JAMES WARREN & Associates Pty Ltd

ECOLOGICAL CONSULTANTS

REVISED SALTMARSH REHABILITATION PLAN

COBAKI LAKES

PREFERRED PROJECT REPORT

OCTOBER 2010

A REPORT TO LEDA MANORSTEAD PTY LTD

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1 INTRODUCTION

1.1 Background

James Warren and Associates (JWA) were engaged by LEDA Manorstead Pty Ltd to complete a Saltmarsh Rehabilitation Plan (SRP) to accompany the Preferred Project Report for the proposed residential development at Cobaki Lakes.

JWA prepared a SRP for the Cobaki Lakes site in October 2008 in response to the Director General's Environmental Assessment Requirements (DGEAR's) issued 21st August 2007. The SRP was placed on public exhibition along with various other reports required by the DGEAR's.

Following submissions from the public and State Agencies, some amendments have occurred to the Concept Plan. Additionally, more detailed survey information is now available over the Saltmarsh area on the site. This Revised SRP has been prepared to reflect changes to the Concept Plan and provide additional information where required.

1.2 The Subject Site

1.2.1 Site description

The Cobaki Lakes site is located in Northern NSW adjacent to the NSW – Queensland State border. The site occupies the lower or eastern end of the Cobaki – Piggabeen Valley system (**FIGURE 1**).

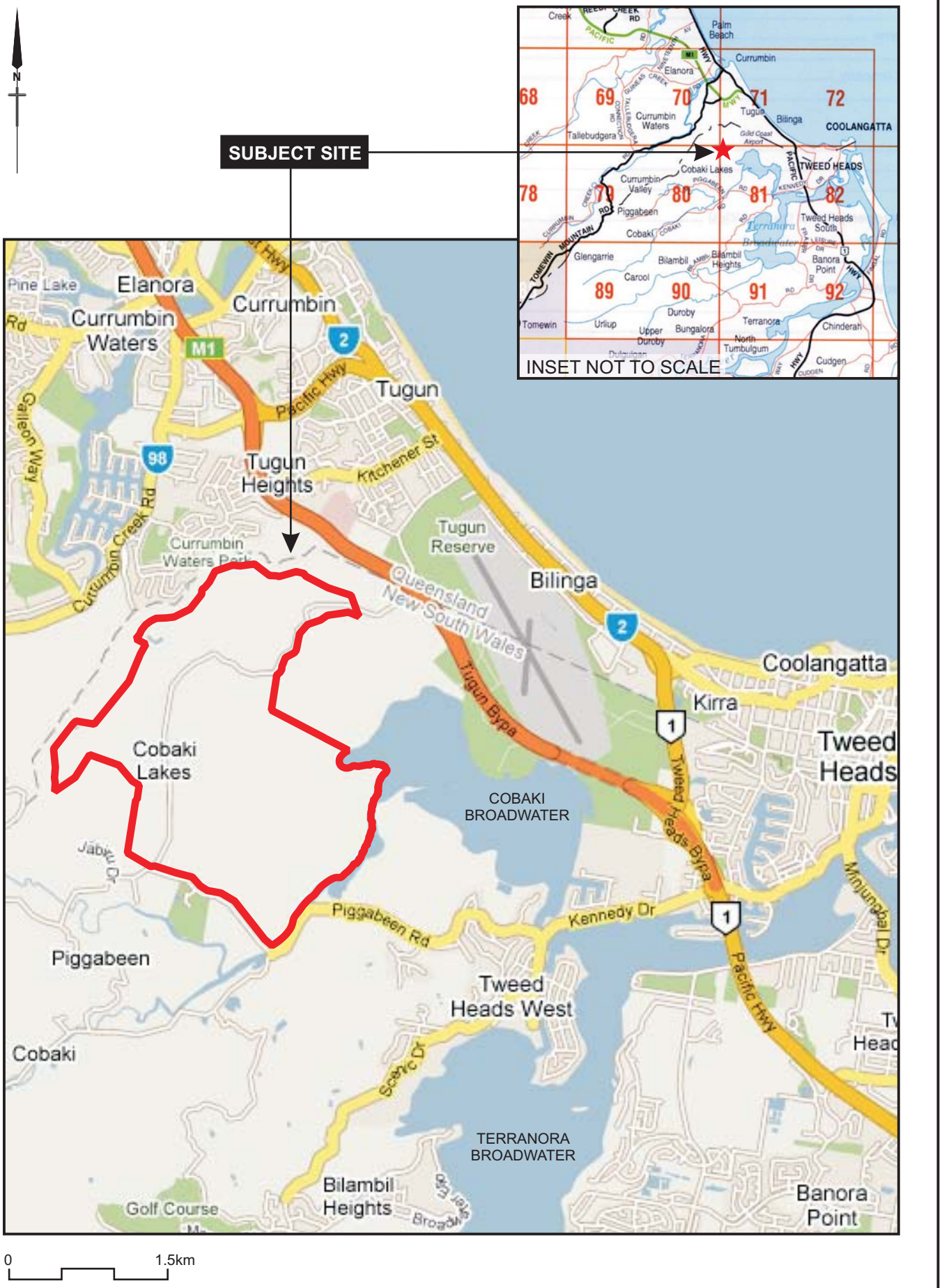
The subject site consists of land described as Lot 1 DP 570076, Lot 2 DP 566529, Lot 1 DP 562222, Lot 1 DP 570077, Lot 1 823679, Lots 46, 54, 55, 199, 200, 201, 202, 205, 206, 209, 228 & 305 DP 755740, Cobaki Lakes, off Pigabeen Road, Tweed Heads. The site covers an area of approximately 605 hectares.

The site topography is considered as two (2) separate systems.

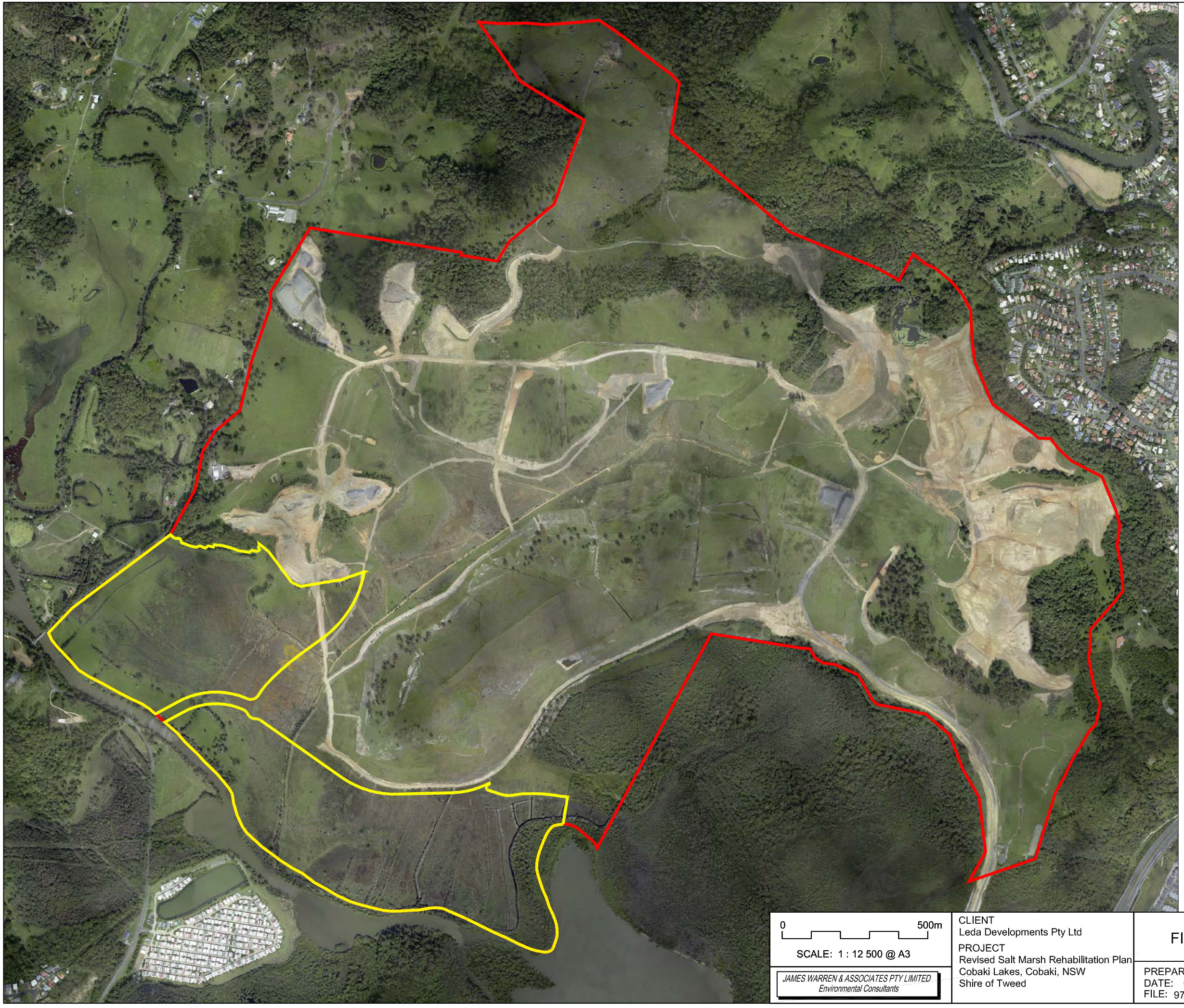
- The Sub-coastal foothills and outcrops of the eastern end of the McPherson Range which comprises the western and northern part of the site, covering an area of approximately 280 hectares.
- The hills enclose a drainage basin comprising the coastal plains in a composite of river/estuarine floodplain and sandplain being former sandbanks, beach or rolled and flattened dunes system.

FIGURE 2 shows a recent aerial photograph of the site. Vegetation clearing and earthworks have occurred in various locations of the subject site (in accordance with relevant approvals) subsequent to this aerial photograph. However, the vegetation assessment has utilised a combination of aerial interpretation and on-site surveys and reflects the current distribution and extent of vegetation communities.

Previous land clearing for agricultural purposes (i.e. grazing) has occurred across the majority of the site. Currently sixteen (16) broad vegetation associations comprising twenty-two (22) vegetation communities occur on the site.



SOURCE: Google Maps SCALE: 1 : 50 000 @ A4 JAMES WARREN & ASSOCIATES PTY LIMITED Environmental Consultants	CLIENT Leda Developments Pty Ltd PROJECT Revised Salt Marsh Rehabilitation Plan Cobaki Lakes, Cobaki, NSW Shire of Tweed	**FIGURE 1** PREPARED: BW DATE: 06 October 2010 FILE: 97038_SMRP_Locality.cdr	TITLE **LOCALITY PLAN**



N

LEGEND

Salt Marsh Rehabilitation Area

Cobaki Lakes Site Outline

SOURCE:
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 500m

SCALE: 1 : 12 500 @ A3

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Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 2

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

AERIAL PHOTOGRAPH

1.2.2 Existing use rights

The property has been grazed by cattle since the early 1900's. Landuse activities which have been a long term and constant feature of this site are defined in Section 106 of the EP&A Act 1979. Existing use rights occur over the subject site for routine agricultural activities including the construction and maintenance of drains, fencing and firebreaks as well as pasture improvement activities.

1.2.3 Land-use Zones

The Subject site currently contains the following landuse zones:

- 2(c) Urban Expansion
- 2(e) Residential Tourist Zone
- Recreation (Special Purposes)
- Environmental Protection (Scenic Escarpment)
- Environmental Protection (Habitat)

The current zoning plan is shown in **FIGURE 3.** The Concept Plan proposes amendments to the current zoning of the site. These amendments fall into five categories as follows:

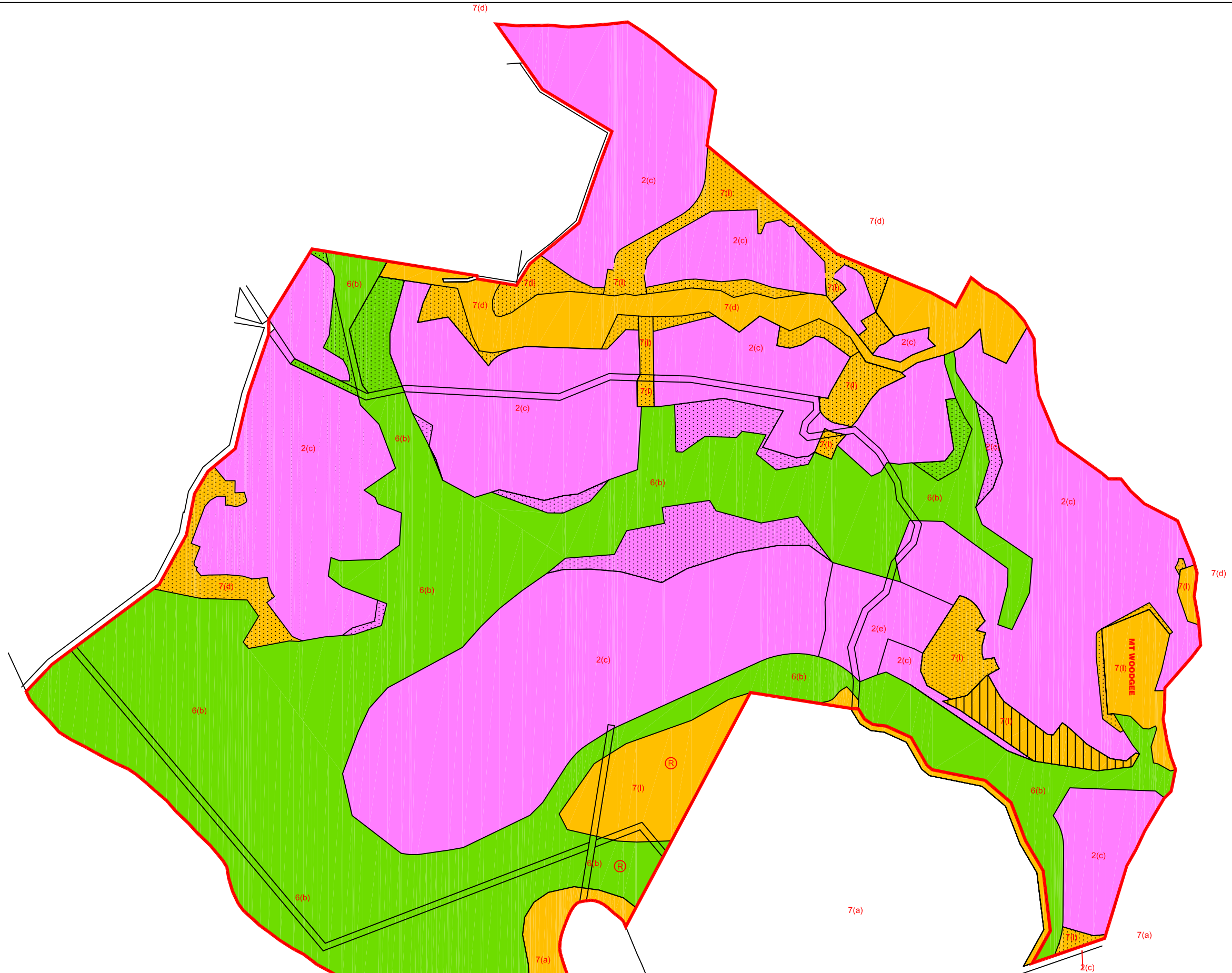
1. Amendments in accordance with Clause 52 of the Tweed LEP 2000;
2. Amendments to zonings contemplated by existing Development Consents;
3. Other proposed additions to the 2(c) Urban Expansion zone;
4. Proposed additions to the 7(l) Environmental Protection (Habitat) zone; and
5. Proposed additions to the 6(b) Recreation zone.

The proposed landuse zones are shown in **FIGURE 4.** The entire area comprising Saltmarsh communities, with the exception of road reserves to Sandy Lane and Cobaki Parkway, including proposed Saltmarsh compensatory areas, is proposed to be zoned Environmental Protection (**FIGURE 4**).

1.2.4 Soils and Geology

The subject site occupies the lower or eastern end of the Cobaki – Pigabeen Valley system**.** The site topography is considered as two (2) separate systems:

- The Sub-coastal foothills and outcrops of the eastern end of the McPherson Range, which comprises the western and northern part of the site and covers an area of approximately 280 hectares, or 42% of the site, and corresponding to a broad north/south line of hills. The terrain of these hills is rolling/hilly to hilly in a series of ridges and spurs with slopes of 10% to 25% and some 16% of the site having slopes in excess of 25%.
- The foothills enclose a coastal plain drainage basin comprising a composite of river/estuarine floodplain and sand-plain formed by sandbanks, beach or rolled and flattened dune systems.



LEGEND

1. RURAL

- 1(a) (a) Rural
- 1(b1) (b1) Agricultural Protection
- 1(b2) (b2) Agricultural Protection
- 1(c) (c) Rural Living

2. RESIDENTIAL

- 2(a) (a) Low Density Residential
- 2(b) (b) Medium Density Residential
- 2(c) (c) Urban Expansion
- 2(d) (d) Village
- 2(e) (e) Residential Tourist
- 2(f) (f) Tourism

5. SPECIAL USES

- 5(a) (a) Special Uses

6. OPEN SPACE

- 6(a) (a) Open Space
- 6(b) (b) Recreation

7. ENVIRONMENTAL PROTECTION

- 7(a) (a) Environmental Protection (Wetlands & Littoral Rainforests)
- 7(d) (d) Environmental Protection (Scenic/Escarpment)
- 7(f) (f) Environmental Protection (Coastal Lands)
- 7(l) (l) Environmental Protection (Habitat)
- S14 SEPP14 - Coastal Wetlands
- Clause 52 (Cobaki Lakes)
- Clause 52 (Cobaki Lakes)
- (R) Restriction On Use (DP1051024)
- Cobaki Lakes Site Outline

SOURCE:
Zoning - Michel Group Services (Ref: 6400-133A.dwg)

0 500m

SCALE: 1 : 12 500 @ A3

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Cobaki Lakes, Cobaki, NSW
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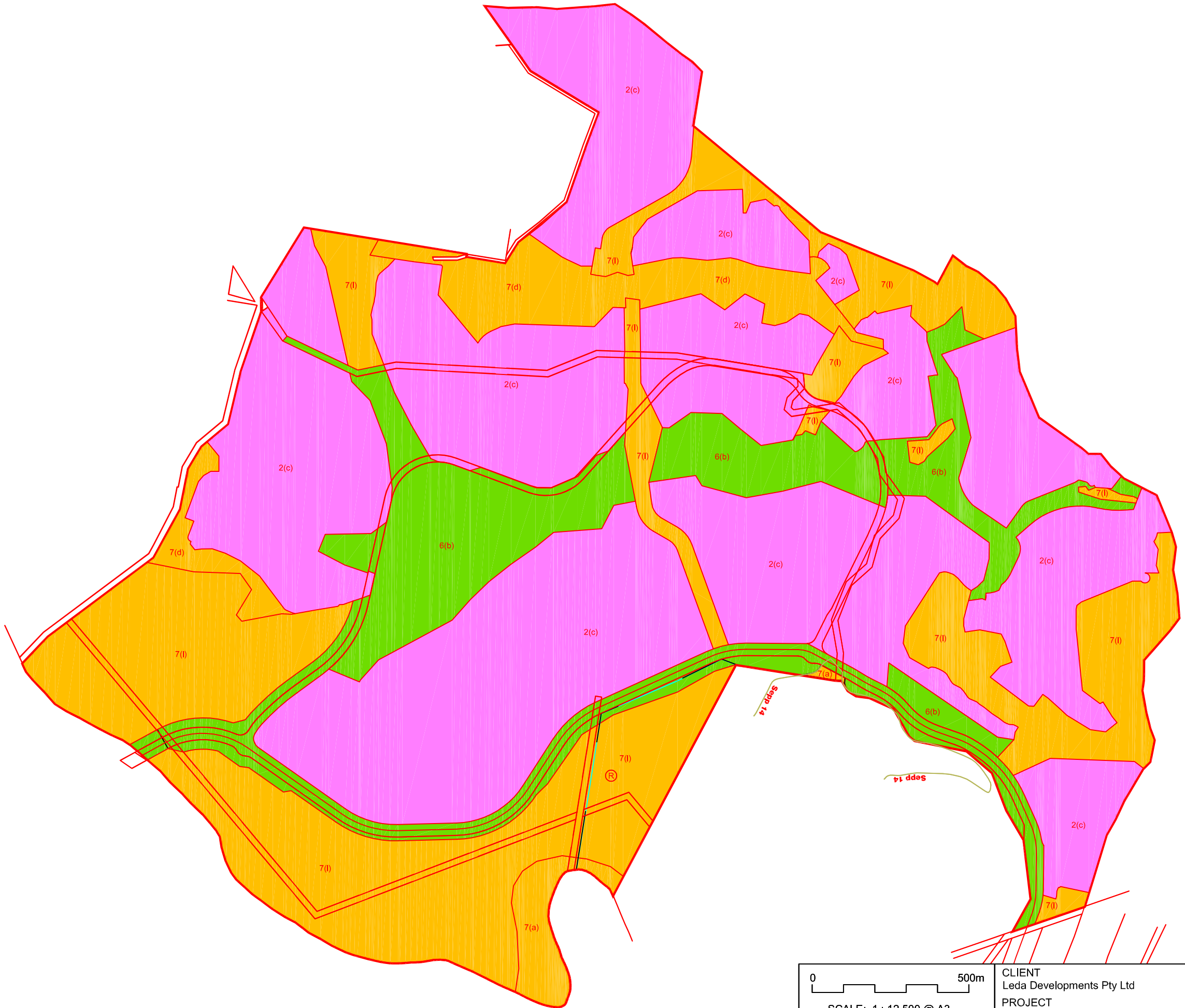
FIGURE 3

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

ZONING PLAN



LEGEND

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- S14 SEPP14 - Coastal Wetlands
- Clause 52 (Cobaki Lakes)
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- Site Outline

SOURCE:
Zoning - Michel Group Services (Ref: 6400-203F.dwg)

0 500m

SCALE: 1 : 12 500 @ A3

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FIGURE 4

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

PROPOSED ZONING AMENDMENTS

The McPherson range foothills and elevated portions of the site derive from bedrock of deeply weathered argillites (greywackes, siltstones and shales) of the Neranleigh – Fernvale Group (metasediments) overlain in parts by basalt fragments of the tertiary volcanics. More recent alluvial and estuarine deposits comprise the coastal plains on the site (Woodward-Clyde 1997).

1.3 Proposed Development

The site is proposed to be developed into a master planned residential community. A concept plan for the development is shown as **FIGURE 5**. The proposed development will include the following:

- Town centre/Neighbourhood centre (18.76 hectares);
- Residential (296.86 hectares);
- Community facilities/Education/Infrastructure (8.35 hectares);
- Public open space (87.12 hectares); and
- Environmental protection areas (194.36 hectares).

1.4 Scope of the Report

The Cobaki Lakes site covers an area of approximately 605 hectares and is proposed to be developed into a master planned residential community.

A large portion of the proposed open space area in the south-eastern portion of the Cobaki Lakes site is comprised of degraded Saltmarsh communities. The area of land which is subject to this plan occurs adjacent to Cobaki Creek in the south-eastern portions of the Cobaki Lakes development site. The Saltmarsh Rehabilitation Area (SRA) is to occur south of the proposed Sandy Lane and to the east of the proposed Cobaki Parkway and covers a total area of approximately 90ha. **FIGURE 6** shows the location and extent of the proposed Saltmarsh Rehabilitation Area (SRA).

Saltmarsh communities have ecological values which have been recognised at a Commonwealth, State and Local government level. However, the Saltmarsh communities on the subject site are currently degraded as a result of cattle grazing over a long period of time. Offsets for the removal of degraded Saltmarsh vegetation from the subject site will include the following:

1. Large areas adjacent to the existing Saltmarsh communities are currently comprised of a mixture of exotic grasses and will be restored to Saltmarsh communities in accordance with this Plan.
2. Re-establishment of saltmarsh species will be completed on the batters along the eastern edge of the Cobaki Parkway after construction is complete.
3. This Plan also includes the provision of retreat areas for Saltmarsh communities in the event of sea-level rise.

BOUNDARY

Queensland

New South Wales

WATER RESERVOR

SANDY ROAD

COBAKI PARKWAY

Piggabeen Road

Cobaki Creek

Environmental Reserve

To Boyd

N

LEGEND

- Town Centre / Neighbourhood Centre
- Residential
- Community Facilities/Education/Utilities
- Open Space
- Environmental Protection Area
- Covenant Protected Areas
- Structured Open Space
- Dam
- Proposed School (approx. 3ha)
- Proposed Community Facilities
- Site Outline

SOURCE:
Layout - Design Forum Pty Ltd
(Ref: SK 01.01 NN Concept Plan.dwg)

0 500m

SCALE: 1 : 12 500 @ A3

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FIGURE 5

PREPARED: BW
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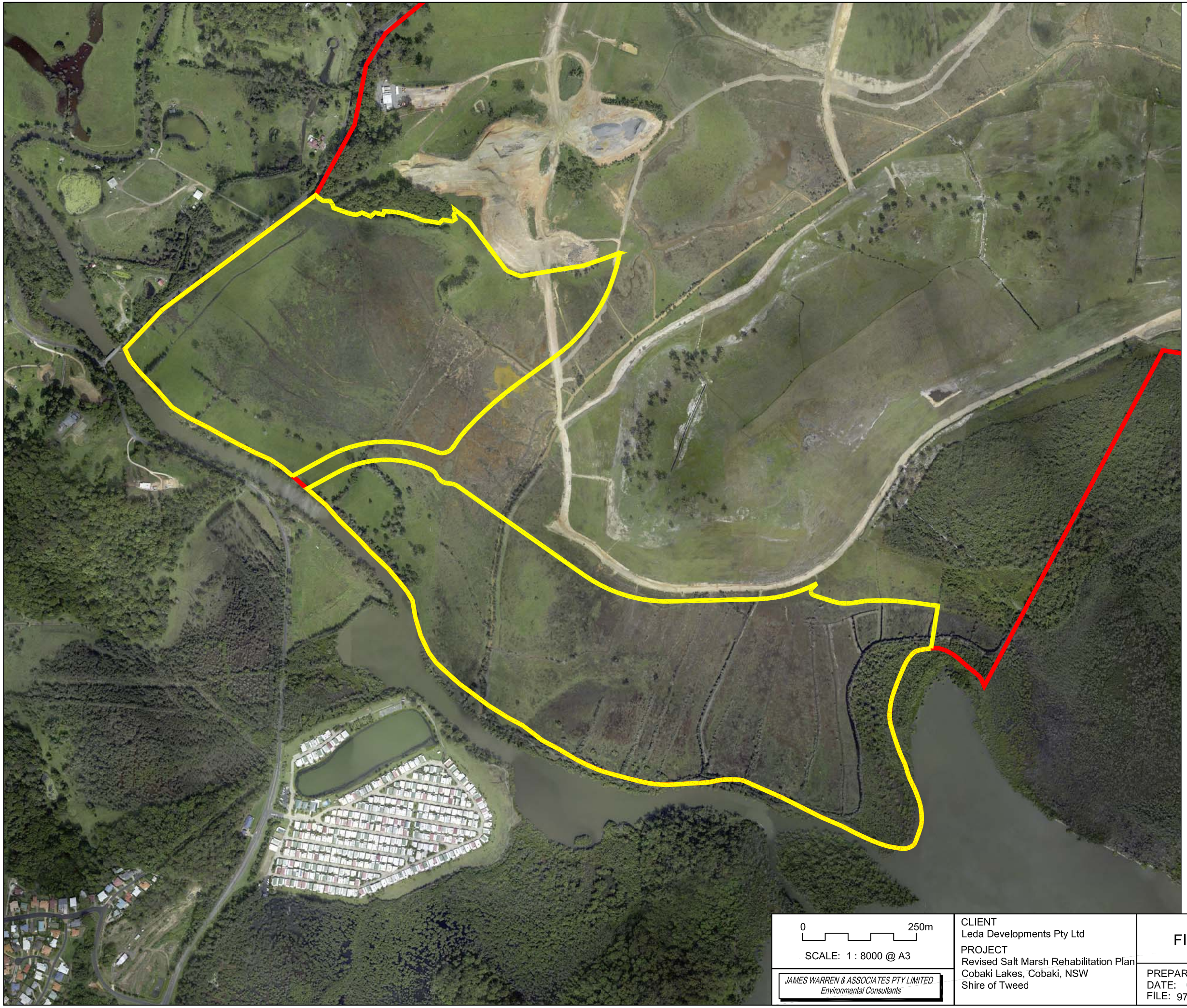
FILE: 97038_SMRP_base.dwg

TITLE

PROPOSED CONCEPT PLAN



LEGEND

- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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Revised Salt Marsh Rehabilitation Plan
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Shire of Tweed

FIGURE 6

PREPARED: BW
DATE: 06 October 2010
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TITLE
IMPACT ON ENDANGERED ECOLOGICAL COMMUNITIES

4. Removal of cattle from the area and subsequent relinquishment of existing use rights is considered an integral component of the rehabilitation process.
5. The entire area of the existing Saltmarsh community which is to be retained (i.e. 46.93ha) will be rehabilitated in accordance with this Plan. This will essentially involve restoring a natural tidal regime to the area.
6. Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works.

Further to the regeneration of the retained 46.93ha Saltmarsh community, an additional 25.49 hectares of Saltmarsh vegetation will be revegetated on the subject site, in combination with Swamp oak revegetation works, to offset the loss of 10.25 hectares. The proposed offsets listed above will result in a net gain of 15.24ha of this EEC on the subject site.

The Revised SRP also provides details of offsets for the removal of a small area of Swamp oak floodplain forest EEC from the subject site. The removal of approximately 0.95 hectares of the Swamp oak floodplain forest community from the subject site will be ameliorated by revegetating compensatory Swamp oak communities within the SRA. Areas within and adjacent to the existing Saltmarsh communities on the subject site are currently comprised of a mixture of exotic grasses and will be restored to Saltmarsh and Swamp oak communities in accordance with this Plan.

In total, 25.49 hectares of Swamp oak floodplain forest will be revegetated on the subject site, in combination with Saltmarsh revegetation works, to offset the loss of 0.95 hectares. The proposed offsets will result in a net gain of 24.54ha of this EEC on the subject site.

2 REVIEW OF RELEVANT LITERATURE

2.1 Saltmarsh Ecosystems and the Predicted Effects of Sea Level Rise

Saltmarshes are a major, widely distributed, inter-tidal habitat. They are dynamic systems, responding to changing environmental conditions (Adam 2002). Saltmarshes have a high biodiversity and economic value, supporting threatened and migratory species and commercially important fish nurseries (Jaensch 2005). Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea, Juncus kraussii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis* and *Zoysia macrantha*. Occasionally mangroves are scattered through the Saltmarsh. Tall reeds may also occur, as well as salt pans.

Mangrove swamps and estuarine saltmarsh are generally considered to be highly productive of organic matter (Weslake, 1963; Odum and Heald, 1972; Whittaker, 1975; Turner, 1976). The major pathways for nutrient cycling appear to occur through their leaf and root matter. It is argued that this important source of organic material for detrital food chains infers that the mangroves and saltmarshes are the nurseries for young fish and crustaceans and are thus an integral part of wetland food webs (Odum and de la Cruz, 1967; Odum and Heald, 1972; Odum and Heald, 1975).

Saline wetland communities utilize imported inorganic matter and export matter in the form of plant and animal detritus which then serves as food for marine food webs. Lugo and Snedaker (1974) state that matter transport is driven by physical processes (daily tides, runoff and rainfall) as well as by biological processes (leaf fall, decomposition, mineral uptake rates and certain activities of the fauna).

Saltmarsh and other inter-tidal vegetation communities are of vital importance to the breeding cycle of several fish species. Saltmarshes play an important role as a juvenile habitat for species such as bream and mullet. Crabs are common in Saltmarsh communities, and are a significant food source for bream and other carnivorous species. Some species, such as Common galaxias (*Galaxias maculatus*), deposit their eggs in Saltmarsh vegetation (NSW Fisheries 2008).

Of critical importance to Saltmarsh ecosystems are changes in relative sea level and in tidal range. Relative sea level is affected by changes in absolute sea level, changes in land level and the capacity of Saltmarshes to accumulate and retain sediment. Many Saltmarshes are starved of sediment because of catchment modification and coastal engineering, or exposure to erosive forces, which may be of natural origin or reflect human interference. The geographical distribution of individual Saltmarsh species reflects climate, so that global climatic change will be reflected by changes in distribution and abundance of species, although the rate of change in communities dominated by perennial plants is difficult to predict.

Humans have the ability to create impacts on Saltmarshes at a range of scales from individual sites to globally. Pressures on the environment created by the continued increase in the human population, particularly in developing tropical countries, and the likely consequences of the enhanced greenhouse effect on both temperature and sea level give rise to particular concerns.

Sea level rise is one of the projected outcomes of climate change documented in the three successive reports over the last decade by the Intergovernmental Panel on Climate Change (IPCC) The most recent IPCC projections (January, 2001) are for sea-level rise of between 9 and 88 cm between 1990 and 2100 and a global average surface temperature rise of between 1.4 and 5.8^{o} C (CSIRO 2001).

By 2025, global sea level rise and warming will have impacts on Saltmarsh communities. However, the most extensive changes are likely to be the direct result of human actions at local or regional scales (Adam 2002).

Management Plans completed for inter-tidal communities need to address the potential for sea level rise and the subsequent retreat of these communities.

2.2 Cobaki Broadwater Management Plan

The Cobaki Lakes site is located immediately adjacent to the western boundary of the Cobaki Broadwater (intertidal) or wetland habitats associated with the Broadwater. There is a significant stormwater and ecological nexus between the Cobaki Lakes site and the Broadwater.

The following is a summary of the findings of the Cobaki Broadwater Management Plan (1998):

> *The Cobaki Broadwater Management Plan was produced in 1998 as a response to the Lower Tweed Estuary Management Plan, which earmarked Cobaki Broadwater as a management priority to conserve all the valuable habitats within the vicinity of the Broadwater.*
>
> *Cobaki Broadwater is an area of high scenic and ecological values. It is located in the lower reaches of the Tweed River Estuary and adjoins Coolangatta airport, west Tweed Heads and potential industrial and residential developments.*
>
> *In 2007 the Cobaki Broadwater Management Plan is under review and an updated version was to be available late 2007(not available in April 2008).*
>
> *The objectives for the Cobaki Broadwater Management Plan are:*
>
> - *To preserve and enhance valuable habitats within the Broadwater.*
> - *To encourage a low level of recreational activities and environmental education that is sensitive to the local environment and its requirements.*

- *To conserve the valuable ecological assets of the Broadwater.*

Cobaki Broadwater and its surrounding area support a number of terrestrial and aquatic habitats. The habitats that are significant to Cobaki Broadwater are:

- *Natural bushlands and wetlands that are present to the north west of the Broadwater. These areas are on crown land, and are in a reasonably pristine condition with the exception of an area of tree dieback that extends from the shoreline. The cause of this dieback is unknown.*
- *Rainforest communities and Aboriginal midden sites located on the north eastern shore of the Broadwater.*
- *Bushland and wetland that has been isolated by Coolangatta airport and surrounding developments to the east of the Broadwater. This area is a potential habitat for endangered plant communities.*
- *Wetland areas along the southern shores of the Broadwater adjacent to Cobaki Village development and along the western bank of Cobaki Creek.*
- *The Broadwater and the mangrove islands present within it.*

Water clarity in Cobaki Broadwater is acceptable, though the clarity of the water decreases due to re-suspension of fine sediments during periods of wind and wave action. The Broadwater is very shallow, generally less than one metre at mean low water, this also affects the turbidity. There is also limited tidal flushing of the Broadwater.

*Whilst the Cobaki Broadwater Management Plan seeks to obtain maximum ecological benefits, it is limited by, (*amongst others*):*

- *Low lying salt marsh/wetland areas to the east which may be impacted by Cobaki Lakes development.*
- *Sediment and nutrient inputs from existing and proposed development within the catchment area which may affect water quality.*

Ecological opportunities that exist around the Cobaki Broadwater are:

- *Habitat replacement or enhancement. This could compensate for any development which may destroy or downgrade any wetland.*
- *Preserve a habitat reservation present on the north west shoreline of the Broadwater*
- *Create fresh/salt water wetlands adjacent to the proposed Cobaki Lakes development. This would create a habitat for migratory birds, both those existing in the area and those that have been affected by airport extensions. Such a wetland would also act as a nutrient and sediment filter for runoff discharged from future residential development.*
- *A riparian corridor along the edge of developable lands will be encouraged. This would connect valuable wetland habitats located along the southern boundary of the Broadwater.*

The Revised Saltmarsh Rehabilitation Plan for the Cobaki Lakes site will seek to achieve all ecological opportunities described within the Cobaki Broadwater Management Plan.

3 STATUTORY CONTROLS

3.1 Introduction

The statutory controls which regulate and manage impacts on Saltmarsh communities are contained in Commonwealth, State and Local legislation.

3.2 Commonwealth legislation

3.2.1 Ramsar Convention on Wetlands of International Importance

The broad aims Ramsar Convention are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. Under the Ramsar Convention a wide variety of natural and human-made habitat types, ranging from rivers to coral reefs, can be classified as wetlands. Wetlands include swamps, marshes, billabongs, lakes, salt marshes, mudflats, mangroves, coral reefs, fens, peat bogs, or bodies of water - whether natural or artificial, permanent or temporary.

The Ramsar Convention encourages the designation of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated these sites are added to the Convention's List of Wetlands of International Importance and become known as Ramsar sites.

Australia was one of the first countries to sign the Ramsar Convention, and Australia designated the world's first Wetland of International Importance. Australia currently has 65 Wetlands of International Importance listed under the Ramsar Convention covering approximately 7.5 million hectares (DEWHA 2008).

Currently there are no Wetlands of international significance (Ramsar wetlands) on the Cobaki Lakes site or within the locality.

3.2.2 Bilateral Migratory Bird Agreements

Migratory waterbirds include species such as plovers, sandpipers, stints, curlews and snipes. These incredible birds make round trip migrations of up to 26,000 km each year between their breeding grounds in the northern hemisphere and their non-breeding areas in the south. These trips are made in several weeks, with brief stops at staging sites along the way to rest and refuel for the next leg of their journey.

The Commonwealth is responsible for the conservation and implementation of several Migratory bird agreements including:

- Japan in 1974 (JAMBA)
- China in 1986 (CAMBA)
- Republic of Korea in July 2007 (ROKAMBA)

The JAMBA, CAMBA and ROKAMBA agreements list terrestrial, water and shorebird species which migrate between Australia and the respective countries. In both cases

the majority of listed species are shorebirds. The agreements require the parties to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

All migratory bird species listed in the annexure to these bilateral agreements are protected in Australia as matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

3.3 State legislation

3.3.1 Endangered Ecological Communities (EEC's)

The NSW Department of Environment and Climate Change (DECC) administer the Threatened Species Conservation Act (TSC). This Act lists ecological communities which are endangered in NSW.

In June 2004 the NSW Scientific Committee gazetted Coastal saltmarsh as an Endangered Ecological Community. The Saltmarsh communities within the Cobaki Lakes site are considered to represent the EEC Coastal saltmarsh in the North Coast Bio-region (NPWS 2004). The Scientific listing of this EEC is Included as **ANNEXURE 1**.

EEC's are generally considered to be of a high conservation value. Small size, weed infestation, physical damage and non-natural genesis can lead to the allocation of a lower conservation status.

3.3.2 SEPP 14

The NSW Department of Planning administer State Environmental Planning Policy (SEPP) No. 14 (Wetlands). This SEPP controls proposed developments on or near the States coastal freshwater and saline wetlands. A large SEPP 14 area (Freshwater, Paperbark and Saline communities) occurs to the immediate north of the proposed Saltmarsh Restoration Area (SRA) (**FIGURE 7**). None of the Saltmarsh occurring within the south-eastern portion of the site is mapped as SEPP 14. This may have been because the site was cleared of Paperbark forest in or around 1980. The SEPP 14 Wetland Policy was gazetted in 1985, at which time there would have been no substantive development of Saltmarsh or re-development of Paperbark.

3.3.3 Fisheries

NSW Fisheries are responsible for managing fisheries and their habitat (including inter-tidal lands) along the coast of NSW. Any development of inter-tidal Saltmarsh areas (below HAT) invite comment by Fisheries. Fisheries have published a document dealing with Fisheries Habitat Management (DPI 2008). These guidelines allow for removal of

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LEGEND

Area subject to SEPP No. 14

Site Outline

SOURCE:
SEPP - Michel Group Services
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 500m

SCALE: 1 : 12 500 @ A3

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PROJECT
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Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 7

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

SEPP 14
COASTAL
WETLANDS

habitat in some instances but require compensation at rates varying between 2 and 5 times the loss due to development.

4 CURRENT CONSERVATION VALUES

4.1 Introduction

Several vegetation communities occur throughout the proposed Saltmarsh Rehabilitation Area (SRA), including large patches of Saltmarsh in the low lying areas. This section discusses the distribution and conservation values of vegetation communities occurring within the SRA.

Scattered patches of the Freshwater wetland EEC also occur in the eastern portions of the site which are generally dominated by Saltmarsh communities. It is likely that the freshwater communities in this portion of the site are occurring as a result of historical changes to the tidal inundation in this portion of the site. As it is proposed to restore the natural tidal regime in the eastern portion of the subject site, with the intention of returning the entire area to its original Saltmarsh status, there will be some loss of the Freshwater wetland EEC. Offsets for the removal of Freshwater wetland EEC are the subject of a Revised Freshwater Wetland Rehabilitation Plan (JWA 2010) and will not be further addressed in this Plan.

4.2 Vegetation within the Saltmarsh Rehabilitation Area

4.2.1 Introduction

This section describes the vegetation communities that occur within the SRA.

4.2.2 Methods

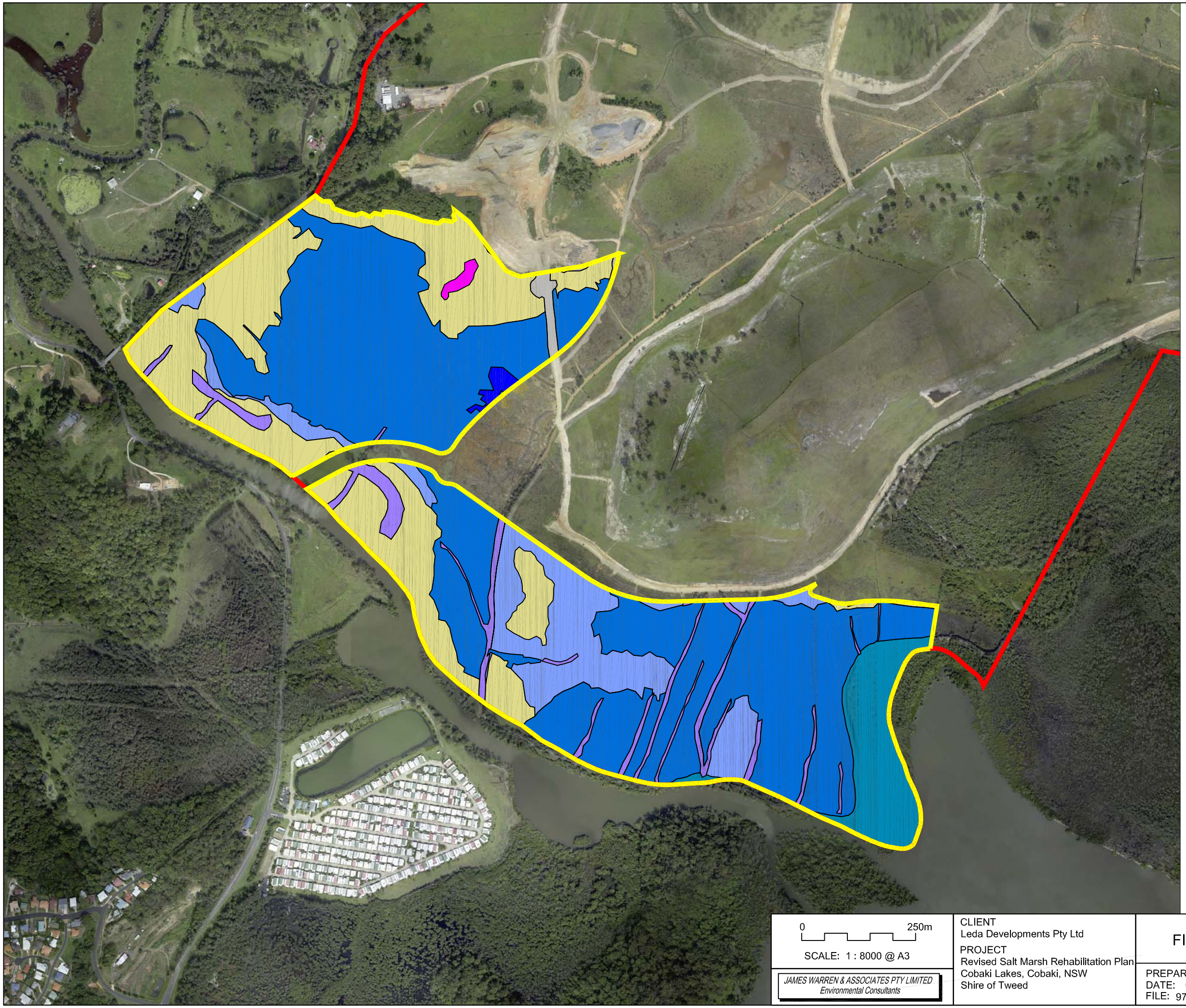
Detailed vegetation mapping for the Cobaki Lakes site was completed in February 2008. Twenty-two (22) vegetation communities were recorded on the site. All of the vegetation communities were mapped and described with reference to Walker and Hopkins (1996), The Regional Forestry Agreement (RFA) and the Tweed Vegetation Management Strategy (2004).

Only the vegetation occurring within the SRA will be described in this Rehabilitation Plan.

4.2.3 Community Descriptions

Seven (7) vegetation communities occur within the Saltmarsh Rehabilitation Area (**FIGURE 8**) including:

- Community 8 - Mid-high open woodland (*E. siderophloia*)
- Community 10 - Low closed grassland with scattered trees (Pastoral grasses +/- mixed species)
- Community 11 - Low closed grassland (*Sporobolus virginicus, Triglochin striata*, + /- *Casuarina glauca*)



LEGEND

- Community 8 - Mid-high open woodland (*E. siderophloia*)
- Community 10 - Low closed grassland with scattered trees (Pastoral grassess +/- Mixed species)
- Community 11 - Low closed grassland (*Sporobolus virginicus*, *Triglochin striata* +/- *Casuarina glauca*)
- Community 12 - Rushland/sedgeland/ grassland (Mixed aquatic species)
- Community 13 - Low to mid-high open mangrove forest (*Avicennia marina* var *australasica* / *Aegiceras corniculatum* +/- *Casuarina glauca*)
- Community 14 - Dams & drainage lines (Mixed aquatic species)
- Community 15 - Low open forest/woodland (*Casuarina glauca* +/- Mixed species)
- Unvegetated land
- Salt Marsh Rehabilitation Area Boundary
- Cobaki Lakes Site Outline

SOURCE:
Vegetation - James Warren & Associates Pty Ltd
July/Sept 2007 & May 2008
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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Revised Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 8

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE
SALT MARSH REHABILITATION AREA VEGETATION COMMUNITIES

- Community 12 - Rushland/sedgeland/grassland (Mixed aquatic species)
- Community 13 - Low to mid-high open mangrove forest (*Avicennia marina* var. *australasica* / *Aegiceras corniculatum* +/- *Casuarina glauca*)
- Community 14 - Dams and drainage lines (Mixed aquatic species)
- Community 15 - Low open forest/woodland (*Casuarina glauca* +\- mixed species).

FIGURE 8 shows the locations of each of the vegetation communities within the SRA. A description of the composition and structure of each vegetation community is provided below.

Community 8 – Mid-high open woodland (*Eucalyptus siderophloia*)

Location and area
Community 8 occurs in the south-east of the subject site and covers an area of 0.27 hectares within the SRA.

Description
The canopy of this community is very open and comprised entirely of Northern grey ironbark. The mid-storey is absent and the ground cover is comprised of pasture grass species and is regularly slashed.

Conservation status
The most appropriate analogue considered in the Regional Forestry Agreement (RFA) report is NFE 54: Grey Box - Red Gum - Grey Ironbark.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is best classified as open forests on bedrock – 202 Grey ironbark/ White mahogany/ Grey gum open forest complex. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 12,820 hectares (vegetated land), which is approximately 18.68 of the vegetated land in the Shire;
- This ecosystem is considered to be adequately conserved over a major part of its range.

Community 10 - Low closed grassland with scattered trees (Pastoral grasses +/- mixed species*)*

Location and area
Community 10 occurs throughout the majority the Cobaki lakes site, and covers an area of approximately 22.30 hectares within the SRA.

Description
The grassland is dominated by a mixture of species that vary with location. The foot slopes and grassy areas adjacent to the forests and woodlands are dominated by a

mixture of native species including Kangaroo grass, Blady grass, Bracken fern, and introduced grasses including Broad leaved paspalum and Setaria.

The flat areas east of Sandy Lane have been historically slashed and grazed, and are comprised of introduced pasture species including Broad-leaved carpet grass, Paspalum, Rhodes grass and African lovegrass.

Several significant trees occur within this community, including a row of old growth Forest red gums at the Piggabeen Road entrance in the southern portion of the Cobaki Lakes site. Several other species of trees occur within this community, including Northern grey ironbark, Scribbly gum, Figs, Camphor laurel, Blackwood wattle, Blackbutt, Tallowwood, Pink bloodwood, Grey gum, Hoop pine, Swamp mahogany and Swamp oak. The most common scattered tree species within the SRA include Forest red gum and Swamp oak.

Conservation status
This community is not considered to be analogous with any of the Forest Ecosystems identified within the Regional Forestry Agreement (RFA) report.

The conservation status of this community is considered to be low. Individual trees within this community may have a raised conservation status. The conservation status of the significant old growth Forest red gums (at the Piggabeen Road entrance in the southern portion of the Cobaki Lakes site) is considered to be moderate–high.

Community 11 - Low closed grassland (*Sporobolus virginicus*, *Triglochin striata* +/- *Casuarina glauca)*

Location and area
Community 11 occurs in the low-lying area in the south-east of the Cobaki Lakes site and covers a total area of approximately 46.93 hectares within the SRA.

Description
This community is dominated by a mixture of Saltmarsh species that vary with location. The most commonly occurring species include Saltwater couch, Streaked arrow-grass, Samphire and Fimbristylis.

Stands of regenerating Swamp oak approximately 3-4 metres in height occur flanking drainage lines throughout this community.

Conservation status
This community is best described by Forest Ecosystem 125: Saltmarsh (CRA Unit 1999). The Regional Forestry Agreement document provides the following data on this ecosystem:

- The pre-1750 extent of this ecosystem type has been calculated at 17 hectares. Approximately 16 hectares remains.
- The ecosystem is considered **Rare**.

- The extent of this ecosystem type contained within the Comprehensive, Adequate & Representative (CAR) reserve system has been calculated, with 55.8% protected in dedicated reserves.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is classified as Estuarine complexes – 603 Saltmarsh. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 49 hectares (vegetated land), which is approximately 0.07% of the vegetated land in the Shire;
- This ecosystem is considered to be inadequately conserved over all its range.

This vegetation community is considered to represent the Endangered Ecological Community (EEC) 'Coastal Saltmarsh in the North Coast Bio-region' (NPWS 2004). This EEC is considered to be of high conservation value on the subject site.

Community 12 – Rushland/ sedgeland/grassland (Mixed Aquatic species)

Location and area
Community 12 occurs in the central portion of the Cobaki Lakes site, covering a total area of approximately 10.09 hectares within the SRA.

Description
Community 12 is comprised of aquatic and semi-aquatic vegetation including Mangrove fern, *Cyperus* sp., Frogsmouth, Swamp water fern, Curly sedge, Bunchy flat sedge, Spike rush, Fringe rush, Tussock rush and Jointed twig rush.

Conservation status
The conservation status of Sedgeland/rushland/grassland communities has not been specifically discussed in the Regional Forestry Agreement document. The most appropriate analogue is NFE 141 Swamp. It is noted that Swamp ecosystems are Rare in the upper north-east section of the NSW North Coast Bioregion.

This community contains species which are indicative of the Endangered Ecological Community (EEC) 'Freshwater Wetlands on Coastal Floodplain'. The conservation value of this community is considered to have been significantly reduced however due a history of drainage construction and maintenance, grazing and slashing. The conservation status of this community on the subject site is considered to be moderate.

Community 13 - Low to mid-high open mangrove forest (*Avicennia marina* var. *australasica* / *Aegiceras corniculatum* +/- *Casuarina glauca*)

Location and area
Community 13 occurs in the east of the Cobaki Lakes site, and covers a total area of approximately 5.66 hectares within the SRA.

Description
This community is dominated by Grey mangrove with River mangrove also occurring. Swamp she-oak, Black mangrove and Milky mangrove also occur sporadically.

Conservation Status
This community is analogous with the Mangrove non-forest ecosystem (Ecosystem 77) (NPWS 1999). The Regional Forestry Agreement document provides the following data for this ecosystem:

- The extent of this ecosystem pre-1750 has not been determined. Approximately 734 hectares remain in the upper north-east section of the NSW North Coast Bioregion. The ecosystem type is considered to be **Rare**.
- The extent of the ecosystem in the Comprehensive, Adequate and Representative (CAR) reserve system has not been determined.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is best classified as Estuarine complexes – 602 Mangrove low closed forest to woodland. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 474 hectares (vegetated land), which is approximately 0.69% of the vegetated land within the Shire and 0.36%;
- Inadequately conserved over all its range.

The conservation status of this community is considered to be high.

Community 14 - Dams & drainage lines (mixed aquatic species)

Location and area
Community 14 occurs sporadically throughout the majority of the Cobaki Lakes site as low lying drainage lines, and as a constructed dam in the north-west of the site. This community covers an area of approximately 0.41 hectares within the SRA.

Description
Community 14 is comprised of aquatic and semi-aquatic vegetation. The vegetation occurring in the constructed dam in the north-west of the site includes Water lilly (*Nymphaea caerulea*) and *Cyperus* sp. The edges of the dam have only recently been constructed and contain very little vegetation. Species present in low abundance include regenerating Paperbark, Prickly moses and Fireweed.

Several drainage lines occur across the SRA. Species which commonly occur within these drainage lines include Frogsmouth, Swamp water fern, Curly sedge, Bunchy flat sedge, Spike rush, Fringe rush, Tussock rush and Jointed twig rush.

Conservation status
The conservation status of dams and drainage lines has not been specifically discussed in the Regional Forestry Agreement document. The most appropriate analogue is NFE 141 Swamp. It is noted that Swamp ecosystems are Rare in the upper north-east section of the NSW North Coast Bioregion.

The conservation value of this community is considered to be low.

Community 15 - Low open forest/woodland (*Casuarina glauca* +/- mixed species)

Location and area
Community 15 occurs across the southern portions of the Cobaki Lakes site and is found most commonly along the low lying drainage lines. This community covers an area of 3.87 hectares within the SRA.

Description
This community is dominated by Swamp oak and occurs in low lying swamp lands, with very few associated species, the exception being Grey mangrove, Tuckeroo, Umbrella Cheese Tree, Cottonwood and some exotic species in the understorey.

Conservation status
Swamp oak communities in the study area are analogous to forest ecosystem 143 (Swamp she-oak) (NPWS 1999). This ecosystem is considered to be Rare in the upper north-east section of the NSW North Coast Bioregion. The Regional Forestry Agreement document provides the following data on this ecosystem:

- Pre-1750 there was 11165 hectares of this ecosystem type in the upper north-east section of the NSW North Coast Bioregion. 2883 hectares (25.8 %) remains;
- The ecosystem is considered to be Rare;
- 8.3% of the ecosystem type is present within the Comprehensive, Adequate and Representative (CAR) reserve system, including 7.6% in dedicated reserves and 0.2% in informal reserves. A further 0.5% is protected by tabulated prescriptions.
- Swamp she-oak communities have been identified as a priority for conservation on private land.

Under the Tweed Vegetation Management Strategy (Ecograph 2004) this ecosystem is classified as Melaleuca and Swamp she-oak - 402 Broad-leaved paperbark/ Swamp she-oak closed forest to woodland. The Tweed Vegetation Management Strategy (Ecograph 2004) provides the following data on this ecosystem:

- This ecosystem covers an area of approximately 180 ha (vegetated land), which is approximately 0.26% of the vegetated land within the shire;
- Inadequately conserved over a major part of its range.

The vegetation community is considered to represent the Endangered Ecological Community (EEC) Swamp oak floodplain forest of the NSW North Coast.

4.3 Conservation Assessment

A diversity of conservation assessment techniques have been developed for wetland plant communities in recent times (e.g. Winning 1990). Most of these schemes relate to an assessment of criteria such as size, shape, hydrological integrity and habitat value. To a certain extent, the inclusion of various wetland communities in either SEPP 14 or

in an Endangered Ecological Community (EEC) category means that they have a high conservation value. It should be noted that a quite small and disturbed plant community can still be categorised as an EEC.

Each of the vegetation communities that are currently occurring within the SRA have been assessed with regard to:

- Size;
- Habitat value;
- Hydrological integrity; and
- The classification of the community as an Endangered Ecological Community (EECs).

TABLE 1 describes the relative conservation values for each of the vegetation communities occurring within the SRA.

TABLE 1
CONSERVATION VALUES FOR EACH OF THE VEGETATION COMMUNITIES OCCURRING WITHIN THE SRA

Vegetation Communities	AREA	Habitat Value	Origin	Hydrological integrity	Current Impacts	EEC	Conservation Value
8. Mid-high open woodland (*E. siderophloia*)	0.27 ha	Moderate	Naturally occurring	Receives freshwater run-off	Minor. Cattle grazing is reducing potential recruitment of seedlings.	No	Low - Moderate
10. Low closed grassland with scattered trees (pastoral grasses +/- mixed species)	22.30 ha	Low	Introduced pastoral grasses have been sown for agricultural purposes after land clearing.	Limited to flooding	This community is dominated by exotic pastoral / agricultural grasses.	No	Low
11. Low Closed Grassland (*Sporobolus virginicus, Triglochin striata* + /- *Casuarina glauca)*	46.93 ha	Moderate	This community has developed as a result of the clearing of the original Swamp forest, construction of drains and installation of tidal flaps.	Tidal flushing + fresh water runoff	Cattle gazing has reduced vegetation cover and continued trampling has caused large parts of this community to become degraded (i.e. patches of bare mud, hoof prints etc.).	Yes	High
12. Rushland/sedgeland/ grassland (mixed aquatic species)	10.09 ha	Moderate	This community has developed as a result of the clearing of the original Swamp forest, construction of drains and installation of tidal flaps.	Fresh water runoff + Tidal flushing on spring tides	Cattle gazing has reduced cover in some areas. Tidal inundation is also a potential impact on this freshwater community type.	Yes	Moderate

Vegetation Communities	AREA	Habitat Value	Origin	Hydrological integrity	Current Impacts	EEC	Conservation Value
13. Low to mid-high open mangrove forest (*Avicennia marina var. australasica/ Aegiceras corniculatum* +/- *Casuarina glauca)*	5.66 ha	High	Naturally occurring community.	Tidal flushing	Minor. Cattle are unable to access this community due to a permanent tidal drain.	No	High
14. Dams & drainage lines (mixed aquatic species)	0.41 ha	Moderate	Aquatic species have colonised the man made drainage lines that have been constructed within the SRA.	Fresh water runoff + Tidal flushing	Cattle grazing. Growth of exotic weeds in drainage lines.	No	Low
15. Low open forest/woodland (*Casuarina glauca* +\- Mixed species)	3.87 ha	Moderate	This community has colonised the edges of the constructed drainage lines within the SRA.	Tidal Flushing along the edges of drains.	Minor infestation of the exotic weed species Coastal morning glory (*Ipomoea cairica*).	Yes	Moderate

5 IMPACT & AMELIORATION ASSESSMENT

5.1 Current Management Issues in the SRA

5.1.1 Introduction

This section discusses the various management issues that are currently causing adverse impacts on the SRA.

5.1.2 Background

Portions of the low-lying land at Cobaki Lakes are subject to tidal inundation from the adjacent Cobaki Creek and Cobaki Broadwater. Freshwater Paperbark forest appears to have dominated the area prior to 1980 (C. Easton *pers. comm.* June 2007). Historical farming activities have led to the clearance of the Paperbark, the construction of one (1) major drain (Dunn's Drain) and a number of smaller drains, and the placement of a tidal flap at the mouth of Dunn's Drain. Vandalism of the tidal flap and other breaches of the berm to the Cobaki Broadwater have allowed tidal water onto the site for over twenty years. This has allowed Saltmarsh communities to develop over much of the area south and south-east of the constructed fill base for the Cobaki Parkway. A mixture of Saltmarsh, brackish and freshwater species occur north of the Parkway and on the western margins of Dunn's Drain. All of these communities have appeared as a result of farming activities on the Cobaki Lakes site.

5.1.3 Land-use

Cattle grazing has been carried out on the Cobaki Lakes site for many years. Grazing has continued alongside residential development activities (bulk earthworks) since 1994. Cattle currently have unfettered access to the SRA in accordance with existing use rights.

5.1.4 Stormwater

Significant land drainage works were completed on the Cobaki Lakes site many years ago. The main drain (Dunn's Drain) was constructed from the middle northern portions on the site to the southern boundary (2.5 km in length). A significant number of smaller drains were constructed particularly in the SRA.

5.1.5 Levee & Tidal flaps

The construction of one (1) major drain (Dunn's Drain) and a number of smaller drains, allowed for tidal water to enter the site. Tidal flaps installed at the mouth of Dunn's Drain to stop saltwater from intruding into the southern portions of the site (the SRA) are damaged. High tides also enter the site by overtopping the Creek levee between the Dunns Drain tidal flap and the Cobaki Broadwater. Tidal inundation has been a regular occurrence over the last twenty (20) years.

5.1.6 Mosquitoes

Within the SRA, the highly altered site conditions have created ideal breeding conditions for a variety of salt and freshwater mosquito species. These breeding habitats on the site are adding to an already serious mosquito problem in the Cobaki Broadwater area. The prevalence of *A. vigilax* (breeds in saline to brackish intertidal pools) is of particular concern as it is a known vector of Ross River Virus and Barmah Forest Virus.

Mosquitoes in well drained saline wetlands are principally found in the areas behind the mangrove communities, on what is called the 'high' marsh, where pools of water in mudflats or Saltmarsh vegetation are left by the highest tides (spring tides) of each month, or are filled by rainfall/runoff, and are not flushed by the daily tide movements during the weeks thereafter.

In wetlands that are not well drained, mosquitoes are also able to exploit impounded 'stagnant' pools retained within stands of mangroves, and other vegetation on the 'low' marsh, caused by siltation or other blockage of the normal tidal channels and thus not subject to the normal daily flushing.

The control of mosquito breeding on the Cobaki Lakes site is seen as a significant health imperative. The problem mosquito breeding areas occur within the low-lying saline and fresh-water ecosystems which have been created by past farming practices.

5.2 Potential Development Impacts on Saltmarsh Communities

The proposed development will, potentially, have detrimental impacts on the Saltmarsh communities both during and after construction. The Cobaki Parkway will cause a minor fragmentation of the Saltmarsh communities. The location of the road reserve is fixed by Tweed Council planning as a future four lane arterial road funded by the Section 94 Development Contribution Scheme.

Other direct impacts on the SRA may potentially occur as a result of the following activities:

- The construction and re-orientation of Sandy Lane;
- Construction and operation of tidal culverts;
- Construction of the Education centre (the proposed school will occur in an area comprised of Saltmarsh which is currently zoned for Recreation). This proposed location of the school is allowable under the present LEP subject to consent in accordance with Clause 8.2;
- The provision of storm water infrastructure; and
- The provision of buffers.

The property has been grazed by cattle since the early 1900's. Existing use rights occur over the subject site for routine agricultural activities including the construction and maintenance of drains, fencing and firebreaks as well as pasture improvement activities.

This rehabilitation plan will put into effect amelioration strategies and measures to reduce the following potential impacts, including:

- Road alignment and infilling for the road construction;
- Alteration of salinity and increased nutrient levels resulting from the discharge of stormwater;
- Pollution from road runoff;
- Damage from construction activities;
- Fire outbreak;
- Increased sedimentation;
- Inappropriate tidal regimes;
- Climate change (sea level rise);
- Degradation from trampling by cattle; and
- Elevated nutrient loads due to accumulation of cattle dung.

5.3 Proposed Amelioration Measures

5.3.1 Storm Water Management

A detailed Stormwater Management Plan for the proposed development has been prepared by Yeats Consulting Engineers. The Stormwater Management Plan (SMP) provides a conceptual model of the proposed Stormwater control methods.

Stormwater management will involve a series of stormwater control devices (treatment trains) that will allow for adequate treatment of the stormwater before it is released into the SRA for the final polishing before entering the adjacent Cobaki Creek and Cobaki Broadwater. Stormwater management within the proposed development will include treatments within the individual lots and broad-scale stormwater treatment devices such as constructed wetlands. The stormwater mitigation measures to be implemented in the development will include:

- Rainwater tanks;
- Infiltration systems;
- Porous paving;
- A series of constructed wetlands;
- Grassed filter strips;
- Vegetated swales;
- High-flow bypass; and
- Bio-retention trenches.

One of the main Stormwater control devices relative to the SRA will involve the construction of a tidal barrage toward the southern end of Sandy Lane. The barrage will allow treated stormwater to be released into the inter-tidal communities south of Sandy Lane. The treated low flows will drain towards the barrage and then flows will be directed along a swale/channel within the Sandy Lane and Cobaki Parkway road reserves. The low flows will then drain via the Cobaki Parkway bank of culverts through to Dunn's drain. Higher flows will overtop the swale/channel and disperse over the Saltmarsh community. The proposed Saltmarsh drainage plan is depicted in **FIGURE 9.**

OPEN SPACE

OPEN CHANNEL

PRECINCT 8

SANDY ROAD

BANK OF CULVERTS UNDER SANDY LANE

MAJOR FLOW OVERTOPS LOW FLOW CHANNEL

ENVIRONMENTAL RESERVE

COBAKI PARKWAY

CREEK

DUNN'S DRAIN ACCESS TRACK PASSING BAYS AT 100m INTERVALS.

DUNN'S DRAIN ACCESS TRACK TURN AROUND AREA

DRAINAGE RESERVE

ROAD / DRAINAGE RESERVE

SANDY ROAD

ROAD / DRAINAGE RESERVE

PRECINCT 9

BANK OF CULVERTS UNDER COBAKI PARKWWAY

ENVIRONMENTAL RESERVE

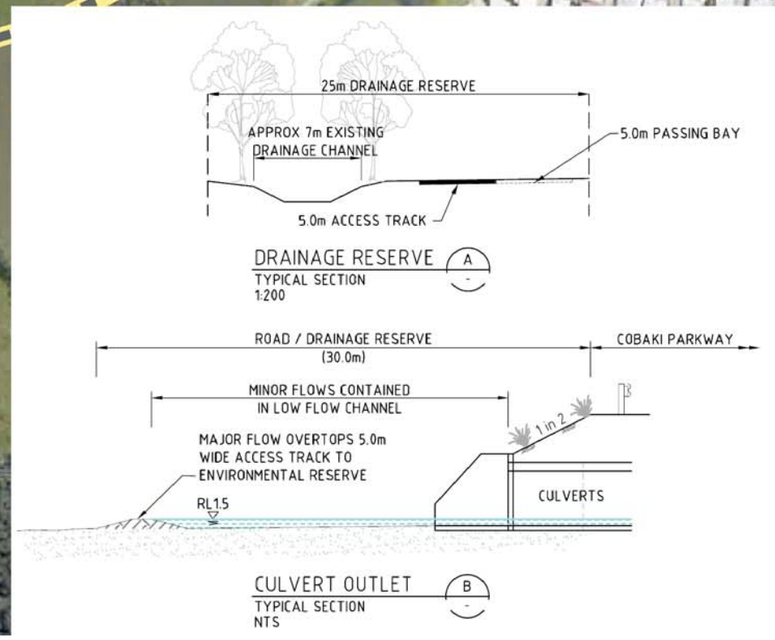
ROAD

COBAKI

PIGGABEEN ROAD

LEGEND

- ROAD / DRAINAGE RESERVE
- LOW FLOW DIRECTION
- MAJOR FLOW DIRECTION
- 5.0 PROPOSED SURFACE CONTOURS



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SOURCE: Yeats (Ref: YC0229-1P1-19_ DRAINAGE LAYOUT - COBAKI PARKWAY AND SANDY ROAD SOUTH -REV C-1.pdf)

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Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 9

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Drainage.cdr

TITLE

DRAINAGE LAYOUT

5.3.2 Mosquito Management

A Biting Midge and Mosquito Control Plan for the Cobaki Lakes site has been prepared by Mosquito Consulting Services Pty Ltd (McGinn 2008). This plan has been developed in consultation with JWA and Gilbert & Sutherland. Furthermore, the Stormwater Management Plan provides for the diffuse discharge of treated stormwater through the construction of under-drained swales with level-spreader devices.

The proposed Saltmarsh rehabilitation works include measures to promote tidal exchange through re-engineering existing levee and drainage systems and some regrading works. More details are provided in **SECTION 6.2.2.** By controlling, repairing and improving the surface water management within the rehabilitated areas, the mosquito and biting midge problem is controlled.

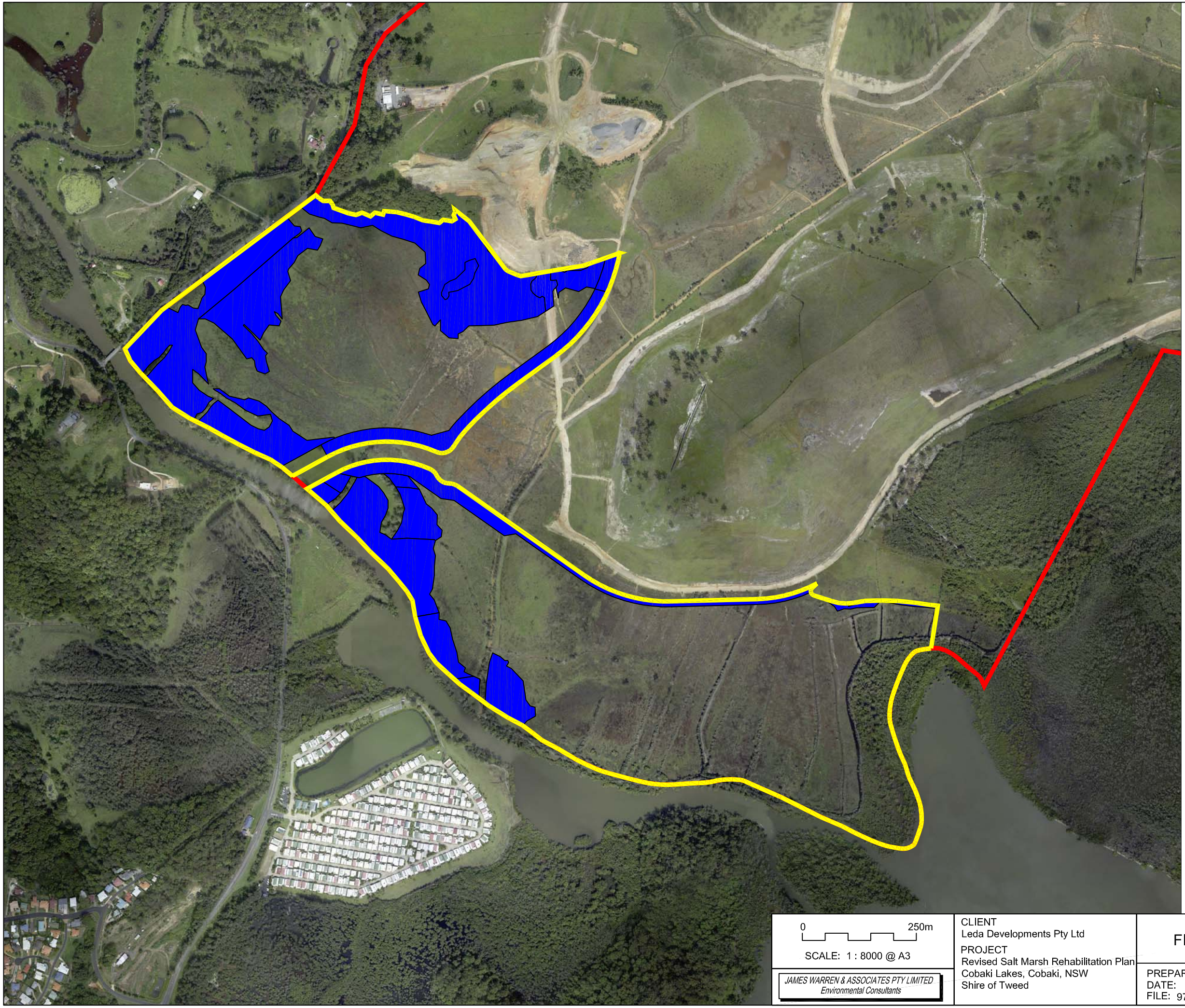
This Biting Midge and Mosquito Control Plan (McGinn 2008), in association with the Stormwater Management Plan, is considered to adequately address the potential issue of mosquito breeding within the SRA and has been prepared to address the requirements of Tweed Shire Council DCP 25. Furthermore, both plans have been prepared in consultation with JWA and take into consideration the long-term enhancement and protection of Saltmarsh communities on the subject site.

5.3.3 Compensation & Rehabilitation

The development proposes to mitigate potential impacts and compensate for any loss of Saltmarsh communities through the provision of offsets (**FIGURES 10 & 11**). Offsets for the removal of degraded Saltmarsh vegetation from the subject site will include the following:

1. Large areas adjacent to the existing Saltmarsh communities are currently comprised of a mixture of exotic grasses and will be restored to Saltmarsh communities in accordance with this Plan.
2. Re-establishment of saltmarsh species will be completed on the batters along the eastern edge of the Cobaki Parkway after construction is complete.
3. This Plan also includes the provision of retreat areas for Saltmarsh communities in the event of sea-level rise.
4. Removal of cattle from the area and subsequent relinquishment of existing use rights is considered an integral component of the rehabilitation process.
5. The entire area of the existing Saltmarsh which is to be retained (i.e. 44.53ha) will be rehabilitated in accordance with this Plan. This will essentially involve restoring a natural tidal regime to the area.
6. Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works.

Further to the regeneration of the retained 46.93ha Saltmarsh community, an additional 25.49 hectares of Saltmarsh vegetation will be revegetated on the subject site, in combination with Swamp oak revegetation works, to offset the loss of 10.25



LEGEND

- Proposed Revegetation Areas - Swamp Oak / Salt Marsh
- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Revegetation - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

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SCALE: 1 : 8000 @ A3

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Shire of Tweed

FIGURE 10

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DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

REVEGETATION AREAS

N

LEGEND

- Proposed Natural Regeneration Areas
- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Regeneration - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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FIGURE 11

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TITLE

REGENERATION AREAS

hectares. The proposed offsets listed above will result in a net gain of 15.24ha of this EEC on the subject site.

The Revised SRP also provides details of offsets for the removal of a small area of Swamp oak floodplain forest EEC from the subject site. The removal of approximately 0.95 hectares of the Swamp oak floodplain forest community from the subject site will be ameliorated by revegetating compensatory Swamp oak communities within the SRA. Areas within and adjacent to the existing Saltmarsh communities on the subject site are currently comprised of a mixture of exotic grasses and will be restored to Saltmarsh and Swamp oak communities in accordance with this Plan.

In total, 25.49 hectares of Swamp oak floodplain forest will be revegetated on the subject site, in combination with Saltmarsh revegetation works, to offset the loss of 0.95 hectares. The proposed offsets will result in a net gain of 24.54ha of this EEC on the subject site.

6 PROPOSED REHABILITATION

6.1 Aims and Objectives

6.1.1 Aims

The broad aim of this rehabilitation plan will be to restore native vegetation communities within the 90ha SRA. Several other aims and objectives for the rehabilitation of the Saltmarsh area include the following:

- Provide compensation for the removal of degraded Saltmarsh communities from the Cobaki Lakes development site;
- Provide compensation for the removal of small patches of Swamp-oak floodplain forest EEC;
- Establishment of healthy Saltmarsh, Mangrove and Swamp oak communities;
- Control of exotic weed species;
- Assist in improving the quality of stormwater entering Cobaki Creek and the Cobaki Broadwater;
- Provision of habitat for fauna;
- Reduce the impact of mosquitoes in the Cobaki Broadwater area; and
- Provide retreat opportunities for the Saltmarsh community as sea levels rise.

6.1.2 Objectives

The Department of Environment and Climate Change (DECC 2008) list the following recovery action measures that may aid in the rehabilitation of Saltmarsh communities. These actions have been adapted to the site in order to provide objectives that are to be assessed in the determination of the success or failure of this rehabilitation plan. The objectives of the plan are as follows:

- Rehabilitate and manage the Saltmarsh so as to assist in the reduction of mosquito breeding on the site;
- Protect areas of Saltmarsh from runoff that contains high levels of nutrients or pollutants;
- Maintain buffer zones of terrestrial vegetation (rehabilitated) adjacent to Saltmarsh to allow for retreat of Saltmarsh;
- Allow areas of Saltmarsh to regenerate naturally where possible;
- Protect from clearing and development through fencing, signage and active management;
- Minimise human disturbance by preventing access by recreational vehicles, including four wheel drives;
- Erect educational signs to provide information to visitors and residents of the importance of coastal Saltmarsh;
- Undertake weed control programs;
- Prohibit grazing and burning;

- Monitoring and subsequent control of tidal regimes to allow the required number of tides per year onto the Saltmarsh.

6.2 Rehabilitation methods

6.2.1 Introduction

The section discusses the rehabilitation methods that will be employed within the SRA to re-establish healthy and viable vegetation communities after the completion of the construction activities.

The rehabilitation methods to be used include:

- Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works;
- Control of invasive grasses and weeds;
- Erection of exclusion fencing;
- Revegetation of Swamp oak and other native species surrounding the Saltmarsh areas;
- Assisted natural regeneration where appropriate; and
- Transplanting patches of Saltmarsh where appropriate.

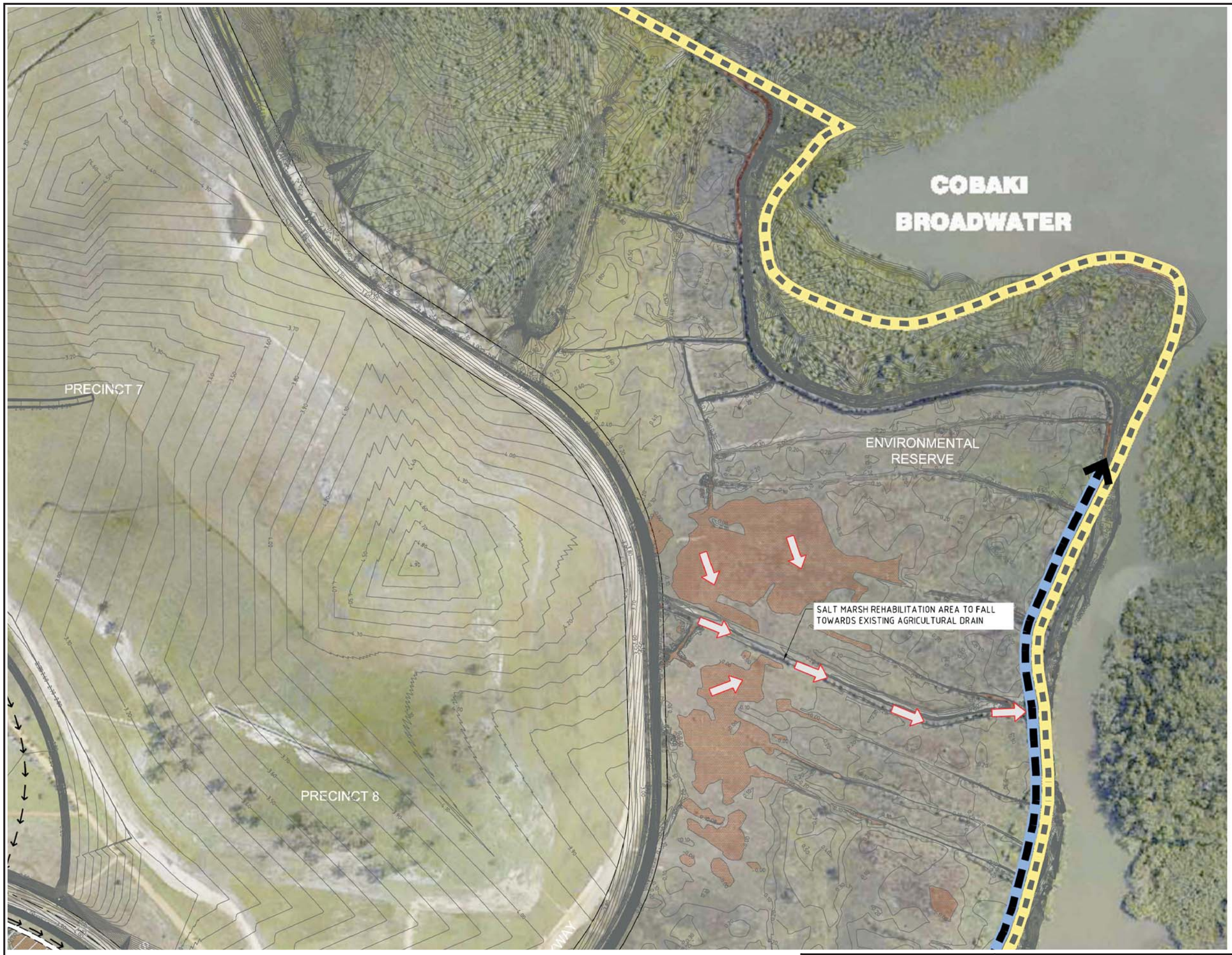
6.2.2 Tidal exchange

Historical farming activities have led to the clearance of the Paperbark, the construction of one (1) major drain (Dunn's Drain) and a number of smaller drains, and the placement of a tidal flap at the mouth of Dunn's Drain. Vandalism of the tidal flap and other breaches of the berm to the Cobaki Broadwater have allowed tidal water onto the site for over twenty (20) years. However, once tidal waters encroach into the low-lying areas of the site, large pools of standing water remain for extended periods of time. These areas of standing water are detrimental to Saltmarsh species and create ideal breeding conditions for a variety of salt and freshwater mosquito species.

To promote tidal exchange within the Saltmarsh communities on the site, the following measures are proposed (**FIGURES 12a & 12b**):

1. The existing levee north of Dunn's drain will be lowered to RL 0.3;
2. Tidal exchange between the Saltmarsh communities to the east and west of the proposed Cobaki Parkway will be maintained via a 10m wide channel (RL 0.3) and a bank of culverts; and
3. As the tidal exchange is to be regulated at RL 0.3, the Dunn's drain outlet and a proposed new outlet adjacent to a main agricultural drain (located approximately 400m north of Dunn's drain) will enable areas of ponded water below RL 0.3 to free drain.

There are also some filling and regrading works required within areas of the Saltmarsh community (**FIGURES 13a & 13b**):



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- SITE BOUNDARY
- OVERLAND FLOW DIRECTION
- 3.70 FINISHED CONTOURS
- LOWER EXISTING DREDGED BUND
- TREATED MINOR DEVELOPMENT FLOW DIRECTION

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

N

0 100m 200m

1 : 8000

SOURCE: Yeats (Ref: YC0229 - SK 114 SALT MARSH DRAINAGE PLAN - SHEET 1 OF 2.pdf)

SCALE: 1 : 8000 @ A3

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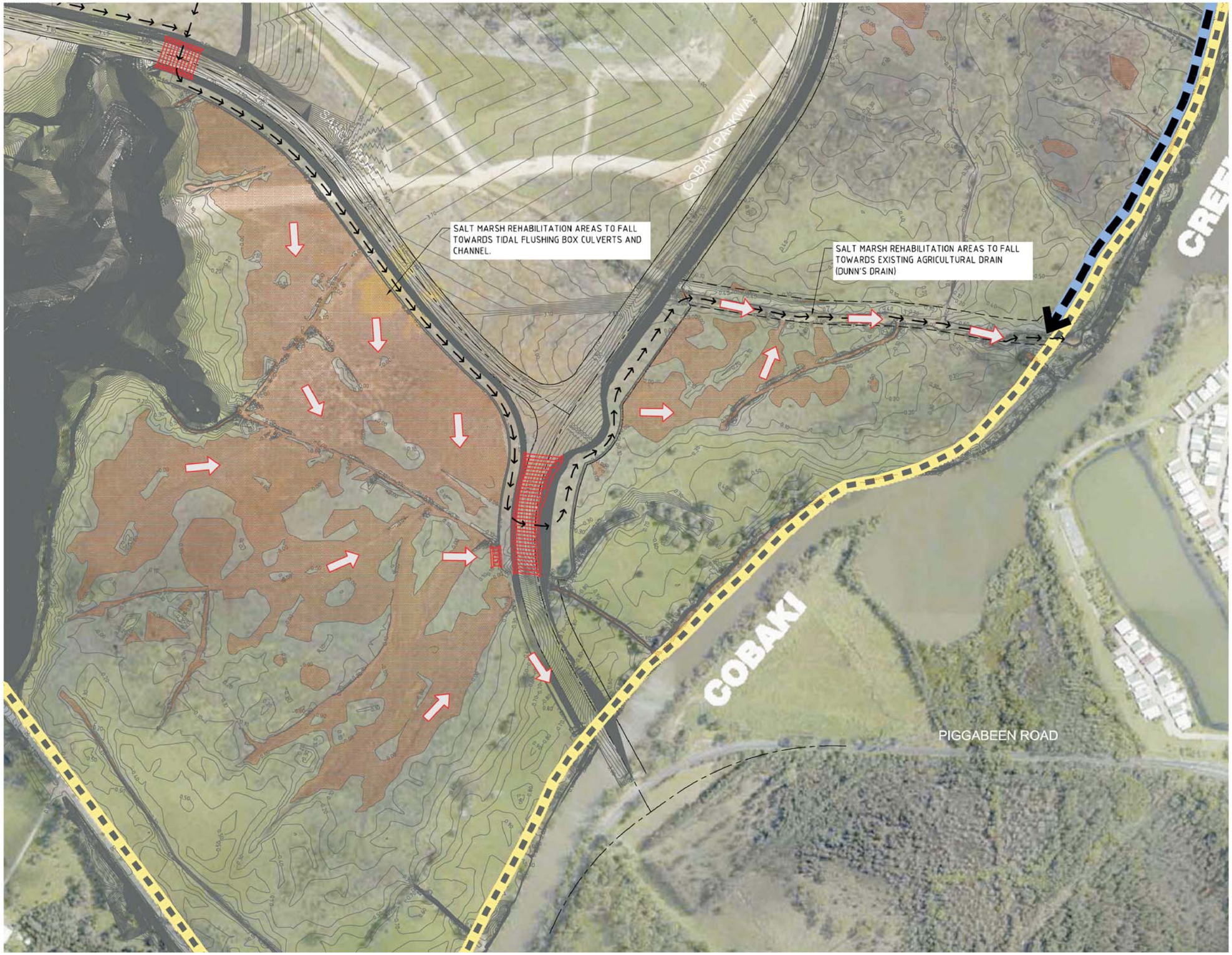
Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 12A

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Tidal.cdr

TITLE

TIDAL EXCHANGE MEASURES



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- SITE BOUNDARY
- OVERLAND FLOW DIRECTION
- 3.70 FINISHED CONTOURS
- LOWER EXISTING DREDGED BUND
- TREATED MINOR DEVELOPMENT FLOW DIRECTION

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
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- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

N

0 100m 200m

1 : 8000

SOURCE: Yeats (Ref: YC0229 - SK 115 SALT MARSH DRAINAGE PLAN - SHEET 2 OF 2.pdf)

SCALE: 1 : 8000 @ A3

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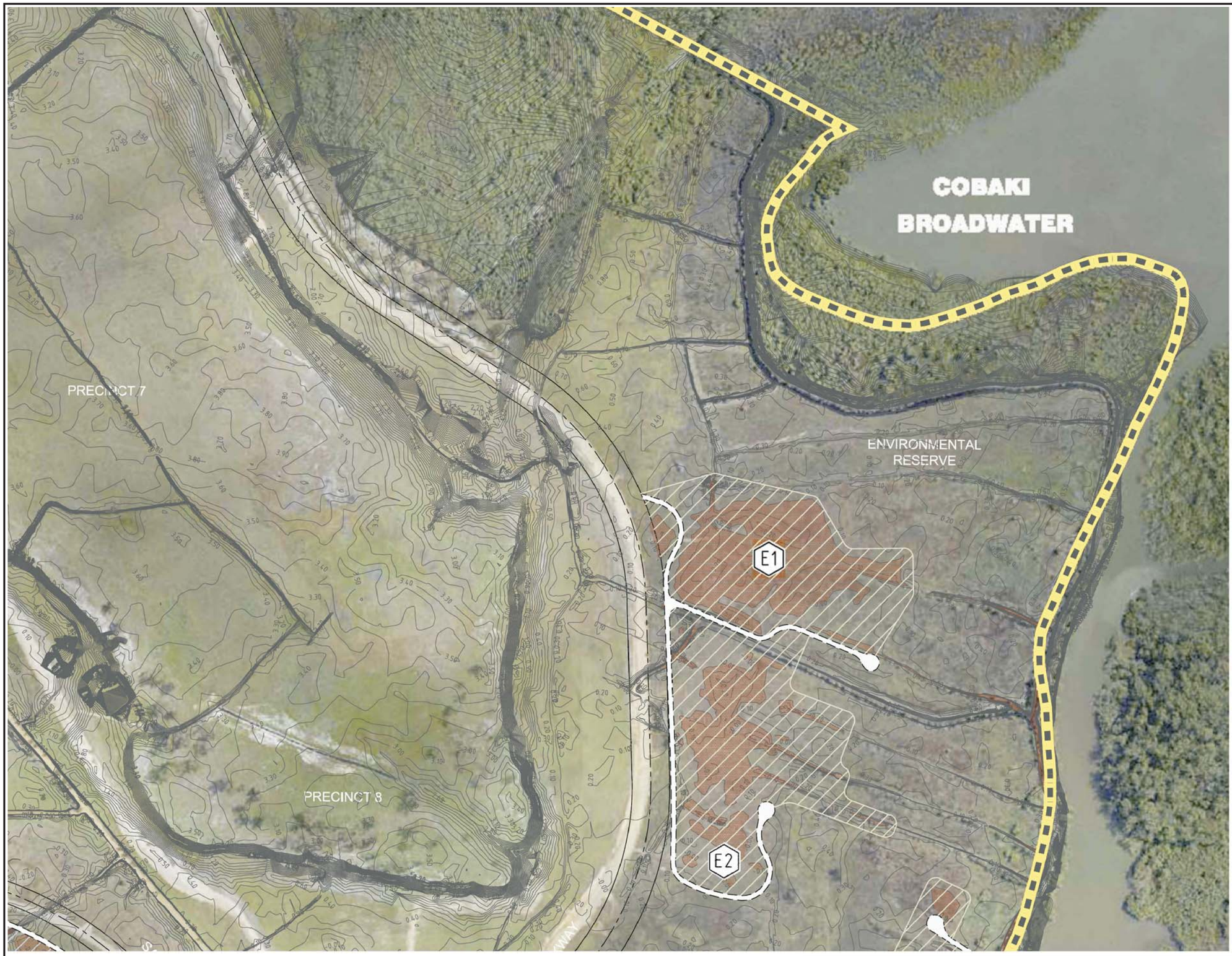
FIGURE 12B

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Tidal.cdr

TITLE

TIDAL EXCHANGE MEASURES



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- REHABILITATION STAGING
- TEMPORARY SALT MARSH REHABILITATION ACCESS TRACK
- SITE BOUNDARY
- 3.70 EXISTING CONTOURS

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

NOTE:
TEMPORARY ACCESS TRACK TO BE REMOVED AND RESTORED FOLLOWING REHABILITATION WORKS TO RL0.0m AHD.

N

0 50m 100m
1 : 4000

SOURCE: Yeats (Ref: YC0229 - SK 116 SALT MARSH REHABILITATION STAGING WORKS - SHEET 1 OF 2.pdf)
SCALE: 1 : 4000 @ A3

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FIGURE 13A

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Staging.cdr

TITLE
PROPOSED SALT MARSH REHABILITATION STAGING WORKS

LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- REHABILITATION STAGING
- TEMPORARY SALT MARSH REHABILITATION ACCESS TRACK
- SITE BOUNDARY
- 3.70 EXISTING CONTOURS

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

NOTE:
TEMPORARY ACCESS TRACK TO BE REMOVED AND RESTORED FOLLOWING REHABILITATION WORKS TO RL0.0m AHD.

N

0 50m 100m
1 : 4000

SOURCE: Yeats (Ref: YC0229 - SK 117 SALT MARSH REHABILITATION STAGING WORKS - SHEET 2 OF 2.pdf)
SCALE: 1 : 4000 @ A3

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FIGURE 13B

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Staging.cdr

TITLE
PROPOSED SALT MARSH REHABILITATION STAGING WORKS

1. Low-lying areas which currently hold pooled water will be filled to RL 0.0. These areas will need some minor profiling to ensure drainage; and
2. The majority of existing agricultural drains will be filled (with the exception of Dunn's drain and the drain approximately 400m north).

These works will be staged to minimise impacts on the Saltmarsh EEC (**FIGURES 13a & 13b**). Where filling is required and Saltmarsh vegetation is present, fill will be placed in a top-dressing fashion at depths of 50mm at a time. Once Saltmarsh vegetation has penetrated the sandy fill a further 50mm can be placed and so on until the desired level of fill is reach.

There are currently two (2) options being considered for completion of the filling works. One option is to pump a mixture of sand and water into the areas requiring fill. Another option is to transport the sand to the required sites using modified light-weight all terrain vehicles. Regardless of which option is utilised, temporary access tracks will be required and are shown in (**FIGURES 13a & 13b**).

6.2.3 Weed management

Currently, weed species are only a minor problem within the existing Saltmarsh area. Weed species present include:

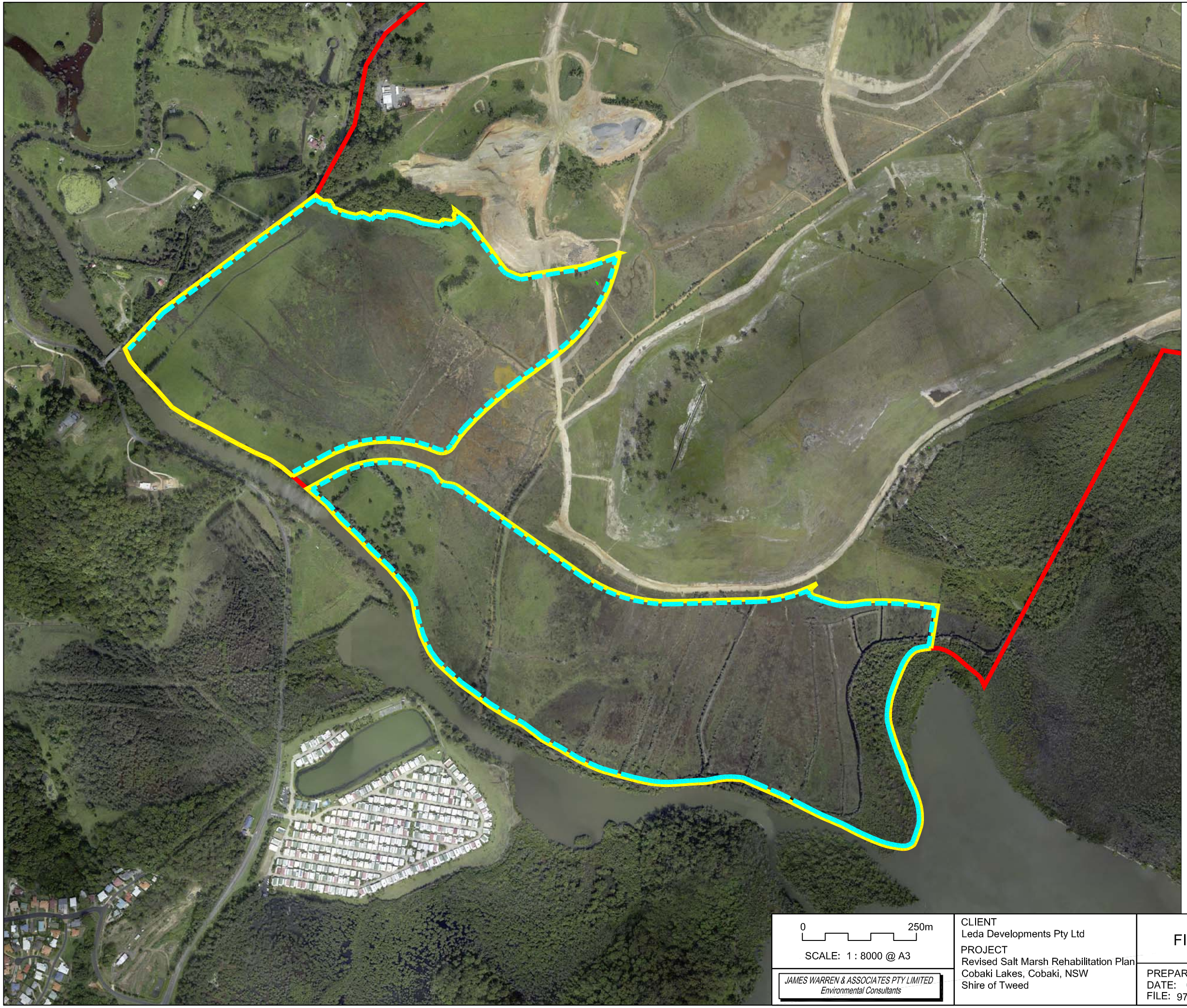
- Exotic Grasses;
- Groundsel bush;
- Coastal morning glory; and
- Other exotic herbs.

Weed control is to be completed by a suitably qualified Bush regenerator engaged via a tendering process. Monitoring and maintenance of weeds will be important components of the SRP and are discussed in Sections 7 & 8.

6.2.4 Access and exclusion

Exclusion of cattle and restrictions on human traffic are vital for the continued regeneration of the SRA. The following procedures are to be followed with regard to access to and exclusion from the SRA:

- The SRA will be fenced to exclude traffic and to clearly identify revegetation areas. The recommended fencing layout is shown in **FIGURE 14;**
- Fences must be erected upon the commencement of the enhancement planting works;
- The fencing will be fauna friendly and will consist of 1.2 m star pickets at 4 metre intervals and with three (3) strands of smooth galvanized wire. A top strand of barbed-wire should also be included to prevent access by cattle;
- A drainage reserve will be created over Dunn's drain as required by Tweed Shire Council to allow implementation of future maintenance rights over this drainage path. An indicative maintenance track with passing bays and a turnaround located along the northern side of Dunn's drain in shown in **FIGURE 9.** Vehicle access is to be strictly limited to maintenance vehicles;



N

LEGEND

- Proposed Fencing
- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Fencing - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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PROJECT
Revised Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 14

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

PROPOSED FENCING

- Any gates are to be locked and maintained/repaired if gates or fences are damaged;
- Signage is to be erected on exclusion fencing stating: "No Entry – Native Plant Revegetation Area". All contractors are to be made aware of restrictions applying to the exclusion zones;
- Buffer plantings are to be provided where appropriate (i.e. adjacent to Cobaki Parkway) and designed provide a screen of trees that will reduce human access;
- Public access into the Saltmarsh area is to be limited to designated pathways and/or boardwalks;
- Educational signage is to be provided which informs visitors and residents of the importance of Coastal Saltmarsh. The signage is to be displayed along the boardwalk;
- Only authorised personnel will be allowed within the Rehabilitation area; and
- No fires will be permitted within the SRA.

6.2.5 Assisted Natural Regeneration

Often maintenance of tidal flushing, removal of cattle or other activities which cause physical damage to soil, combined with the existence or creation of appropriate marsh morphology (i.e. elevation, slope, grade, substrate, etc.) will be enough to rapidly revegetate an area with native Saltmarsh communities (Sinicrope *et al* 1990).

It is considered that the most appropriate method to regenerate large areas of the SRA will be to use the principles of natural regeneration (**ANNEXURE 2**).

Natural regeneration refers to the natural process by which plants replace or re-establish themselves. Cremer (1990) defines "natural regeneration as "*reproduction from self-sown seeds of by vegetative recovery*". Temple and Bungey (1980) define it as "*regrowth which occurs naturally after stress or disturbance. It may be grown from seed of both pioneer and permanent species*".

Natural regeneration ensures that plants established on a site are from parents that currently occupy the site. Natural regeneration is a powerful tool to be used to re-establish native vegetation which is capable of with-standing the long term condition variations and should do well, once established.

Within the SRA a diversity of native species have been observed to be naturally regenerating, including:

- Salt couch (*Sporobolus virginicus)*
- Streaked arrow grass *(Triglochin striata)*
- Swamp oak (*Casuarina glauca)*
- Tuckeroo (*Cupaniopsis anacardioides)*
- Twig rush *(Baumea juncea)*
- Salt rush *(Juncus kraussii)*
- Samphire *(Sarcocornia quinqueflora)*

It is considered that with regular weed control and re-introduction of the appropriate tidal regime, natural regeneration will continue to occur. The methods that are to be used to encourage the natural regeneration process will include:

- Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works;
- Erection of fences and regular maintenance of the fencing;
- Primary weed control to be completed by a qualified bush regenerator;
- Regular maintenance & weed control;
- Monitoring and regular reporting; and
- Adaptive management.

Several areas within the SRA have been identified as suitable areas for utilising natural regeneration techniques. The areas designated for natural regeneration are shown in **FIGURE 11.**

6.2.6 Revegetation/Compensatory Plantings

6.2.6.1 Introduction

This section discusses the revegetation/compensatory plantings, including a rationale, a species selection and the planting methodology.

6.2.6.2 Rationale for plantings

Within the SRA several patches of Swamp oak forest/woodland currently occur. It is considered appropriate to embellish some of the areas surrounding the Saltmarsh community through compensatory plantings (**FIGURE 10**). Some of the benefits of the enhancement plantings will include the following:

- Buffer functions;
- Provision of habitat for fauna;
- Provision of wildlife corridors;
- Protection of areas of Saltmarsh from runoff that contain high levels of nutrients or pollutants; and
- Maintenance of buffer zones of terrestrial vegetation adjacent to Saltmarsh to allow for the gradual retreat of Saltmarsh in the event of sea-level rise.

6.2.6.3 Species selection

It is considered that revegetation is required for the areas currently dominated by exotic pasture grasses. As tidal exchange within the SRA is proposed to be significantly improved through re-engineering and regrading works, all areas currently dominated by exotic grasses within the SRA are considered to be suitable for planting Saltmarsh and/or Swamp oak communities. These areas will provide retreat areas for Saltmarsh communities in the event of future sea-level rise.

Species to be utilised in revegetation areas within the SRA are listed in **TABLE 2.**

TABLE 2
SUGGESTED SPECIES FOR REVEGETATION AREAS WITHIN THE SRA

Botanical Name	Common Name
Trees	
Casuarina glauca	Swamp oak
Shrubs/small trees	
Hibiscus tiliaceus	Cottonwood
Cupaniopsis anacardioides	Tuckeroo
Glochidion ferdinandi	Cheese tree
Breynia oblongifolia	Coffee bush
Groundcovers	
Baumea juncea	Bare twig-rush
Crinum pedunculatum	Swamp lilly
Entolasia marginata	Wiry panic
Juncus kraussii	Salt rush
Sarcocornia quinqueflora	Samphire
Sporobolus virginicus	Salt couch
Triglochin striata	Streaked arrowgrass
Isolepis inundata	Swamp club rush
Isolepis nodosa	Nodding club rush

6.2.6.4 Planting methodology

The bush regeneration contractor is to adhere to the following methods for the completion of the revegetation plantings:

- All plantings are to be completed by a qualified bush regenerator.
- Existing native trees should be retained wherever possible as the root zones of these trees are already established. This diversity of planting should also allow for some assisted natural regeneration where appropriate.
- Planting is recommended between February and June when rainfall is most likely and weather conditions most favourable. Initial efforts should focus on site preparation.
- All species selected for planting should be sourced locally where possible and sun hardened.
- The preparation will consist of the spraying of grasses and weeds with a suitable herbicide (e.g. Roundup biactive©). Areas selected for planting should be prepared two (2) weeks before planting is to occur to allow for dieback of any grasses or weeds before planting.
- All trees should be well watered, fertilised and heavily mulched with organic material sourced from on-site. If conditions at the time of planting are particularly dry, the use of water crystals is recommended.
- Any plantings that fail will be replaced.
- Planting methods (including material adapted from Greening Australia 2001) are summarised in **TABLE 3**.

TABLE 3
A GUIDE TO PLANTING

Selecting plant stock
Plants to be used should be acquired from a nursery that propagates plants using locally sourced seeds and cuttings (i.e. from within 10-20 km of the Subject site). Stock should be fully sun hardened and not planted direct from a shade house. Tube stock is the best as it is a cost effective plant container size, light in weight and easy to handle. Plants should have a strong stem and not be root bound or have yellowing or discoloured leaves.
Site preparation
Trees should be planted at 2 metre centres (for rainforest trees). Glyphosate (Roundup) is generally used as a "knockdown" non-residual herbicide. Where grass cover is established on the area to be planted, Glyphosate should be sprayed at planting centres to kill grass in a 60cm diameter circle. Plants can be planted without the need for Glyphosate if they are regularly hand-weeded until established, although this is recommended only for small-scale plantings.
Planting
Planting should begin when the weeds and grass cover have died (about 3 weeks). Dead grass and weeds should be trimmed to ground level. Holes should be dug in the centre of each circle at least 10 cm deeper than the tree container and twice as wide. The soil at the base and sides of the hole should be loose to allow root penetration. Plants should be watered well before planting to ensure a moist root ball.
A generous amount of water should be placed into each hole before planting (2-4 litres if the soil is dry), as losses are reduced by planting into a moist root zone. The plant should be tapped out of its container and any pot bound or circular roots loosened. Roots should be pruned if they are very bound up. The plant should be put in the hole with the water and fertiliser and filled in with loose crumbly soil. The tree should be firmed in well with the hands. This is very important for settling the tree roots in, and to provide a stress free start for each plant.
A slow release fertiliser (e.g. Osmocote/Nutricote, or plant fertiliser pills) should be incorporated into each planting hole and mixed well with the back filled soil, so that the roots are not in direct contact with concentrated fertiliser. Banksias should not be fertilised unless specific fertiliser is available.
Straw or hay should be used for mulching the whole planting area. Mulch should be laid right up to the stem, but should be “fluffed up” rather than laid in heavy slabs.
Maintenance of the planting
Weeds should be controlled in the planting area until canopy cover is established (approximately three (3) years). Weed control should be carried out by suitably experienced persons. Weed control is essential for strong healthy growth as grass and weeds compete for nutrients, water and light.
Weeds should be controlled on a regular basis. Three or four visits a year should be adequate for weed control.
Re-fertilising and re-mulching is recommended in the second growth season.

7 MAINTENANCE PROGRAM

7.1 Introduction

Maintenance or follow up works are vital for the continuing rehabilitation of the SRA. This section discusses the maintenance requirements as well the timing of the maintenance visits, and the personnel responsible for the implementation of this maintenance plan.

7.2 Maintenance requirements

7.2.1 Background

Maintenance within the SRA is to be completed by a suitably qualified bush regenerator and/or fencing contractor, employed by the landowner. Maintenance will occur within two (2) discrete areas i.e.:

- Revegetation/compensatory planting areas; and
- Natural regeneration areas.

7.2.2 Revegetation/Compensatory Planting Areas

Maintenance within the revegetation areas is to be completed by an experienced Bush Regeneration company and will include:

- Control of invasive weeds and grasses;
- Ensuring adequate soil nutrient levels within revegetation zones through periodic fertilising;
- Ensuring adequate soil moisture levels within revegetation zones through irrigation during times of prolonged drought;
- Repairing exclusion fencing when required;
- Pruning and thinning to allow for optimal growth and form;
- Staking or propping–up of trees which have fallen or developed a permanent lean;
- Replacing any dead plants;
- Re-mulching and re-fertilising of the revegetation plantings is recommended after the first year.

Continued maintenance after canopy closure will be required only once every six (6) months, and will include:

- Pruning and thinning to allow for optimal growth and form;
- Control of invasive weeds and grasses; and
- Repairing or removing fencing when required.

Regular maintenance will be completed by the regeneration team. Once canopy closure has been achieved the period of time between maintenance visits will increase.

7.2.3 Natural Regeneration Areas

Maintenance of the natural regeneration areas is likely to involve spraying of invasive grasses and other exotic species.

Continued monitoring will ensure that adaptive management techniques are used in the natural regeneration areas. Some of the adaptive management techniques that may be employed include the following:

- Replacement areas of Saltmarsh community using tiles removed from the local Saltmarsh areas which are to be lost;
- Potential planting of Saltmarsh species within areas which have failed to colonise;
- Reconfiguration of the tidal gates to allow for a more appropriate tidal regime; and
- Various other adaptive management techniques that will need to be implemented in the case of sea level rise.

7.3 Timing of Maintenance

After primary weeding and revegetation works, regular follow up maintenance will be required within the regeneration and revegetation areas. The Contracted Bush Regeneration Team will be required to complete regular maintenance of the natural regeneration & revegetation areas (i.e. once every three (3) months) until:

- Canopy closure has been achieved within the revegetation areas; or
- Saltmarsh or another appropriate vegetation community has adequately colonised within the natural regeneration areas.

This is expected to take between two (2) – three (3) years.

After canopy closure or substantial biomass increases of plantings in the natural regeneration areas has been achieved, the removal of weed re-growth and other general maintenance tasks will only be completed every six (6) months for the duration of the five (5) year project.

7.4 Adaptive management

The principles of adaptive management have been incorporated into the administration of restoration projects within a variety of governmental funding authorities and programs (Thom 1997). Comprehensive, long-term monitoring is a component of adaptive management, which relies on the accumulation of evidence (via long-term monitoring) to support a decision that demands action. If established early in the project planning phase and implemented during successive monitoring and management phases, adaptive management can be a powerful method to systematically assess and improve the performance of restored ecosystems (Thom 2000).

Examples of some potential adaptive management actions that may be required in the future include:

- Areas of natural regenerating Saltmarsh might reveal encroachment by Phragmites or other invasive plant species.
- Monitoring of tidal and/or Stormwater devices may reveal deficiencies in the design of a culvert or water control structure, which may result in insufficient drainage.
- Manual harvesting or chemical control may be periodically required to control the spread of invasive plants.
- The specific design features of a culvert or water control structure may require enhancement or modification during successive years to optimize tidal flow patterns

Before the implementation of any Adaptive management strategies a report is to be provided to the Tweed Shire Council detailing the proposed management actions and the predicted outcomes from such management practices.

8 MONITORING PROGRAM

8.1 Introduction

A well-designed restoration monitoring program will allow project managers to detect results months, years, or decades following implementation of a plan. This section outlines the monitoring for the Cobaki Lakes Saltmarsh Rehabilitation Area and will include a description of the general monitoring of the naturally regenerating Saltmarsh areas and the Revegetation areas.

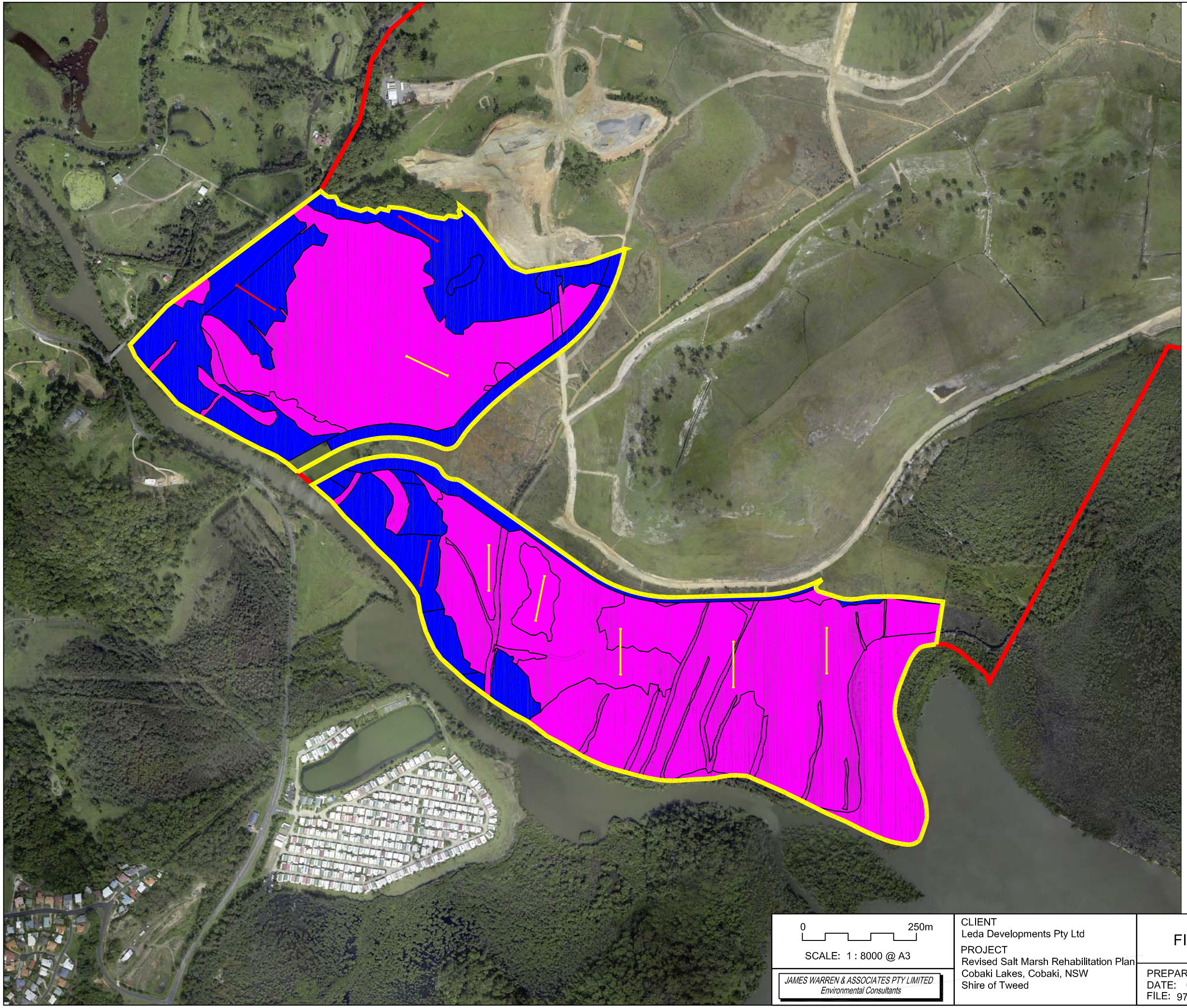
Long term monitoring of the overall vegetation communities within the SRA is to be completed using aerial photography and ground truthing of the vegetation composition. A plan for the long term monitoring is also included in this section. Monitoring data can be used by project managers to demonstrate the ability of the project to meet stated goals and objectives.

8.2 Monitoring of Saltmarsh Natural Regeneration Areas

The monitoring of natural regeneration areas will include regular monitoring by a qualified ecologist who is to complete the following:

- **Transects**
  - Six (6) transects are to be evenly placed across the Saltmarsh;
  - Transect locations are to be permanently marked (**FIGURE 15**);
  - Transects are to be 100 metres in length;
  - During monitoring visits tape measures are to be placed on the ground and the specific measureable features recorded along the transects. The zero distance is to be placed at the marker that is most near the development site;
  - Specific measurable features include:
    - Areas of vegetation cover (Saltmarsh species);
    - Areas of vegetation cover (other native species);
    - Areas of weed cover;
    - Areas of salt pans/bare ground/mud;
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
  - Five (5) Quadrats ($1m^2$) are to be placed along each of the transects;
  - Quadrats must be placed 20m apart along the length of the transect ;
  - Quadrats are to be placed semi randomly within five (5) meters of the transect line;
  - The boundary of the quadrat with respect to the tape measure (e.g. between 3.5 – 4.5 metres on tape measure) will be recorded;
  - For each quadrat the following specific measurable features will be recorded:
    - Plant species occurring
    - Percentage cover



N

LEGEND

- Monitoring Transects - Revegetation Areas (100m Transects)
- Monitoring Transects - Natural Regeneration Areas (100m Transects)
- Proposed Revegetation Areas - Swamp Oak / Salt Marsh
- Proposed Natural Regeneration Areas
- Salt Marsh Rehabilitation Area Boundary
- Cobaki Lakes Site Outline

SOURCE:
Transects - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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FIGURE 15

PREPARED: BW
DATE: 06 October 2010
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TITLE

MONITORING TRANSECTS

        - Height
        - Relative abundance of Saltmarsh species
        - Weed cover
    - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
    - The transect markers which occur closest to Cobaki Creek are to be used as permanent photo stations for photographic monitoring;
    - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;
    - Photos should be taken at low tide;
    - Photos should be labelled with the:
        - Transect code
        - Direction of view
        - The date & time
        - The tide
    - Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

8.3 Monitoring of Revegetation areas

The monitoring or revegetation areas is to be completed at the same time as the Saltmarsh natural regeneration areas. The monitoring will be completed by a suitably qualified ecologist who is to complete the following:

- **Transects**
    - Three (3) transects are to be evenly placed across the revegetation areas;
    - Transect locations are to be permanently marked (**FIGURE 15**);
    - Transects are to be 50 metres in length;
    - During monitoring visits the transects are to be walked and specific measurable features recorded along the length of the transect. The zero distance is to be placed at the marker that is most near the development site;
    - Specific measurable features include:
        - Areas of vegetation cover (revegetation species);
        - Areas of vegetation cover (other species);
        - Areas of weed cover;
        - Areas of deceased plants/bare ground/mud;
    - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
    - Three (3) Quadrats ($5m^2$) are to be placed along each of the transects;
    - Quadrats must be placed 10m apart along the length of the transect
    - Quadrats are to be placed semi randomly within five (5) meters of the transect line;

  - For each quadrat the following specific measurable features will be recorded:
    - Plant species and number occurring
    - Percentage cover
    - Canopy height
    - Weed cover
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
  - The transect markers which occur closest to Cobaki Creek are to be used as permanent photo stations for photographic monitoring;
  - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;
  - Photos should be labelled with the:
    - Transect code,
    - Direction of view
    - The date & time
    - The tide
  - Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

8.4 Timing of monitoring visits

The monitoring is to be completed by a suitably qualified ecologist. Site visits should occur:

- Six (6) weeks after primary weeding;
- Six (6) weeks after initial plant-out;
- Every three (3) months thereafter until plants are sufficiently established (i.e. between two (2) - three (3) years)
- Every six (6) months after establishment until project is completed.

8.5 Reporting of Monitoring Results

Following each inspection by the qualified ecologist, a report will be prepared that will include tables and photographs from the monitoring visits. At the end of each year a detailed report will be prepared for the Department of Environment and Climate Change (DECC) and Tweed Shire Council. The report will discuss the following:

- Works undertaken;
- Progress of regeneration/revegetation areas using photos and tables showing the results of the monitoring visits;
- Significant problems encountered (death of seedlings, broken fences, vandalism etc.) and the effect of these on the plantings and aims of the revegetation or regeneration strategy;

- Success or failures of measures implemented to rectify previously identified problems; and
- Measures to be taken to rectify new problems.

8.6 Long term Monitoring

Along with the regular monitoring within the revegetation and regeneration areas, the overall vegetation composition within the SRA is to be regularly assessed and recorded. Long term monitoring will use both aerial photos and yearly assessments (ground truthing) of the vegetation communities using a hand held GPS.

The Long term monitoring of the vegetation composition with the SRA will include:

- A detailed vegetation map at a scale of 1:5,000 is to be completed within the SRA every twelve (12) months;
- Each year, after completion of vegetation mapping, a report is to be completed showing the changes in the composition of the vegetation communities within he SRA. The results are to be shown in a table that shows the vegetation community and the area of the vegetation community as a percentage of the SRA.

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ANNEXURE 1

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions - Endangered Ecological Community listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.
The Scientific Committee has found that:

1. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Coastal saltmarsh has been recorded from sites along the NSW coast. (NSW North Coast, Sydney Basin and South East Corner Bioregions).
2. Characteristic vascular plant species of Coastal Saltmarsh are:

Baumea juncea	*Isolepis nodosa*
Juncus kraussii	*Samolus repens*
Sarcocornia quinqueflora	*Selliera radicans*
Sporobolus virginicus	*Suaeda australis*
Triglochin striata	*Zoysia macrantha*

The total list of species is larger, with many species present in low abundance or at few sites. A more extensive list of species is provided by Adam et al. (1988). The sediment surface may support a diversity of both micro-algae and macro-algae.

3. Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam et al. 1988). These headland communities and those of inland saline areas are not included within this Determination of the Coastal Saltmarsh Ecological Community.

4. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions provide habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004)

5. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands. Occasional

scattered mature Avicennia marina trees occur through saltmarsh at some sites, and Avicennia (and less frequently Aegiceras corniculatum) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (Phragmites australis, Bulboschoenus spp., Schoenoplectus spp., Typha spp.) may occur as part of the community.

6. West et al. (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 hectares distributed in fragmented patches mostly less than 100 hectares. Since this estimate, further reduction and fragmentation have occurred.

7. Species composition within Coastal Saltmarsh varies with elevation. Sarcocornia quinqueflora dominates at lower, and hence more frequently flooded, levels than Sporobolus virginicus which dominates the mid saltmarsh, while Juncus kraussii and Baumea juncea are upper saltmarsh species. There is also geographic variation, with much more extensive stands of Sporobolus virginicus being found in northern NSW, and conversely more extensive Sarcocornia quinqueflora stands in the south. Coastal Saltmarsh in southern NSW is generally more species rich than further north, with Austrostipa stipoides, Gahnia filum, Limonium australe and Sclerostegia arbuscula forming a characteristic southern suite of species. A number of other species with restricted distribution in Coastal Saltmarsh include Distichlis distichophylla (endangered), Halosarcia pergranulata subsp. pergranulata, Wilsonia backhousei (vulnerable) and Wilsonia rotundifolia (endangered).

8. Saltmarshes are globally threatened, and many of the threatening processes identified by Adam (2002) operate in NSW including infilling, modified tidal flow, weed invasion, damage by domestic and feral animals, human disturbance, altered fire regimes and climate change.

9. Historically, substantial areas of saltmarsh have been infilled for roads and aerodromes and for residential, recreational, waste disposal, industrial and agricultural purposes. With increased recognition of the ecological value of saltmarshes, the threat of further large-scale reclamation is less, but smaller scale infilling still occurs (Harty and Cheng 2003).

10. Patterns of tidal flow have been restricted by artificial structures in many NSW saltmarshes (Williams and Watford 1997), while discharge of stormwater alters salinity regimes, increases nutrient levels and facilitates the spread of Phragmites and weeds.

11. In recent decades there has been widespread invasion of saltmarsh in southeast Australia by mangroves (Mitchell and Adam 1989, Saintilan and Williams 1999, 2000). The factors driving mangrove invasion are still unclear. The mangrove invasion limits the use of saltmarshes by birds that would normally make use of this habitat and has been a factor in their decline (Saintilan 2003, Straw 1999, 2000).

12. A large number of weed species occur in NSW saltmarshes (Adam 1981, Adam et al. 1988). In terms of change to the community structure and function, the most serious weed is Juncus acutus; other major weeds include Baccharis halimifolia, Cortaderia selloana and Hydrocotyle bonariensis. The upper saltmarsh zone may be dominated by introduced annuals or shortlived perennials, including Parapholis incurva, Plantago coronopus and Polypogon monspeliensis.

13. Damage to saltmarshes by recreational vehicles, including four wheel drives, is widespread, and deep wheel ruts persist for many years even after exclusion of vehicles. Use of BMX and mountain bikes is increasing, and even saltmarshes within conservation reserves have been seriously damaged (Adam 2002).

14. Grazing and trampling by domestic stock and feral herbivores occurs at a number of sites. Stock grazing has been shown to substantially change the vegetation composition and structure (Adam 1990), while on muddy substrates trampling can cause loss of plant cover and modify drainage patterns.

15. Saltmarshes have frequently been used for casual rubbish dumping and are at risk from waterborne pollution - including oil and chemical spills, both from shipping and road accidents, and catchment runoff of nutrients and agricultural chemicals.
16. Upper saltmarsh stands dominated by Juncus kraussii and Baumea juncea have high flammable fuel loads. While the natural incidence of fire in saltmarshes is likely to have been low, a number of saltmarshes have been burnt in recent years. The recovery of these sites is relatively slow and the long-term impacts of burning are uncertain.

17. Global warming and increased relative sea level are likely to pose an increasing threat to the survival of many areas of Coastal Saltmarsh (Adam 2002, Hughes 2003).

18. Coastal Saltmarsh occurs in a number of conservation reserves including the Ramsar listed sites at Towra Point and Kooragang Island Nature Reserves. Reserve status, however, does not confer protection from mangrove and weed invasion, recreational vehicles, pollution, fire or sea level rise without active management.

19. In view of the above the Scientific Committee is of the opinion that the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

Dr Lesley Hughes
Deputy Chairperson
Scientific Committee

Proposed Gazettal date: 04/06/04
Exhibition period: 04/06/04 - 16/07/04

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ANNEXURE 2

Ecological Restoration Principles

Ecological restoration aims to restore pre-existing indigenous ecosystems and ecological processes on disturbed sites, maintaining and developing the natural ecosystem to self perpetuate (Perkins 1992). Perkins (1992) put forward a restoration continuum spanning from assisted natural regeneration, the least interventionist, to reconstruction (of original communities on cleared sites) and fabrication (of new communities on changed sites). These activities are undertaken in different circumstances in the field, but the boundaries are blurred, allowing practitioners to consider sites on an individual basis, according to the level of disturbance and the restoration potential identified in the site. The aim of ecological restoration is to restore to the highest practicable extent, and to develop a system that is sustainable in the long term.

In disturbed areas that cannot solely rely on natural regeneration potential, revegetation can be undertaken to reconstruct the original forested communities. Cleared sites can be replanted with species grown from seed collected in nearby local native vegetation. The use of seed of local provenance (origin) is a key principle underpinning the integrity of the work, and avoids possible genetic pollution of local woodland when future pollen exchange takes place between remnant and replanted woodland.

Unfortunately the suite of species that is available is often narrow, determined by practicalities of seed collection, the ability to propagate in a nursery and limits on field establishment in the environmental conditions prevailing on cleared land. Conceptually, this is merely establishing a framework into which additional plant and animal diversity can recruit or be reintroduced once the environment is modified (Perkins 1992).

Cleared sites are seldom completely devoid of native species. It is common to observe paddocks supporting threads of the original ground cover vegetation. This is often apparent in paddocks historically sown with exotic grasses to improve pasture. While the introduced grasses are usually dominant, a surprising diversity of native grasses and groundcovers can often persist. They have remained through a history of sustained grazing and are by definition adapted to grazing. The act of excluding livestock or other management activities can threaten native diversity, as biomass from the introduced grasses smothers these plants. Alternative biomass reduction can be achieved with slashing and fire however these have different effects and their own practical limitations.

Total groundcover biomass is reduced under a developing canopy, a phenomenon also evident in re-growing forest communities. The vigour of exotic grasses is greatly diminished and some are unable to grow, leaving room for native plants that are adapted to the woodland ecosystem. Of course some native plants lose vigour in the forest canopy as well. Revegetation is thus forming an important mechanism for grassland manipulation and as a tool for creating a variety of niches in the ground layer. At the same time, revegetation is achieving the obvious objectives of increasing habitat values, restoring normal hydrology and increasing the range of species available

to recover in a site after disturbance. Revegetation needs to be used in combination with other techniques, and these processes will need to be studied in detail before they can be conclusively described as positive.

The mechanism of planting is likely to be a most important strategy in revegetation of the site, not as an end in itself, but as an important tool to ameliorate changed sites and release ecosystem resilience. While prolonged monitoring needs to be maintained in revegetation areas, there are indications that environmental conditions within the site will change in interesting ways as revegetation develops.

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