STRATEGEN
environmental consultants

Mr Anthony Sutton
Director
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PERTH WA 6850

Dear Mr Sutton

RESPONSE TO SUBMISSIONS ON MANGLES BAY MARINA BASED TOURISM PRECINCT PUBLIC ENVIRONMENTAL REVIEW (ASSESSMENT NO. 1846)

I refer to your letter of 18 October 2012, which advises that the Office of the Environmental Protection Authority (OEPA) requires further information prior to finalising the response to submissions documentation and preparing an assessment strategy for the Environmental Protection Authority (EPA). This letter presents Cedar Woods' response to your requirements for further information. In it we identify:

- the key assets at risk which require protection
- the key commitments on which the assessment is based
- the key impact assessment predictions made regarding Lake Richmond and groundwater quality in domestic bores
- mitigations proposed and contingencies available if management action is required
- proposed monitoring plan for Lake Richmond TEC's
- proposed management triggers to protect Lake Richmond TEC's
- proposed risk based hierarchical decision making framework
- proposed management of domestic bores
- suggested outcome based conditions.

Key assets at risk

The key assets addressed in this letter are:

- the Lake Richmond thrombolite community
- the sedgelands in Holocene dunes TEC which surround Lake Richmond
- the domestic groundwater bores that occur adjacent the marina project site.

Figure 1 shows the revised outline of the proposed marina and canal water body. Figure 2 highlights the known and inferred location of domestic bores adjacent the Proposal and Lake Richmond. Most of the bores are located to the north and east of Lake Richmond. There are very few bores located to the west of the proposed marina. The sedgeland community is the vegetation surrounding the outer edge of the lake, whilst the thrombolites occur on a flat sloping sill between the sedges and the deep basin of the Lake (refer PER, figure 109).

A key concern raised in submissions to the PER is that the marina water body may enable landward migration of the seawater wedge thereby salinising groundwater in and around Lake Richmond and potentially adversely affecting the health of the adjacent sedgeland and thrombolite communities. Of particular concern in this regard was the potential occurrence of porous and permeable pathways in the Safety Bay Sand represented by former (now buried) channelway(s) which could have existed prior to

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and during the slow isolation of the lake system over the last 2-3,000 years. The PER presented a description of the stratigraphy of the groundwater bores that were installed between the project and the Lake and concluded that there was no indication of the occurrence of such a channelway. In his peer review of the groundwater assessment in the PER, Professor Lindsay Collins of Curtin University, acknowledged that,

> The preparatory work undertaken in advance of the project and its planned excavation of a marina basin is adequate and consideration is given to risks such as saltwater intrusion and lake outflows, including issues such as potential karst development in the Tamala Limestone and assessment of porous and permeable pathways in the Safety Bay Sand. However as part of risk mitigation it would be appropriate to undertake additional geotechnical assessments before commencement of marina excavations.

Another concern raised in submissions was that groundwater levels in Lake Richmond and beneath the adjacent sedgelands could reduce to the extent that the thrombolite and sedgeland communities are adversely affected to the extent that their long term survival is compromised. A third concern raised was that domestic bore users in the vicinity of the marina water body may be disadvantaged in the event that salinity concentrations increase as a result of landward migration of the seawater wedge.

Key commitments on which assessment is based

As indicated in the Response to Submissions document (Strategen 2012) the marina has been designed to minimise the potential for adverse impacts to groundwater levels and salt content. The key design initiatives on which assessment is based are as follows:

- the marina water body and canals will be located as shown in the PER and will not extend any closer to Lake Richmond thereby maximising separation distance
- the marina will be excavated 'in the wet' by dredging thereby avoiding the need to dewater the site and lower adjacent groundwater tables during the construction period.

Key impact assessment predictions

Extensive and detailed groundwater modelling has been undertaken by the Proponent to determine the scale of impacts to groundwater characteristics anticipated from both construction and operation of the Marina water body based on the above design initiatives. The key impact assessment predictions are as follows:

- there will be a very minor lowering of groundwater levels adjacent the marina and in Lake Richmond both during the construction period and afterwards during operation (0.032 m to 0.038 m lowering respectively)
- seawater intrusion to groundwater is very much restricted to the marina footprint with no potential for intrusion into Lake Richmond (Figure 3)
- it is likely that only domestic bores located within 200-300 m from the water body will potentially be affected by landward migration of the seawater wedge at depth. The only bores which occur within this distance are located immediately to the west of the marina (Figure 1). Only a few bores are likely to be impacted.

The above predictions have been supported by independent peer review.

Contingencies available to manage Lake Richmond water levels

Water level manipulation mitigation and contingency actions include:

1. To mitigate the predicted effects of the project on groundwater levels, it is proposed to raise the invert level of the Lake Richmond drain at the beginning of winter to allow storage of greater volumes of water in the lake at start of summer, thereby balancing out the small reduction in groundwater levels caused by the marina over the longer term. Increasing the weir height would increase water levels during the winter period when water levels may be above the top of the weir. However, once the water level in Lake Richmond falls below the weir level (usually occurs in early summer), the change would not have an effect other than reduce the probability of lake levels

reaching the historic low water mark (HLWM) of -0.4 m AHD established in 1996 (Whincup P [ERM] 2012, pers. comm.). The proposed changes with an increase of weir height of 0.038 m will be modelled through the use of combined surface water – groundwater modelling to confirm the effectiveness of such a mitigation option following project approval. The studies will also confirm for the Water Corporation that an increase in height of the weir of 0.038 m will not impact on the function of the urban drainage system to mitigate flooding.

2. A conceptual design to realign the Lake Richmond drain outlet beneath Hymus road and discharge into deeper water from the eastern break water of the marina has been discussed with the Water Corporation.
3. The contingency action proposed if lake levels reduce to the extent that a threat to the survival of the sedgelands and thrombolites is identified is to artificially recharge the lake water to historic low water mark towards the end of summer by topping up from a suitable but deeper groundwater source nearby. ERM (Whincup P [ERM] 2012, pers. comm.) have suggested that groundwater quality in the Tamala limestone (TL) aquifer located >1 km to the east of Lake Richmond should be adequate for topping up lake levels and that getting approval to access that aquifer could be obtained quickly. A production bore could be installed and operated at such time if water level trends in the lake indicated that the HLWM was about to be breached.

Proposed monitoring plan for Lake Richmond TEC's

Objective: The objective of this monitoring program is twofold:

1. To confirm the reliability of the predicted scale of impact on ground water levels and salinity; and
2. To ensure that the Lake Richmond TEC's (Thrombolite and Sedgeland communities) are not adversely affected as a result of the project.

Background: As indicated earlier, the conclusions of the groundwater investigations are that the marina poses no risk of saltwater intrusion into Lake Richmond, and will only result in a long-term minor water level reduction in late summer of 3.8 cm. Impacts on the **thrombolite TEC** are not expected to be significant, noting that:

- Lake levels fluctuate significantly on a seasonal basis and in response to the magnitude of annual rainfall during winter and subsequent evaporation during the dry summer. The Lake acts as a groundwater recharge mound during winter and a groundwater sink during summer. Lake water levels can fall below 0 m AHD towards the end of summer and seasonal variation is about one metre (English et al. 2003)
- the thrombolites occur in an area about 15 m wide in a rim around much of the lake margin. Sunlight and fresh water rich in calcium bicarbonate and carbonate are likely to be essential to the growth and survival of the thrombolites. The thrombolites are exposed at the surface during summer and submerged under shallow water during winter (English et al. 2003)
- the lake levels and water quality of the lake at present have also been significantly modified since the three stormwater inlet drains and lake outfall were installed several decades ago. For example, about 50 years ago lake salinities were three times higher than they are now and lake water levels were 0.5 m higher than they are at present (Goodale et al. 1998). Sluice gates have been installed on the outlet drain to prevent salt water intrusion. Hence the thrombolite community of Lake Richmond has in recent times, already survived substantially more change in both water levels and salinity than is predicted to occur as a result of marina construction.

The small decline in water levels of 0.038 m in Lake Richmond will result following the construction of the marina and will only occur towards the end of summer when water levels are naturally low. The 0.038 m is in addition to the approximately 1 m natural variation of the lake level. The outcome of the Proposal may therefore be that a few more thrombolites that occur near historical low water mark levels (if they occur at all at that level) will now be exposed to the atmosphere for short periods. Given that thrombolites are capable of withstanding short periods of exposure and currently do so, and that thrombolites have survived greater changes in the recent past than is predicted to occur from marina

construction, it would seem reasonable to conclude that the thrombolite community will survive the very small changes in water level resulting from the Proposal.

Similarly, no adverse impact is anticipated for the **sedgeland TEC** from the predicted 0.038 m reduction in water levels of Lake Richmond. Sedgelands in damplands and sumplands of the Holocene dune swales have relatively specific water regime requirements to maintain current biology, but are also known to be tolerant of seasonal and longer-term variations that reflect natural climatic patterns. The sedgeland community has obviously survived the mean seasonal low water levels of -.0.1 m AHD in Lake Richmond each year and have also survived the HLWM of -0.4 m AHD established in 1996.

Therefore both TEC's are known to be able to tolerate seasonal variations in ground and surface water levels and temporary exposure to drought conditions.

However it also needs to be noted that:

- ground and surface water levels in and adjacent the lake vary both seasonally and inter annually as a result of the volume of rainfall received during winter, the duration and intensity (heat and evaporation potential) of the summer drought period and groundwater abstraction by adjacent domestic and licensed bores
- reduced rainfall resulting from climate change, as already experienced in the SW of WA, probably has a more direct impact on groundwater levels than the 0.038 m decline induced by the marina
- predicted sea level increases of more than 0.038 m are predicted over the ensuing decades and would re-establish the baseline water table level and Lake Richmond water levels to, and possibly above those existing prior to marina construction. This will to some extent be achieved artificially in the short term by the proposed mitigation action of raising the invert level of the Lake Richmond drain.

Hence whilst reduced water levels are unlikely to occur if the proposed mitigation action works as anticipated, should they occur, they are likely to be the result of natural weather conditions and over abstraction of the superficial groundwater resource which occurs in the Safety Bay Sands and most unlikely to be caused by the project.

Management Approach: The overarching management approach proposed to achieve the two key objectives can be separated into three stages as follows:

1. Establish baseline condition
2. Construction phase monitoring
3. Operational phase monitoring

Further detail on the scope of works proposed for each stage follows.

Baseline establishment

Prior to initiation of marina excavation works, it is proposed to establish a detailed baseline understanding of:

- the distribution and condition of both TEC's relative to survey level
- the sedimentology and stratigraphy of the Safety Bay Sands in the marina and between the marina and Lake Richmond
- and groundwater characteristics between the marina water body and Lake Richmond.

Upon commencement of construction Stage 1 and prior to construction of the marina commencing (Stage 3) groundwater monitoring bores will be established around the outskirts of the project site and particularly between the marina water body and Lake Richmond. These bores will only extend into the Safety Bay Sand superficial aquifer to a depth of approximately 15 m. The detailed stratigraphy of each bore will be documented and analysed by specialist and independent marine sedimentologists to confirm the PER conclusion that no subterranean channel exists between Lake Richmond and Mangles Bay. All geotechnical bores undertaken within the project footprint will be similarly analysed and

together with the analysis of the groundwater bores, form the basis for describing the geoheritage value of the Cape Peron Tombolo. This work will be completed prior to initiation of marina excavation and provide further confidence in the groundwater modelling undertaken for the PER and the conclusion that Lake Richmond is at very low risk of salinisation as a result of the project proceeding.

Groundwater salinity and levels between the marina water body and Lake Richmond and elsewhere around the project site will be monitored on a monthly basis for at least two years before Stage 3 commences. Water levels in Lake Richmond will also be monitored on a monthly basis to confirm the predevelopment relationship between lake water levels and groundwater levels adjacent the project.

It is anticipated that the water levels, as recognized previously, will be influenced by a number of factors including rainfall, stormwater runoff, evapotranspiration, groundwater abstraction, land clearing, sea level rises etc and the purpose of the monitoring will be to assess the influence of these various factors on the observed water levels. This baseline data set will then enable re-calibration of the model during the construction period by separating out the marina induced water level changes from those derived from the other influences mentioned above.

The baseline distribution of the thrombolite and sedgeland community will be determined. The Proponent has already engaged researchers from Curtin University, led by Professor Lindsay Collins to:

- determine the geodetic survey level within which thrombolites exist on the margins of Lake Richmond
- map the location and condition of the thrombolite community all around the Lake.

Appropriate consultants will also be engaged to map the distribution and composition of the sedgeland community. Once the mapping of both communities has been completed, the condition of both TEC's will be monitored annually on an opportunistic basis towards the end of summer and onset of winter each year when water levels are naturally low.

Whilst this is a relatively easy task for the sedgeland community (based on monitoring ground cover of sedgeland plants, weed incursion and soil moisture), it is recognised that determining the condition of thrombolites is not easy. To address this knowledge gap, and immediately the Project commences construction the Proponent will establish a funding grant to Curtin University for research into thrombolite ecology and population dynamics in South Western Australian lakes. The monitoring of the condition of the thrombolite community will be undertaken by Curtin University researchers.

Similarly the condition of the sedgeland TEC will be monitored by appropriately experienced consultants.

Construction phase monitoring

Initiation of stage three of the project (excavation of the marina water body) will only occur after independent confirmation that a subterranean channel between the Lake and Mangles Bay does not exist. Such confirmation will mean that it is physically impossible for Lake Richmond to increase in salinity as a result of the project proceeding. Therefore monitoring effort will focus on determining the relationship between groundwater levels near the marina and water levels in lake Richmond.

To provide even further confidence, the baseline monitoring program will be continued as described above during the construction period with the exception that the frequency of groundwater monitoring will increase to a weekly basis during the first summer (Jan-June) after construction of the marina commences to confirm that salt water intrusion is not occurring and that water levels behave as predicted by the groundwater modelling undertaken for the PER.

Should the water level predictions prove to be different from those observed, then the model will be re-calibrated and re-run to re-calculate the scale of the predicted lowering of long-term water levels. In the unlikely event that this is necessary, the scale of variation in water level is anticipated to be extremely minor. Should a variation in prediction of long term water level reductions be required, it can be readily mitigated by both increasing the invert level of the Lake Richmond drain, and establishing a new trigger level for initiation of the contingency plan described earlier.

Once a pattern develops and sufficient data are available to confirm the reliability of the model predictions, monitoring will reduce in frequency and revert back to a monthly then quarterly basis, details of the monitoring program (monitoring bore locations and depths) will be provided in the Construction EMP.

Operational phase monitoring

Once the marina water body is completed and commences operating as a marina (i.e. approximately one year after completion of marina walls and excavation, the model prediction regarding the localised scale of seawater intrusion should have been confirmed. Assuming that the model is shown to be correct, groundwater monitoring will focus on determining water levels at the end of summer. Hence monitoring will reduce to seasonal (quarterly) surveys for most of the year except the period between April and June/July (inclusive) when it will revert to fortnightly monitoring in order to ensure detection of lower than expected water levels.

Proposed Management triggers for protection of Lake Richmond TEC's

Three management triggers are proposed for implementation once construction of stage three commences:

The first trigger will be implemented in the unlikely event that groundwater monitoring adjacent the marina during construction indicates that water levels are reducing at scales greater than anticipated from the model predictions. This trigger will initiate the series of tasks outlined above under 'construction phase monitoring' (i.e., recalibrate and re-run model to determine if long term water level prediction of 0.038m needs to be revised, and if so amend mitigation and contingency action triggers accordingly.)

The second trigger will be implemented when HLWM (-0.4 m) has been reached and will result in increasing groundwater and lake level monitoring to a weekly basis and monitoring of the condition of Lake Richmond TEC's. Approvals for deep groundwater abstraction from the TL aquifer will also be obtained in case the next trigger is breached.

The third trigger will occur when/if water levels reduce to the predicted level of 0.038 m below HLWM. This trigger will initiate consideration of artificial water level enhancement of Lake Richmond by groundwater recharge. The need for management action will be based on an assessment by independent experts of:

- the condition of both the thrombolite TEC and the Sedgeland TEC
- the need for action, taking into consideration the time of year and the potential duration of drought conditions prior to the predicted onset of winter. This decision will be taken in discussion with DEC, DSEWPaC, City of Rockingham and DOW.

If it is decided to implement the proposed contingency action, a production bore and a temporary pipeline will be installed and operated for a period of 3-4 weeks at most. Preliminary calculations by ERM (Whincup P [ERM] 2012, pers. Comm.) indicate that such a short term recharge is feasible and would provide sufficient recharge to increase lake levels back to HLWM.

Proposed risk based hierarchical decision making framework

Figure 4 presents a conceptual risk based hierarchical decision tree for the protection of the Lake Richmond TEC's. It is based on monitoring of water level and salinity in Lake Richmond (LR) and groundwater bores between Lake Richmond and the marina, and the condition of the sedgeland and thrombolite communities in autumn each year.

The first decision that needs determination is: *Are ground water levels and salinity between the Marina and Lake Richmond behaving as predicted in the PER?* If the answer is YES, then continue monitoring water level and salinity in Lake Richmond at the prescribed frequency. If the answer is NO then

implement Management Trigger 1 and determine scale of variance with expectation and potential cause of variance, risk to LR TEC's and need for revision of mitigation and contingency action trigger levels.

If the answer to the first decision was YES, then the second decision that needs determination is: *Are water levels in Lake Richmond at or approaching HLWM?* If the answer is YES, then implement the second Management Trigger of monitoring of thrombolites and sedges adjacent Lake Richmond. If the answer is NO, then continue Lake Richmond water level monitoring as prescribed.

If the answer to the second decision was YES, then the third decision to be determined is: *Are the thrombolites and sedges showing signs of deteriorating health condition*? If the answer is YES, or if lake levels reduce to 0.038m below HLWM, then implement the third Management Trigger. If the answer is NO, then continue to monitor LR water levels and condition of sedges and thrombolites until either water levels increase as a result of the onset of winter rains, or the condition of the TEC's deteriorates, where the second management trigger will again be breached.

The third management trigger will decide the need for implementation of contingency action as described previously.

It is anticipated that the above conceptual decision framework will need to be refined and agreed with key stakeholders including DEC, DoW, DSEWPaC and City of Rockingham.

Proposed management for domestic bores

The Proponent has committed in the PER to undertake a census of all domestic bores within 500m of the project site prior to commencement of marina construction (Stage 3 of Project). This census will determine the existing quality of groundwater at each bore as well as provide detail on the location and depth of each domestic bore, their annual usage, time of usage (summer months) and whether groundwater salinity increases with volume and duration of pumping.

In Appendix 4 of the Response to Submissions package it was acknowledged that only domestic bores within 200 to 300 m of the marina will potentially be impacted by migration of the saline wedge at depth and an increase in salinity. Bores within 300 m of the marina footprint, particularly to the west, may experience some increase in salinity during the summer irrigation period as they are most likely to be sunk into the mid-upper part of the Safety Bay Sand aquifer.

Should salinisation of these domestic bores occur AND the monitoring of bores adjacent the marina indicate that the marina is responsible, the Proponent will provide bore owners affected with scheme water subject to:

- bore being used for irrigation purposes
- a period of 10 years
- the lot is not redeveloped
- existing owner retains the property.

It is acknowledged groundwater in the area is largely brackish and saline at depth. It is anticipated many of the local domestic bores will gradually salinise each summer as the shallow fresh water lense in this area is depleted. This is likely to occur as a result of over abstraction rather than landward migration of the seawater interface from the marina water body.

Suggested Outcome Based Conditions

A suggested outcome based condition is provided below for consideration by the EPA to address the Lake Richmond TEC's (thrombolites and sedges) and the protection of groundwater in the vicinity of domestic bores.

X Lake Richmond TECs

X-1 The proponent shall ensure that the implementation of the proposal does not adversely affect Lake Richmond's Sedgelands in Holocene Dunes or Thrombolite threatened ecological communities (TEC) shown in Figure X of this statement.

X-2 To verify that the requirements of condition X-1 are met the proponent shall prepare a Lake Richmond Monitoring and Management Plan to the satisfaction of the CEO prior to the commencement of construction.

The management plan shall include:

1. Location and identification of monitoring sites and reference sites (where appropriate).
2. Protocols and procedures to confirm/establish baselines for:
    - groundwater quality and levels surrounding Lake Richmond
    - sedimentation and stratigraphy of Safety Bay Sands in the vicinity of the marina
    - soil moisture levels
    - water quality and water levels within Lake Richmond
    - the health, diversity and cover of the Sedgelands TEC
    - the extent and condition of the Thrombolite TEC.
3. Protocols and procedures for monitoring these parameters during the implementation of the proposal and comparing results against modelled predictions.
4. Development of indicators to quantitatively determine the health of the Sedgeland and Thrombolite TEC's.
5. Development of risk-based tiered management trigger levels in consultation with appropriate stakeholders for establishing impacts on Sedgeland or Thrombolite TEC's to the satisfaction of the CEO which includes monitoring against:
    i. primary investigation and management triggers
    ii. secondary contingency action trigger levels in the event the primary management trigger levels in i. are exceeded.
6. A framework for the development of further investigations, management and contingency actions in the event that the trigger levels referred to in condition X-2-2 i. and ii. are exceeded.
7. The reporting procedures, including the format, timing and frequency for the reporting of monitoring data against the trigger levels in X-2-2.

X-3 Monitoring is to be carried out in accordance with the approved Lake Richmond Monitoring and Management Plan.

X-4 In the event that monitoring required by condition X-3 indicates an exceedence of trigger levels determined by condition X-2-2(ii):

1. The proponent shall report such findings to CEO within 7 days of the exceedence being identified.
2. The proponent shall provide evidence which allows determination of the cause of the exceedence.
3. If determined by the CEO to be a result of activities undertaken in implementing the proposal, the proponent shall submit actions to be taken to address the exceedence within 21 days of the determination being made to the CEO.
4. The proponent shall implement actions to address the exceedence and shall continue until such time the CEO determines that the actions may cease.

X-5 Monitoring is to continue until such time as the CEO determines that monitoring and management actions may cease or monitoring can be reduced in frequency.

X-6 The proponent shall submit annually the results of monitoring required by condition X-3 to the CEO as part of the compliance assessment report required by condition X-X.

X Protection of domestic bores

X-1 The proponent shall monitor groundwater to identify whether, in implementing the proposal, the quality of water sourced from domestic bores adjacent the marina project site as shown in Figure X, declines such that its continued use is affected.

X-2 The proponent shall prepare a Domestic Bore Management Plan with consideration to the Groundwater Monitoring Plan to the satisfaction of the CEO prior to the commencement of construction.

The management plan shall include:

1. Establishment of baseline domestic bore water quality adjacent to the marina.
2. Protocols and procedures for monitoring groundwater quality adjacent to the marina during the implementation of the proposal.
3. Development of contingency management action trigger levels for relevant water quality indicators in consultation with relevant stakeholders.
4. The reporting procedures, including the format, timing and frequency for the reporting of monitoring data against the trigger levels in X-2-3.

X-3 The Proponent shall implement the Domestic Bore Management Plan required by condition X-2 to the satisfaction of the CEO.

X-4 In the event that monitoring required by condition X-2 indicates an exceedence of the contingency management action trigger levels referred to in condition X-2 the proponent shall implement the following management contingencies:

1. Payment to the affected property owner(s) for the quantity of water used for irrigation, as determined by the multiple of garden water use requirements by the area of garden.
2. Payment is to continue for a period of ten years or until the lot owner sells or redevelops the property, whichever is the sooner.

X-5 The proponent shall submit annually the results of monitoring required by condition X-3, exceedence of any groundwater quality trigger levels and effectiveness of the contingency management measures to the CEO as part of the compliance assessment report required by condition X-X.

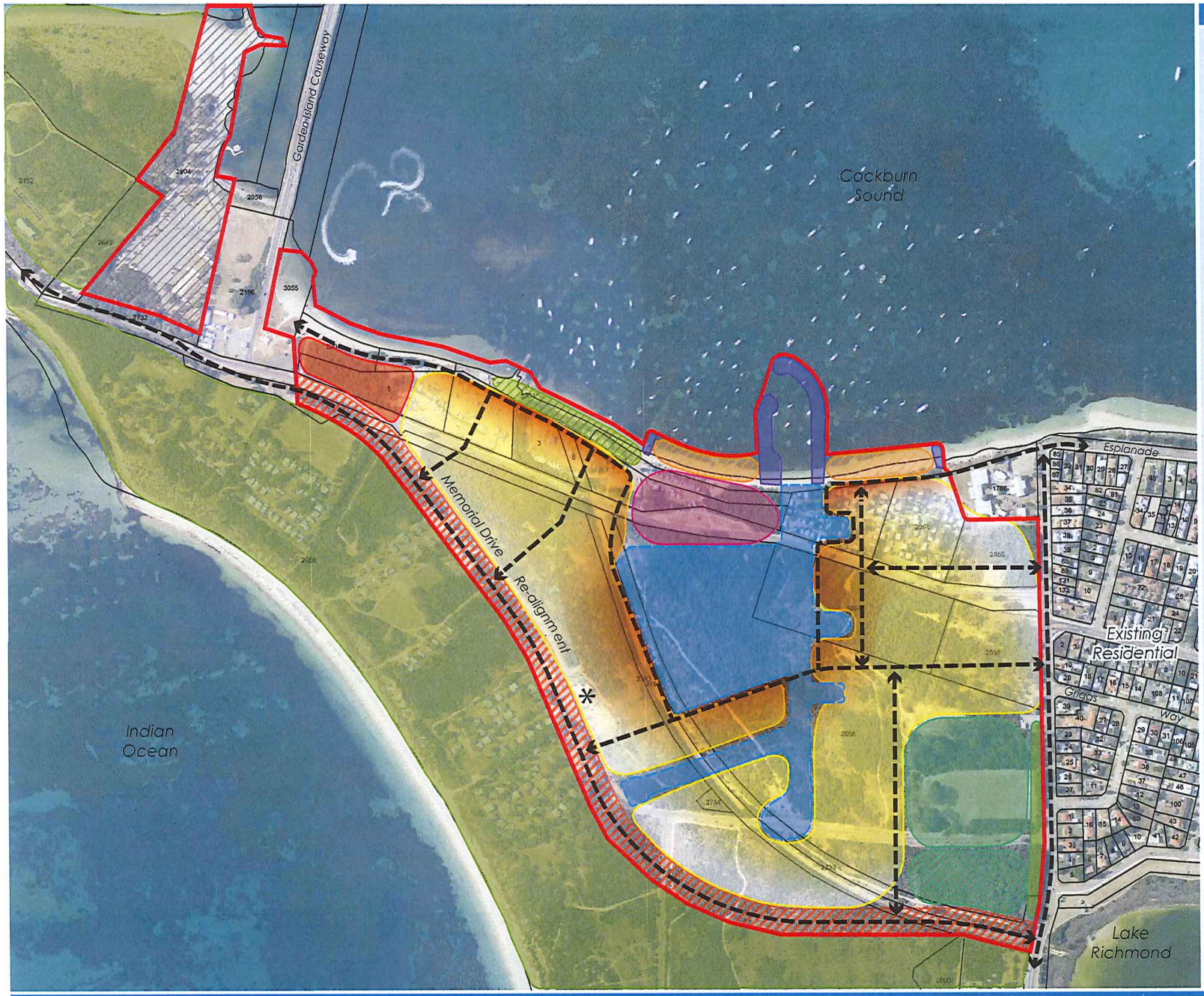
Conclusion

We trust that the above is adequate response to the matters raised in your correspondence of 18 October and contains sufficient information to enable the OEPA to finalise its assessment strategy for the EPA's consideration. Please advise should you require any clarification or require any further information.

Yours sincerely

Darren Walsh
CEO AND SENIOR PRINCIPAL

12 November 2012



Legend

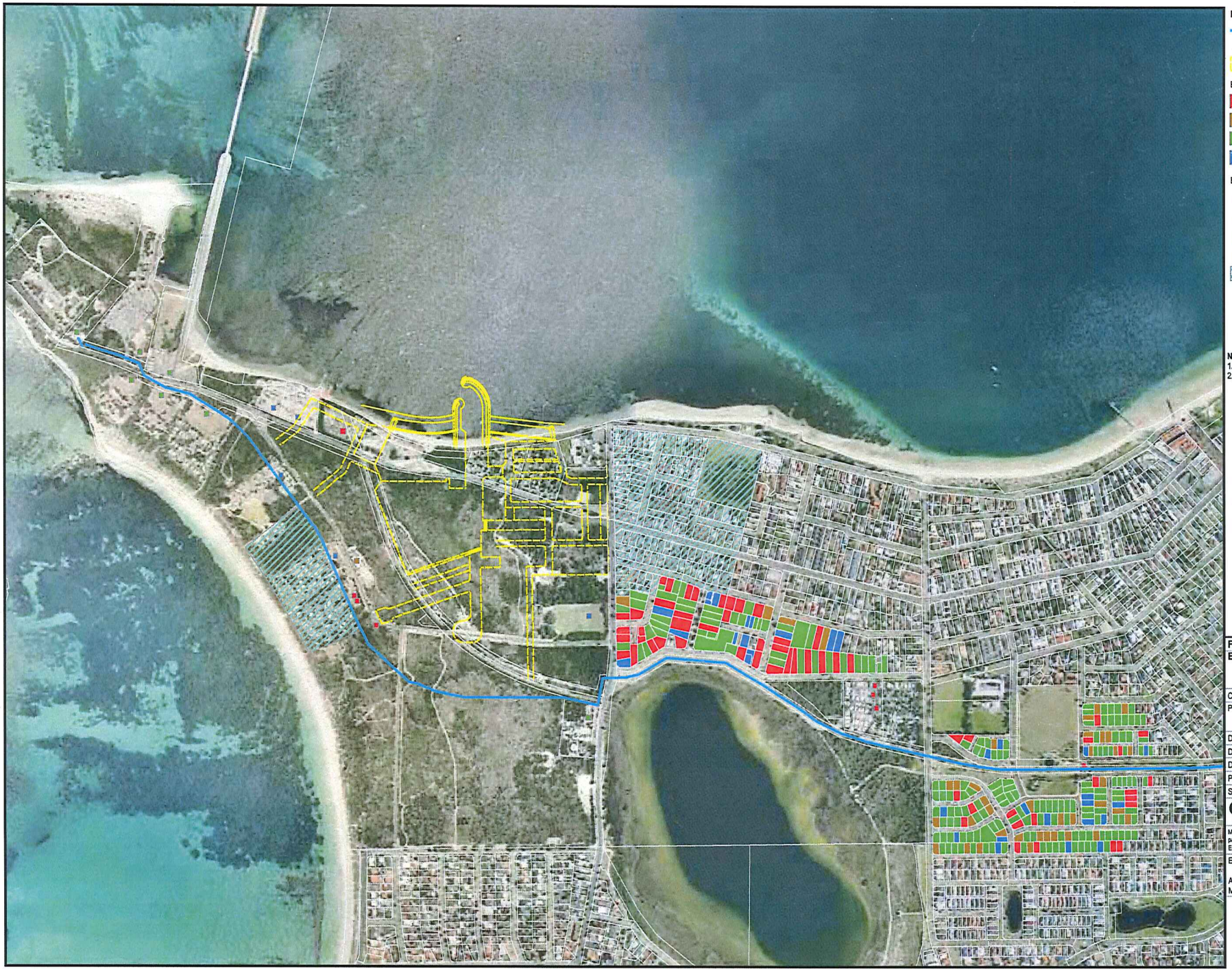
- Project Boundary
- Retention and Enhancement (area not to be cleared and rehabilitated)
- Active Recreational Area
- Vegetation Corridor
- Proposed Service Corridor (Memorial Drive Realignment)
- Proposed Marina Waterbody
- Indicative Land Development
  - Commercial / Mixed Use
  - Residential
- Beach Reclamation with Enhancement
- Breakwaters
- Eco Friendly Chalet Facility for Family Affordable Accommodation
- Proposed Boat Club / Chandlery Site
- Coastal Enhancement Area
- Pedestrian / Vehicular Connections and Linkages
- Rehabilitation Improvement Areas
- Improvement of Existing Public Boat Ramp
- Retention of R.S.L Hall

Figure 1 Indicative Land Use Plan

INDICATIVE LAND USE PLAN
For Mangles Bay Marina Based Tourist Precinct

0m 30 60 90m
s: 1:6000@A3
d: 13 Nov 2012
p: 10/033/G007G

Taylor Burrell Barnett Town Planning and Design
187 Roberts Road Subiaco Western Australia 6008
p: (08) 9382 2911 f: (08) 9382 4586
e: admin@tbbplanning.com.au



Legend

- SDOOL (Cedar Woods Alignment)
- Cadastral Boundaries
- Proposed Marina

Bore Usage (cadastral lots)

- Bore Infrastructure (bore observed)
- No Bore Observed (evidence of bore use - iron staining)
- Irrigated land (no bore observed)
- No Irrigation Evident

Bore Usage (individual locations / part lots)

- Bore Infrastructure (bore observed)
- No Bore Observed (evidence of bore use - iron staining)
- Irrigated land (no bore observed)
- No Irrigation Evident
- Area not assessed for Bore Usage

Notes:
1. Non-interactive bore survey conducted on 18/10/2010.
2. Results based on visual observations from verge.

Figure 2
Bore Census

Client:	Cedar Woods
Project:	Cedar Woods Mangles Bay Marina
Drawing No:	01286191p_GWM_G002_R0.mxd
Date:	30/08/2011 — Drawing size: A3
Drawn by:	DN — Reviewed by: BC
Projection:	GDA 94 MGA Zone 50
Scale:	Refer to Scale Bar

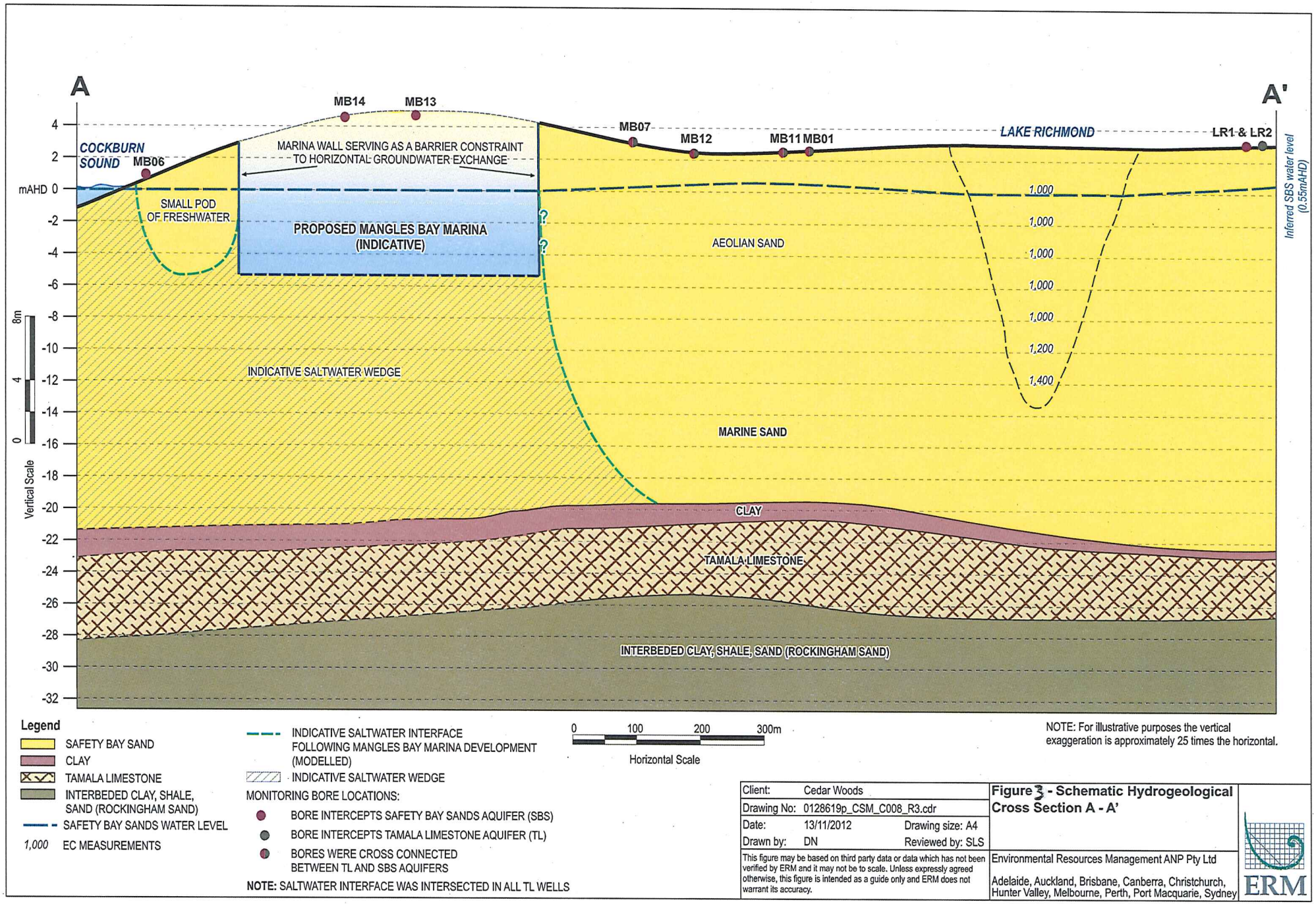
N

0 100 200 300m

Environmental Resources Management Australia Pty Ltd

Auckland, Adelaide, Brisbane, Canberra, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM



Client:	Cedar Woods		
Drawing No:	0128619p_CSM_C008_R3.cdr		
Date:	13/11/2012	Drawing size: A4	
Drawn by:	DN	Reviewed by: SLS	

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 3 - Schematic Hydrogeological Cross Section A - A'

Environmental Resources Management ANP Pty Ltd

Adelaide, Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Figure 4 Risk Based Decision Tree for Protection of Lake Richmond TEC's