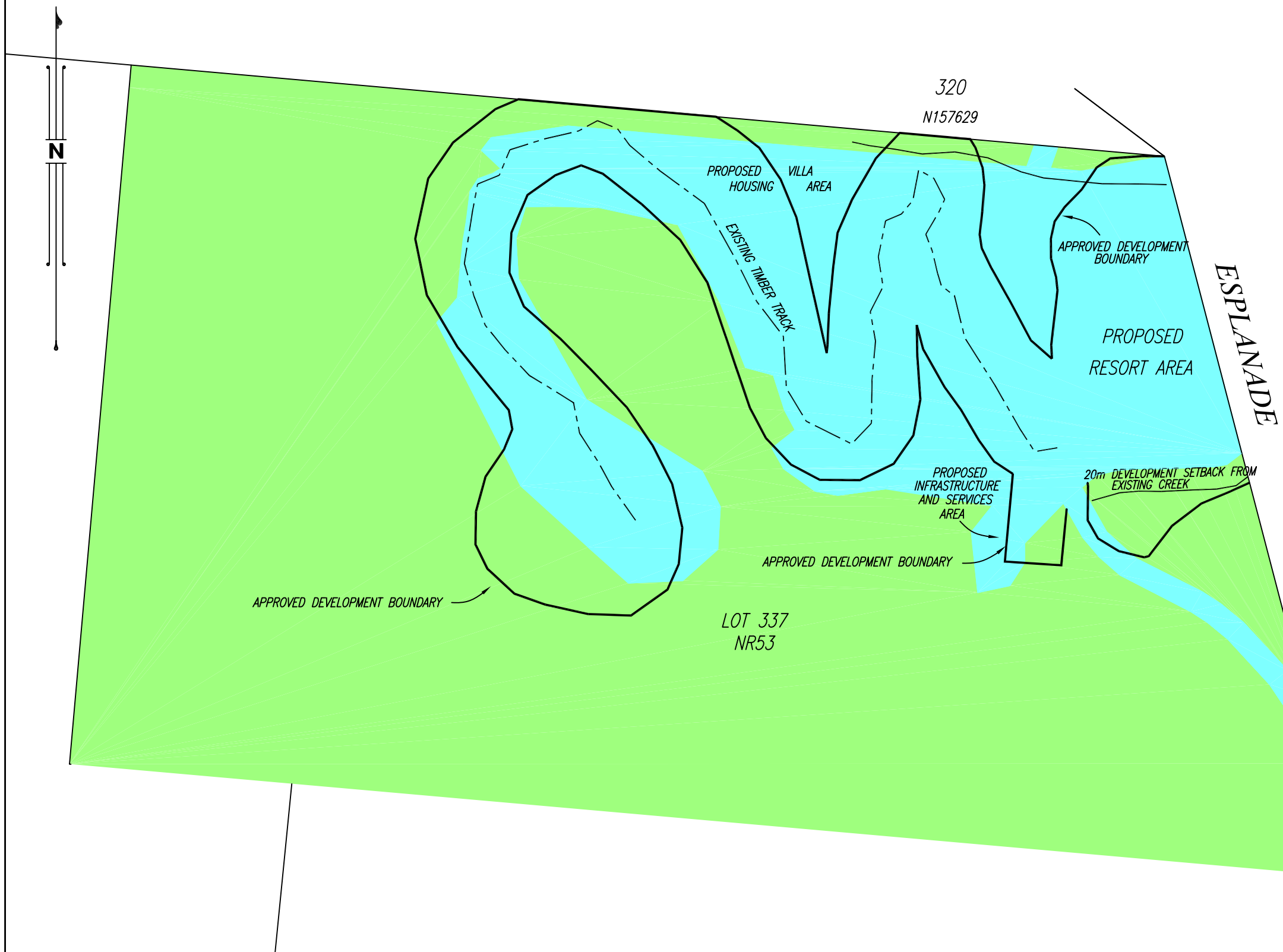
ETS GROUP

- ARCHITECTS
- ENGINEERS
- INTERIOR DESIGNERS

AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL - mail@etsgroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7653
EMAIL - etspng@datec.com.pg
SINGAPORE • NEW ZEALAND • INDONESIA
UNITED ARAB EMIRATES

JOB CODE: JHSREB
SHEET NUMBER: P01 REV: B

FORM E027 30 MAR 2000



SUMMARY	
SITE AREA = 64.73ha	100%
APPROVED DEVELOPMENT AREA = 18.72ha	29%
APPROVED CONSERVATION AREA = 46.01ha	71%
PROPOSED RESORT AREA = 4.2ha	6.5%
PROPOSED VILLA HOUSING AREA = 13.52ha	18.9%
PROPOSED INFRASTRUCTURE AREA = 0.4ha	0.6%
TOTAL PROPOSED DEVELOPMENT AREA = 18.12ha	28%
PROPOSED CONSERVATION AREA = 46.61ha	72%
ADDITIONAL CONSERVATION AREA 0.60ha	**1.3%**

COMPARATIVE SUMMARY
APPROVED CONSERVATION AREA = 46.01ha
PROPOSED CONSERVATION AREA = 46.61ha
ADDITIONAL CONSERVATION AREA 0.60ha

LEGEND

- PROPOSED DEVELOPMENT PRECINCT
- PROPOSED CONSERVATION PRECINCT
- APPROVED DEVELOPMENT BOUNDARY

0 40 80 120 160 200

metres

SCALE 1:4000 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

PRELIMINARY ONLY

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED
29/1/05	B	REVISED DEVELOPMENT ZONE	KPH
	A	ORIGINAL ISSUE	KPH

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS PTY LTD
PROJECT: ELLA BAY LOT 337 ON NR53
LOCATION: ELLA BAY
SHEET TITLE: OVERLAY OF APPROVED DEVELOPMENT PRECINCT BOUNDARY OVER PROPOSED DEVELOPMENT PRECINCT / CONSERVATION PRECINCT

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED DATE
DATE NOVEMBER 2005

APPROVED DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:4000

30 1975-2005 BUILDING ON 30 YEARS

ETS GROUP

- ARCHITECTS
- ENGINEERS
- INTERIOR DESIGNERS

AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL – mail@etsgroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7653
EMAIL – etspng@datec.com.pg
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UNITED ARAB EMIRATES

JOB CODE: JHSREB
SHEET NUMBER: P02 REV: B

FORM E027 30 MAR 2000

DEVELOPMENT ZONE = 17.11 ha

320
N157629

20m BUFFER ZONE

PROPOSED VILLA HOUSING PRECINCT 12.14 ha

PROPOSED
CONSERVATION PRECINCT
AREA 47.62 HA

TOTAL 64.73HA

EXISTING CREEK

PROPOSED RESORT PRECINCT
4.2ha

ESPLANADE

PROPOSED
SERVICES AND
INFRASTRUCTURE
PRECINCT
0.4 ha

B2V
NR53

N

LEGEND

	AREA
PROPOSED DEVELOPMENT PRECINCT	17.11ha
PROPOSED CONSERVATION PRECINCT	47.62ha
PROPOSED ROAD	
EXISTING TIMBER TRACK	

0 25 50 75 100 125
metres

SCALE 1:2500 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

PRELIMINARY ONLY

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS
PROJECT: ELLA BAY DEVELOPMENT STAGE 1
LOCATION: ELLA BAY
SHEET TITLE: PROPOSED LAYOUT

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED DATE
DATE NOVEMBER 2005

APPROVED DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:2500

30 1975-2005 BUILDING ON 30 YEARS

ETS GROUP

· ARCHITECTS
· ENGINEERS
· INTERIOR DESIGNERS

AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL - mail@etsgroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7853
EMAIL - etspng@datec.com.pg
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JOB CODE: JHSREB
SHEET NUMBER: P03 REV: A

SUMMARY	
SITE AREA = 64.73ha	100%
DEVELOPMENT PRECINCT = 16.88ha	26%
CONSERVATION PRECINCT = 47.85ha	74%

320
N157629

APPROVED RESORT AREA

ESPLANADE

APPROVED VILLA HOUSING AREA

APPROVED CONSERVATION PRECINCT

APPROVED INFRASTRUCTURE AND SERVICES AREA

LOT 337
NR53

N

1. Proposed Resort Area 4.2 ha
2. Proposed Villa Housing Area 14.12ha
3. Proposed Infrastructure and Services Area 0.4ha
4. Proposed Conservation Precinct 46.84 ha

LEGEND

- APPROVED VILLA HOUSING AREA
- APPROVED RESORT AREA
- APPROVED INFRASTRUCTURE AND SERVICES AREA
- APPROVED CONSERVATION PRECINCT

PRELIMINARY ONLY

0 40 80 120 160 200
metres

SCALE 1:4000 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS PTY LTD
PROJECT: ELLA BAY LOT 337 ON NR 53
LOCATION: ELLA BAY
SHEET TITLE: APPROVED DEVELOPMENT LAYOUT

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED
DATE NOVEMBER 2005

APPROVED
DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:4000

30
1975-2005
BUILDING ON
30 YEARS

ETS GROUP

- ARCHITECTS
- ENGINEERS
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AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL - mail@etsgroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7653
EMAIL - etspng@datec.com.pg
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UNITED ARAB EMIRATES

JOB CODE: JHSREB
SHEET NUMBER: P04
REV: A

FORM E027
30 MAR 2000

320
N157629

20m BUFFER

PROPOSED VILLA HOUSING AREA

IRRIGATION AREA 4/5
1.673ha

LOT IRRIGATION AREA
3.65ha

IRRIGATION AREA 6
1.486ha

IRRIGATION AREA 2
1.21ha

IRRIGATION AREA 1
1.93ha

IRRIGATION AREA 3/7
0.84ha

PROPOSED RESORT AREA
4.2 ha

ESPLANADE

20m DEVELOPMENT BOUNDARY SETBACK FROM EXISTING CREEK

PROPOSED SERVICES AND INFRASTRUCTURE AREA
0.4 ha

LOT 337
NR53

SUMMARY	
SITE AREA = 64.73ha	100%
TOTAL DEVELOPMENT PRECINCT = 18.12ha	28%
PROPOSED CONSERVATION PRECINCT = 46.61ha	72%
TOTAL IRRIGATION AREA = 10.75ha	16.6%

N

LEGEND

- PROPOSED DEVELOPMENT PRECINCT
- PROPOSED CONSERVATION PRECINCT
- PROPOSED IRRIGATION AREA IN DEVELOPMENT PRECINCT
- PROPOSED IRRIGATION AREA WITHIN LOTS
- PROPOSED ROAD
- EXISTING TIMBER TRACK

NOTE:

BUFFER DISTANCE OF 1M FROM ROADS AND BUILDINGS ALLOWED FOR IN IRRIGATION DESIGN

0 25 50 75 100 125
metres

SCALE 1:2500 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

PRELIMINARY ONLY

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED
01/12/05	C	REVISED IRRIGATION AREAS	KPH
29/11/05	B	REVISED IRRIGATION AREAS	KPH
	A	ORIGINAL ISSUE	KPH

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS PTY LTD
PROJECT: ELLA BAY LOT 337 NR 53
LOCATION: ELLA BAY
SHEET TITLE: DETAILED SITE LAYOUT PLAN

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED DATE
DATE NOVEMBER 2005

APPROVED DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:2500

30 1975-2005 BUILDING ON 30 YEARS

ETS GROUP

- ARCHITECTS
- ENGINEERS
- INTERIOR DESIGNERS

AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL – mail@etagroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7653
EMAIL – etapng@datec.com.pg
SINGAPORE • NEW ZEALAND • INDONESIA
UNITED ARAB EMIRATES

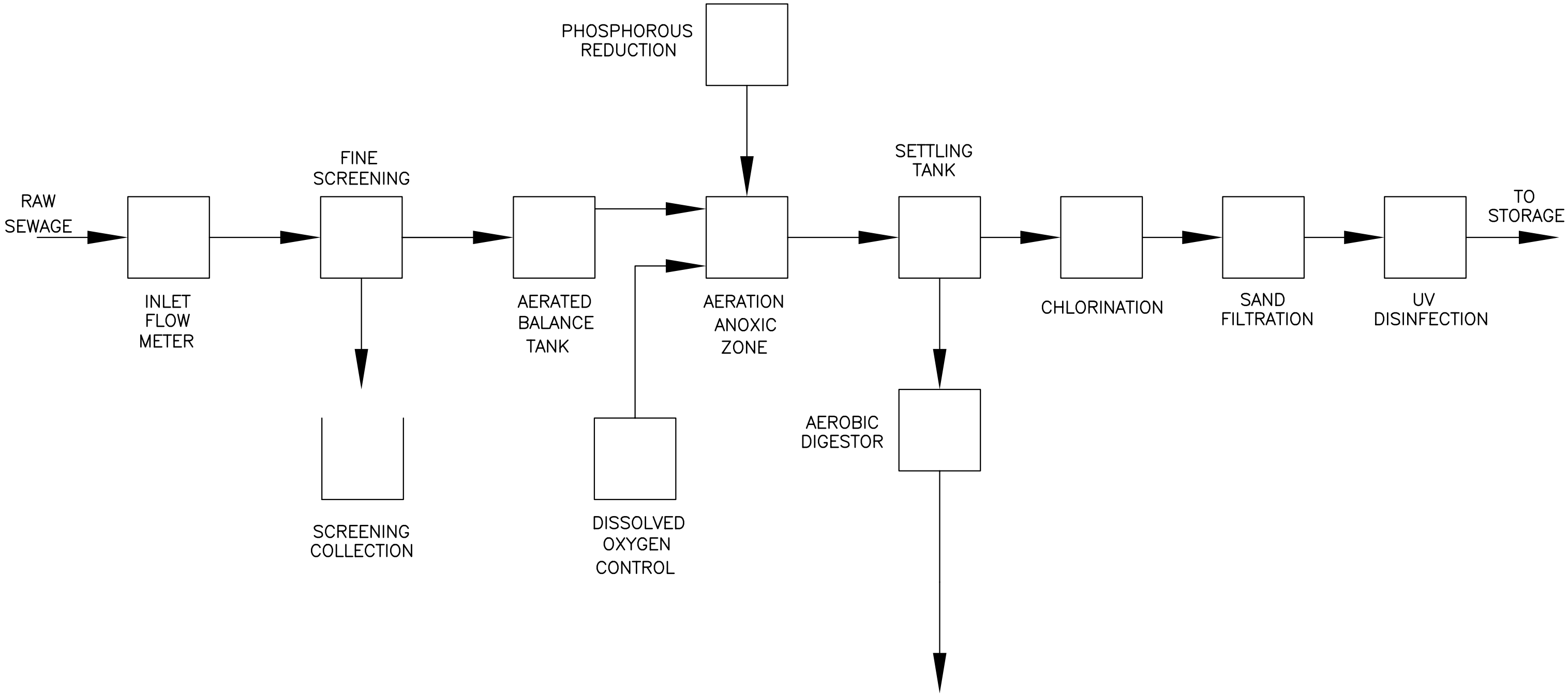
JOB CODE: JHSREB
SHEET NUMBER: P05 REV: C

FORM E027 30 MAR 2000

APPENDIX B

TREATMENT PLANT PROCESS DIAGRAM

THIRD ANGLE PROJECTION



FOR TENDER
SIGNED & DATED

DO NOT SCALE

NOTES

REF. DWG.

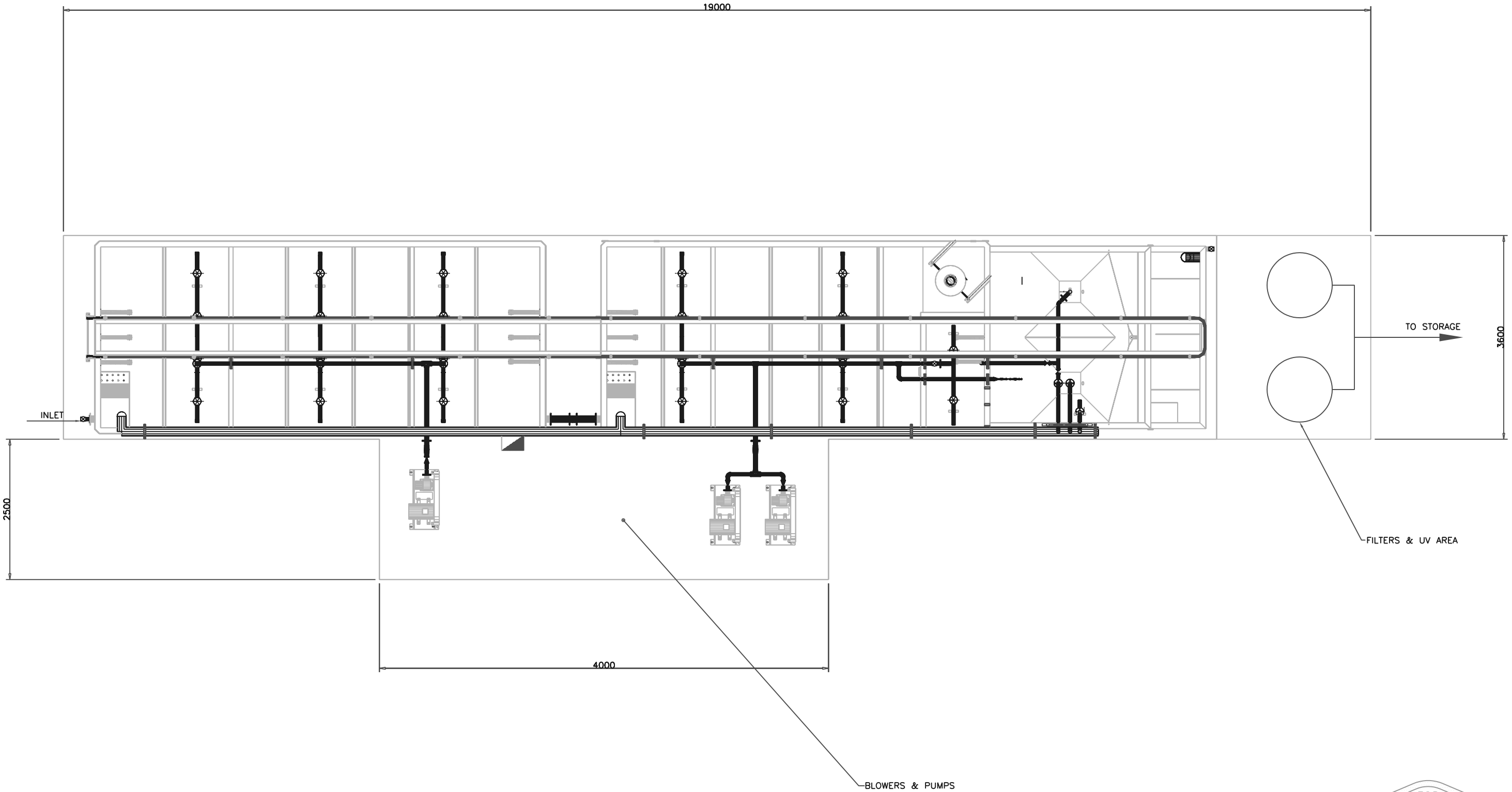
EPCO AUSTRALIA – BRISBANE

ISSUE	DATE	DRN	CKD	REVISIONS
0	03/11/05	SAM	GWC	ORIGINAL ISSUE

PACKAGE SEWAGE PLANT – FAECAL COLIFORMS >10
EFFLUENT QUALITY BOD10/SS1/P1/TN5
FLOW DIAGRAM

DRAWING SCALE	NTS	A3	12942	SHT 0 REV
PLOT SCALE	1:1			

THIRD ANGLE PROJECTION



FOR APPROVAL
SIGNED & DATED

DIAGRAMATIC ONLY

10825

NOTES

REF. DWG.

EPCO AUSTRALIA – BRISBANE

ELLA BAY RESORT
PACKAGE SEWAGE PLANT
FOOTPRINT

ISSUE	DATE	DRN	CKD	REVISIONS
0	03/11/05	SAM	GWC	ORIGINAL ISSUE

DRAWING SCALE NTS
PLOT SCALE 1:1
A1 10825/12943
SHT
0 REV

APPENDIX C

EMERGENCY RESPONSE
CONTINGENCY PLANS & PROCEDURES

EB-CP-01 POWER FAILURE CONTINGENCY PROCEDURE

Objective	To minimise disruption to plant/equipment during power failure
Performance Indicator	Minimise environmental incidents associated with power failures
Responsible officer	Operations Personnel Operations Manager
Monitoring/ Reporting	1. Contact Power Supplier and inform them of power failure. Find out approximate time that power supply will be disrupted. 2. Inspect site to ensure that no overflows or uncontrolled sewage discharges are occurring or are likely to occur. 3. If uncontrolled sewage flows are likely to occur, temporary generated power is to be provided until such time that mains power is restored. Generated power is to be primarily directed to the operation of sewage treatment plant and equipment 4. If uncontrolled effluent discharges are or have occurred refer to Contingency Procedure EB-CP-02 5. Record the event and actions taken in operational log books.
Corrective Action	None Directly Required (note: corrective action and reporting may be required under EB-CP-01).

EB-CP-02 OVERFLOWS FROM PLANT & EQUIPMENT

Objective	• Minimise environmental damage associated with uncontrolled release of effluent from plant and equipment. • Monitor overflow of effluent from plant and equipment during periods of uncontrolled release.
Performance Indicators	• Minimise duration of overflow event • Accurately evaluate and report on extent of any resultant environmental damage.
Responsible officer	Operations Personnel Operations Manager
Monitoring/ Reporting	1. Inform superiors of discharge 2. Investigate cause of discharge and attempt to rectify problem to prevent further release of effluent 3. If discharge cannot be stopped immediately redirect effluent to available storage areas, or onto effluent disposal areas. 4. Take grab samples of : - overflow at discharge point from plant - runoff discharges entering any environmental waters - upstream & downstream of discharge to the environment. 5. Despatch samples to NATA Registered Laboratory for analysis of BOD, pH, suspended solids, total nitrogen, TKN, nitrate, nitrite, ammonia, total phosphorus, ortho phosphorus, TOG and faecal coliforms. 6. Estimate volume of discharge entering environment. 7. Screen any solid material out of overflow using straw bails, or hessian barriers, 8. Monitor the volume of discharge for the duration of the release period; 9. Record the event in Incident Register. 10. Submit an incident report to the regulating authority as per procedure EB-02
Corrective Action	Investigate the incident and reassess / modify plant and equipment and operational procedures accordingly.

EB-CP-03 UNCONTROLLED RUNOFF FROM IRRIGATION AREAS

Objective	• Minimise environmental damage associated with uncontrolled runoff of effluent from disposal areas • Monitor runoff water during periods of uncontrolled release.
Performance Indicators	• Minimise duration of runoff event • Accurately evaluate and report on extent of any resultant environmental damage.
Responsible officer	Operations Personnel Operations Manager
Monitoring/ Reporting	1. Stop irrigation and divert effluent to wet weather storage facility, until such time that hydraulic overload subsides; 2. If there is insufficient holding capacity in the wet weather storage, irrigate effluent evenly across all effluent release areas until storage capacity becomes available; 3. Inform superiors of excess application event and monitor areas for runoff; 4. Take grab sample of: - discharge point from plant - runoff discharges entering any environmental waters - upstream & downstream of discharge to the environment. 5. Despatch samples to NATA Registered Laboratory for analysis of BOD, pH, suspended solids, total nitrogen, TKN, nitrate, nitrite, ammonia, total phosphorus, ortho phosphorus, TOG and faecal coliforms. 6. Estimate the volume of discharge entering the environment; 7. Monitor the volume of discharge for the duration of release; 8. Record the event in Incident Register; 9. Submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Investigate the incident and reassess the effluent storage system and irrigation program.

EB-CP-04 PUMP FAILURE CONTINGENCY PROCEDURE

Objective	Minimise disruption to hydraulic flows due to pump failure
Performance Indicator	Prevent uncontrolled effluent discharge due to pump failure.
Responsible officer	Operations Personnel Operations manager
Monitoring & Reporting	1. Inspect site to ensure that no discharge of raw sewage or treated effluent is occurring. 2. If discharge is occurring, refer to EB-CP-02 3. Switch to standby pump if operational, 4. If not operational fix failed pump, or provide temporary or permanent replacement, whichever is more immediate. 5. Record the event in Incident Register; 6. Operations Manager to submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Review maintenance and operational procedures for pumps to ensure failure is prevented in future.

EB-CP-05 POTABLE WATER CONTAMINATION

Objective	Minimise the disruption to the Potable Water Supply in the event of contamination
Performance Indicator	Prevent loss of supply of Potable Water
Responsible Officer	Operations Personnel Operations Manager
Monitoring & Reporting	1. Inspect Filters and Disinfection system for Obvious Problems 2. Rectify if found. (Backwash Filters, Flush Treatment system) 3. If no problem found, check stored water and delivery system for sources of contamination (Animal Matter, etc). Flush delivery System if necessary 4. Return storage tank contents into pre-treatment pump well and retreat water if necessary 5. Sample for contaminant indicators daily after breach. 6. Notify EPA of breach.
Corrective Action	Review maintenance procedure for treatment system, and increase visual inspection of delivery and storage system for possible sources of contamination

EB-CP-06 PIPE FAILURE CONTINGENCY PROCEDURE

Objective	Minimise disruption to hydraulic flows due to Pipe failure
Performance Indicator	Prevent uncontrolled effluent discharge due to Pipe failure.
Responsible officer	Operations Personnel Operations manager
Monitoring & Reporting	1. Inspect site to ensure that no discharge of raw sewage or treated effluent is occurring. 2. If discharge is occurring, refer to EB-CP-02 3. Halt discharge and direct treated effluent to storage until pipe can be replaced or repaired 4. If storage is full irrigate evenly over other areas until pipe can be replaced. 5. Record the event in Incident Register; 6. Operations Manager to submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Review maintenance and operational procedures for pipes to ensure failure is prevented in future.

EB-CP-07 BLOWER FAILURE CONTINGENCY PROCEDURE

Objective	Minimise disruption to hydraulic flows due to Aeration Blower failure
Performance Indicator	Prevent uncontrolled effluent discharge due to Aeration Blower failure.
Responsible officer	Operations Personnel Operations manager
Monitoring & Reporting	1. Inspect site to ensure that no discharge of raw sewage or treated effluent is occurring. 2. If discharge is occurring, refer to EB-CP-02 3. Switch to standby Blower, if available 4. If not operational fix failed blower, or provide temporary or permanent replacement, whichever is more immediate. 5. Record the event in Incident Register; 6. Operations Manager to submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Review maintenance and operational procedures for Aeration Blowers to ensure failure is prevented in future.

EB-CP-08 UV-DISINFECTION FAILURE CONTINGENCY PROCEDURE

Objective	Minimise disruption to effluent quality due to UV-Disinfection system failure
Performance Indicator	Prevent uncontrolled effluent discharge due to UV-Disinfection system failure.
Responsible officer	Operations Personnel Operations manager
Monitoring & Reporting	1. Take grab samples of: STP Effluent and Effluent Storage 2. Halt Treatment system and use Aeration Buffer tank as temporary storage. Repair Disinfection System. 3. If Buffer tank level gets too high start Treatment system without UV Disinfection. Take samples of STP Effluent and Effluent Storage. 4. Record the event in Incident Register; 5. Operations Manager to submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Review maintenance and operational procedures for UV-Disinfection System to ensure failure is prevented in future.

EB-CP-09 CHLORINE DOSING FAILURE CONTINGENCY PROCEDURE

Objective	Minimise disruption to effluent quality due to Chlorine Dosing system failure
Performance Indicator	Prevent uncontrolled effluent discharge due to UV-Disinfection system failure.
Responsible officer	Operations Personnel Operations manager
Monitoring & Reporting	1. Take grab samples of: STP Effluent and Effluent Storage 2. Halt Treatment system and use Aeration Buffer tank as temporary storage. Repair Disinfection System. 3. If Buffer tank level gets too high start Treatment system without Chlorine Dosing. Take samples of STP Effluent and Effluent Storage. If Possible dose with Chlorine manually. 4. Record the event in Incident Register; 5. Operations Manager to submit an incident report as per Incident Reporting Procedure EB-02 to regulating authority.
Corrective Action	Review maintenance and operational procedures for Chlorine Dosing System to ensure failure is prevented in future.

APPENDIX D

COMPLAINT, INCIDENT & EXCEPTION

INVESTIGATION, PROCESSING & REPORTING PROCEDURES

EB-01 COMPLAINTS PROCEDURE

Objective	• To address complaints effectively and quickly • To comply with Licence and Management Plan requirements for addressing and reporting complaints
Performance Indicators & Targets	• Record and reduce time taken to respond to complaints • Reduce the number of complaints reported
Responsible Officer	Operations Manager
Monitoring/ Reporting	• Register complaints with EPA using "Complaints Record Proforma" and retain copy for on-site records • Record and report investigative and corrective actions taken
Corrective Action	• Investigate nature and extent of problem by site inspection and contacting complainant • Implement corrective action or instigate further investigation as required • Inform complainant of corrective action taken

EB-02 INCIDENT/EMERGENCY REPORTING PROCEDURE

Objective	• To address incidents effectively and quickly • To comply with Licence and Management Plan requirements for addressing and reporting of environmental incidents;
Performance Indicators & Targets	• Report all incidents as soon as practicable, and provide written advice within 14 days of incident to EPA. • Maintain accurate maintenance of records • Reduce the number of incidents reported
Responsible officer	Operations Manager
Monitoring/ Reporting	• Investigate and manage incident as per Emergency Response Contingency Procedures (Appendix C) • Report the incident as per Environmental Incident Report proforma • As soon as practical, inform EPA of incident by telephone or fax using the Incident Notification Report proforma; • Provide written advice as per the Incident Notification Report proforma not more than 14 days after the incident.
Corrective Action	Implement proposed actions to reduce the possibility of recurrence of incident.

EB-03 EXCEPTION REPORTING PROCEDURE

Objective	• To address exceptions effectively and quickly • To comply with Licence and Management Plan requirements for addressing and reporting of exceptions;
Performance Indicators & Targets	• Report all exceptions within 28 days of completion of analysis. • Reduce the number of exceptions reported
Responsible officer	Operations Manager
Monitoring/ Reporting	• Plant monitoring should be carried out as per Licence and Management Plan requirements • The EPA must be notified in writing within 28 days using the Exception Reporting Proforma of any monitoring results that are not in accordance with the conditions of the Licence.
Corrective Action	Investigate the cause of the exception and formulate corrective actions, to ensure that exceptions do not recur.

ELLA BAY SEWAGE TREATMENT PLANT
ENVIRONMENTAL AUTHORITY NO. (to be inserted)

COMPLAINT RECORDING PROFORMA

FAX TO:
Environmental Protection Agency
Licence Compliance Division - Cairns
Fax No: 4046 6606
Attn: _____

as per procedure EB-01

DATE OF COMPLIANT	
TIME OF COMPLAINT	
DESCRIPTION OF COMPLAINT: (eg. odour, noise, spray drift, runoff.)	
TYPE OF COMMUNICATION:	Telephone Letter Personal Others_____
DETAILS OF COMPLAINANT: NAME: ADDRESS: TEL NO: FAX NO: (Only if complainant wishes to be identified)	
DETAILS OF PERSON REGISTERING COMPLAINT: NAME: ADDRESS: TEL NO: MOBILE NO: FAX NO: E-MAIL:	
INVESTIGATION CONDUCTED:	
INVESTIGATION BY: DATE:	
CORRECTIVE ACTION TAKEN: DATE:	
ACTION BY: DATE:	
OPERATIONS MANAGER: DATE:	

ELLA BAY SEWAGE TREATMENT PLANT
ENVIRONMENTAL AUTHORITY NO. (to be inserted)
INCIDENT NOTIFICATION - IMMEDIATE REPORT

FAX IMMEDIATELY TO:

Environmental Protection Agency
Licence Compliance Division - Cairns
Fax No: 4046 6606
Attn: _____

as per Procedure EB-02

HOLDER OF ENVIRONMENTAL AUTHORITY	Ella Bay Property Pty Ltd
LOCATION	Lot 337 on NR 53, Ella Bay
EMERGENCY STATUS	EMERGENCY NON EMERGENCY
ENVIRONMENTAL AUTHORITY NUMBER	
NAME OF DESIGNATED CONTACT PERSON TEL NO:	
NATURE OF INCIDENT:	
TIME OF INCIDENT	
DATE OF INCIDENT	
CAUSE OF INCIDENT	EQUIPMENT MALFUNCTION POWER FAILURE OTHER_____
DURATION OF INCIDENT	
ENVIRONMENTAL HARM CAUSED OR POTENTIALLY CAUSED	
INVESTIGATION UNDERTAKEN :	
SAMPLES TAKEN FOR ANALYSIS:	
INCIDENT REPORTED BY: DATE OF NOTIFICATION: TIME OF NOTIFICATION:	
CORRECTIVE ACTION TAKEN:	
CORRECTIVE ACTION TAKEN BY: DATE:	TIME:

ELLA BAY SEWAGE TREATMENT PLANT
ENVIRONMENTAL AUTHORITY NO. (to be inserted)

INCIDENT NOTIFICATION - FOLLOW-UP REPORT

(not more than 14 days following the initial notification of incident)

as per Procedure EB-02

FAX TO:

Environmental Protection Agency
Licence Compliance Division - Cairns
Fax No: 4046 6606
Attn: _____

Immediate Incident Notification Attached: **Yes / No**

Proposed action to prevent recurrence of the emergency or incident:

_____

_____

Outcome of the actions taken at the time of the incident to prevent or minimise environmental harm:

_____

_____

Environmental monitoring performed / required:

_____

_____

Results of environmental monitoring (not more than six weeks from the date of the incident):

_____

_____

Signed Director of Operations : _____

Date: _____

ELLA BAY SEWAGE TREATMENT PLANT

ENVIRONMENTAL AUTHORITY NO. (to be inserted)

EXCEPTION REPORTING PROFORMA

FAX TO:
Environmental Protection Agency
Licence Compliance Division - Cairns
Fax No: 4046 6606
Attn: _____

as per Procedure EB-03

DATE OF EXCEEDENCE	
TYPE OF EXCEEDENCE	ODOUR RELEASE OF POOR QUALITY EFFLUENT NOISE OTHER : _____
ANALYSIS ATTACHED	YES NO
REASON FOR EXCEEDENCE OR INVESTIGATION UNDERTAKEN	
CORRECTIVE ACTION	
ACTION BY: DATE: TIME:	
SUBSEQUENT ANALYSIS:	
Signed - Director of Operations Date:	

APPENDIX E

ANNUAL RETURN CHECKLIST

ELLA BAY SEWAGE TREATMENT PLANT

ENVIRONMENTAL AUTHORITY NO. (to be inserted)

ANNUAL RETURN CHECKLIST

To: Environmental Protection Agency
Cairns District Office
Licencing Department
GPO Box 2066
CAIRNS QLD 4870

- Monitoring period (Year): _____

- Monthly Test Reports Attached : **Yes / No**

- Tabulated Daily Flow Data Attached : **Yes / No**

- Trend Graphs Attached: **Yes / No**

6. Statement of Compliance / Non-compliance Throughout Year Attached **Yes / No**

   If No, provide incident or exception report detailing non-compliance and remedial actions

7. Additional Comments (details of achievements, capital works, training, controls etc.

_____

_____

_____

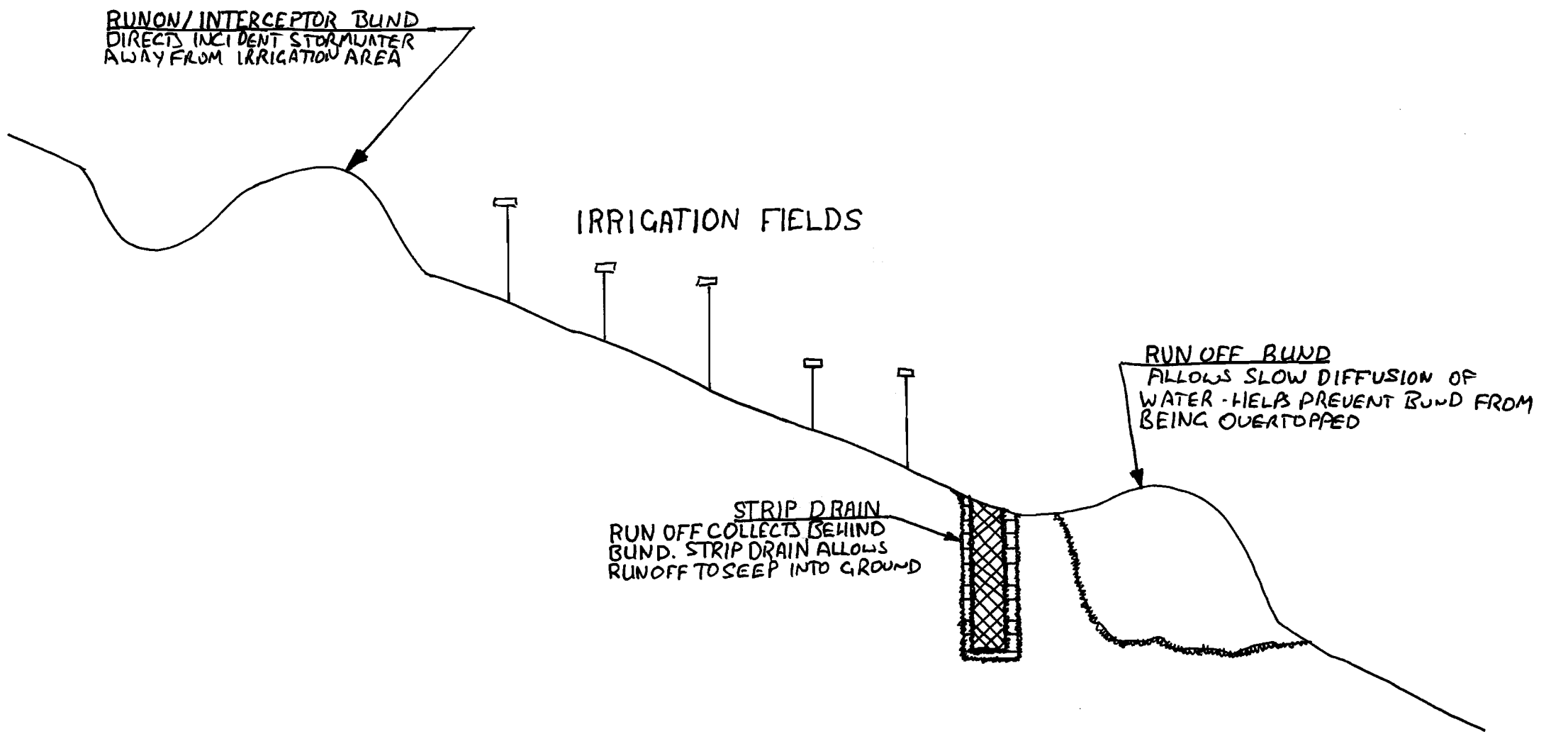
Signed: Ella Bay Property Pty Ltd _____

Date: _____

APPENDIX F

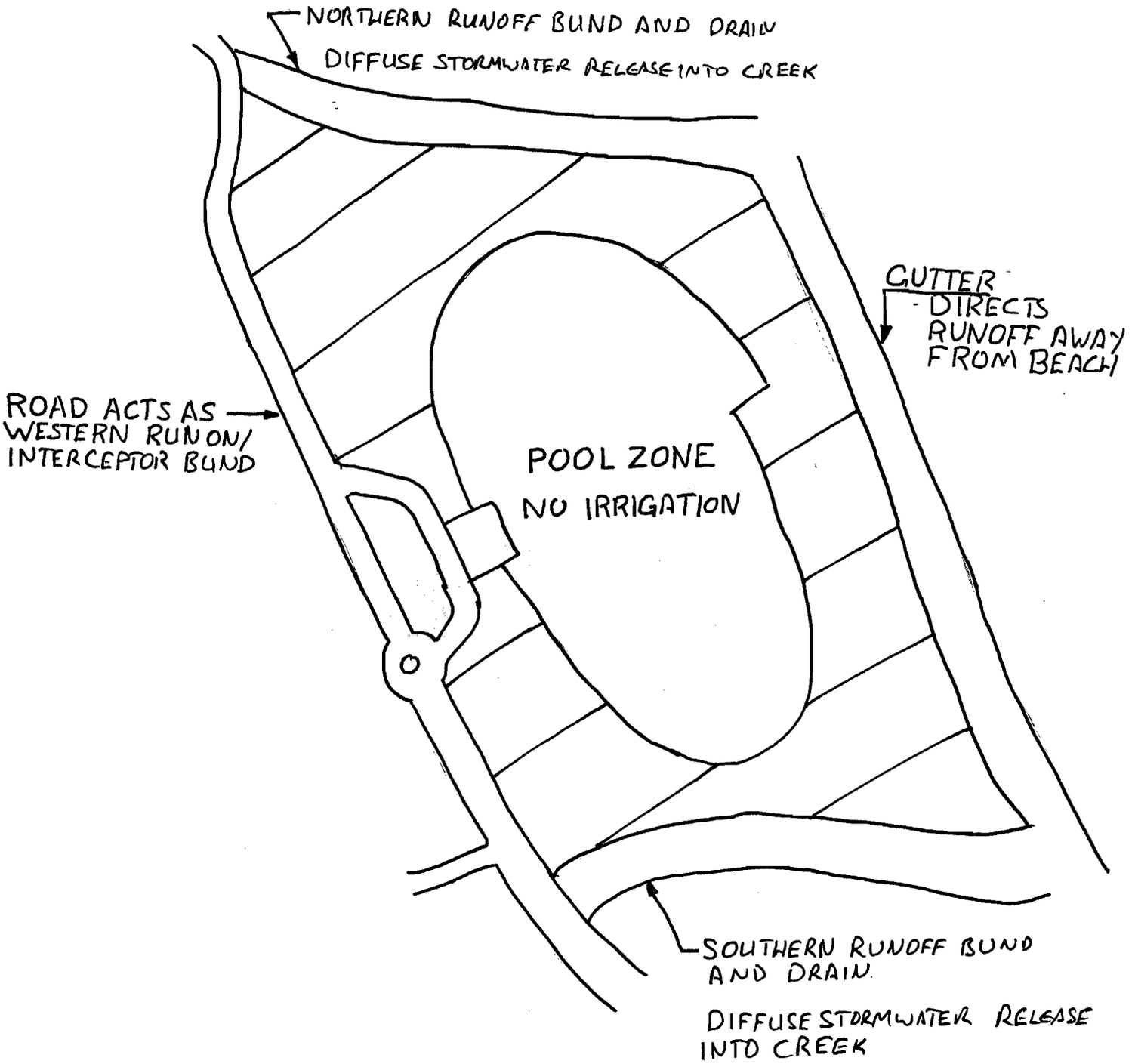
BUNDED AREA SKETCHES

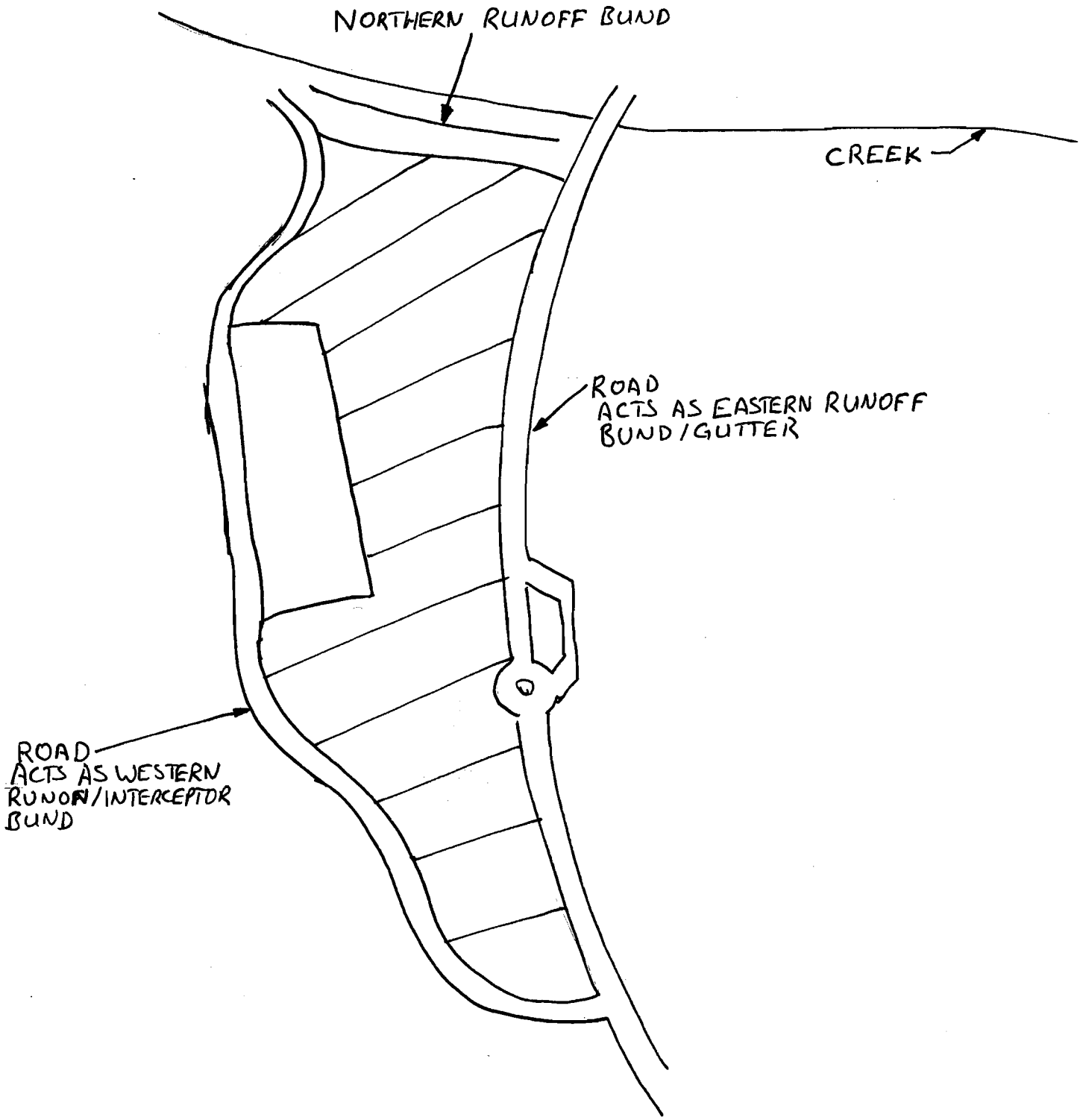
BASIC BUND AND DRAIN CONFIGURATION



IRRIGATION AREA 1

1.93 HA, 2.0MM/DAY

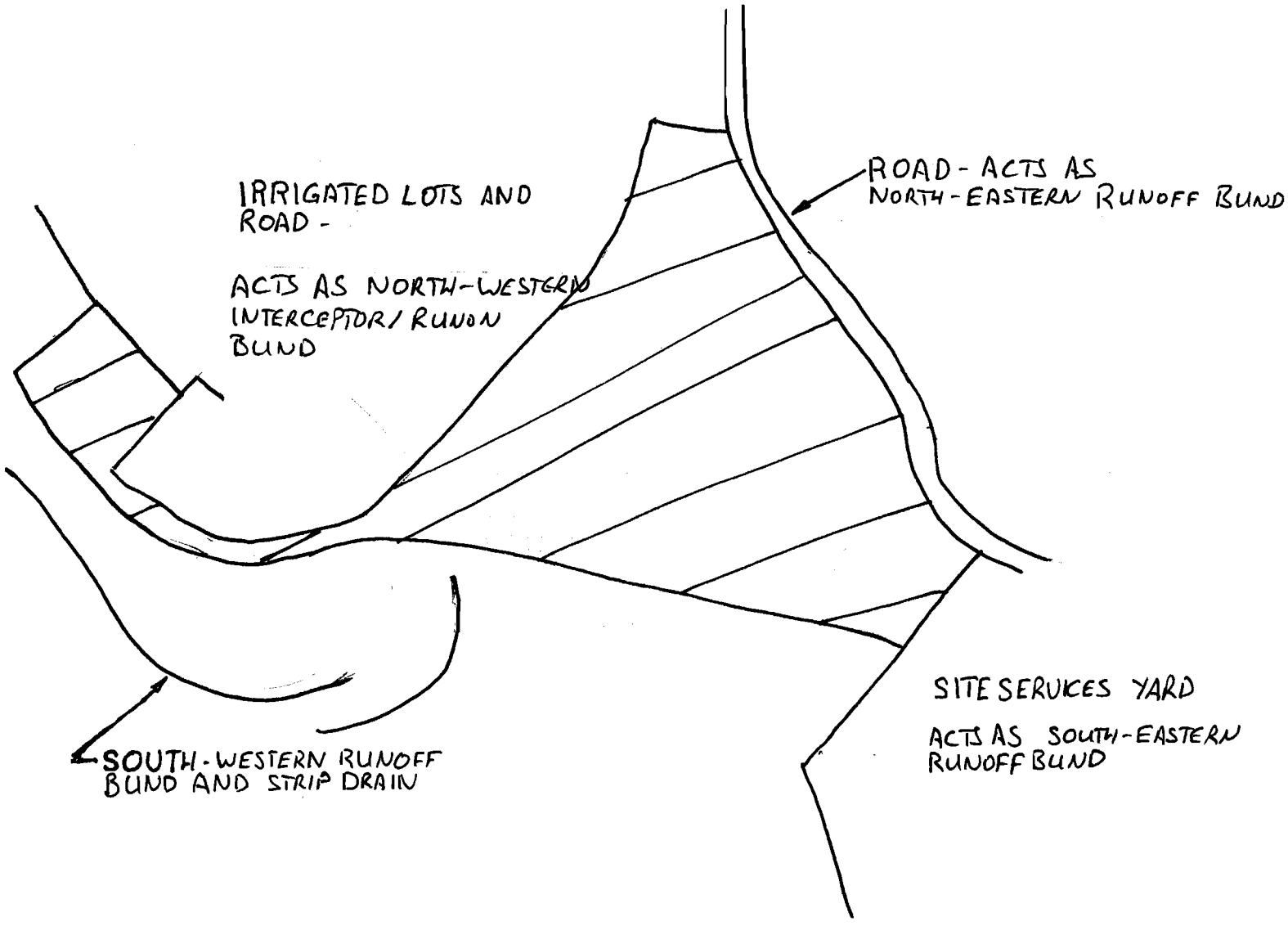




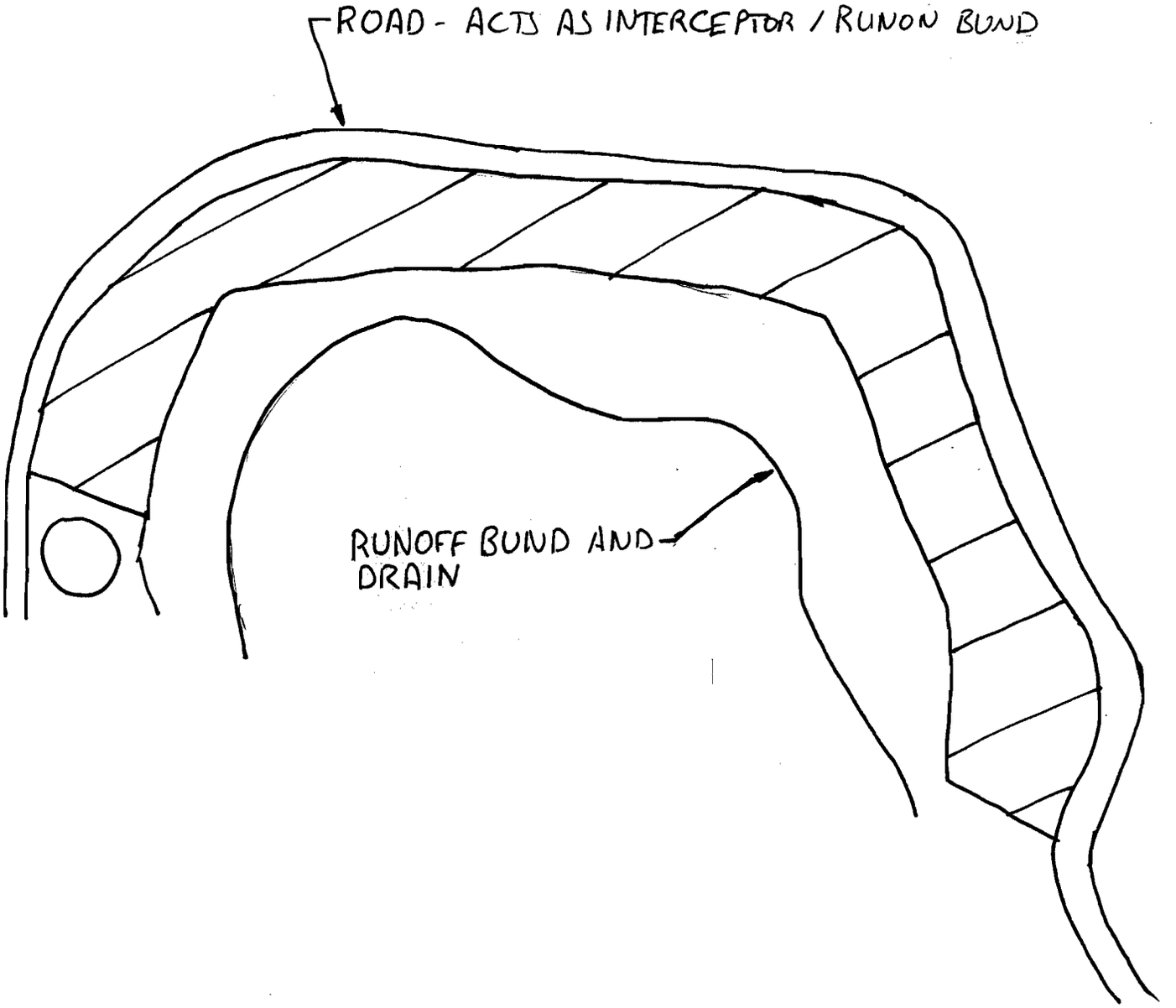
IRRIGATION AREA 2
1.21 HA, 2.0 MM/DAY

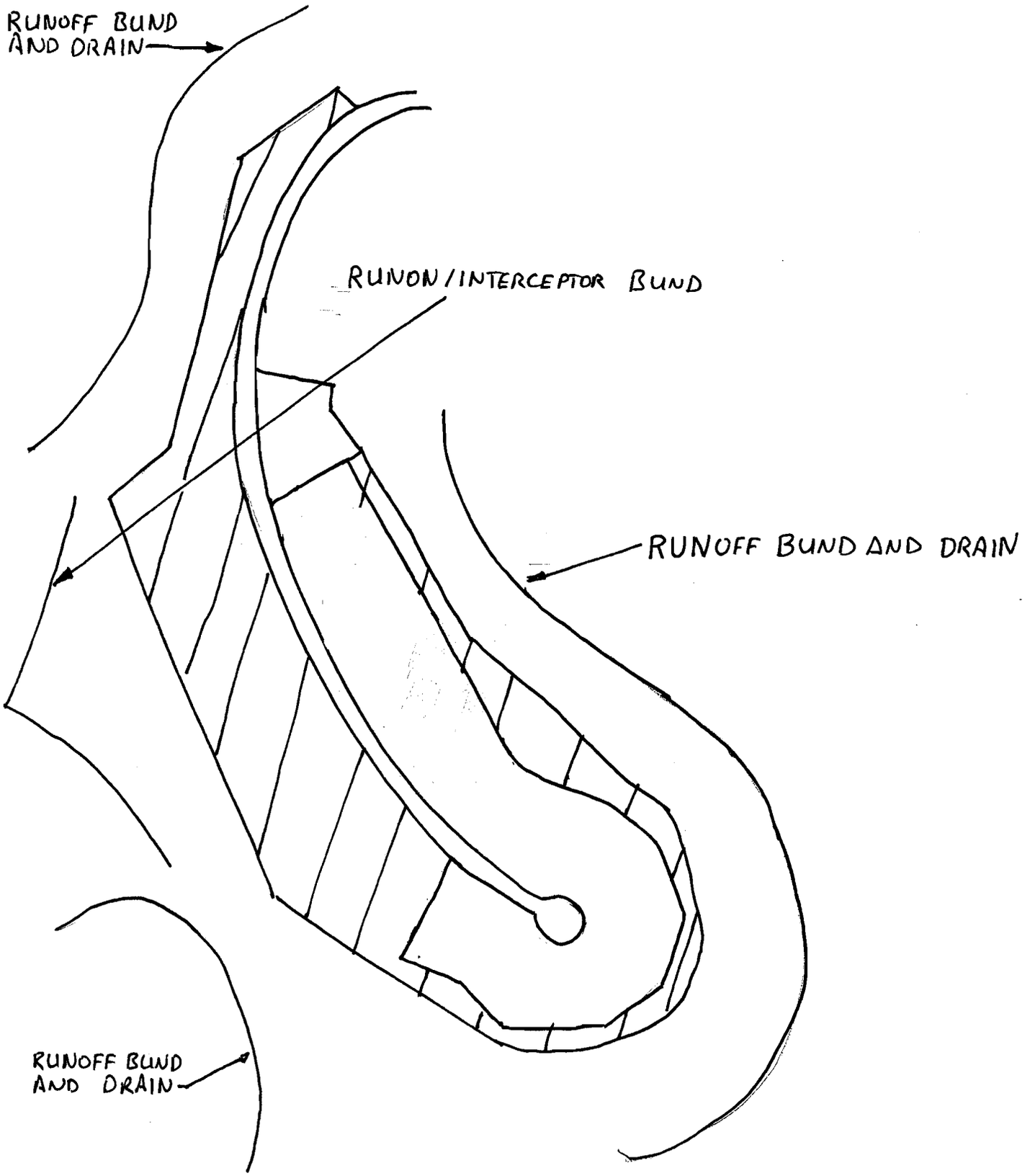
IRRIGATION AREA 3/7

0·84HA, 0·25mm/DAY



IRRIGATION AREA 4/5
1.673 HA, 1 MM/DAY





IRRIGATION AREA 6
1.464A. 1.0MM/DAY

APPENDIX G

AS 1547:2000 APPENDIX 4.2D

AS 1547:2000 APPENDIX 4.5D

APPENDIX 4.2D

TYPICAL DOMESTIC-WASTEWATER FLOW DESIGN ALLOWANCES

(Informative)

Source	Typical wastewater flow allowance in L/person/day (see Note 1)	
	On-site roof water tank supply	Reticulated community or a bore-water supply
Households with standard fixtures (including automatic washing machine)	140	180
Households with standard water reduction fixtures (see Note 2)	115	145
Households with full water-reduction facilities (see Note 3)	80	110
Households with extra wastewater producing facilities	170	220
Households (blackwater only)	50	60
Households (greywater only)	90	120
Motels/hotels		
- guests, resident staff	140	180
- non-resident staff	30	40
- reception rooms	20	30
- bar trade (per customer)	20	25
- restaurant (per diner)	20	30
Community halls		
- banqueting	20	30
- meetings	10	15
Restaurants (per diner)		
- dinner	20	30
- lunch	15	25
Tea rooms (per customer)		
- without restroom facilities	10	15
- with restroom facilities	15	25
School (pupils plus staff)	30	40
Rural factories, shopping centres	30	50
Camping grounds		
- fully serviced	100	130
- recreation areas	50	65

NOTES:

1 These flows are minimum rates unless actual flows from past experience can be demonstrated.

2 Standard water-reduction fixtures include dual flush 11/5.5 litre water closets, shower-flow restrictors, aerator faucets (taps) and water-conserving automatic washing machines.

3 Full water-reduction fixtures include the combined use of reduced flush 6/3 litre water closets, shower-flow restrictors, aerator faucets, front-load washing machines and flow/pressure control valves on all water-use outlets. Additionally, water reduction may be achieved by treatment of greywater and recycling for water closet flushing (reclaimed water cycling).

APPENDIX 4.5D

CONSTRUCTION AND INSTALLATION REQUIREMENTS FOR SURFACE IRRIGATION SYSTEMS

(Normative)

4.5D1 SCOPE

This is an Appendix to Clause 4.5 of this Standard. It sets out the construction and installation requirements for the treatment of effluent using a surface-irrigation system.

A surface-irrigation system can be a covered drip or a spray system.

4.5D2 CONSTRUCTION

4.5D2.1 General

Both covered surface drip and spray-irrigation systems shall be constructed so that there is no pooling or run-off of the effluent within or from the surface of the land-application area.

4.5D2.2 Covered surface drip

Covered drip systems shall be laid over the topsoil following installation of the distribution pipework and then covered with mulch (see Figure 4.5D1).

4.5D2.3 Irrigation area

The irrigation area shall have an adequate depth of natural topsoil (or imported topsoil if necessary) to store the applied effluent and to support the growth of evergreen plants/vegetation to maximize evapo-transpiration.

4.5D2.4 Inflow of water

Inflow of surface and seepage water into the land-application area shall be controlled or prevented. A cut-off trench or diversion drain shall be constructed to divert surface and groundwater away from the irrigation area.

4.5D3 INSTALLATION

4.5D3.1 Pump system

The pump and irrigation system shall:

(a) Have a separate effluent storage chamber provided that it has a storage volume to match the electrical starting requirements of the irrigation pump motor and to cope with the design flow.

Comment. *A minimum volume of 200 L is recommended.*

(b) Have performance characteristics that match the hydraulic characteristics of the irrigation system.

(c) Be able to discharge at least 50 % more than the maximum 30-minute flow rate.

4.5D3.2 Pipework

The pipes and fittings shall:

(a) Be rated to withstand a minimum of 150 % of the shut-off head of the irrigation pump.

(b) Have a semi-flexible robust system of pipes and fittings.

Comment. *Polyethylene pipes and fittings complying with AS/NZS 4130 and AS/NZS 4129 (Int) are suitable. UPVC pipes and fittings and garden hoses and fittings are not suitable.*

(c) Have pipe laterals connecting spray heads buried to a depth of at least 150 mm and the irrigation system shall be permanently installed. The presence of the buried pipes shall be indicated, e.g. using underground marking tape to AS/NZS 2648.1.

4.5D3.3 Distribution

4.5D3.3.1 *Covered surface drip*

The number of outlets required depends on the type and capacity of the distribution orifices or drippers, and the absorption capacity of the soil.

4.5D3.3.2 *Spray*

Spray systems shall:

(a) Distribute the effluent through coarse spray heads suitable for use with effluent.

(b) Shall distribute the effluent evenly and shall not produce aerosols. (Refer to Paragraph 4.2A10.5).

(c) Comply with setback requirements. Allowance shall be made for wind-carried spray from spray-irrigation systems when determining final setback clearances to boundaries, dwellings and food crops.

4.5D3.3.3 *Solids, soil and water*

Measures shall be taken to prevent malfunction:

(a) In-line strainers (150 – 200 mesh) shall be provided on the pump discharge to protect pipework from any effluent solids carried over from the wastewater-treatment unit into the irrigation lines and to facilitate system servicing.

(b) Vacuum breakers with surface boxes shall be provided to prevent ingress of soil into the irrigation lines under the effects of negative pipeline pressures.

(c) Scour valves in surface boxes and scour-point subsurface trenches shall be provided to allow periodic cleaning of the system. Their positions should be marked.

4.5D4 PRE-COMMISSIONING TESTS

A pre-commissioning test shall be carried out after all on-site components including the pump have been installed. As a minimum the test shall take the following steps:

(a) Fill pump to "pump-on" level with water;

(b) Start pump;

(c) For surface irrigation check that water flows evenly from all perforations before covering with mulch.

For spray irrigation, check the location and coverage achieved by the spray heads and adjust to ensure even distribution to the design area.

(d) Record time taken to pump from "pump-on" level to the pump-off level. This shall be approximately 3 minutes. Record time in the on-system log.

(e) Follow pump manufacturer's recommendations for commissioning pump;

(f) Check pumping main to ensure there are no leaks and air release valve is functioning.

4.5D5 COMMISSIONING

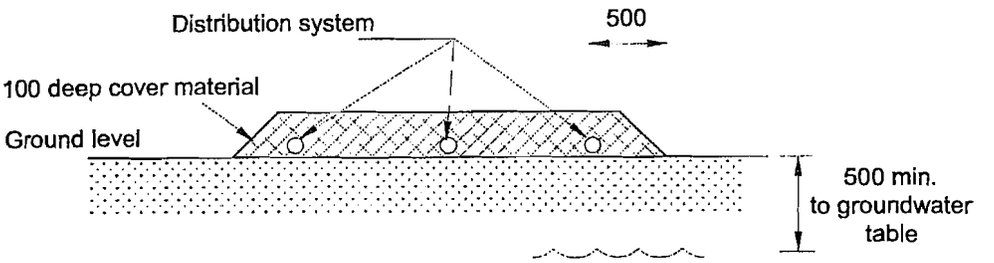
The on-site wastewater system shall be inspected, checked and commissioned according to Clause 4.5.6.

4.5D6 MARKING

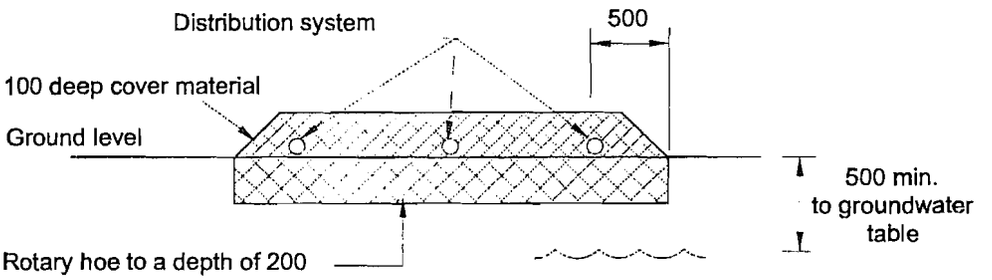
The irrigation area shall be delineated as required by Paragraph 4.2A10.4 and marked as required by Paragraph 4.2A10.5.

4.5D7 REPORTING

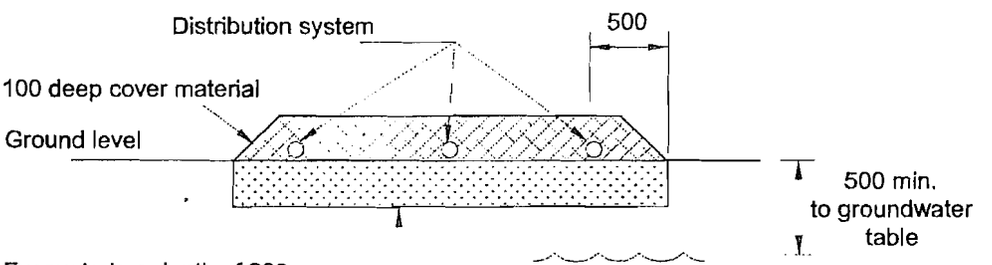
An installation and commissioning report shall be produced to include the 'as-built' details following construction, the results of construction inspections and the commissioning process. This report shall be provided to the owner of the wastewater system and to the approval authority, if required (see Clause 4.5.6.4).



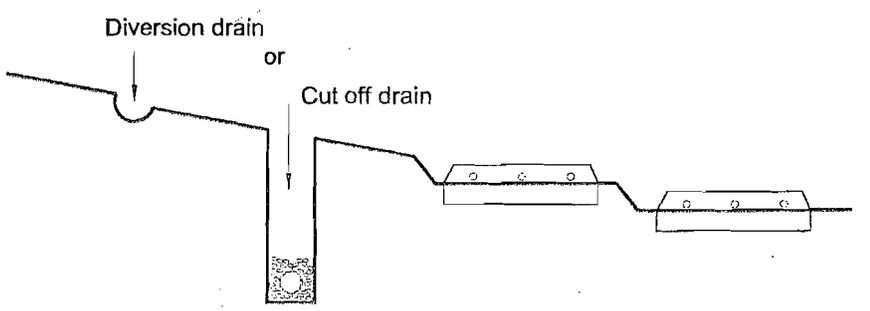
SANDY SOILS



LOAMS/GRAVEL SOILS



CLAY SOILS



Not to scale

SLOPING SITE - GREATER THAN 1:20

FIGURE 4.5D1 COVERED SURFACE DRIP IRRIGATION SYSTEM

APPENDIX H

MEDLI MODEL OUTPUT

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Ellabay 0.25mm/day 100Lep
Run Date: 14/12/05 Time:14:49:44.50

****

GENERAL INFORMATION

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION

Irrigation (mm)	4	4	4	4	4	3	3	3	3	3	3	4	44

SOIL PROPERTIES

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	0.8697
Nitrogen	(tonne/year)	0.0073
Phosphorus	(tonne/year)	0.0007
Salinity	(tonne/year)	0.2922
Nitrogen Concentration	(mg/L)	8.3993
Phosphorus Concentration	(mg/L)	0.8399
Salinity	(mg/L)	335.9739
Salinity	(dS/m)	0.5250

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.9070
Phosphorus Concentration	(mg/L)	0.7907
TDS Concentration	(mg/L)	316.2805
Salinity	(dS/m)	0.4942

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 0 mm

AREA

Total Irrigation Area	(ha)	1.9660

VOLUMES

Total Irrigation	(ML/year)	0.8684
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.0000

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.5254
Average salinity of Irrigation	(mg/L)	336.2710
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.1030
After ammonia loss	(mg/L)	7.8599
Average Phosphorus Conc of Irrigation	(mg/L)	0.8407

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.0062
Final liquid volume	(ML)	0.0062
Final sludge volume	(ML)	0.0000
Average pond volume	(ML)	0.0055
Average active volume	(ML)	0.0055
Maximum pond volume	(ML)	0.0250
Minimum allowable pond volume	(ML)	0.0025
Average pond depth	(m)	1.2602
Pond depth at outlet	(m)	4.0000
Maximum water surface area	(m2 x1000)	0.0062
Pond catchment area	(m2 x1000)	0.0202
Pond footprint length	(m)	4.4975
Pond footprint width	(m)	4.4975

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	0.8697
Recycle Volume from pond system	(ML/yr)	0.0000
Rain water added to pond system	(ML/yr)	0.0000
Evaporation loss from pond system	(ML/yr)	0.0000
Seepage loss from pond system	(ML/yr)	0.0002
Irrigation from last pond	(ML/yr)	0.8684
Volume of overtopping	(ML/yr)	0.0010
Sludge accumulated	(ML/yr)	0.0000
Sludge accumulated	(t DM/yr)	0.0000
Sludge removed	(ML/yr)	0.0000
No of desludging events every 10 years		0.0000
Increase in pond water volume	(ML/yr)	0.0001

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.00

No. of days pond overtops per 10 years 3.33
Average Length of overtopping events (days) 5.33
% Reuse 99.86
No. of overtopping events every 10 years

> 0.000 ML	0.63
> 0.000 ML*	0.63
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.0000
Average Length of such periods (days) 0.0000

POND NITROGEN BALANCE

Nitrogen Added by Effluent (tonne/yr) 0.0073 Irrig. from pond (ML/yr) 0.9
Nitrogen removed by Irrigation (tonne/yr) 0.0070
Nitrogen removed by Volatilisation (tonne/yr) 0.0003
Nitrogen removed by Seepage (tonne/yr) 0.0000
Nitrogen accumulated in Sludge (tonne/yr) 0.0000
Nitrogen lost by Overtopping (tonne/yr) 0.0000
Nitrogen involved in Recycling (tonne/yr) 0.0000
Increase in pond Nitrogen (tonne/yr) 0.0000

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent (tonne/yr) 0.0007 Irrig. from pond (ML/yr) 0.9
Phosphorus removed by Irrigation (tonne/yr) 0.0007
Phosphorus removed by Seepage (tonne/yr) 0.0000
Phosphorus accumulated in Sludge (tonne/yr) 0.0000
Phosphorus lost by Overtopping (tonne/yr) 0.0000
Phosphorus involved in Recycling (tonne/yr) 0.0000
Increase in pond Phosphorus (tonne/yr) 0.0000

POND SALINITY BALANCE

Salinity Added by Effluent (tonne/yr) 0.2922
Salinity removed by Irrigation (tonne/yr) 0.2920
Salinity removed by Seepage (tonne/yr) 0.0001
Salinity lost by Overtopping (tonne/yr) 0.0001
Salinity involved in Recycling (tonne/yr) 0.0000
Increase in pond Salinity (tonne/yr) 0.0000

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	347.8
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	6.8
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	283.3
EC of Pond Liquid	(dS/m)	0.4
Potassium Conc of Pond Liquid	(mg/L)	3.5

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.0000
Phosphorus in removed Sludge (db)	(kg/tonne)	0.0000
Salt in removed Sludge (db)	(kg/tonne)	0.0000
Potassium in removed Sludge (db)	(kg/tonne)	0.0000

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.0000
Phosphorus in removed Sludge	(tonne/yr)	0.0000
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.0000
Salt in removed Sludge	(tonne/yr)	0.0000
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.0000
Potassium in removed Sludge	(tonne/yr)	0.0000

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.17% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 2.0
Irrigation	(mm/year)	44.2		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1208.7		
Runoff	(mm/year)	549.5		
Drainage	(mm/year)	1889.0		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	43.5	142.5	1007.7	508.4	2016.1	-228.3
1958	3286.0	43.5	0.0	1108.2	400.5	1788.6	32.2
1959	5062.0	47.1	0.0	1200.6	995.1	2740.0	173.4
1960	2674.0	42.3	0.0	1125.6	257.9	1330.7	2.1
1961	2462.0	42.3	0.0	1120.8	203.8	1167.3	12.4
1962	3221.0	43.2	0.0	1183.8	267.8	1934.5	-121.9
1963	3845.0	44.7	0.0	1275.9	436.1	2066.1	111.6
1964	4909.0	46.8	0.0	1236.8	944.3	2821.6	-46.9
1965	4226.0	45.6	0.0	1161.9	472.3	2570.0	67.4
1966	2222.0	41.4	0.0	1180.8	82.8	1168.1	-168.3
1967	4088.0	45.0	0.0	1249.3	1062.0	1748.4	73.4
1968	3009.0	43.2	0.0	1186.3	413.0	1615.6	-162.7
1969	3845.0	44.7	0.0	1225.2	473.8	1986.1	204.5
1970	4023.0	45.0	0.0	1724.5	625.0	1656.2	62.3
1971	3293.0	43.5	0.0	1092.9	590.0	1857.4	-203.8
1972	4716.0	46.5	0.0	1220.0	1014.1	2523.8	4.6
1973	5608.0	48.0	0.0	1310.9	1165.9	2938.0	241.3
1974	3470.0	43.8	0.0	1015.0	357.4	2308.9	-167.6
1975	5140.0	47.4	0.0	1136.9	954.6	2899.9	196.1
1976	3624.0	44.4	0.0	1134.7	400.3	2213.0	-79.7
1977	5887.0	48.0	0.0	1104.4	2188.2	2723.1	-80.7
1978	3021.0	43.2	0.0	1276.2	330.9	1461.0	-3.9
1979	4493.0	45.6	0.0	1118.9	993.7	2273.1	153.0
1980	2577.0	42.6	0.0	1271.0	137.5	1339.3	-128.1
1981	5367.0	45.9	0.0	1300.5	1918.2	2209.8	-15.5
1982	2882.0	42.9	0.0	1231.7	271.2	1527.7	-105.8
1983	3159.0	43.2	0.0	1203.1	405.0	1430.4	163.7
1984	3331.0	43.8	0.0	1227.0	557.0	1588.9	1.8
1985	3230.0	43.5	0.0	1318.9	428.5	1684.9	-158.8

1986	3256.0	43.5	0.0	1289.2	412.1	1614.0	-15.8
1987	3184.0	43.2	0.0	1344.2	205.8	1503.5	173.7
1988	3311.0	43.8	0.0	1217.5	208.5	1837.9	90.8
1989	4065.0	45.3	0.0	1279.4	546.8	2383.5	-99.3
1990	3313.0	43.5	0.0	1107.2	400.3	1817.8	31.1
1991	3172.0	43.5	0.0	1004.5	654.4	1763.7	-207.1
1992	2172.0	41.4	0.0	985.1	72.3	963.0	193.0
1993	2590.0	42.0	0.0	1363.6	92.4	1253.7	-77.7
1994	3656.0	44.4	0.0	1172.6	462.9	2125.9	-61.0
1995	3165.0	43.5	0.0	1358.9	411.5	1398.3	39.8
1996	3176.0	43.2	0.0	1172.7	336.5	1688.3	21.7
1997	2965.0	42.9	0.0	1270.5	236.3	1312.7	188.3
1998	3490.0	44.1	0.0	1139.8	416.0	2095.1	-116.9
1999	5515.0	48.0	0.0	1256.8	1105.4	3183.5	17.2
2000	4919.0	46.8	0.0	1204.5	763.8	3006.5	-9.0
2001	2954.0	42.9	0.0	1250.3	430.1	1492.8	-176.4
2002	2011.0	41.1	0.0	1237.8	72.4	726.5	15.4
2003	2449.0	42.0	0.0	1289.2	128.8	876.3	196.7
2004	3701.0	44.4	0.0	1125.0	565.4	2041.1	14.0

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	3.6	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.1	Deep Drainage (mm/year) 1889.0
Nitrogen added in irrigation	(kg/ha/year)	3.5	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	72.6	
Denitrification	(kg/ha/year)	0.4	
Leached NO3-N	(kg/ha/year)	1.0	
Change in soil organic-N	(kg/ha/year)	-69.1	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	284.7	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.0	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	0.4	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	0.2	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.0	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	878.2	0.2
1958	2	878.3	0.2
1959	3	878.4	0.3

1960	4	880.9	0.1
1961	5	878.7	0.1
1962	6	878.8	0.2
1963	7	878.9	0.2
1964	8	881.3	0.3
1965	9	878.8	0.3
1966	10	878.9	0.1
1967	11	879.0	0.2
1968	12	881.4	0.2
1969	13	879.1	0.2
1970	14	879.1	0.2
1971	15	879.1	0.2
1972	16	881.5	0.3
1973	17	879.1	0.3
1974	18	879.0	0.2
1975	19	879.0	0.3
1976	20	881.4	0.2
1977	21	878.9	0.3
1978	22	879.0	0.1
1979	23	879.0	0.2
1980	24	881.4	0.1
1981	25	879.0	0.2
1982	26	879.0	0.2
1983	27	879.1	0.1
1984	28	881.5	0.2
1985	29	879.1	0.2
1986	30	879.2	0.2
1987	31	879.2	0.1
1988	32	881.6	0.2
1989	33	879.1	0.2
1990	34	879.1	0.2
1991	35	879.1	0.2
1992	36	881.7	0.1
1993	37	879.3	0.1
1994	38	879.2	0.2
1995	39	879.3	0.1
1996	40	881.7	0.2
1997	41	879.3	0.1
1998	42	879.3	0.2
1999	43	879.2	0.3
2000	44	881.5	0.3
2001	45	879.1	0.1
2002	46	879.2	0.1
2003	47	879.3	0.1
2004	48	881.7	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	44.	Totl Irrigation Area(ha) 2.0
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	153.	
Yield produced per unit transp.	(kg/ha/mm)	5.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	6477.			
Net nitrogen removed by plant	(kg/ha/yr)	73.	Shoot Concn	(%DM)	1.12
Net phosphorus removed by plant	(kg/ha/yr)	0.	Shoot Concn	(%DM)	0.00

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	431.	0.9	0.0	0.0	0.0
2	430.	0.9	0.0	0.0	0.0
3	512.	0.9	0.0	0.0	0.0
4	514.	0.9	0.0	0.0	0.0
5	519.	0.8	0.0	0.0	0.0
6	525.	0.8	0.1	0.0	0.0
7	577.	0.8	0.2	0.0	0.0
8	642.	0.8	0.1	0.0	0.0
9	661.	0.9	0.0	0.0	0.0
10	648.	0.9	0.0	0.1	0.0
11	540.	0.9	0.0	0.2	0.0
12	476.	0.9	0.0	0.2	0.0
No. of normal harvests per year					0.9

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water	(dS/m)	0.5	Irrigation	(mm/year) 44.2
Average EC of Rainwater	(dS/m x10)	0.3	Rainfall	(mm/year) 3607.0
Average EC of Infiltrated water	(dS/m)	0.0		
Av. water-upt-weightd rootzone EC	(dS/m s.e.)	0.0		
EC soil soln (FC) at base of rootzone	(dS/m)	0.1	Deep Drainage	(mm/year) 1889.0
Reduction in Crop yield due to Salinity	(%)	0.0		
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity		0.0		

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.02	0.06	100.
1958 - 1967	0.02	0.06	100.
1959 - 1968	0.02	0.06	100.
1960 - 1969	0.02	0.06	100.
1961 - 1970	0.02	0.06	100.
1962 - 1971	0.02	0.06	100.
1963 - 1972	0.02	0.06	100.
1964 - 1973	0.02	0.06	100.
1965 - 1974	0.02	0.06	100.
1966 - 1975	0.02	0.06	100.
1967 - 1976	0.02	0.06	100.
1968 - 1977	0.02	0.06	100.
1969 - 1978	0.02	0.06	100.
1970 - 1979	0.02	0.06	100.
1971 - 1980	0.02	0.06	100.
1972 - 1981	0.02	0.06	100.

1973 - 1982	0.02	0.06	100.
1974 - 1983	0.02	0.06	100.
1975 - 1984	0.02	0.06	100.
1976 - 1985	0.02	0.06	100.
1977 - 1986	0.02	0.06	100.
1978 - 1987	0.02	0.07	100.
1979 - 1988	0.02	0.07	100.
1980 - 1989	0.02	0.06	100.
1981 - 1990	0.02	0.06	100.
1982 - 1991	0.02	0.06	100.
1983 - 1992	0.02	0.07	100.
1984 - 1993	0.02	0.07	100.
1985 - 1994	0.02	0.06	100.
1986 - 1995	0.02	0.07	100.
1987 - 1996	0.02	0.06	100.
1988 - 1997	0.02	0.07	100.
1989 - 1998	0.02	0.06	100.
1990 - 1999	0.02	0.06	100.
1991 - 2000	0.02	0.06	100.
1992 - 2001	0.02	0.06	100.
1993 - 2002	0.02	0.06	100.
1994 - 2003	0.02	0.06	100.
1995 - 2004	0.02	0.06	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 101.7
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
Last	2004	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	20
Dry weatherProduction (ML/day)	0.002
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

---

1 file(s) copied

UNCONDITIONAL FINISH

****

SUMMARY OUTPUT

MEDLI Version 1.30

Data Set: Ellabay 1mm/day 100Lep
Run Date: 14/12/05 Time:14:44:48.07

****

GENERAL INFORMATION

****

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD

****

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION

****

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION

****

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Irrigation (mm)	16	16	17	15	15	14	14	13	13	13	13	15	174

SOIL PROPERTIES

****

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	5.479
Nitrogen	(tonne/year)	0.046
Phosphorus	(tonne/year)	0.005
Salinity	(tonne/year)	1.841
Nitrogen Concentration	(mg/L)	8.399
Phosphorus Concentration	(mg/L)	0.840
Salinity	(mg/L)	335.974
Salinity	(dS/m)	0.525

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.907
Phosphorus Concentration	(mg/L)	0.791
TDS Concentration	(mg/L)	316.281
Salinity	(dS/m)	0.494

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 1 mm

AREA

Total Irrigation Area	(ha)	3.133

VOLUMES

Total Irrigation	(ML/year)	5.467
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.000

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.526
Average salinity of Irrigation	(mg/L)	336.424
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.106
After ammonia loss	(mg/L)	7.863
Average Phosphorus Conc of Irrigation	(mg/L)	0.841

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.038
Final liquid volume	(ML)	0.038
Final sludge volume	(ML)	0.000
Average pond volume	(ML)	0.032
Average active volume	(ML)	0.032
Maximum pond volume	(ML)	0.158
Minimum allowable pond volume	(ML)	0.016
Average pond depth	(m)	1.192
Pond depth at outlet	(m)	4.000
Maximum water surface area	(m2 x1000)	0.039
Pond catchment area	(m2 x1000)	0.069
Pond footprint length	(m)	8.282
Pond footprint width	(m)	8.282

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	5.479
Recycle Volume from pond system	(ML/yr)	0.000
Rain water added to pond system	(ML/yr)	0.000
Evaporation loss from pond system	(ML/yr)	0.000
Seepage loss from pond system	(ML/yr)	0.001
Irrigation from last pond	(ML/yr)	5.467
Volume of overtopping	(ML/yr)	0.010
Sludge accumulated	(ML/yr)	0.000
Sludge accumulated	(t DM/yr)	0.000
Sludge removed	(ML/yr)	0.000
No of desludging events every 10 years		0.000
Increase in pond water volume	(ML/yr)	0.001

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.01

No. of days pond overtops per 10 years 5.00
Average Length of overtopping events (days) 4.80
% Reuse 99.79
No. of overtopping events every 10 years

> 0.000 ML	1.04
> 0.000 ML*	1.04
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.000
Average Length of such periods (days) 0.000

POND NITROGEN BALANCE

Nitrogen Added by Effluent (tonne/yr) 0.046 Irrig. from pond (ML/yr) 5.5
Nitrogen removed by Irrigation (tonne/yr) 0.044
Nitrogen removed by Volatilisation (tonne/yr) 0.002
Nitrogen removed by Seepage (tonne/yr) 0.000
Nitrogen accumulated in Sludge (tonne/yr) 0.000
Nitrogen lost by Overtopping (tonne/yr) 0.000
Nitrogen involved in Recycling (tonne/yr) 0.000
Increase in pond Nitrogen (tonne/yr) 0.000

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent (tonne/yr) 0.005 Irrig. from pond (ML/yr) 5.5
Phosphorus removed by Irrigation (tonne/yr) 0.005
Phosphorus removed by Seepage (tonne/yr) 0.000
Phosphorus accumulated in Sludge (tonne/yr) 0.000
Phosphorus lost by Overtopping (tonne/yr) 0.000
Phosphorus involved in Recycling (tonne/yr) 0.000
Increase in pond Phosphorus (tonne/yr) 0.000

POND SALINITY BALANCE

Salinity Added by Effluent (tonne/yr) 1.841
Salinity removed by Irrigation (tonne/yr) 1.839
Salinity removed by Seepage (tonne/yr) 0.001
Salinity lost by Overtopping (tonne/yr) 0.001
Salinity involved in Recycling (tonne/yr) 0.000
Increase in pond Salinity (tonne/yr) 0.000

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	346.0
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	6.8
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	285.5
EC of Pond Liquid	(dS/m)	0.4
Potassium Conc of Pond Liquid	(mg/L)	3.6

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.000
Phosphorus in removed Sludge (db)	(kg/tonne)	0.000
Salt in removed Sludge (db)	(kg/tonne)	0.000
Potassium in removed Sludge (db)	(kg/tonne)	0.000

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.000
Phosphorus in removed Sludge	(tonne/yr)	0.000
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.000
Salt in removed Sludge	(tonne/yr)	0.000
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.000
Potassium in removed Sludge	(tonne/yr)	0.000

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.57% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 3.1
Irrigation	(mm/year)	174.5		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1234.3		
Runoff	(mm/year)	560.7		
Drainage	(mm/year)	1982.5		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	172.0	144.3	1046.8	513.8	2093.7	-223.7
1958	3286.0	172.0	0.0	1153.7	408.0	1856.9	39.5
1959	5062.0	186.0	0.0	1203.8	1032.3	2850.4	161.5
1960	2674.0	168.0	0.0	1157.8	260.8	1406.7	16.8
1961	2462.0	166.0	0.0	1283.9	201.7	1151.3	-9.0
1962	3221.0	172.0	0.0	1196.3	270.6	2027.0	-100.9
1963	3845.0	177.0	0.0	1231.6	442.3	2254.2	93.9
1964	4909.0	185.0	0.0	1298.7	952.2	2879.0	-35.8
1965	4226.0	179.0	0.0	1160.0	483.1	2702.7	59.2
1966	2222.0	164.0	0.0	1252.7	82.6	1235.0	-184.2
1967	4088.0	177.0	0.0	1254.0	1064.6	1886.0	60.4
1968	3009.0	171.0	0.0	1139.8	418.6	1719.9	-98.3
1969	3845.0	176.0	0.0	1168.1	529.0	2083.9	240.0
1970	4023.0	178.0	0.0	1807.1	645.6	1756.0	-7.6
1971	3293.0	173.0	0.0	1248.3	585.9	1855.9	-224.1
1972	4716.0	183.0	0.0	1369.0	988.0	2562.6	-20.6
1973	5608.0	190.0	0.0	1289.1	1176.3	3045.5	287.1
1974	3470.0	173.0	0.0	1061.2	370.5	2363.8	-152.5
1975	5140.0	187.0	0.0	1125.4	972.5	3038.6	190.5
1976	3624.0	175.0	0.0	1176.9	415.0	2298.8	-91.7
1977	5887.0	188.0	0.0	1173.8	2205.5	2702.4	-6.7
1978	3021.0	170.0	0.0	1271.3	354.1	1623.1	-57.4
1979	4493.0	181.0	0.0	1087.9	1047.3	2400.5	138.3
1980	2577.0	168.0	0.0	1219.4	139.5	1549.1	-163.0
1981	5367.0	181.0	0.0	1223.6	1907.9	2407.8	8.7
1982	2882.0	169.0	0.0	1287.9	271.2	1579.3	-87.4
1983	3159.0	171.0	0.0	1206.0	420.7	1548.9	154.3
1984	3331.0	173.0	0.0	1255.8	563.9	1682.3	2.1
1985	3230.0	172.0	0.0	1355.5	436.2	1733.2	-122.8

1986	3256.0	172.0	0.0	1302.8	427.5	1810.4	-112.7
1987	3184.0	171.0	0.0	1196.6	206.3	1663.9	288.2
1988	3311.0	173.0	0.0	1359.4	210.0	1878.8	35.8
1989	4065.0	178.0	0.0	1175.1	564.7	2616.8	-113.6
1990	3313.0	173.0	0.0	1236.8	400.3	1802.6	46.3
1991	3172.0	171.0	0.0	1097.7	660.4	1833.3	-248.3
1992	2172.0	164.0	0.0	997.6	73.4	1032.2	232.8
1993	2590.0	167.0	0.0	1249.5	97.7	1357.5	52.4
1994	3656.0	175.0	0.0	1366.9	536.8	2094.1	-166.8
1995	3165.0	171.0	0.0	1192.7	427.7	1649.3	66.4
1996	3176.0	172.0	0.0	1342.2	334.9	1687.1	-16.2
1997	2965.0	168.0	0.0	1141.4	249.6	1545.5	196.5
1998	3490.0	176.0	0.0	1350.8	434.8	2021.7	-141.3
1999	5515.0	189.0	0.0	1079.7	1124.2	3479.1	21.0
2000	4919.0	186.0	0.0	1313.1	761.6	3047.8	-17.5
2001	2954.0	169.0	0.0	1231.3	442.9	1490.7	-41.9
2002	2011.0	163.0	0.0	1327.8	94.2	858.7	-106.6
2003	2449.0	165.0	0.0	1289.8	139.3	992.0	193.0
2004	3701.0	176.0	0.0	1290.4	566.8	2006.4	13.4

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	14.1	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.4	Deep Drainage (mm/year) 1982.5
Nitrogen added in irrigation	(kg/ha/year)	13.7	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	83.9	
Denitrification	(kg/ha/year)	0.5	
Leached NO3-N	(kg/ha/year)	1.1	
Change in soil organic-N	(kg/ha/year)	-70.2	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	231.0	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.1	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	1.5	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	1.1	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.2	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	878.7	0.2
1958	2	879.8	0.2
1959	3	880.6	0.3

1960	4	883.8	0.1
1961	5	882.2	0.1
1962	6	882.7	0.2
1963	7	883.1	0.2
1964	8	885.8	0.3
1965	9	883.5	0.3
1966	10	883.8	0.1
1967	11	884.1	0.2
1968	12	886.7	0.2
1969	13	884.5	0.2
1970	14	884.6	0.2
1971	15	884.7	0.2
1972	16	887.3	0.3
1973	17	885.0	0.3
1974	18	884.9	0.2
1975	19	885.0	0.3
1976	20	887.4	0.2
1977	21	885.0	0.3
1978	22	885.0	0.2
1979	23	885.0	0.2
1980	24	887.6	0.2
1981	25	885.2	0.2
1982	26	885.3	0.2
1983	27	885.4	0.2
1984	28	887.8	0.2
1985	29	885.4	0.2
1986	30	885.4	0.2
1987	31	885.5	0.2
1988	32	887.9	0.2
1989	33	885.4	0.3
1990	34	885.5	0.2
1991	35	885.5	0.2
1992	36	888.2	0.1
1993	37	885.8	0.1
1994	38	885.7	0.2
1995	39	885.7	0.2
1996	40	888.1	0.2
1997	41	885.8	0.2
1998	42	885.7	0.2
1999	43	885.6	0.3
2000	44	887.9	0.3
2001	45	885.5	0.1
2002	46	885.7	0.1
2003	47	885.9	0.1
2004	48	888.3	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	175.	Totl Irrigation Area(ha) 3.1
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	159.	
Yield produced per unit transp.	(kg/ha/mm)	6.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots) (kg/ha/yr) 7292.
Net nitrogen removed by plant (kg/ha/yr) 84. Shoot Concn (%DM) 1.15
Net phosphorus removed by plant (kg/ha/yr) 1. Shoot Concn (%DM) 0.02

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	544.	0.9	0.0	0.1	0.0
2	525.	0.9	0.0	0.0	0.0
3	611.	0.8	0.0	0.0	0.0
4	584.	0.8	0.0	0.0	0.0
5	571.	0.8	0.0	0.0	0.0
6	558.	0.8	0.1	0.0	0.0
7	600.	0.8	0.2	0.0	0.0
8	683.	0.8	0.1	0.0	0.0
9	717.	0.8	0.0	0.0	0.0
10	721.	0.9	0.0	0.0	0.0
11	608.	0.9	0.0	0.1	0.0
12	571.	0.9	0.0	0.1	0.0

No. of normal harvests per year 1.0

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.5 Irrigation (mm/year) 174.5
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 3607.0
Average EC of Infiltrated water (dS/m) 0.1
Av. water-upt-weightd rootzone EC(dS/m s.e.) 0.0
EC soil soln (FC) at base of rootzone (dS/m) 0.1 Deep Drainage (mm/year) 1982.5
Reduction in Crop yield due to Salinity (%) 0.0
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity 0.0

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.03	0.09	100.
1958 - 1967	0.03	0.09	100.
1959 - 1968	0.03	0.09	100.
1960 - 1969	0.03	0.09	100.
1961 - 1970	0.03	0.09	100.
1962 - 1971	0.03	0.09	100.
1963 - 1972	0.03	0.09	100.
1964 - 1973	0.03	0.09	100.
1965 - 1974	0.03	0.09	100.
1966 - 1975	0.03	0.09	100.
1967 - 1976	0.03	0.09	100.
1968 - 1977	0.03	0.08	100.
1969 - 1978	0.03	0.08	100.
1970 - 1979	0.03	0.08	100.
1971 - 1980	0.03	0.08	100.
1972 - 1981	0.03	0.08	100.

1973 - 1982	0.03	0.08	100.
1974 - 1983	0.03	0.09	100.
1975 - 1984	0.03	0.09	100.
1976 - 1985	0.03	0.09	100.
1977 - 1986	0.03	0.09	100.
1978 - 1987	0.04	0.10	100.
1979 - 1988	0.04	0.10	100.
1980 - 1989	0.04	0.10	100.
1981 - 1990	0.03	0.10	100.
1982 - 1991	0.04	0.10	100.
1983 - 1992	0.04	0.10	100.
1984 - 1993	0.04	0.10	100.
1985 - 1994	0.04	0.10	100.
1986 - 1995	0.04	0.10	100.
1987 - 1996	0.04	0.10	100.
1988 - 1997	0.04	0.10	100.
1989 - 1998	0.04	0.10	100.
1990 - 1999	0.04	0.10	100.
1991 - 2000	0.03	0.09	100.
1992 - 2001	0.03	0.09	100.
1993 - 2002	0.03	0.09	100.
1994 - 2003	0.03	0.10	100.
1995 - 2004	0.03	0.10	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 170.1
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.1	0.1	0.1
Last	2004	0.1	0.1	0.1

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	126
Dry weatherProduction (ML/day)	0.0126
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

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1 file(s) copied

UNCONDITIONAL FINISH

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Ellabay 2mm/day 100Lep
Run Date: 14/12/05 Time:14:38:58.03

****

GENERAL INFORMATION

****

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD

****

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION

****

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION

****

Irrigation (mm)	33	32	35	31	30	27	27	27	26	26	27	29	351

SOIL PROPERTIES

****

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	11.05
Nitrogen	(tonne/year)	0.09
Phosphorus	(tonne/year)	0.01
Salinity	(tonne/year)	3.71
Nitrogen Concentration	(mg/L)	8.40
Phosphorus Concentration	(mg/L)	0.84
Salinity	(mg/L)	335.97
Salinity	(dS/m)	0.52

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.91
Phosphorus Concentration	(mg/L)	0.79
TDS Concentration	(mg/L)	316.28
Salinity	(dS/m)	0.49

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 2 mm

AREA

Total Irrigation Area	(ha)	3.14

VOLUMES

Total Irrigation	(ML/year)	11.02
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.53
Average salinity of Irrigation	(mg/L)	336.43
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.11
After ammonia loss	(mg/L)	7.86
Average Phosphorus Conc of Irrigation	(mg/L)	0.84

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.05
Final liquid volume	(ML)	0.05
Final sludge volume	(ML)	0.00
Average pond volume	(ML)	0.06
Average active volume	(ML)	0.06
Maximum pond volume	(ML)	0.32
Minimum allowable pond volume	(ML)	0.03
Average pond depth	(m)	1.19
Pond depth at outlet	(m)	4.00
Maximum water surface area	(m2 x1000)	0.08
Pond catchment area	(m2 x1000)	0.12
Pond footprint length	(m)	10.90
Pond footprint width	(m)	10.90

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	11.05
Recycle Volume from pond system	(ML/yr)	0.00
Rain water added to pond system	(ML/yr)	0.00
Evaporation loss from pond system	(ML/yr)	0.00
Seepage loss from pond system	(ML/yr)	0.00
Irrigation from last pond	(ML/yr)	11.02
Volume of overtopping	(ML/yr)	0.02
Sludge accumulated	(ML/yr)	0.00
Sludge accumulated	(t DM/yr)	0.00
Sludge removed	(ML/yr)	0.00
No of desludging events every 10 years		0.00
Increase in pond water volume	(ML/yr)	0.00

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.02

No. of days pond overtops per 10 years 5.21
Average Length of overtopping events (days) 5.00
% Reuse 99.79
No. of overtopping events every 10 years

> 0.000 ML	1.04
> 0.000 ML*	1.04
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.00
Average Length of such periods (days) 0.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	0.09	Irrig. from pond (ML/yr) 11.0
Nitrogen removed by Irrigation	(tonne/yr)	0.09	
Nitrogen removed by Volatilisation	(tonne/yr)	0.00	
Nitrogen removed by Seepage	(tonne/yr)	0.00	
Nitrogen accumulated in Sludge	(tonne/yr)	0.00	
Nitrogen lost by Overtopping	(tonne/yr)	0.00	
Nitrogen involved in Recycling	(tonne/yr)	0.00	
Increase in pond Nitrogen	(tonne/yr)	0.00	

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent	(tonne/yr)	0.01	Irrig. from pond (ML/yr) 11.0
Phosphorus removed by Irrigation	(tonne/yr)	0.01	
Phosphorus removed by Seepage	(tonne/yr)	0.00	
Phosphorus accumulated in Sludge	(tonne/yr)	0.00	
Phosphorus lost by Overtopping	(tonne/yr)	0.00	
Phosphorus involved in Recycling	(tonne/yr)	0.00	
Increase in pond Phosphorus	(tonne/yr)	0.00	

POND SALINITY BALANCE

Salinity Added by Effluent	(tonne/yr)	3.71
Salinity removed by Irrigation	(tonne/yr)	3.71
Salinity removed by Seepage	(tonne/yr)	0.00
Salinity lost by Overtopping	(tonne/yr)	0.00
Salinity involved in Recycling	(tonne/yr)	0.00
Increase in pond Salinity	(tonne/yr)	0.00

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	346.0
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3
(On final day of simulation)		
Nitrogen Conc of Pond Liquid	(mg/L)	6.9
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	290.1
EC of Pond Liquid	(dS/m)	0.5
Potassium Conc of Pond Liquid	(mg/L)	3.6

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.00
Phosphorus in removed Sludge (db)	(kg/tonne)	0.00
Salt in removed Sludge (db)	(kg/tonne)	0.00
Potassium in removed Sludge (db)	(kg/tonne)	0.00

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.00
Phosphorus in removed Sludge	(tonne/yr)	0.00
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.00
Salt in removed Sludge	(tonne/yr)	0.00
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.00
Potassium in removed Sludge	(tonne/yr)	0.00

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 1.14% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 3.1
Irrigation	(mm/year)	351.0		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1265.0		
Runoff	(mm/year)	574.1		
Drainage	(mm/year)	2114.9		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	346.0	144.1	1081.9	518.3	2203.1	-198.3
1958	3286.0	346.0	0.0	1221.0	416.2	1938.1	56.7
1959	5062.0	374.0	0.0	1214.5	1049.2	3049.7	122.6
1960	2674.0	338.0	0.0	1202.6	262.8	1523.6	22.9
1961	2462.0	334.0	0.0	1210.7	212.0	1385.2	-11.9
1962	3221.0	346.0	0.0	1256.7	272.3	2103.8	-65.9
1963	3845.0	354.0	0.0	1250.4	458.8	2442.1	47.6
1964	4909.0	374.0	0.0	1228.4	983.3	3094.9	-23.6
1965	4226.0	360.0	0.0	1203.3	497.8	2831.9	53.0
1966	2222.0	330.0	0.0	1240.3	84.5	1369.7	-142.4
1967	4088.0	356.0	0.0	1283.8	1075.5	2019.1	65.5
1968	3009.0	344.0	0.0	1187.1	430.6	1868.7	-133.4
1969	3845.0	354.0	0.0	1281.2	525.3	2182.4	210.1
1970	4023.0	358.0	0.0	1713.8	664.6	1990.5	12.0
1971	3293.0	348.0	0.0	1335.7	592.6	1926.5	-213.8
1972	4716.0	368.0	0.0	1399.7	1017.0	2686.5	-19.2
1973	5608.0	382.0	0.0	1319.8	1185.6	3209.7	274.8
1974	3470.0	348.0	0.0	1163.8	373.5	2450.3	-169.6
1975	5140.0	376.0	0.0	1098.0	988.5	3219.8	209.7
1976	3624.0	352.0	0.0	1236.7	434.7	2403.9	-99.3
1977	5887.0	378.0	0.0	1243.3	2225.7	2797.0	-1.0
1978	3021.0	342.0	0.0	1260.1	360.3	1768.7	-26.2
1979	4493.0	364.0	0.0	1256.7	1050.7	2431.5	118.1
1980	2577.0	338.0	0.0	1320.7	142.2	1568.8	-116.7
1981	5367.0	362.0	0.0	1216.2	1967.5	2584.3	-38.9
1982	2882.0	342.0	0.0	1303.5	279.5	1598.0	43.0
1983	3159.0	344.0	0.0	1297.9	497.6	1692.3	15.2
1984	3331.0	348.0	0.0	1273.8	574.5	1830.9	-0.3
1985	3230.0	344.0	0.0	1340.9	444.1	1838.4	-49.3

1986	3256.0	348.0	0.0	1356.4	464.1	1938.4	-154.9
1987	3184.0	344.0	0.0	1267.9	231.3	1786.1	242.7
1988	3311.0	348.0	0.0	1256.8	215.4	2138.1	48.7
1989	4065.0	358.0	0.0	1210.1	606.4	2709.9	-103.4
1990	3313.0	348.0	0.0	1296.4	415.5	1910.3	38.8
1991	3172.0	344.0	0.0	1118.7	672.6	1960.0	-235.4
1992	2172.0	330.0	0.0	1103.0	74.9	1106.5	217.6
1993	2590.0	334.0	0.0	1260.3	101.3	1576.8	-14.4
1994	3656.0	354.0	0.0	1351.6	468.8	2195.6	-6.1
1995	3165.0	344.0	0.0	1302.7	481.1	1765.8	-40.5
1996	3176.0	346.0	0.0	1273.9	343.3	1861.9	43.0
1997	2965.0	338.0	0.0	1204.3	307.2	1664.2	127.4
1998	3490.0	352.0	0.0	1298.5	415.2	2243.2	-114.8
1999	5515.0	382.0	0.0	1130.0	1148.6	3601.5	17.0
2000	4919.0	372.0	0.0	1261.1	781.1	3253.9	-5.0
2001	2954.0	342.0	0.0	1342.1	443.9	1625.3	-115.2
2002	2011.0	326.0	0.0	1363.4	87.1	908.2	-21.7
2003	2449.0	334.0	0.0	1386.0	140.9	1088.6	167.5
2004	3701.0	354.0	0.0	1292.8	574.4	2172.2	15.5

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	28.5	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.9	Deep Drainage (mm/year) 2114.9
Nitrogen added in irrigation	(kg/ha/year)	27.6	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	98.0	
Denitrification	(kg/ha/year)	0.5	
Leached NO3-N	(kg/ha/year)	1.1	
Change in soil organic-N	(kg/ha/year)	-70.5	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	214.5	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.1	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	3.0	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	2.4	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.3	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	879.4	0.2
1958	2	881.7	0.2
1959	3	883.6	0.3

1960	4	887.6	0.2
1961	5	886.5	0.1
1962	6	887.5	0.2
1963	7	888.4	0.2
1964	8	891.3	0.3
1965	9	889.3	0.3
1966	10	889.8	0.1
1967	11	890.2	0.2
1968	12	892.9	0.2
1969	13	890.8	0.2
1970	14	891.0	0.2
1971	15	891.1	0.2
1972	16	893.7	0.3
1973	17	891.5	0.3
1974	18	891.5	0.2
1975	19	891.6	0.3
1976	20	894.0	0.2
1977	21	891.5	0.3
1978	22	891.6	0.2
1979	23	891.6	0.2
1980	24	894.2	0.2
1981	25	891.7	0.3
1982	26	891.8	0.2
1983	27	891.8	0.2
1984	28	894.3	0.2
1985	29	891.9	0.2
1986	30	891.9	0.2
1987	31	892.1	0.2
1988	32	894.5	0.2
1989	33	892.0	0.3
1990	34	892.0	0.2
1991	35	892.0	0.2
1992	36	894.9	0.1
1993	37	892.5	0.2
1994	38	892.4	0.2
1995	39	892.3	0.2
1996	40	894.8	0.2
1997	41	892.3	0.2
1998	42	892.3	0.2
1999	43	892.2	0.4
2000	44	894.5	0.3
2001	45	892.2	0.2
2002	46	892.4	0.1
2003	47	892.5	0.1
2004	48	895.0	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	351.	Totl Irrigation Area(ha) 3.1
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	168.	
Yield produced per unit transp.	(kg/ha/mm)	6.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots) (kg/ha/yr) 8220.
Net nitrogen removed by plant (kg/ha/yr) 98. Shoot Concn (%DM) 1.19
Net phosphorus removed by plant (kg/ha/yr) 2. Shoot Concn (%DM) 0.03

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	645.	0.8	0.0	0.0	0.0
2	602.	0.8	0.0	0.0	0.0
3	689.	0.8	0.0	0.0	0.0
4	641.	0.8	0.0	0.0	0.0
5	624.	0.8	0.0	0.0	0.0
6	615.	0.8	0.1	0.0	0.0
7	670.	0.8	0.2	0.0	0.0
8	747.	0.8	0.1	0.0	0.0
9	774.	0.8	0.0	0.0	0.0
10	817.	0.8	0.0	0.0	0.0
11	719.	0.9	0.0	0.1	0.0
12	677.	0.9	0.0	0.1	0.0

No. of normal harvests per year 1.1

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.5 Irrigation (mm/year) 351.0
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 3607.0
Average EC of Infiltrated water (dS/m) 0.1
Av. water-upt-weightd rootzone EC(dS/m s.e.) 0.0
EC soil soln (FC) at base of rootzone (dS/m) 0.1 Deep Drainage (mm/year) 2114.9
Reduction in Crop yield due to Salinity (%) 0.0
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity 0.0

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.05	0.13	100.
1958 - 1967	0.05	0.13	100.
1959 - 1968	0.05	0.13	100.
1960 - 1969	0.05	0.13	100.
1961 - 1970	0.05	0.13	100.
1962 - 1971	0.05	0.13	100.
1963 - 1972	0.05	0.12	100.
1964 - 1973	0.05	0.12	100.
1965 - 1974	0.05	0.12	100.
1966 - 1975	0.05	0.12	100.
1967 - 1976	0.04	0.12	100.
1968 - 1977	0.04	0.12	100.
1969 - 1978	0.04	0.12	100.
1970 - 1979	0.04	0.12	100.
1971 - 1980	0.04	0.12	100.
1972 - 1981	0.04	0.11	100.

1973 - 1982	0.04	0.12	100.
1974 - 1983	0.05	0.12	100.
1975 - 1984	0.05	0.13	100.
1976 - 1985	0.05	0.13	100.
1977 - 1986	0.05	0.14	100.
1978 - 1987	0.05	0.14	100.
1979 - 1988	0.05	0.14	100.
1980 - 1989	0.05	0.14	100.
1981 - 1990	0.05	0.14	100.
1982 - 1991	0.05	0.14	100.
1983 - 1992	0.05	0.14	100.
1984 - 1993	0.05	0.14	100.
1985 - 1994	0.05	0.14	100.
1986 - 1995	0.05	0.14	100.
1987 - 1996	0.05	0.14	100.
1988 - 1997	0.05	0.14	100.
1989 - 1998	0.05	0.14	100.
1990 - 1999	0.05	0.14	100.
1991 - 2000	0.05	0.13	100.
1992 - 2001	0.05	0.13	100.
1993 - 2002	0.05	0.13	100.
1994 - 2003	0.05	0.14	100.
1995 - 2004	0.05	0.14	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 181.8
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
Last	2004	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	254
Dry weatherProduction (ML/day)	0.0254
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

---

1 file(s) copied

UNCONDITIONAL FINISH

APPENDIX I

ELLA BAY SEWERAGE SCHEME
EFFLUENT IRRIGATION ASSESSMENT

40 Reginald Street,
Rocklea 4108
PO Box 3160,
Yeronga Qld 4104
Australia

Ph: (07) 3710 9100
Free call: 1800 620 690
Fax: (07) 3710 9199
Email:
info@simmondsbristow.com.au

Simmonds & Bristow
Established 1965 ACN 010 252 418 Pty Ltd

benchmark IN QUALITY ISO 9001 JAS-ANZ

Laboratory Services

- Water & Wastewater Analysis
- Microbiological Analysis
- Soil Analysis
- Corrosion Assessments
- Concrete & Aggregates
- Sludge Analysis

Scientific & Engineering Services

- Process Engineering
- Acid Sulphate Soils Investigations
- Blue-Green Algae Investigations
- Stormwater Management
- Contaminated Sites Investigations
- Environmental Plans & Programmes
- EASI Sampling
- Litigation Support

Training

- Sewage & Wastewater Treatment Plant Operator Training
- Drinking & Industrial Water Treatment Plant Operator Training
- Swimming Pool Operator Training
- Environmental Awareness
- Sampling & Environmental Compliance

Ella Bay Resort Development

Review of Effluent Irrigation Areas

By: David Bristow *B.E.(Chem), MIEAust, CPENG, AFAIM*

For: EPCO Australia

Authorised for Release: David Bristow *B.E.(Chem), MIEAust, CPENG, AFAIM*

Date: 2 October, 2005

Ella Bay Resort Development
Review of Effluent Irrigation Areas

Table of Contents

Ella Bay Resort Development
Review of Effluent Irrigation Areas

1. Introduction

This report has been prepared at the request of EPCO Australia, to assess the required irrigation areas, and wet weather storage to assimilate treated effluents from the proposed Ella Bay Eco Tourist Resort Development into the environment via land disposal techniques.

2. The Development

The development is located immediately behind the beach front at Ella Bay, north of Flying Fish Point adjacent to the Ella Bay National Park.

The sewerage scheme and effluent irrigation areas are located on Lot 337 NR at Ella Bay, Johnstone Shire.

The development is a controlled community eco tourist resort and consists of a central complex with a 100 seat restaurant, 100 accommodation villas (70 Holiday Villas and 30 Beach Resort Bures), and a managers residence.

The main complex is to be located on the coastal flat, on the lower portion of the property behind the beach. The accommodation units in the main, are on the top of ridge lines and the significant hill top in the centre of the property.

The site is to be serviced by reticulated water and sewerage operated by the resort, and is to cater for 400 persons.

The Water supply is to be harvested from the permanent creek on the property and the feed to the reticulation system from a storage reservoir located on a hill top in the bottom south west corner of the site, at an elevation of 150m above sea water.

The sewage treatment plant is to be located in the services yard, within the coastal flat behind the main complex. Effluent is planned to be irrigated throughout the development.

The development has an estimated water demand of 251 kL/day, comprising of 82 kL/day for domestic supply, 12 kL/day pool water top up and 157 kL/day for irrigation of 11 Ha of landscaped land (Colefax Clayton & Smith - Civil Engineers report on Infrastructure - Sept 1995).

3. The Land

The development covers a total area of 64.7 Ha with a 650m long beach frontage to Ella Bay.

The land rises from the beach to 110-120 m above sea level within 450m of the beach.

The land has significant flat areas on the coastal flat and on the top of the hills and ridges. The coastal flat is elevated at between 10-20m above seawater, and has a slope of 5-10%.

The ridge & hill tops are undulating at between 100 and 120m above seawater with slopes of 5-10%.

The hill slopes are very steep, rising 110m in 100m with slopes ranging from 35% to 50% and within gully lines even steeper.

The property has significant stands of primary rainforests on the coastal flat and hill tops and dense to open forest/woodland on the hill slopes.

Several water courses dissect the property, including one significant permanent creek that runs west to east in the southern portion of the land.

The land form was described by Golder & Associates (Sept 1995) as stiff to very stiff gravelly sandy silty clay top soil overlying schist type rocks of the Hodgkinson formation.

Observation of track cuts and erosion lines, indicated a topsoil depth on the hill slopes of 300-1000mm over fractured rock, with significant basalt rock "floaters" frequently present.

Soil sampling on the coastal flat area indicated the soils to be predominantly brown/red loamy, sandy clays, though a yellow sandy loamy clay was predominant in the south eastern corner on the southern side of the significant permanent creek.

Soils on the coastal flat where sampled to 1000mm. A rich organic thin topsoil of 50-100mm was found over brown/red sandy loamy clays of uniform consistency. Groundwater was not encountered. Drilling was easy at 1000mm, indicating soil depths to extend beyond 1000mm.

Soil sampling on the hill slopes was not undertaken as these were considered unsuitable for irrigation due to their slope and thin stony soils.

Soil sampling on the ridges and hill tops was undertaken to a depth of 1000mm. A thin rich organic topsoil of 50-100mm was found over brown/red sandy loamy clays of uniform consistency. Groundwater was not encountered. Although the augur was not rejected, drilling was difficult at 1000mm depth, indicating that the soil at that depth was more like weathered rock.

The soils on analysis (Appendix B) were generally classified as clays and had low permeability. The soils were acidic with a pH of less than 5, typically pH 4-4.5, not atypical for rainforest soils with significant organic acids present for the breakdown of forest mulch.

The soils had a low salt concentration as expected. The soils were low in Calcium and Magnesium, but rich in Sodium and Potassium. The latter is an important soil nutrient when irrigating soils with effluents typically rich in sodium and presenting an elevated sodium adsorption ratio.

The soils had a high concentration of organic nitrogen, were low in phosphorus and had a moderate ammonia concentration. These soils are expected to have high phosphorus absorption capacity, but naturally leach nitrogen to groundwater.

4. Sewage Generation

The sewage generation rates predicted for the development by Colefax Clayton & Smith are in line with typical domestic sewage guidelines.

Resorts however tend to be very water hungry. The low permeability of the soils coupled with the restricted areas for effluent disposal and restricting slopes, and wet season climate indicate that strict water management practices need to be implemented to reduce effluent volumes.

The development intends to support 400 persons, with fully catered facilities and will be equivalent to a small village community.

The steep slopes and elevation differentials, coupled with an expected high basic water demand will, from experience, see water consumption and sewage generation rates significantly elevated, possibly as high as 500L/person/day.

Irrigation load and pool make water will push this even higher.

The current sewage generation rates are estimated at 82kL/day or 205L/person/day.

To minimise the risk of over demand and reduce the base sewage load, hence minimising effluent disposal areas and wet weather storage requirements, the following strategies are strongly recommended:

- Full Pressure Balancing of Water Supply to ensure uniform water flows at all elevations within the resort. Pressure at the supply taps throughout the resort should be set at 100 to 150 kPa for domestic supply and 200 kPa for fire fighting hydrants. Estimated water demand reduction - 25 to 30%, Sewage Generation Rate reduction 25-30%.

- Reclamation of treated effluent - using this water to flush toilets, landscape irrigation and resort wash down water. Water quality should be equivalent to unrestricted non potable reuse (ANZECC & NHMRC Reclaimed Water Guidelines) Estimated water demand reduction - 25 to 50%, Sewage generation rate reduction - nil.

- Installation of water saving (5 star) washing machines (clothes & dish washes) and dual flush toilets- Water demand & sewage generation rate reduction - 20-25%

The use of standard water reduction devices, coupled with provision of a controlled water supply managed and operated on-site will result in significant reductions in water use.

As the sewer in the lower portion of the site may be inundated during the wet season, and during storm events there may be some stormwater infiltration into the sewer system. The treatment and effluent disposal system must be able to cater for this additional flow.

The modern design of well constructed sewers (UPVC or MDPE smart sewers, minimal manholes, high quality construction techniques and site controls and a small catchment), is expected to exclude infiltration, to less than 20% of the daily sewage flow.

Spreadsheet water balance modelling was carried out to assess the impact of infiltration of groundwater and stormwater on the sewer flows.

Groundwater infiltration to the sewerage system was calculated using the Sewerage Code of Australia. Using this Code, the volume of groundwater infiltrating the sewerage system was calculated to be approximately 8000L/day.

This value is unlikely to be experienced as the sewers should be generally laid above groundwater, however a 31% system submergence has been used to determine this figure, for prudence, given the proximity of the main complex to coastal dunes, and the likely size and depth of the final sections of the sewer around the main complex .

The stormwater infiltration rate was also calculated using the Sewerage Code of Australia. Using this Code, the rate of stormwater infiltrating the sewerage system was calculated to be approximately 4.9 L/sec.

The spreadsheet modelling was based on the last 48 years of rainfall data provided by the Australian Bureau of Meteorology and the calculated groundwater infiltration rate at 12000L/day. Stormwater infiltration was said to occur during storm events greater than 5mm over a period of up to approximately four hours.

The results from the spreadsheet modelling indicate that the average increase in Average Dry Weather Flow (ADWF) due to stormwater and groundwater infiltration is approximately 22%, with a surcharge factor of 2.1 ADWF.

Based on these strategies and flow estimates documented in AS1547, water flows within the resort are re-estimated as follows:

Table 4.1
Estimated Water Supply & Sewage Generation Rates

Demand/Generation Source	Water Supply Demand			Sewage Generated		
	Average Daily Fresh Water Demand kL/day	***Mean Day Maximum Month kL/day***	***Reuse Water kL/day***	***Average Dry Weather Flow kL/day***	***Peak Wet Weather Flow kL/day***	***Effluent Reuse***
Main Complex 40 employees @ 30L/ep/day	1.2	1.8	0.3	1.5	3.15	0.5
Restaurant 100 seat 3meals/day @ 20L/meal	6	9	1.5	7.5	15.75	1.5
Hill Top Accommodation Units 70 units @ 3ep/unit @ 80L/ep/day	16	24	4.8	20.8	43.68	7.2
Beach Accommodation Units 30 units @ 2.4ep/unit @ 80L/ep/day	5	7.5	1.25	6.25	13.125	1.8
Manager's Residence 3.5 ep @ 80L/ep/day	0.2	0.3	0.06	0.26	0.546	0.1
Swimming Pool @ 3500m2 @ 25mm/week	12	18	0	4.5	9.45	0
Irrigation (Available)			37.9			37.9
Total	40	61	46	41	86	49
Flow L/ep/day	101	151	114	102	214	122

The rate of 100L/person/day for sewage generation equates well with our experience of controlled communities and flow estimates from AS1547.

This yields an overall flow of approximately 61,000 L/day for the water supply plant and 30,000 L ADWF for the sewage treatment plant. .

The system flows for evaluation of mean performance of the sewage treatment plant would be approximately 40,000 L/day.

The sewage treatment plant should be assessed on its capacity to treat 40,000 L/day of raw sewage, and 8000 L/day of groundwater infiltration, plus a peak hydraulic load during storm events of 5 L/sec.

The sewer system should be assessed based on the maximum likely flow. Again, using the sewer code of Australia, this calculates to 8.1 L/sec, based on a Q2 design event.

Irrigation areas should be assessed for a dry weather flow of approximately 36,000 L/day with a wet weather surcharge on average of 10,000 L/day, or a total irrigation volume of 46,000L/day. This is an overestimation of the irrigation water likely to be available, but the conservative volume predicted to be collected for irrigation, should the reclaimed water recycling not be installed

5. Reclaimed Water Quality

The sewage/water reclamation plant design effluent quality is reported as follows;

Table 5.1
Design Effluent Quality

Parameter	Value (50th Percentile)
pH	6.5-8.0
Suspended Solids mg/L	<1
Turbidity (NTU)	<2.0
BOD_5 mg/L	<10
Total Nitrogen mg/L	<1
Total Phosphorus mg/L	<1
Faecal Coliforms orgs/100mL	<10

This water quality will allow reuse of the treated/reclaimed water for toilet flushing, for wash down water, and unrestricted irrigation throughout the resort complex.

6. Effluent Irrigation

The irrigation of reclaimed water/treated effluent throughout the resort will allow for landscape areas to remain green and vibrant year round, even during the annual dry season.

The irrigation of reclaimed water on the site will require specific design features to address the site geological and climatic constraints. The primary site constraints are:

- Site slopes limit suitable irrigation areas to the coastal flat, ridge tops and hill tops.
- Site development proposals utilise a fair percentage of the "flat" land for building works
- The site is located in tropical north Qld and experiences a distinct wet season that lasts three months in every twelve.
- The site has significant areas reserved as habitat conservation zones. Some of these coincide with suitable irrigation land.

6.1 Available Irrigation Areas

The site covers some 65 Ha, of which some 11-15 Ha of relatively flat areas are proposed to be developed. Of this developed area, an estimated 50% will be under rooves, pavements and impervious surfaces.

Some areas of the development have been placed on land with steeply slopes up to 45%.

The soils are predominantly brown/red sandy loamy clays, that will become quickly waterlogged if over irrigated.

Irrigation must be controlled based on soil moisture tensiometers and rain station monitoring.

Soil conditions in likely irrigation areas, were assessed by a hand augur drilling program, to determine soil types and permeability. Laboratory results for permeability are presented in Appendix B.

Likely irrigation areas are predominantly on to flat costal area plus on ridge tops and saddles.

Proposed irrigation areas are shown on drawing No P05-A by ETS and is included in Appendix A.

Soil permeability can be summarised as follows:

Table 6.1.1
Soil Profile Summary

		Soil Permeability mm/hr				
Soil Horizon	***Thickness (mm)***	***Area 1 Base of Hill***	***Area 2 Hill Top Saddle***	***Area 3 Coastal Flat***	***Area 4 Creek Flat***	***Area 5 Hill Top Saddle***
Top Soil	0-200	7/62	18	55	3	14
Sandy Loamy Clay	200-500	66/44	78	25	13	59
Clay	500-1000	34/33	38	35	7	130
Groundwater		Not Detected	Not Detected	Not Detected	Not Detected	Not Detected

6.2 Irrigation MEDLI Assessment

To determine the required area to assimilate the effluent not recycled and reused for toilet flushing and to assess the performance of the irrigation areas, MEDLI modelling was undertaken, using the last 48 years of daily rainfall & evaporation data for the area (1957-2004).

MEDLI is a complex, daily time step, hydrological and nutrient balance simulation for effluent irrigation systems. The program incorporates historical climatic data with input parameters specific to each effluent irrigation system (ie. effluent quality and quantity, land area, storage area, soil water and nutrient adsorption properties, crop growth and removal) to assess the hydrological and nutrient balance of the system.

The model output includes estimates of runoff, evaporation, transpiration, drainage, nutrient and salt leaching rates and plant yield, as well as plant stress due to nitrogen, temperature and soil moisture.

The soils as tested would allow an irrigation loading rate of 15-20mm/week, if slope was not a limitation (AS1547).

MEDLI modelling of the profile under these conditions using an effluent generation rate of 50,000 L/day (raw sewage plus stormwater & groundwater allowances), indicated that an area of 5 Ha, would be required to assimilate the effluent without leaching nutrients to the groundwater, nor causing runoff from the irrigated areas, other than due to rain fall.

A wet weather storage is required to hold effluents when soil moisture or rainfall are likely to cause runoff of irrigation waters.

A wet weather storage of 500m3 was found to be the smallest sized storage required for this function. Over topping was predicted, but only on 3 occasions over a ten year period for a total of 5.42 days in 3650. A total of 0.03 ML of water is expected to over top, giving an event volume of only 5.5m3.

This will require reclaimed water to be irrigated during rainfall to prevent an actual over topping, otherwise a wet weather storage over flow will need to be provided and approvals obtained. Reclaimed water quality will need to be good enough to ensure adequate dilution occurs to negate any impacts of the irrigated waters on the receiving waters within the site.

The water quality recommended is very high and nitrogen is the only significant environmental parameter likely to require dilution.

The recommended limit of <10 mg/L nitrogen would require 2 fold dilution to meet Great Barrier reef Marine Park effluent discharge standards, and a 100 fold dilution to be below the fresh water nitrogen eutrophication concentration of <0.1 mg/L.

Over topping of the wet weather storage is most likely to occur during the wet season. Inspection of the rainfall records for the period 1957 to 2005, indicates that the wet season would typically see storm activity in excess of 20mm per day.

Flow through the site from site runoff alone are expected to be well in excess of 4 ML/day during the wet. The over topping event volume of 5.5 m3, will be diluted some 550 times if released into this flow. The impact of the release of the overtopping volume, either to land or directly to a water course is therefore expected to be unmeasurable.

Soil saturation was not predicated, though with some plant species the nitrogen concentrations in the irrigation water are so low that nitrogen deficit stressing is significant.

Slope does present a significant limitation though, and to ensure that this is addressed it is usual practice to reduce the application rate, and protect the up slope and down slope of the irrigation area with runoff diversion/collection bunds and contour banks.

AS1547 allows subsoil drip irrigation on slopes of up to 25% before slope is considered a limitation. Some guidelines put a limit of 15% for irrigation systems. These limits are not regulations, and are simply guidelines to flag that standard designs should not be employed on slopes above the limit set.

By reducing the application rate, and providing cutoff drains, these limitations can be over come.

Based on our experience of irrigating steep slopes, an application rate of 1mm/day or 7 mm/week, would be applicable for the slopes between 15-30%, and an irrigation rate of 2mm/day or 15mm/week would be suitable for slopes less than 15%.

Modelling using this reduced application rates over entire area with the soil types recorded, indicates that an area of 5Ha is required. The resort appears to have in excess of 10 Ha of land suitable for irrigation within the development envelope, from the beach front to the hill top cluster.

Successful irrigation of effluent on these areas should be managed in the following manner:

- Weekly application rates should not exceed 10mm/week, and average 7mm/week.
- Top of slope runoff control bunds should be maintained to ensure up slope runoff is excluded from the area.
- Bottom of slope interception contour banks should be maintained to collect and capture steep slope runoff, and direct same back to the wet weather storage tank.
- Effluent water quality should be high as recommended.
- Effluent must be applied using drip irrigation or droplet irrigation techniques, either under mulch or close to the ground.
- Moisture loving, nutrient tolerant plants should be used throughout irrigated landscape areas to maximise moisture uptake.
- Effluent irrigation should be stopped if soil moisture exceeds 90% field capacity, and or rainfall in the catchment exceeds 5mm in a day.
- A minimum of 1m buffer should be provided between the irrigation area and paths/roads were drip irrigation is practised and 3m were droplet (wobbler) above ground systems are used. All buildings should have 2m set backs of windows & decks and 1m setbacks of blank walls from irrigation systems.
- A minimum set back of 10m should be provided from water courses for drip irrigation and 20m for droplet spray systems.
- Pressure burst protection is provided on the irriagtion pump, to shut the pump down in the event of a line burst.

7. Conclusions

The proposed Ella Bay Eco-tourist resort proposes to reclaim its effluents and reuse them for irrigation of landscape areas throughout the resort.

Effluent volumes without infiltration were estimated in 1995 at approximately 100m3/day.

The site land forms are constrained with regard to effluent irrigation, due to slope, geology, habitat reserves and climate. Effluent volumes need to be controlled and reduced because of these constraints.

It was recommended that to achieve control and effluent volume reductions, effluents be reused for toilet flushing and wash down water in addition to irrigation of landscape areas. It was also recommended that pressure balancing of the water supply occur and the installation of 5 star washing machines and dual flush toilets be carried out to further reduce the volume of effluents produced.

Effluent generation rates in excess of 200L/ep/day were predicted in 1995. With the use of technological advances in water demand management, this was shown to be able to be reduced to 100L/ep/day. For the 400 ep resort this resulted in an overall reduction in expected sewage flows from 100m3/day to less than 40 m3/day.

Flow allowances for infiltration and stormwater were not accounted for previously, and modelling of the sewers indicates that a surcharge of 22% must be allowed for in predicting effluent flows. It was also recommended that based on the infiltration modelling that the sewage treatment plant be capable of treating up to 70 m3/day.

Site soils were sampled and found to be suitable for effluent irrigation.

A reduced irrigation rate will need to be applied for sustainable disposal of an estimated 50,000L/day of effluents, due to slope, geology and climate.

MEDLI modelling of the irrigation system, determined that an area of 5 Ha is required for sustainable assimilation of the effluents. A wet weather storage tank of 500m3 working volume is required to support the irrigation scheme, so that effluents can be held during rain events greater than 5mm/day, or when soil field capacity exceeds 90%.

Effluent quality will need to be high, to allow unrestricted non potable reuse of the effluents, to minimise buffer distances, and allow controlled and successful release of effluents to the environment during wet weather storage over topping events when they infrequently occur.

The site appears to have in excess of 10 Ha of suitable unused land available to establish an effluent irrigation reuse scheme.

David Bristow *B.E.(Chem), MIEAust, CPENG, AFAIM*
Managing Director & Principal Engineer

Appendix A

Proposed Irrigation Areas
And
MEDLI Model Summaries

320
N157629

20m BUFFER

PROPOSED VILLA HOUSING AREA

IRRIGATION AREA 4/5
1.673ha

LOT IRRIGATION AREA
3.65ha

IRRIGATION AREA 6
1.486ha

IRRIGATION AREA 2
1.21ha

IRRIGATION AREA 1
1.93ha

IRRIGATION AREA 3/7
0.84ha

PROPOSED RESORT AREA
4.2 ha

ESPLANADE

20m DEVELOPMENT BOUNDARY SETBACK FROM EXISTING CREEK

PROPOSED SERVICES AND INFRASTRUCTURE AREA
0.4 ha

LOT 337
NR53

SUMMARY	
SITE AREA = 64.73ha	100%
TOTAL DEVELOPMENT PRECINCT = 18.12ha	28%
PROPOSED CONSERVATION PRECINCT = 46.61ha	72%
TOTAL IRRIGATION AREA = 10.75ha	16.6%

N

LEGEND

- PROPOSED DEVELOPMENT PRECINCT
- PROPOSED CONSERVATION PRECINCT
- PROPOSED IRRIGATION AREA IN DEVELOPMENT PRECINCT
- PROPOSED IRRIGATION AREA WITHIN LOTS
- PROPOSED ROAD
- EXISTING TIMBER TRACK

NOTE:

BUFFER DISTANCE OF 1M FROM ROADS AND BUILDINGS ALLOWED FOR IN IRRIGATION DESIGN

0 25 50 75 100 125
metres

SCALE 1:2500 IS APPLICABLE ONLY TO THE ORIGINAL SHEET SIZE. (A3)

PRELIMINARY ONLY

ASSOCIATED CONSULTANTS
C & B GROUP

PRELIMINARY

DATE	REV	DESCRIPTION	AUTHORISED
01/12/05	C	REVISED IRRIGATION AREAS	KPH
29/11/05	B	REVISED IRRIGATION AREAS	KPH
	A	ORIGINAL ISSUE	KPH

REVISIONS

CLIENT: ELLA BAY DEVELOPMENTS PTY LTD
PROJECT: ELLA BAY LOT 337 NR 53
LOCATION: ELLA BAY
SHEET TITLE: DETAILED SITE LAYOUT PLAN

DESIGNED A.W.S.A.
DRAWN A.W.S.A.
CHECKED DATE
DATE NOVEMBER 2005

APPROVED DATE
KEITH HOWELLS RPEQ 7295
SCALE 1:2500

30 1975-2005 BUILDING ON 30 YEARS

ETS GROUP

- ARCHITECTS
- ENGINEERS
- INTERIOR DESIGNERS

AUSTRALIA
1 SWANN ROAD TARINGA BRISBANE QLD 4068
TELEPHONE (07) 3371 7000 FACSIMILE (07) 3371 5679
EMAIL – mail@etagroup.net.au
PAPUA NEW GUINEA
5TH FLOOR CUTHBERTSON HOUSE PO BOX 908 PORT MORESBY
TELEPHONE (675) 321 1333 FACSIMILE (675) 321 7653
EMAIL – etapng@datec.com.pg
SINGAPORE • NEW ZEALAND • INDONESIA
UNITED ARAB EMIRATES

JOB CODE: JHSREB
SHEET NUMBER: P05 REV: C

FORM E027 30 MAR 2000

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Ellabay 0.25mm/day 100Lep
Run Date: 14/12/05 Time:14:49:44.50

****

GENERAL INFORMATION

****

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD

****

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION

****

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION

****

Irrigation (mm)	4	4	4	4	4	3	3	3	3	3	3	4	44

SOIL PROPERTIES

****

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	0.8697
Nitrogen	(tonne/year)	0.0073
Phosphorus	(tonne/year)	0.0007
Salinity	(tonne/year)	0.2922
Nitrogen Concentration	(mg/L)	8.3993
Phosphorus Concentration	(mg/L)	0.8399
Salinity	(mg/L)	335.9739
Salinity	(dS/m)	0.5250

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.9070
Phosphorus Concentration	(mg/L)	0.7907
TDS Concentration	(mg/L)	316.2805
Salinity	(dS/m)	0.4942

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 0 mm

AREA

Total Irrigation Area	(ha)	1.9660

VOLUMES

Total Irrigation	(ML/year)	0.8684
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.0000

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.5254
Average salinity of Irrigation	(mg/L)	336.2710
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.1030
After ammonia loss	(mg/L)	7.8599
Average Phosphorus Conc of Irrigation	(mg/L)	0.8407

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.0062
Final liquid volume	(ML)	0.0062
Final sludge volume	(ML)	0.0000
Average pond volume	(ML)	0.0055
Average active volume	(ML)	0.0055
Maximum pond volume	(ML)	0.0250
Minimum allowable pond volume	(ML)	0.0025
Average pond depth	(m)	1.2602
Pond depth at outlet	(m)	4.0000
Maximum water surface area	(m2 x1000)	0.0062
Pond catchment area	(m2 x1000)	0.0202
Pond footprint length	(m)	4.4975
Pond footprint width	(m)	4.4975

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	0.8697
Recycle Volume from pond system	(ML/yr)	0.0000
Rain water added to pond system	(ML/yr)	0.0000
Evaporation loss from pond system	(ML/yr)	0.0000
Seepage loss from pond system	(ML/yr)	0.0002
Irrigation from last pond	(ML/yr)	0.8684
Volume of overtopping	(ML/yr)	0.0010
Sludge accumulated	(ML/yr)	0.0000
Sludge accumulated	(t DM/yr)	0.0000
Sludge removed	(ML/yr)	0.0000
No of desludging events every 10 years		0.0000
Increase in pond water volume	(ML/yr)	0.0001

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.00

No. of days pond overtops per 10 years 3.33
Average Length of overtopping events (days) 5.33
% Reuse 99.86
No. of overtopping events every 10 years

> 0.000 ML	0.63
> 0.000 ML*	0.63
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.0000
Average Length of such periods (days) 0.0000

POND NITROGEN BALANCE

Nitrogen Added by Effluent (tonne/yr) 0.0073 Irrig. from pond (ML/yr) 0.9
Nitrogen removed by Irrigation (tonne/yr) 0.0070
Nitrogen removed by Volatilisation (tonne/yr) 0.0003
Nitrogen removed by Seepage (tonne/yr) 0.0000
Nitrogen accumulated in Sludge (tonne/yr) 0.0000
Nitrogen lost by Overtopping (tonne/yr) 0.0000
Nitrogen involved in Recycling (tonne/yr) 0.0000
Increase in pond Nitrogen (tonne/yr) 0.0000

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent (tonne/yr) 0.0007 Irrig. from pond (ML/yr) 0.9
Phosphorus removed by Irrigation (tonne/yr) 0.0007
Phosphorus removed by Seepage (tonne/yr) 0.0000
Phosphorus accumulated in Sludge (tonne/yr) 0.0000
Phosphorus lost by Overtopping (tonne/yr) 0.0000
Phosphorus involved in Recycling (tonne/yr) 0.0000
Increase in pond Phosphorus (tonne/yr) 0.0000

POND SALINITY BALANCE

Salinity Added by Effluent (tonne/yr) 0.2922
Salinity removed by Irrigation (tonne/yr) 0.2920
Salinity removed by Seepage (tonne/yr) 0.0001
Salinity lost by Overtopping (tonne/yr) 0.0001
Salinity involved in Recycling (tonne/yr) 0.0000
Increase in pond Salinity (tonne/yr) 0.0000

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	347.8
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	6.8
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	283.3
EC of Pond Liquid	(dS/m)	0.4
Potassium Conc of Pond Liquid	(mg/L)	3.5

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.0000
Phosphorus in removed Sludge (db)	(kg/tonne)	0.0000
Salt in removed Sludge (db)	(kg/tonne)	0.0000
Potassium in removed Sludge (db)	(kg/tonne)	0.0000

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.0000
Phosphorus in removed Sludge	(tonne/yr)	0.0000
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.0000
Salt in removed Sludge	(tonne/yr)	0.0000
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.0000
Potassium in removed Sludge	(tonne/yr)	0.0000

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.17% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 2.0
Irrigation	(mm/year)	44.2		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1208.7		
Runoff	(mm/year)	549.5		
Drainage	(mm/year)	1889.0		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	43.5	142.5	1007.7	508.4	2016.1	-228.3
1958	3286.0	43.5	0.0	1108.2	400.5	1788.6	32.2
1959	5062.0	47.1	0.0	1200.6	995.1	2740.0	173.4
1960	2674.0	42.3	0.0	1125.6	257.9	1330.7	2.1
1961	2462.0	42.3	0.0	1120.8	203.8	1167.3	12.4
1962	3221.0	43.2	0.0	1183.8	267.8	1934.5	-121.9
1963	3845.0	44.7	0.0	1275.9	436.1	2066.1	111.6
1964	4909.0	46.8	0.0	1236.8	944.3	2821.6	-46.9
1965	4226.0	45.6	0.0	1161.9	472.3	2570.0	67.4
1966	2222.0	41.4	0.0	1180.8	82.8	1168.1	-168.3
1967	4088.0	45.0	0.0	1249.3	1062.0	1748.4	73.4
1968	3009.0	43.2	0.0	1186.3	413.0	1615.6	-162.7
1969	3845.0	44.7	0.0	1225.2	473.8	1986.1	204.5
1970	4023.0	45.0	0.0	1724.5	625.0	1656.2	62.3
1971	3293.0	43.5	0.0	1092.9	590.0	1857.4	-203.8
1972	4716.0	46.5	0.0	1220.0	1014.1	2523.8	4.6
1973	5608.0	48.0	0.0	1310.9	1165.9	2938.0	241.3
1974	3470.0	43.8	0.0	1015.0	357.4	2308.9	-167.6
1975	5140.0	47.4	0.0	1136.9	954.6	2899.9	196.1
1976	3624.0	44.4	0.0	1134.7	400.3	2213.0	-79.7
1977	5887.0	48.0	0.0	1104.4	2188.2	2723.1	-80.7
1978	3021.0	43.2	0.0	1276.2	330.9	1461.0	-3.9
1979	4493.0	45.6	0.0	1118.9	993.7	2273.1	153.0
1980	2577.0	42.6	0.0	1271.0	137.5	1339.3	-128.1
1981	5367.0	45.9	0.0	1300.5	1918.2	2209.8	-15.5
1982	2882.0	42.9	0.0	1231.7	271.2	1527.7	-105.8
1983	3159.0	43.2	0.0	1203.1	405.0	1430.4	163.7
1984	3331.0	43.8	0.0	1227.0	557.0	1588.9	1.8
1985	3230.0	43.5	0.0	1318.9	428.5	1684.9	-158.8

1986	3256.0	43.5	0.0	1289.2	412.1	1614.0	-15.8
1987	3184.0	43.2	0.0	1344.2	205.8	1503.5	173.7
1988	3311.0	43.8	0.0	1217.5	208.5	1837.9	90.8
1989	4065.0	45.3	0.0	1279.4	546.8	2383.5	-99.3
1990	3313.0	43.5	0.0	1107.2	400.3	1817.8	31.1
1991	3172.0	43.5	0.0	1004.5	654.4	1763.7	-207.1
1992	2172.0	41.4	0.0	985.1	72.3	963.0	193.0
1993	2590.0	42.0	0.0	1363.6	92.4	1253.7	-77.7
1994	3656.0	44.4	0.0	1172.6	462.9	2125.9	-61.0
1995	3165.0	43.5	0.0	1358.9	411.5	1398.3	39.8
1996	3176.0	43.2	0.0	1172.7	336.5	1688.3	21.7
1997	2965.0	42.9	0.0	1270.5	236.3	1312.7	188.3
1998	3490.0	44.1	0.0	1139.8	416.0	2095.1	-116.9
1999	5515.0	48.0	0.0	1256.8	1105.4	3183.5	17.2
2000	4919.0	46.8	0.0	1204.5	763.8	3006.5	-9.0
2001	2954.0	42.9	0.0	1250.3	430.1	1492.8	-176.4
2002	2011.0	41.1	0.0	1237.8	72.4	726.5	15.4
2003	2449.0	42.0	0.0	1289.2	128.8	876.3	196.7
2004	3701.0	44.4	0.0	1125.0	565.4	2041.1	14.0

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	3.6	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.1	Deep Drainage (mm/year) 1889.0
Nitrogen added in irrigation	(kg/ha/year)	3.5	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	72.6	
Denitrification	(kg/ha/year)	0.4	
Leached NO3-N	(kg/ha/year)	1.0	
Change in soil organic-N	(kg/ha/year)	-69.1	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	284.7	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.0	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	0.4	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	0.2	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.0	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	878.2	0.2
1958	2	878.3	0.2
1959	3	878.4	0.3

1960	4	880.9	0.1
1961	5	878.7	0.1
1962	6	878.8	0.2
1963	7	878.9	0.2
1964	8	881.3	0.3
1965	9	878.8	0.3
1966	10	878.9	0.1
1967	11	879.0	0.2
1968	12	881.4	0.2
1969	13	879.1	0.2
1970	14	879.1	0.2
1971	15	879.1	0.2
1972	16	881.5	0.3
1973	17	879.1	0.3
1974	18	879.0	0.2
1975	19	879.0	0.3
1976	20	881.4	0.2
1977	21	878.9	0.3
1978	22	879.0	0.1
1979	23	879.0	0.2
1980	24	881.4	0.1
1981	25	879.0	0.2
1982	26	879.0	0.2
1983	27	879.1	0.1
1984	28	881.5	0.2
1985	29	879.1	0.2
1986	30	879.2	0.2
1987	31	879.2	0.1
1988	32	881.6	0.2
1989	33	879.1	0.2
1990	34	879.1	0.2
1991	35	879.1	0.2
1992	36	881.7	0.1
1993	37	879.3	0.1
1994	38	879.2	0.2
1995	39	879.3	0.1
1996	40	881.7	0.2
1997	41	879.3	0.1
1998	42	879.3	0.2
1999	43	879.2	0.3
2000	44	881.5	0.3
2001	45	879.1	0.1
2002	46	879.2	0.1
2003	47	879.3	0.1
2004	48	881.7	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	44.	Totl Irrigation Area(ha) 2.0
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	153.	
Yield produced per unit transp.	(kg/ha/mm)	5.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	6477.			
Net nitrogen removed by plant	(kg/ha/yr)	73.	Shoot Concn	(%DM)	1.12
Net phosphorus removed by plant	(kg/ha/yr)	0.	Shoot Concn	(%DM)	0.00

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	431.	0.9	0.0	0.0	0.0
2	430.	0.9	0.0	0.0	0.0
3	512.	0.9	0.0	0.0	0.0
4	514.	0.9	0.0	0.0	0.0
5	519.	0.8	0.0	0.0	0.0
6	525.	0.8	0.1	0.0	0.0
7	577.	0.8	0.2	0.0	0.0
8	642.	0.8	0.1	0.0	0.0
9	661.	0.9	0.0	0.0	0.0
10	648.	0.9	0.0	0.1	0.0
11	540.	0.9	0.0	0.2	0.0
12	476.	0.9	0.0	0.2	0.0
No. of normal harvests per year					0.9

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water	(dS/m)	0.5	Irrigation	(mm/year) 44.2
Average EC of Rainwater	(dS/m x10)	0.3	Rainfall	(mm/year) 3607.0
Average EC of Infiltrated water	(dS/m)	0.0		
Av. water-upt-weightd rootzone EC	(dS/m s.e.)	0.0		
EC soil soln (FC) at base of rootzone	(dS/m)	0.1	Deep Drainage	(mm/year) 1889.0
Reduction in Crop yield due to Salinity	(%)	0.0		
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity		0.0		

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.02	0.06	100.
1958 - 1967	0.02	0.06	100.
1959 - 1968	0.02	0.06	100.
1960 - 1969	0.02	0.06	100.
1961 - 1970	0.02	0.06	100.
1962 - 1971	0.02	0.06	100.
1963 - 1972	0.02	0.06	100.
1964 - 1973	0.02	0.06	100.
1965 - 1974	0.02	0.06	100.
1966 - 1975	0.02	0.06	100.
1967 - 1976	0.02	0.06	100.
1968 - 1977	0.02	0.06	100.
1969 - 1978	0.02	0.06	100.
1970 - 1979	0.02	0.06	100.
1971 - 1980	0.02	0.06	100.
1972 - 1981	0.02	0.06	100.

1973 - 1982	0.02	0.06	100.
1974 - 1983	0.02	0.06	100.
1975 - 1984	0.02	0.06	100.
1976 - 1985	0.02	0.06	100.
1977 - 1986	0.02	0.06	100.
1978 - 1987	0.02	0.07	100.
1979 - 1988	0.02	0.07	100.
1980 - 1989	0.02	0.06	100.
1981 - 1990	0.02	0.06	100.
1982 - 1991	0.02	0.06	100.
1983 - 1992	0.02	0.07	100.
1984 - 1993	0.02	0.07	100.
1985 - 1994	0.02	0.06	100.
1986 - 1995	0.02	0.07	100.
1987 - 1996	0.02	0.06	100.
1988 - 1997	0.02	0.07	100.
1989 - 1998	0.02	0.06	100.
1990 - 1999	0.02	0.06	100.
1991 - 2000	0.02	0.06	100.
1992 - 2001	0.02	0.06	100.
1993 - 2002	0.02	0.06	100.
1994 - 2003	0.02	0.06	100.
1995 - 2004	0.02	0.06	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 101.7
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
Last	2004	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	20
Dry weatherProduction (ML/day)	0.002
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

---

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UNCONDITIONAL FINISH

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Ellabay 1mm/day 100Lep
Run Date: 14/12/05 Time:14:44:48.07
****

GENERAL INFORMATION
****

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD
****

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION
****

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION
****

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Irrigation (mm)	16	16	17	15	15	14	14	13	13	13	13	15	174

SOIL PROPERTIES
****

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	5.479
Nitrogen	(tonne/year)	0.046
Phosphorus	(tonne/year)	0.005
Salinity	(tonne/year)	1.841
Nitrogen Concentration	(mg/L)	8.399
Phosphorus Concentration	(mg/L)	0.840
Salinity	(mg/L)	335.974
Salinity	(dS/m)	0.525

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.907
Phosphorus Concentration	(mg/L)	0.791
TDS Concentration	(mg/L)	316.281
Salinity	(dS/m)	0.494

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 1 mm

AREA

Total Irrigation Area	(ha)	3.133

VOLUMES

Total Irrigation	(ML/year)	5.467
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.000

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.526
Average salinity of Irrigation	(mg/L)	336.424
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.106
After ammonia loss	(mg/L)	7.863
Average Phosphorus Conc of Irrigation	(mg/L)	0.841

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.038
Final liquid volume	(ML)	0.038
Final sludge volume	(ML)	0.000
Average pond volume	(ML)	0.032
Average active volume	(ML)	0.032
Maximum pond volume	(ML)	0.158
Minimum allowable pond volume	(ML)	0.016
Average pond depth	(m)	1.192
Pond depth at outlet	(m)	4.000
Maximum water surface area	(m2 x1000)	0.039
Pond catchment area	(m2 x1000)	0.069
Pond footprint length	(m)	8.282
Pond footprint width	(m)	8.282

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	5.479
Recycle Volume from pond system	(ML/yr)	0.000
Rain water added to pond system	(ML/yr)	0.000
Evaporation loss from pond system	(ML/yr)	0.000
Seepage loss from pond system	(ML/yr)	0.001
Irrigation from last pond	(ML/yr)	5.467
Volume of overtopping	(ML/yr)	0.010
Sludge accumulated	(ML/yr)	0.000
Sludge accumulated	(t DM/yr)	0.000
Sludge removed	(ML/yr)	0.000
No of desludging events every 10 years		0.000
Increase in pond water volume	(ML/yr)	0.001

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.01

No. of days pond overtops per 10 years 5.00
Average Length of overtopping events (days) 4.80
% Reuse 99.79
No. of overtopping events every 10 years

> 0.000 ML	1.04
> 0.000 ML*	1.04
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.000
Average Length of such periods (days) 0.000

POND NITROGEN BALANCE

Nitrogen Added by Effluent (tonne/yr) 0.046 Irrig. from pond (ML/yr) 5.5
Nitrogen removed by Irrigation (tonne/yr) 0.044
Nitrogen removed by Volatilisation (tonne/yr) 0.002
Nitrogen removed by Seepage (tonne/yr) 0.000
Nitrogen accumulated in Sludge (tonne/yr) 0.000
Nitrogen lost by Overtopping (tonne/yr) 0.000
Nitrogen involved in Recycling (tonne/yr) 0.000
Increase in pond Nitrogen (tonne/yr) 0.000

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent (tonne/yr) 0.005 Irrig. from pond (ML/yr) 5.5
Phosphorus removed by Irrigation (tonne/yr) 0.005
Phosphorus removed by Seepage (tonne/yr) 0.000
Phosphorus accumulated in Sludge (tonne/yr) 0.000
Phosphorus lost by Overtopping (tonne/yr) 0.000
Phosphorus involved in Recycling (tonne/yr) 0.000
Increase in pond Phosphorus (tonne/yr) 0.000

POND SALINITY BALANCE

Salinity Added by Effluent (tonne/yr) 1.841
Salinity removed by Irrigation (tonne/yr) 1.839
Salinity removed by Seepage (tonne/yr) 0.001
Salinity lost by Overtopping (tonne/yr) 0.001
Salinity involved in Recycling (tonne/yr) 0.000
Increase in pond Salinity (tonne/yr) 0.000

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	346.0
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	6.8
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	285.5
EC of Pond Liquid	(dS/m)	0.4
Potassium Conc of Pond Liquid	(mg/L)	3.6

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.000
Phosphorus in removed Sludge (db)	(kg/tonne)	0.000
Salt in removed Sludge (db)	(kg/tonne)	0.000
Potassium in removed Sludge (db)	(kg/tonne)	0.000

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.000
Phosphorus in removed Sludge	(tonne/yr)	0.000
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.000
Salt in removed Sludge	(tonne/yr)	0.000
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.000
Potassium in removed Sludge	(tonne/yr)	0.000

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.57% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 3.1
Irrigation	(mm/year)	174.5		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1234.3		
Runoff	(mm/year)	560.7		
Drainage	(mm/year)	1982.5		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	172.0	144.3	1046.8	513.8	2093.7	-223.7
1958	3286.0	172.0	0.0	1153.7	408.0	1856.9	39.5
1959	5062.0	186.0	0.0	1203.8	1032.3	2850.4	161.5
1960	2674.0	168.0	0.0	1157.8	260.8	1406.7	16.8
1961	2462.0	166.0	0.0	1283.9	201.7	1151.3	-9.0
1962	3221.0	172.0	0.0	1196.3	270.6	2027.0	-100.9
1963	3845.0	177.0	0.0	1231.6	442.3	2254.2	93.9
1964	4909.0	185.0	0.0	1298.7	952.2	2879.0	-35.8
1965	4226.0	179.0	0.0	1160.0	483.1	2702.7	59.2
1966	2222.0	164.0	0.0	1252.7	82.6	1235.0	-184.2
1967	4088.0	177.0	0.0	1254.0	1064.6	1886.0	60.4
1968	3009.0	171.0	0.0	1139.8	418.6	1719.9	-98.3
1969	3845.0	176.0	0.0	1168.1	529.0	2083.9	240.0
1970	4023.0	178.0	0.0	1807.1	645.6	1756.0	-7.6
1971	3293.0	173.0	0.0	1248.3	585.9	1855.9	-224.1
1972	4716.0	183.0	0.0	1369.0	988.0	2562.6	-20.6
1973	5608.0	190.0	0.0	1289.1	1176.3	3045.5	287.1
1974	3470.0	173.0	0.0	1061.2	370.5	2363.8	-152.5
1975	5140.0	187.0	0.0	1125.4	972.5	3038.6	190.5
1976	3624.0	175.0	0.0	1176.9	415.0	2298.8	-91.7
1977	5887.0	188.0	0.0	1173.8	2205.5	2702.4	-6.7
1978	3021.0	170.0	0.0	1271.3	354.1	1623.1	-57.4
1979	4493.0	181.0	0.0	1087.9	1047.3	2400.5	138.3
1980	2577.0	168.0	0.0	1219.4	139.5	1549.1	-163.0
1981	5367.0	181.0	0.0	1223.6	1907.9	2407.8	8.7
1982	2882.0	169.0	0.0	1287.9	271.2	1579.3	-87.4
1983	3159.0	171.0	0.0	1206.0	420.7	1548.9	154.3
1984	3331.0	173.0	0.0	1255.8	563.9	1682.3	2.1
1985	3230.0	172.0	0.0	1355.5	436.2	1733.2	-122.8

1986	3256.0	172.0	0.0	1302.8	427.5	1810.4	-112.7
1987	3184.0	171.0	0.0	1196.6	206.3	1663.9	288.2
1988	3311.0	173.0	0.0	1359.4	210.0	1878.8	35.8
1989	4065.0	178.0	0.0	1175.1	564.7	2616.8	-113.6
1990	3313.0	173.0	0.0	1236.8	400.3	1802.6	46.3
1991	3172.0	171.0	0.0	1097.7	660.4	1833.3	-248.3
1992	2172.0	164.0	0.0	997.6	73.4	1032.2	232.8
1993	2590.0	167.0	0.0	1249.5	97.7	1357.5	52.4
1994	3656.0	175.0	0.0	1366.9	536.8	2094.1	-166.8
1995	3165.0	171.0	0.0	1192.7	427.7	1649.3	66.4
1996	3176.0	172.0	0.0	1342.2	334.9	1687.1	-16.2
1997	2965.0	168.0	0.0	1141.4	249.6	1545.5	196.5
1998	3490.0	176.0	0.0	1350.8	434.8	2021.7	-141.3
1999	5515.0	189.0	0.0	1079.7	1124.2	3479.1	21.0
2000	4919.0	186.0	0.0	1313.1	761.6	3047.8	-17.5
2001	2954.0	169.0	0.0	1231.3	442.9	1490.7	-41.9
2002	2011.0	163.0	0.0	1327.8	94.2	858.7	-106.6
2003	2449.0	165.0	0.0	1289.8	139.3	992.0	193.0
2004	3701.0	176.0	0.0	1290.4	566.8	2006.4	13.4

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	14.1	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.4	Deep Drainage (mm/year) 1982.5
Nitrogen added in irrigation	(kg/ha/year)	13.7	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	83.9	
Denitrification	(kg/ha/year)	0.5	
Leached NO3-N	(kg/ha/year)	1.1	
Change in soil organic-N	(kg/ha/year)	-70.2	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	231.0	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.1	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	1.5	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	1.1	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.2	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	878.7	0.2
1958	2	879.8	0.2
1959	3	880.6	0.3

1960	4	883.8	0.1
1961	5	882.2	0.1
1962	6	882.7	0.2
1963	7	883.1	0.2
1964	8	885.8	0.3
1965	9	883.5	0.3
1966	10	883.8	0.1
1967	11	884.1	0.2
1968	12	886.7	0.2
1969	13	884.5	0.2
1970	14	884.6	0.2
1971	15	884.7	0.2
1972	16	887.3	0.3
1973	17	885.0	0.3
1974	18	884.9	0.2
1975	19	885.0	0.3
1976	20	887.4	0.2
1977	21	885.0	0.3
1978	22	885.0	0.2
1979	23	885.0	0.2
1980	24	887.6	0.2
1981	25	885.2	0.2
1982	26	885.3	0.2
1983	27	885.4	0.2
1984	28	887.8	0.2
1985	29	885.4	0.2
1986	30	885.4	0.2
1987	31	885.5	0.2
1988	32	887.9	0.2
1989	33	885.4	0.3
1990	34	885.5	0.2
1991	35	885.5	0.2
1992	36	888.2	0.1
1993	37	885.8	0.1
1994	38	885.7	0.2
1995	39	885.7	0.2
1996	40	888.1	0.2
1997	41	885.8	0.2
1998	42	885.7	0.2
1999	43	885.6	0.3
2000	44	887.9	0.3
2001	45	885.5	0.1
2002	46	885.7	0.1
2003	47	885.9	0.1
2004	48	888.3	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	175.	Totl Irrigation Area(ha) 3.1
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	159.	
Yield produced per unit transp.	(kg/ha/mm)	6.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots) (kg/ha/yr) 7292.
Net nitrogen removed by plant (kg/ha/yr) 84. Shoot Concn (%DM) 1.15
Net phosphorus removed by plant (kg/ha/yr) 1. Shoot Concn (%DM) 0.02

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	544.	0.9	0.0	0.1	0.0
2	525.	0.9	0.0	0.0	0.0
3	611.	0.8	0.0	0.0	0.0
4	584.	0.8	0.0	0.0	0.0
5	571.	0.8	0.0	0.0	0.0
6	558.	0.8	0.1	0.0	0.0
7	600.	0.8	0.2	0.0	0.0
8	683.	0.8	0.1	0.0	0.0
9	717.	0.8	0.0	0.0	0.0
10	721.	0.9	0.0	0.0	0.0
11	608.	0.9	0.0	0.1	0.0
12	571.	0.9	0.0	0.1	0.0

No. of normal harvests per year 1.0

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.5 Irrigation (mm/year) 174.5
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 3607.0
Average EC of Infiltrated water (dS/m) 0.1
Av. water-upt-weightd rootzone EC(dS/m s.e.) 0.0
EC soil soln (FC) at base of rootzone (dS/m) 0.1 Deep Drainage (mm/year) 1982.5
Reduction in Crop yield due to Salinity (%) 0.0
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity 0.0

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.03	0.09	100.
1958 - 1967	0.03	0.09	100.
1959 - 1968	0.03	0.09	100.
1960 - 1969	0.03	0.09	100.
1961 - 1970	0.03	0.09	100.
1962 - 1971	0.03	0.09	100.
1963 - 1972	0.03	0.09	100.
1964 - 1973	0.03	0.09	100.
1965 - 1974	0.03	0.09	100.
1966 - 1975	0.03	0.09	100.
1967 - 1976	0.03	0.09	100.
1968 - 1977	0.03	0.08	100.
1969 - 1978	0.03	0.08	100.
1970 - 1979	0.03	0.08	100.
1971 - 1980	0.03	0.08	100.
1972 - 1981	0.03	0.08	100.

1973 - 1982	0.03	0.08	100.
1974 - 1983	0.03	0.09	100.
1975 - 1984	0.03	0.09	100.
1976 - 1985	0.03	0.09	100.
1977 - 1986	0.03	0.09	100.
1978 - 1987	0.04	0.10	100.
1979 - 1988	0.04	0.10	100.
1980 - 1989	0.04	0.10	100.
1981 - 1990	0.03	0.10	100.
1982 - 1991	0.04	0.10	100.
1983 - 1992	0.04	0.10	100.
1984 - 1993	0.04	0.10	100.
1985 - 1994	0.04	0.10	100.
1986 - 1995	0.04	0.10	100.
1987 - 1996	0.04	0.10	100.
1988 - 1997	0.04	0.10	100.
1989 - 1998	0.04	0.10	100.
1990 - 1999	0.04	0.10	100.
1991 - 2000	0.03	0.09	100.
1992 - 2001	0.03	0.09	100.
1993 - 2002	0.03	0.09	100.
1994 - 2003	0.03	0.10	100.
1995 - 2004	0.03	0.10	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 170.1
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.1	0.1	0.1
Last	2004	0.1	0.1	0.1

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	126
Dry weatherProduction (ML/day)	0.0126
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

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UNCONDITIONAL FINISH

****

SUMMARY OUTPUT

MEDLI Version 1.30

Data Set: Ellabay 2mm/day 100Lep
Run Date: 14/12/05 Time:14:38:58.03

****

GENERAL INFORMATION

****

Title: Ella Bay Effluent Reuse Scheme
Subject: [no entry]
Client: EPCO Australia
User: [no entry]
Time: Wed Dec 14 14:20:34 2005
Comments: Effluent Volumes based on Pressure balanced water supply and effluent reuse for toilet flushing - This run is after irrigation commenses

RUN PERIOD

****

Starting Date 1/ 1/1957
Ending Date 31/12/2004
Run Length 48 years 0 days

CLIMATE INFORMATION

****

Enterprise site: Ella Bay Resort -17.4 deg S 146.1 deg E
Weather station: ellabay_17.40S_146.05E <Inte

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	2520.	3312.	5254.
Pan Evap mm/year	1675.	1721.	1946.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	536	615	622	424	331	198	131	107	96	88	167	293	3607
Pan Evap (mm)	176	141	150	127	112	102	111	129	158	187	188	189	1771
Ave Max Temp DegC	30	29	29	27	25	24	23	24	26	28	29	30	27
Ave Min Temp DegC	23	22	22	21	19	16	15	16	17	19	21	22	19
Rad (MJ/m2/day)	20	18	18	17	15	15	16	18	21	24	24	22	19

MONTHLY IRRIGATION

****

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Irrigation (mm)	33	32	35	31	30	27	27	27	26	26	27	29	351

SOIL PROPERTIES

****

Soil type: Ella Bay Loamy Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3
Bulk Density	(g/cm3)	1.0	1.0	1.0
Porosity	(mm/layer)	124.5	311.3	311.3
Saturated Water Content	(mm/layer)	120.0	275.0	250.0
Drained Upper Limit	(mm/layer)	80.0	210.0	225.0
Lower Storage Limit	(mm/layer)	34.0	100.0	125.0
Air Dry Moisture Content	(mm/layer)	8.6		
Layer Thickness	(mm)	200.0	500.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	645.0	445.0
Total Drained Upper Limit	(mm)	515.0	335.0
Total Lower Storage Limit	(mm)	259.0	159.0
Total Air Dry Moisture Content	(mm)	9.6	9.2
Total Depth	(mm)	1200.0	800.0

Maximum Plant Available Water Capacity		176.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	20.0
Limiting	(mm/hr)	5.0

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.0
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

Sewage treatment plant waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	11.05
Nitrogen	(tonne/year)	0.09
Phosphorus	(tonne/year)	0.01
Salinity	(tonne/year)	3.71
Nitrogen Concentration	(mg/L)	8.40
Phosphorus Concentration	(mg/L)	0.84
Salinity	(mg/L)	335.97
Salinity	(dS/m)	0.52

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	7.91
Phosphorus Concentration	(mg/L)	0.79
TDS Concentration	(mg/L)	316.28
Salinity	(dS/m)	0.49

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 2 mm

AREA

Total Irrigation Area	(ha)	3.14

VOLUMES

Total Irrigation	(ML/year)	11.02
Minimum Volume must be full irrig. requiremt		
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.53
Average salinity of Irrigation	(mg/L)	336.43
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.11
After ammonia loss	(mg/L)	7.86
Average Phosphorus Conc of Irrigation	(mg/L)	0.84

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	0.05
Final liquid volume	(ML)	0.05
Final sludge volume	(ML)	0.00
Average pond volume	(ML)	0.06
Average active volume	(ML)	0.06
Maximum pond volume	(ML)	0.32
Minimum allowable pond volume	(ML)	0.03
Average pond depth	(m)	1.19
Pond depth at outlet	(m)	4.00
Maximum water surface area	(m2 x1000)	0.08
Pond catchment area	(m2 x1000)	0.12
Pond footprint length	(m)	10.90
Pond footprint width	(m)	10.90

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	11.05
Recycle Volume from pond system	(ML/yr)	0.00
Rain water added to pond system	(ML/yr)	0.00
Evaporation loss from pond system	(ML/yr)	0.00
Seepage loss from pond system	(ML/yr)	0.00
Irrigation from last pond	(ML/yr)	11.02
Volume of overtopping	(ML/yr)	0.02
Sludge accumulated	(ML/yr)	0.00
Sludge accumulated	(t DM/yr)	0.00
Sludge removed	(ML/yr)	0.00
No of desludging events every 10 years		0.00
Increase in pond water volume	(ML/yr)	0.00

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	0.02

No. of days pond overtops per 10 years 5.21
Average Length of overtopping events (days) 5.00
% Reuse 99.79
No. of overtopping events every 10 years

> 0.000 ML	1.04
> 0.000 ML*	1.04
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

No. periods/year without irrigable effluent 0.00
Average Length of such periods (days) 0.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	0.09	Irrig. from pond (ML/yr) 11.0
Nitrogen removed by Irrigation	(tonne/yr)	0.09	
Nitrogen removed by Volatilisation	(tonne/yr)	0.00	
Nitrogen removed by Seepage	(tonne/yr)	0.00	
Nitrogen accumulated in Sludge	(tonne/yr)	0.00	
Nitrogen lost by Overtopping	(tonne/yr)	0.00	
Nitrogen involved in Recycling	(tonne/yr)	0.00	
Increase in pond Nitrogen	(tonne/yr)	0.00	

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent	(tonne/yr)	0.01	Irrig. from pond (ML/yr) 11.0
Phosphorus removed by Irrigation	(tonne/yr)	0.01	
Phosphorus removed by Seepage	(tonne/yr)	0.00	
Phosphorus accumulated in Sludge	(tonne/yr)	0.00	
Phosphorus lost by Overtopping	(tonne/yr)	0.00	
Phosphorus involved in Recycling	(tonne/yr)	0.00	
Increase in pond Phosphorus	(tonne/yr)	0.00	

POND SALINITY BALANCE

Salinity Added by Effluent	(tonne/yr)	3.71
Salinity removed by Irrigation	(tonne/yr)	3.71
Salinity removed by Seepage	(tonne/yr)	0.00
Salinity lost by Overtopping	(tonne/yr)	0.00
Salinity involved in Recycling	(tonne/yr)	0.00
Increase in pond Salinity	(tonne/yr)	0.00

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	8.2
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	346.0
Average Salinity of Pond Liquid	(dS/m)	0.5
Average Potassium Conc of Pond Liquid	(mg/L)	4.3
(On final day of simulation)		
Nitrogen Conc of Pond Liquid	(mg/L)	6.9
Phosphorus Conc of Pond Liquid	(mg/L)	0.7
TDS Conc of Pond Liquid	(mg/L)	290.1
EC of Pond Liquid	(dS/m)	0.5
Potassium Conc of Pond Liquid	(mg/L)	3.6

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.00
Phosphorus in removed Sludge (db)	(kg/tonne)	0.00
Salt in removed Sludge (db)	(kg/tonne)	0.00
Potassium in removed Sludge (db)	(kg/tonne)	0.00

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.00
Phosphorus in removed Sludge	(tonne/yr)	0.00
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.00
Salt in removed Sludge	(tonne/yr)	0.00
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.00
Potassium in removed Sludge	(tonne/yr)	0.00

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 1.14% of field capacity)

Rainfall	(mm/year)	3607.0	Irrigation Area	(ha) 3.1
Irrigation	(mm/year)	351.0		
Soil Evaporation	(mm/year)	3.0		
Transpiration	(mm/year)	1265.0		
Runoff	(mm/year)	574.1		
Drainage	(mm/year)	2114.9		
Change in soil moisture	(mm/year)	1.0		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1957	3403.0	346.0	144.1	1081.9	518.3	2203.1	-198.3
1958	3286.0	346.0	0.0	1221.0	416.2	1938.1	56.7
1959	5062.0	374.0	0.0	1214.5	1049.2	3049.7	122.6
1960	2674.0	338.0	0.0	1202.6	262.8	1523.6	22.9
1961	2462.0	334.0	0.0	1210.7	212.0	1385.2	-11.9
1962	3221.0	346.0	0.0	1256.7	272.3	2103.8	-65.9
1963	3845.0	354.0	0.0	1250.4	458.8	2442.1	47.6
1964	4909.0	374.0	0.0	1228.4	983.3	3094.9	-23.6
1965	4226.0	360.0	0.0	1203.3	497.8	2831.9	53.0
1966	2222.0	330.0	0.0	1240.3	84.5	1369.7	-142.4
1967	4088.0	356.0	0.0	1283.8	1075.5	2019.1	65.5
1968	3009.0	344.0	0.0	1187.1	430.6	1868.7	-133.4
1969	3845.0	354.0	0.0	1281.2	525.3	2182.4	210.1
1970	4023.0	358.0	0.0	1713.8	664.6	1990.5	12.0
1971	3293.0	348.0	0.0	1335.7	592.6	1926.5	-213.8
1972	4716.0	368.0	0.0	1399.7	1017.0	2686.5	-19.2
1973	5608.0	382.0	0.0	1319.8	1185.6	3209.7	274.8
1974	3470.0	348.0	0.0	1163.8	373.5	2450.3	-169.6
1975	5140.0	376.0	0.0	1098.0	988.5	3219.8	209.7
1976	3624.0	352.0	0.0	1236.7	434.7	2403.9	-99.3
1977	5887.0	378.0	0.0	1243.3	2225.7	2797.0	-1.0
1978	3021.0	342.0	0.0	1260.1	360.3	1768.7	-26.2
1979	4493.0	364.0	0.0	1256.7	1050.7	2431.5	118.1
1980	2577.0	338.0	0.0	1320.7	142.2	1568.8	-116.7
1981	5367.0	362.0	0.0	1216.2	1967.5	2584.3	-38.9
1982	2882.0	342.0	0.0	1303.5	279.5	1598.0	43.0
1983	3159.0	344.0	0.0	1297.9	497.6	1692.3	15.2
1984	3331.0	348.0	0.0	1273.8	574.5	1830.9	-0.3
1985	3230.0	344.0	0.0	1340.9	444.1	1838.4	-49.3

1986	3256.0	348.0	0.0	1356.4	464.1	1938.4	-154.9
1987	3184.0	344.0	0.0	1267.9	231.3	1786.1	242.7
1988	3311.0	348.0	0.0	1256.8	215.4	2138.1	48.7
1989	4065.0	358.0	0.0	1210.1	606.4	2709.9	-103.4
1990	3313.0	348.0	0.0	1296.4	415.5	1910.3	38.8
1991	3172.0	344.0	0.0	1118.7	672.6	1960.0	-235.4
1992	2172.0	330.0	0.0	1103.0	74.9	1106.5	217.6
1993	2590.0	334.0	0.0	1260.3	101.3	1576.8	-14.4
1994	3656.0	354.0	0.0	1351.6	468.8	2195.6	-6.1
1995	3165.0	344.0	0.0	1302.7	481.1	1765.8	-40.5
1996	3176.0	346.0	0.0	1273.9	343.3	1861.9	43.0
1997	2965.0	338.0	0.0	1204.3	307.2	1664.2	127.4
1998	3490.0	352.0	0.0	1298.5	415.2	2243.2	-114.8
1999	5515.0	382.0	0.0	1130.0	1148.6	3601.5	17.0
2000	4919.0	372.0	0.0	1261.1	781.1	3253.9	-5.0
2001	2954.0	342.0	0.0	1342.1	443.9	1625.3	-115.2
2002	2011.0	326.0	0.0	1363.4	87.1	908.2	-21.7
2003	2449.0	334.0	0.0	1386.0	140.9	1088.6	167.5
2004	3701.0	354.0	0.0	1292.8	574.4	2172.2	15.5

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	28.5	% of Total as ammonium 30.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.9	Deep Drainage (mm/year) 2114.9
Nitrogen added in irrigation	(kg/ha/year)	27.6	
Nitrogen added in seed	(kg/ha/year)	0.0	
Nitrogen removed by crop	(kg/ha/year)	98.0	
Denitrification	(kg/ha/year)	0.5	
Leached NO3-N	(kg/ha/year)	1.1	
Change in soil organic-N	(kg/ha/year)	-70.5	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-1.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3600.0	
Final soil organic-N	(kg/ha)	214.5	
Initial soil inorganic-N	(kg/ha)	72.0	
Final soil inorganic-N	(kg/ha)	0.1	
Average N03-N conc in the root zone	(mg/L)	0.0	
Average N03-N conc below root zone	(mg/L)	0.0	
Average N03-N conc of deep drainage	(mg/L)	0.1	

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	3.0	% of Total as phosphate 100.0
Phosphorus added in seed	(kg/ha/year)	0.0	
Phosphorus removed by crop	(kg/ha/year)	2.4	
Leached PO4-P	(kg/ha/year)	0.2	
Change in dissolved PO4-P	(kg/ha/year)	0.0	
Change in adsorbed PO4-P	(kg/ha/year)	0.3	
Average P04-P conc in the root zone	(mg/L)	0.0	
Average P04-P conc below root zone	(mg/L)	0.0	

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1957	1	879.4	0.2
1958	2	881.7	0.2
1959	3	883.6	0.3

1960	4	887.6	0.2
1961	5	886.5	0.1
1962	6	887.5	0.2
1963	7	888.4	0.2
1964	8	891.3	0.3
1965	9	889.3	0.3
1966	10	889.8	0.1
1967	11	890.2	0.2
1968	12	892.9	0.2
1969	13	890.8	0.2
1970	14	891.0	0.2
1971	15	891.1	0.2
1972	16	893.7	0.3
1973	17	891.5	0.3
1974	18	891.5	0.2
1975	19	891.6	0.3
1976	20	894.0	0.2
1977	21	891.5	0.3
1978	22	891.6	0.2
1979	23	891.6	0.2
1980	24	894.2	0.2
1981	25	891.7	0.3
1982	26	891.8	0.2
1983	27	891.8	0.2
1984	28	894.3	0.2
1985	29	891.9	0.2
1986	30	891.9	0.2
1987	31	892.1	0.2
1988	32	894.5	0.2
1989	33	892.0	0.3
1990	34	892.0	0.2
1991	35	892.0	0.2
1992	36	894.9	0.1
1993	37	892.5	0.2
1994	38	892.4	0.2
1995	39	892.3	0.2
1996	40	894.8	0.2
1997	41	892.3	0.2
1998	42	892.3	0.2
1999	43	892.2	0.4
2000	44	894.5	0.3
2001	45	892.2	0.2
2002	46	892.4	0.1
2003	47	892.5	0.1
2004	48	895.0	0.2

PLANT

Plant species: Tropical pasture

PLANT WATER USE

Irrigation	(mm/year)	351.	Totl Irrigation Area(ha) 3.1
Pan coefficient	(%)	1.0	
Maximum crop coefficient	(%)	0.8	
Average Plant Cover	(%)	91.	
Average Plant Total Cover	(%)	100.	
Average Plant Rootdepth	(mm)	799.	
Average Plant Available Water Capacity	(mm)	176.	
Average Plant Available Water	(mm)	168.	
Yield produced per unit transp.	(kg/ha/mm)	6.	

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots) (kg/ha/yr) 8220.
Net nitrogen removed by plant (kg/ha/yr) 98. Shoot Concn (%DM) 1.19
Net phosphorus removed by plant (kg/ha/yr) 2. Shoot Concn (%DM) 0.03

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	645.	0.8	0.0	0.0	0.0
2	602.	0.8	0.0	0.0	0.0
3	689.	0.8	0.0	0.0	0.0
4	641.	0.8	0.0	0.0	0.0
5	624.	0.8	0.0	0.0	0.0
6	615.	0.8	0.1	0.0	0.0
7	670.	0.8	0.2	0.0	0.0
8	747.	0.8	0.1	0.0	0.0
9	774.	0.8	0.0	0.0	0.0
10	817.	0.8	0.0	0.0	0.0
11	719.	0.9	0.0	0.1	0.0
12	677.	0.9	0.0	0.1	0.0

No. of normal harvests per year 1.1

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.5 Irrigation (mm/year) 351.0
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 3607.0
Average EC of Infiltrated water (dS/m) 0.1
Av. water-upt-weightd rootzone EC(dS/m s.e.) 0.0
EC soil soln (FC) at base of rootzone (dS/m) 0.1 Deep Drainage (mm/year) 2114.9
Reduction in Crop yield due to Salinity (%) 0.0
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity 0.0

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1957 - 1966	0.05	0.13	100.
1958 - 1967	0.05	0.13	100.
1959 - 1968	0.05	0.13	100.
1960 - 1969	0.05	0.13	100.
1961 - 1970	0.05	0.13	100.
1962 - 1971	0.05	0.13	100.
1963 - 1972	0.05	0.12	100.
1964 - 1973	0.05	0.12	100.
1965 - 1974	0.05	0.12	100.
1966 - 1975	0.05	0.12	100.
1967 - 1976	0.04	0.12	100.
1968 - 1977	0.04	0.12	100.
1969 - 1978	0.04	0.12	100.
1970 - 1979	0.04	0.12	100.
1971 - 1980	0.04	0.12	100.
1972 - 1981	0.04	0.11	100.

1973 - 1982	0.04	0.12	100.
1974 - 1983	0.05	0.12	100.
1975 - 1984	0.05	0.13	100.
1976 - 1985	0.05	0.13	100.
1977 - 1986	0.05	0.14	100.
1978 - 1987	0.05	0.14	100.
1979 - 1988	0.05	0.14	100.
1980 - 1989	0.05	0.14	100.
1981 - 1990	0.05	0.14	100.
1982 - 1991	0.05	0.14	100.
1983 - 1992	0.05	0.14	100.
1984 - 1993	0.05	0.14	100.
1985 - 1994	0.05	0.14	100.
1986 - 1995	0.05	0.14	100.
1987 - 1996	0.05	0.14	100.
1988 - 1997	0.05	0.14	100.
1989 - 1998	0.05	0.14	100.
1990 - 1999	0.05	0.14	100.
1991 - 2000	0.05	0.13	100.
1992 - 2001	0.05	0.13	100.
1993 - 2002	0.05	0.13	100.
1994 - 2003	0.05	0.14	100.
1995 - 2004	0.05	0.14	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 181.8
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
Last	2004	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
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STP INPUT PARAMETERS - DATA SUMMARY

Equivalent persons	254
Dry weatherProduction (ML/day)	0.0254
Effluent per person (L/day)	100
Effluent per person (L/yr)	36500
Effluent volume per 1000 EPs per year (ML)	36.5

Infiltration low

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UNCONDITIONAL FINISH

Appendix B

Laboratory Soil Test Certificates

Simmonds & Bristow

Established 1965 ABN 33 010 252 418 Pty Ltd

P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Ph. : (07)3710 9100
Fax : (07)3710 9199

Attention : **Grant Cobbin** **Client Order No** **Analysis Soil**

Client : **EPCO Australia**
PO Box 111
SUMNER PARK
QLD **4074**

Batch Reference No. : **64095**

Analytical Certificate

Sample Reference			255001	255002	255003	255004	255005	255006	255007
Sample Name			EB 1A/1.	EB 1A/2.	EB 1A/3.	EB 1B/2.	EB 1B/3.	EB 2/2.	EB 2/3.
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005
Analyte		**Units**							
* SP050.5	Water at saturation	%	54.	44.	41.	49.	41.	52.	46.
* SP050.6	Soil Classification (Water Con			CLAY.	CLAY.	CLAY.	CLAY.	CLAY.	CLAY.
SP300.	Constant Head Permeability AS4	cm/hour	0.7	6.6	3.4	4.4	3.3	7.8	3.8
SC025.111	Calcium as Ca (Soil/Sludge)	mg/kg	120.						
SC040.2	Exchangeable Sodium	mEq/100g	0.1						
SC040.3	Exchangeable Potassium	mEq/100g	0.2						
SC040.4	Exchangeable Calcium	mEq/100g	0.1						
SC040.5	Exchangeable Magnesium	mEq/100g	0.2						
SC055.111	Magnesium as Mg (Soils)	mg/kg	600.						
* SC060.1	Bulk Density (AS4419-1998)	kg/L	1.1						
SC075.111	Potassium as K (Soils)	mg/kg	1300.						
SC090.111	Sodium as Na (Soils)	mg/kg	1200.						
SC250.13	Ammonia as N (Tecator)	mg/kg	180.						
* SC250.22	Nitrate Calc	mg/Kg	0.42						
SC250.311	Nitrite (1:5 Extract)	mg/Kg	0.88						

Note : * All tests covered by NATA accreditation except where marked
For a NATA accreditation certificate please contact us on 1800 620 690

Date : 18/11/2005

Authorised for release :

Simmonds & Bristow

Established 1965 ABN 33 010 252 418 Pty Ltd

P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Ph. : (07)3710 9100
Fax : (07)3710 9199

Attention : **Grant Cobbin** **Client Order No** **Analysis Soil**

Client : **EPCO Australia**
PO Box 111
SUMNER PARK
QLD **4074**

Batch Reference No. : **64095**

Analytical Certificate

Analyte		Units							
Sample Reference			255001	255002	255003	255004	255005	255006	255007
Sample Name			EB 1A/1.	EB 1A/2.	EB 1A/3.	EB 1B/2.	EB 1B/3.	EB 2/2.	EB 2/3.
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005
SC250.41	Nitrate + Nitrite (1:5 extract	mg/kg	1.3						
SC250.63	Total Nitrogen	mg/kg	1300.						
* SC250.8	Organic Nitrogen (calc)	mg/kg	1118.7						
SC270.2	Available Phosphorus as P	mg/kg	< 0.006						
* OS610.1	Field Capacity	%	31.6						
* OS610.2	Wilting point	%	13.3						
* OS610.3	Porosity	% v/v	N.A.						
G030.1	Moisture Content @ 40øC	%	23.	18.	16.	20.	17.	23.	18.
G040.	Conductivity (1:5 Soil:Water)	uS/cm	79.	44.	36.	35.	19.	68.	28.
G090.	pH [1:5 Soil:Water]		4.2	4.3	4.3	4.5	4.7	4.2	4.5

Note : * All tests covered by NATA accreditation except where marked
For a NATA accreditation certificate please contact us on 1800 620 690

Date : 18/11/2005

Authorised for release :

Simmonds & Bristow

Established 1965 ABN 33 010 252 418 Pty Ltd

P/O Box 3160 Yeronga 4104
40 Reginald St
Rocklea, Qld 4106

Ph. : (07)3710 9100
Fax : (07)3710 9199

Attention : **Grant Cobbin** **Client Order No** **Analysis Soil**

Client : **EPCO Australia**
PO Box 111
SUMNER PARK
QLD **4074**

Batch Reference No. : **64095**

Analytical Certificate

Sample Reference			255008	255009	255010	255011	255012	255013	255014
Sample Name			EB 3/2.	EB 3/3.	EB 4/2.	EB 4/3.	EB 5/2.	EB 5/3.	EB 1B/1.
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005
Analyte		**Units**							
* SP050.5	Water at saturation	%	50.	50.	51.	47.	53.	46.	53.
* SP050.6	Soil Classification (Water Con		CLAY.	CLAY.	CLAY.	CLAY.	CLAY.	CLAY.	
SP300.	Constant Head Permeability AS4	cm/hour	2.5	3.5	1.3	0.7	5.9	13.	6.2
SC025.111	Calcium as Ca (Soil/Sludge)	mg/kg							100.
SC040.2	Exchangeable Sodium	mEq/100g							0.1
SC040.3	Exchangeable Potassium	mEq/100g							0.1
SC040.4	Exchangeable Calcium	mEq/100g							0.1
SC040.5	Exchangeable Magnesium	mEq/100g							0.2
SC055.111	Magnesium as Mg (Soils)	mg/kg							120.
* SC060.1	Bulk Density (AS4419-1998)	kg/L							1.0
SC075.111	Potassium as K (Soils)	mg/kg							1000.
SC090.111	Sodium as Na (Soils)	mg/kg							1100.
SC250.13	Ammonia as N (Tecator)	mg/kg							130.
* SC250.22	Nitrate Calc	mg/Kg							5.70
SC250.311	Nitrite (1:5 Extract)	mg/Kg							1.6

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Batch Reference No. : **64095**

Analytical Certificate

Analyte		Units							
Sample Reference			255008	255009	255010	255011	255012	255013	255014
Sample Name			EB 3/2.	EB 3/3.	EB 4/2.	EB 4/3.	EB 5/2.	EB 5/3.	EB 1B/1.
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005	31/08/2005
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005	6/09/2005
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005	23/09/2005
SC250.41	Nitrate + Nitrite (1:5 extract	mg/kg							7.3
SC250.63	Total Nitrogen	mg/kg							1300.
* SC250.8	Organic Nitrogen (calc)	mg/kg							1162.7
SC270.2	Available Phosphorus as P	mg/kg							< 0.006
* OS610.1	Field Capacity	%							33.6
* OS610.2	Wilting point	%							12.7
* OS610.3	Porosity	% v/v							N.A.
G030.1	Moisture Content @ 40øC	%	19.	16.	19.	18.	20.	51.	24.
G040.	Conductivity (1:5 Soil:Water)	uS/cm	51.	30.	31.	21.	98.	51.	65.
G090.	pH [1:5 Soil:Water]		4.4	4.6	4.5	4.6	4.0	4.3	4.4

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Client : **EPCO Australia**
PO Box 111
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QLD **4074**

Batch Reference No. : **64095**

Analytical Certificate

Sample Reference			255015	255016	255017	255018			
Sample Name			EB 2/1.	EB 3/1.	EB 4/1.	EB 5/1.			
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005			
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005			
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005			
Analyte		**Units**							
* SP050.5	Water at saturation	%	67.	62.	50.	63.			
* SP050.6	Soil Classification (Water Con								
SP300.	Constant Head Permeability AS4	cm/hour	1.8	5.5	0.3	14.			
SC025.111	Calcium as Ca (Soil/Sludge)	mg/kg	110.	340.	94.	150.			
SC040.2	Exchangeable Sodium	mEq/100g	0.2	0.2	< 0.1	0.2			
SC040.3	Exchangeable Potassium	mEq/100g	0.1	0.3	0.1	0.3			
SC040.4	Exchangeable Calcium	mEq/100g	0.1	0.9	0.1	0.2			
SC040.5	Exchangeable Magnesium	mEq/100g	0.4	0.9	0.2	0.5			
SC055.111	Magnesium as Mg (Soils)	mg/kg	160.	310.	310.	570.			
* SC060.1	Bulk Density (AS4419-1998)	kg/L	0.7	0.9	0.9	0.8			
SC075.111	Potassium as K (Soils)	mg/kg	860.	1300.	1400.	1400.			
SC090.111	Sodium as Na (Soils)	mg/kg	960.	1300.	1100.	1400.			
SC250.13	Ammonia as N (Tecator)	mg/kg	200.	260.	120.	250.			
* SC250.22	Nitrate Calc	mg/Kg	5.00	0.70	1.39	6.26			
SC250.311	Nitrite (1:5 Extract)	mg/Kg	1.7	1.1	0.31	0.14			

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Batch Reference No. : **64095**

Analytical Certificate

Analyte		Units							
Sample Reference			255015	255016	255017	255018			
Sample Name			EB 2/1.	EB 3/1.	EB 4/1.	EB 5/1.			
Date Collected			31/08/2005	31/08/2005	31/08/2005	31/08/2005			
Date Received			6/09/2005	6/09/2005	6/09/2005	6/09/2005			
Date Testing Completed			23/09/2005	23/09/2005	23/09/2005	23/09/2005			
SC250.41	Nitrate + Nitrite (1:5 extract	mg/kg	6.7	1.8	1.7	6.4			
SC250.63	Total Nitrogen	mg/kg	1800.	2100.	930.	2600.			
* SC250.8	Organic Nitrogen (calc)	mg/kg	1593.3	1838.2	808.3	2343.6			
SC270.2	Available Phosphorus as P	mg/kg	< 0.006	< 0.006	< 0.006	< 0.006			
* OS610.1	Field Capacity	%	40.5	41.8	35.3	44.2			
* OS610.2	Wilting point	%	17.5	17.1	14.5	20.0			
* OS610.3	Porosity	% v/v	0.58	0.56	0.49	N.A.			
G030.1	Moisture Content @ 40øC	%	30.	27.	23.	26.			
G040.	Conductivity (1:5 Soil:Water)	uS/cm	120.	96.	52.	120.			
G090.	pH [1:5 Soil:Water]		4.1	4.5	4.3	3.9			

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